TCP/IP Network Administration Guide

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Preface

TCP/IP Network Administration Guide explains how to set up, maintain, and ultimately expand a network running the Solaris implementation of the TCP/IP protocol suite. The manual:

- Defines networking concepts used when working with TCP/IP
- Describes tasks necessary for setting up a new network
- Presents information for maintaining the network
- Explains how to expand the existing network by using routers to create an internetwork
- Describes how to use Point-to-Point Protocol (PPP) to allow remote machines to connect to the network
- Explains how to set up communications with remote machines via the UNIX-to-UNIX Copy Program (UUCP)

Who Should Use This Book

TCP/IP Network Administration Guide contains information for network administrators with a wide range of experience. The text assumes that you are already familiar with the Solaris™ environment and have administered local machines and peripheral devices such as modems.

If you are setting up a new network, read *TCP/IP Network Administration Guide* before going on to the other books in the *Solaris 2.4 System Administrator AnswerBook*. If you are administering or expanding an existing network, refer to the specific chapters related to the tasks that you want to perform.

Note – If you need to set up a brand new network at a site that has never had a Solaris or other UNIX-based network, read Chapter 3, "Planning Your Network," before installing the Solaris software. This chapter provides important information that supplements the installation tasks in *SPARC: Installing Solaris Software*.

You do not have to read the chapters in sequence, but each chapter assumes that you are familiar with the contents of previous chapter.

Before You Read This Book

You should know the information contained in the following books before continuing with the *TCP/IP Network Administration Guide*:

- *SPARC: Installing Solaris Software*
- *x86: Installing Solaris Software*
- *Solaris Advanced User's Guide*
- *User Accounts, Printers, and Mail Administration*
- *Common Administration Tasks*
- *Peripherals Administration*

How This Book Is Organized

TCP/IP Network Administration Guide contains the following chapters.

Chapter 1, "Overview of Network Administration," describes the tasks a network administrator is likely to perform and introduces basic networking concepts.

Chapter 2, "TCP/IP Protocol Suite," introduces the protocols composing the TCP/IP protocol suite.

Chapter 3, "Planning Your Network," presents the issues that you need to consider when designing a new network, such as Internet Protocol (IP) addressing, network topology, and so forth.

Chapter 4, "Configuring TCP/IP on the Network," contains procedures for setting up the machines on the new network.

Chapter 5, "Configuring Routers," explains how to expand the network through use of routers.

Chapter 6, "Troubleshooting TCP/IP," explains how to use the tools available for diagnosing and fixing TCP/IP-related problems.

Chapter 7, "Understanding PPP," introduces the PPP data link protocol that enables you to expand a network through use of modems and phone lines.

Chapter 8, "Preparing Your PPP Configuration," explains issues that you need to consider when designing a particular PPP configuration.

Chapter 9, "Configuring PPP," contains procedures for configuring two basic types of PPP links.

Chapter 10, "Troubleshooting PPP," explains how to diagnose and fix problems related to PPP.

Chapter 11, "Tailoring Your PPP Link," contains information for setting up more complex PPP links.

Chapter 12, "UUCP Databases and Programs," explains how to set up the UUCP database files.

Chapter 13, "Configuring and Maintaining UUCP," explains how to start up UUCP and troubleshoot problems on UUCP links.

Related Books

After you have set up the network, you probably will want to add the network services provided by the Solaris operating system. They are described in the following books:

- *NFS Administration Guide*
- *Name Services Administration Guide*
- *NIS+ Transition Guide*

What Typographic Changes and Symbols Mean

The following table describes the type changes and symbols used in this book.

Table P-1 Typographic Conventions

Typeface or Symbol	Meaning	Example
`AaBbCc123`	The names of commands, files, and directories; on-screen computer output	Edit your `.login` file. Use `ls -a` to list all files. `system% You have mail.`

`AaBbCc123`	What you type, contrasted with on-screen computer output	`system%` **`su`**
		`Password:`

AaBbCc123	Command-line placeholder: replace with a real name or value	To delete a file, type `rm` *filename*.
AaBbCc123	Book titles, new words or terms, or words to be emphasized	Read Chapter 6 in *User's Guide*. These are called *class* options. You *must* be root to do this.
Code samples are included in boxes and may display the following:		
`%`	UNIX C shell prompt	`system%`
`$`	UNIX Bourne and Korn shell prompt	`system$`
`#`	Superuser prompt, all shells	`system#`

Part 1 — Setting Up and Administering TCP/IP Networks

Part 1 explains how to set up a network that will run the Solaris implementation of TCP/IP. The text assumes that you are familiar with UNIX and have some experience administering local UNIX systems. It does not assume that you are an experienced network administrator.

Overview of Network Administration 1

This chapter introduces the role of the network administrator. If you are a new network administrator, the topics covered will give you an idea of the tasks you may perform. The chapter then presents fundamental networking concepts that you'll need to know as you progress through this book. If you are an experienced network administrator, consider moving on to the next chapter.

Responsibilities of the Network Administrator

As a network administrator, your tasks generally will fall into four areas:

- Designing and planning the network
- Setting up the network
- Maintaining the network
- Expanding the network

Each task area corresponds to a phase in the continuing life cycle of a network. You may be responsible for all the phases, or you may ultimately specialize in a particular area, for example, network maintenance.

Designing the Network

The first phase in the life cycle of a network involves creating its design, a task not usually performed by new network administrators. Designing a network involves making decisions about the type of network that best suits the needs of your organization. In larger sites this task is performed by a senior network architect: an experienced network administrator familiar with both network software and hardware.

Chapter 3, “Planning Your Network,” describes the factors involved in network design.

Setting Up the Network

After the new network is designed, the second phase of network administration begins, which involves setting up and configuring the network. This consists of installing the hardware that makes up the physical part of the network, and configuring the files and/or databases, hosts, routers, and network configuration servers.

The tasks involved in this phase are a major responsibility for network administrators. You should expect to perform these tasks unless your organization is very large, with an adequate network structure already in place.

Chapter 4, “Configuring TCP/IP on the Network,” contains instructions for the tasks involved in this phase of the network life cycle.

Maintaining the Network

The third phase of network administration consists of ongoing tasks that will typically comprise the bulk of your responsibilities. They might include:

- Adding new host machines to the network
- Network security
- Administering network services, such as NFS, name services, and electronic mail

- Troubleshooting network problems

Chapter 4 explains how to set up new hosts on an existing network. Chapter 6, "Troubleshooting TCP/IP," contains hints for solving network problems. For information on network services, you can refer to the documents *NFS Administration Guide*, *Name Services Administration Guide*, *NIS+ Transition Guide*, and *User Accounts, Printers, and Mail Administration*. For security-related tasks, refer to *Security, Performance, and Accounting Administration*.

Expanding the Network

The longer a network is in place and functioning properly, the more your organization will want to expand its features and services. Initially, you can increase network population by adding new hosts and expand network services by providing additional shared software. But eventually, a single network will expand to the point where it can no longer operate efficiently. That is when it must enter the fourth phase of the network administration cycle: expansion.

Several options are available for expanding your network:

- Setting up a new network and connecting it to the existing network via a machine functioning as a *router*, thus creating an *internetwork*.
- Configuring machines in users' homes or in remote office sites and enabling these machines to connect over telephone lines to your network.
- Connecting your network to the global Internet, thus enabling users on your network to retrieve information from other systems throughout the world.
- Configuring UUCP communications, enabling users to exchange files and electronic mail with remotely located machines.

Chapter 5, "Configuring Routers," contains procedures for setting up an internetwork. Part 2, "Expanding Your Network with PPP," explains how to set up nomadic computers. Part 3, "Administering UUCP Communications," explains how to use UUCP to exchange information between your machine and other UUCP systems.

What a Network Is

Computer networks now proliferate throughout the world. More and more organizations set up networks of computers within their buildings. More and more individuals are establishing communications with public networks featuring special interest bulletin boards. Newspapers, radio, and television programs feature stories about the "information highway" and the global reach of giant networks.

Because of its subject matter, this book uses numerous networking terms, many of which may be familiar to you. The following section explains these terms and tries to answer some basic networking questions from a Solaris and—perhaps more importantly—from a TCP/IP perspective.

What TCP/IP Is

A network *communications protocol* is a set of formal rules that describe how software and hardware should interact within a network. For the network to function properly, the information being sent must be delivered to the intended destination in an intelligible form. Because different types of networking software and hardware need to interact to perform the network function, designers developed the concept of the communications protocol.

The Solaris operating system includes the software needed for network operations for your organization. This networking software implements the communications protocol "suite" collectively referred to as *TCP/IP*. TCP/IP is recognized as a standard by major international standards organizations and is used throughout the world. Because it is a set of standards, TCP/IP runs on many different types of computers, making it easy for you to set up a heterogeneous network running the Solaris operating system.

TCP/IP provides services to many different types of computers, operating systems, and networks. Types of networks range from local area networks, such as Ethernet, FDDI, and Token Ring, to wide area networks, such as X.25 and ATM.

You can use TCP/IP to construct a network out of a number of local area networks. You can also use TCP/IP to construct a wide area network using virtually any point-to-point digital circuit.

TCP/IP and its aggregate protocols are fully described in Chapter 2, "TCP/IP Protocol Suite."

Types of Hardware That Make Up a Solaris Network

The term local area network (LAN) refers to a single network of computers limited to a moderate geographical range, such as the floor of a building or two adjacent buildings. A local area network has both hardware and software components. From a hardware perspective, a basic Solaris LAN consists of two or more computers attached to some form of local area network media.

Local Area Network Media

The cabling or wiring used for computer networks is referred to as *network media*. Figure 1-1 shows four computers connected to the Ethernet. In the Solaris LAN environment, Ethernet is the most commonly used local area network media. Other types of local area network media used in a Solaris LAN might include FDDI or Token Ring.

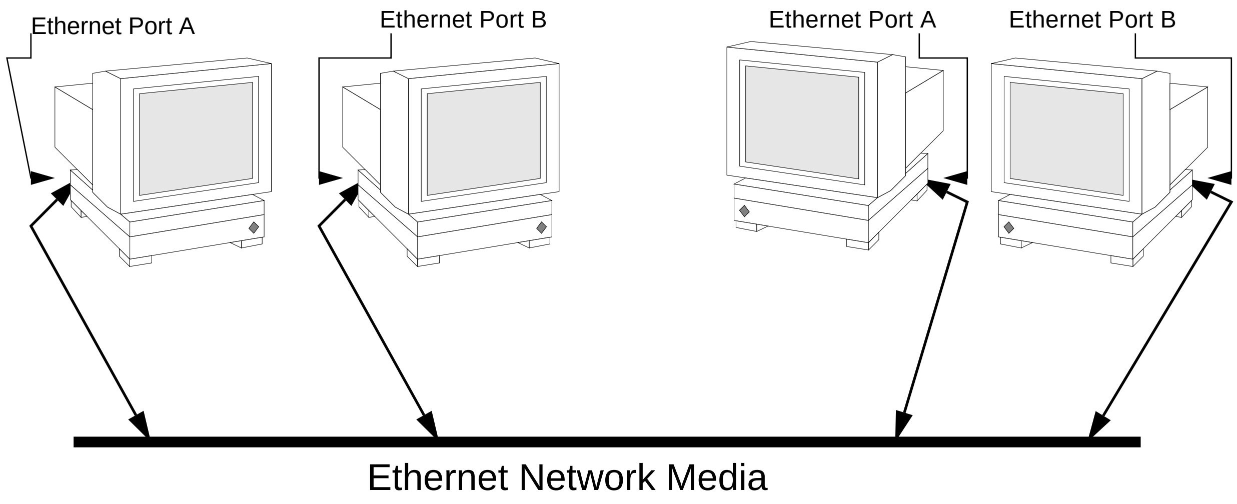

Figure 1-1 A Solaris Local Area Network

Computers and Their Connectors

Computers on a TCP/IP network have two different types of connectors that you use for connecting them to network media, the serial port and the ports on the network interface.

Serial Ports

Each computer has at least two *serial ports*, the connectors that enable you to plug a printer or modem into the computer. The serial ports may be attached to the CPU board, or you may have to purchase them. You use these ports when attaching a modem to the system to establish a PPP or UUCP connection. PPP and UUCP actually provide wide area network services, since they use telephone lines as their network media.

Network Interfaces

The hardware in a computer that enables you to connect it to a network is known as a *network interface*. Many computers come with a pre-installed network interface; others may require you to purchase the network interface separately.

Each LAN media type has its own associated network interface. For example, if you want to use Ethernet as your network media, you must have an Ethernet interface installed in each host to be part of the network. The connectors on the board to which you attach the Ethernet cable are referred to as *Ethernet ports*. If you plan to use FDDI, each prospective host must have an FDDI network interface, and so on.

This document refers to the default network interface on a host as the *primary network interface*.

Note – Installing network hardware is outside the scope of this guide. Refer to *Peripherals Administration* for instructions for configuring serial ports and manuals accompanying network media for installation instructions.

How Network Software Transfers Information

Setting up network software is an involved task. Therefore, it helps to understand how the network software you are about to set up will transfer information.

Figure 1-2 shows the basic elements involved in network communication.

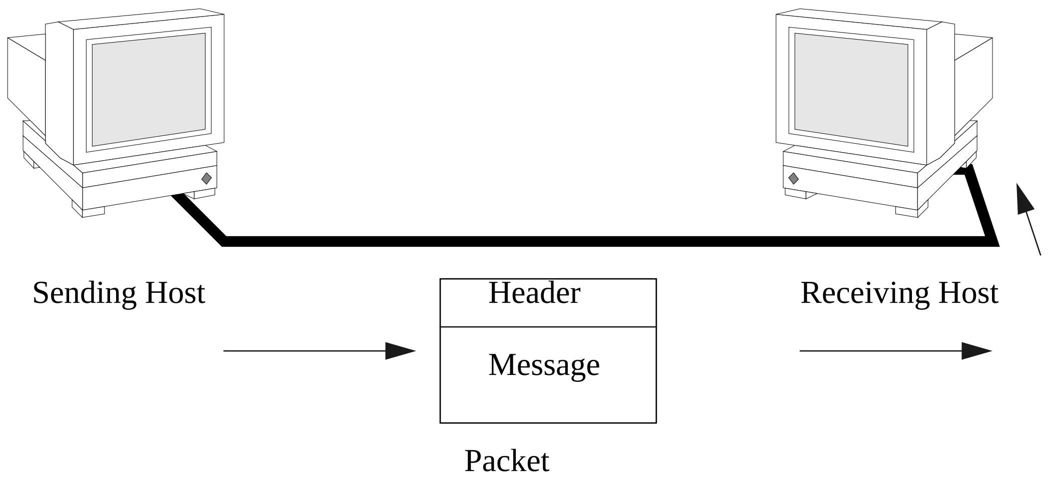

Figure 1-2 How Information is Transferred on a Network

In this figure, a computer sends a packet over the network media to another computer attached to the same media.

How Information is Transferred: the Packet

The basic unit of information to be transferred over the network is generically referred to as a *packet*. A packet is organized much like a conventional letter.

Each packet has a *header*, which corresponds to the envelope. The header contains the addresses of the recipient and the sender, plus information on how to handle the packet as it travels through each layer of the protocol suite.

The *message* part of the packet corresponds to the letter itself. Packets can only contain a finite number of bytes of data, depending on the network media in use. Therefore, typical communications such as email messages are sometimes split into packet fragments.

Who Sends and Receives Information: the Host

If you are an experienced Solaris user, you are no doubt familiar with the term "host," a word often used as a synonym for "computer" or "machine." From a TCP/IP perspective, only two types of entities exist on a network: routers and hosts.

A *router* is a machine that forwards packets from one network to another. To do this, the router must have at least two network interfaces. A machine with only one network interface cannot forward packets, and therefore is considered a *host*. Most of the machines you set up on a network will be hosts.

When a host initiates communication, it is called a *sending* host, or, simply, the sender. For example, a host initiates communications when its user types `rlogin` or sends an email message to another user. The host that is the target of the communication is called the *receiving* host, or recipient. For example, the remote host specified as the argument to `rlogin` is the recipient of the request to log in.

Each host has three characteristics that help identify it to its peers on the network. These characteristics include its:

- Host name
- Internet address, or *IP address,* the form used in this book
- Hardware address

Host Name

The *host name* is the name of the local machine, combined with the name of your organization. Many organizations let users choose the host names for their machines. Programs such as `sendmail` and `rlogin` use host names to specify remote machines on a network. The guide *User Accounts, Printers, and Mail Administration* contains more information about host names.

The host name of the machine also becomes the name of the primary network interface. This concept becomes important when you set up the network databases or configure routers.

When setting up a network, you will have to obtain the host names of all machines to be involved. You will use this information when setting up network databases, as described in Chapter 4, "Configuring TCP/IP on the Network."

IP Address

The *IP address* is one of the two addresses each machine has on a TCP/IP network that identifies the machine to its peers on the network. This address also gives peer hosts a notion of *where* a particular host is located on the network. If you have installed Solaris on a machine on a network, you may recall specifying the IP address during the installation process. IP addressing is a significant aspect of TCP/IP and is explained fully in ”Designing Your IP Addressing Scheme” on page 31.

Hardware Address

Each host on a network has a hardware address, which also identifies it to its peers. This address is physically assigned to the machine’s CPU or network interface by the manufacturer. Each hardware address is unique.

This book uses the term *Ethernet address* to correspond to the hardware address. Because Ethernet is the most commonly used network media on Solaris-based networks, the text assumes that the hardware address of your Solaris host is an Ethernet address. If you are using other network media, such as FDDI, refer to the documentation that came with your media for hardware addressing information.

Reaching Beyond the Local Area Network—the Wide Area Network

As your network continues to function successfully, users may need to access information available from other companies, institutes of higher learning, and other organizations not on your LAN. To obtain this information, they may need to communicate over a *wide area network* (WAN), a network that covers a potentially vast geographic area and uses network media such as leased data/telephone lines, X.25, and ISDN services.

A prime example of a WAN is the Internet, the global public network that is the successor to the WANs for which TCP/IP was originally developed. Other examples of WANs are *enterprise networks*, linking the separate offices of a single corporation into one network spanning an entire country, or perhaps an entire continent. It is entirely possible for your organization to construct its own WAN.

As network administrator, you may have to provide access to WANs to the users on your local net.   Within the TCP/IP and UNIX community, the most commonly used public network has been the Internet. Information about directly connecting to the Internet is outside the scope of this book. You can find many helpful books on this subject in a computer bookstore.

TCP/IP Protocol Suite 2

This chapter introduces the Solaris implementation of the TCP/IP network protocol suite.

The information is particularly geared to network administrators who are unfamiliar with the TCP/IP. (For an introduction to basic network concepts, see Chapter 1, “Overview of Network Administration.”) If you are an experienced TCP/IP network administrator, consider moving on to chapters covering the tasks you want to perform.

Introducing the Internet Protocol Suite

This section presents an in-depth introduction to the protocols that compose TCP/IP. Although the information is purely conceptual, you should learn the names of the protocols and what each does. This is important because TCP/IP books explain tasks with the assumption that you understand the concepts introduced here.

TCP/IP is the commonly used nickname for the set of network protocols composing the *Internet Protocol suite*. Many texts use the term “Internet” interchangeably, when describing both the protocol suite and the global wide area network. In this document, the term *TCP/IP* refers specifically to the Internet protocol suite; the term *Internet* refers to the wide area network and the bodies that govern it.

To interconnect your TCP/IP network with other networks, you must obtain a unique IP network number. At the time of this writing, IP network numbers are assigned by an organization known as the InterNIC.

If hosts on your network are going to participate in the Internet Domain Name Service (DNS), you must obtain and register a unique domain name. The InterNIC also handles the registration of domain names under certain top-level domains such as .COM (Commercial), .EDU (Education), and .GOV (Government). Chapter 3, "Planning Your Network," contains more information about the InterNIC. (For more information on DNS, refer to *Name Services Administration Guide*.)

Protocol Layers and the OSI Model

Most network protocol suites are structured as a series of layers, sometimes referred to collectively as a *protocol stack*. Each layer is designed for a specific purpose and exists on both the sending and receiving hosts. Each is designed so that a specific layer on one machine sends or receives exactly the same object sent or received by its *peer process* on another machine. These activities take place independently from what is going on in layers above or below the layer under consideration. In other words, each layer on a host acts independently of other layers on the same machine, and in concert with the same layer on other hosts.

OSI Reference Model

That most network protocol suites are viewed as structured in layers is a result of the Open Systems Interconnect (OSI) Reference Model designed by the International Standards Organization (ISO). The OSI model describes network activities as having a structure of seven layers, each of which has one or more protocols associated with it. The layers represent data transfer operations common to all types of data transfers among cooperating networks.

The protocol layers of the OSI Reference Model are traditionally listed from the top (Layer 7) to the bottom (Layer 1) up, as shown in Table 2-1 on page 13:

Table 2-1 The Open Systems Interconnect Reference Model

Layer No.	Layer Name	Description
7	Application	Consists of standard communication services and applications that everyone can use.
6	Presentation	Ensures that information is delivered to the receiving machine in a form that it can understand.
5	Session	Manages the connections and terminations between cooperating computers.
4	Transport	Manages the transfer of data and assures that received and transmitted data are identical.
3	Network	Manages data addressing and delivery between networks.
2	Data Link	Handles the transfer of data across the network media.
1	Physical	Defines the characteristics of the network hardware.

The operations defined by the OSI model are purely conceptual and not unique to any particular network protocol suite. For example, the OSI network protocol suite implements all seven layers of the OSI Reference Model. TCP/IP uses some of OSI model layers and combines others. Other network protocols, such as SNA, add an eighth layer.

TCP/IP Protocol Architecture Model

The OSI model describes an idealized network communications protocol family. TCP/IP does not correspond to this model directly, as it either combines several OSI layers into a single layer, or does not use certain layers at all. Table 2-2 on page 14 shows the layers of the Solaris implementation of TCP/IP, listed from topmost layer (Application) to lowest (Physical Network).

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Table 2-2 TCP/IP Protocol Stack

OSI Ref. Layer No.	OSI Layer Equivalent	TCP/IP Layer	TCP/IP Protocol Examples
5,6,7	Application, Session, Presentation	Application	NFS, NIS+, DNS, `telnet`, `ftp`, “r” commands, RIP, RDISC, others
4	Transport,	Transport	TCP, UDP
3	Network	Internet	IP, ARP, ICMP
2	Data Link	Data Link	PPP, IEEE 802.2
1	Physical	Physical Network	Ethernet (IEEE 802.3) Token Ring, RS-232, others

The table shows the TCP/IP protocol layers, their OSI Model equivalents, and examples of the protocols available at each level of the TCP/IP protocol stack. Each host involved in a communication transaction runs its own implementation of the protocol stack.

Physical Network Layer

The Physical Network layer specifies the characteristics of the hardware to be used for the network. For example, it specifies the physical characteristics of the communications media. The physical layer of TCP/IP describes hardware standards such as IEEE 802.3, the specification for Ethernet network media, and RS-232, the specification for standard pin connectors.

Data Link Layer

The Data Link layer identifies the network protocol type of the packet, in this case TCP/IP. It also provides error control and “framing.” Examples of Data Link layer protocols are Ethernet IEEE 802.2 framing and Point-to-Point Protocol (PPP) framing.

Internet Layer

This layer, also known as the Network layer, accepts and delivers packets for the network. It includes the powerful Internet protocol (IP), the ARP protocol, and the ICMP protocol.

IP Protocol

The IP protocol and its associated routing protocols are possibly the most significant of the entire TCP/IP suite. IP is responsible for:

- IP addressing. The IP addressing conventions are part of the IP protocol. (Chapter 3, “Planning Your Network,” describes IP addressing in complete detail.)
- Host-to-host communications. IP determines the path a packet must take, based on the receiving host’s IP address.
- Packet formatting. IP assembles packets into units known as *IP datagrams.* Datagrams are fully described on page 22.
- Fragmentation. If a packet is too large for transmission over the network media, IP on the sending host breaks the packet into smaller fragments. IP on the receiving host then reconstructs the fragments into the original packet.

ARP Protocol

The Address Resolution Protocol (ARP) conceptually exists between the Data Link and Internet layers. ARP assists IP in directing datagrams to the appropriate receiving host by mapping Ethernet addresses (48 bits long) to known IP addresses (32 bits long).

ICMP Protocol

Internet Control Message Protocol (ICMP) is the protocol responsible for detecting network error conditions and reporting on them. ICMP reports on:

- Dropped packets (when packets are arriving too fast to be processed)
- Connectivity failure (when a destination host can’t be reached)
- Redirection (which tells a sending host to use another router)

Chapter 6, “Troubleshooting TCP/IP,” contains more information on the operating system commands that use ICMP for error detection.

Transport Layer

The TCP/IP Transport layer protocols ensure that packets arrive in sequence and without error, by swapping acknowledgments of data reception, and retransmitting lost packets. This type of communication is known as "end-to-end." Transport layer protocols at this level are Transmission Control Protocol (TCP) and User Datagram Protocol (UDP).

TCP Protocol

TCP enables applications to communication with each other as though connected by a physical circuit. TCP sends data in a form that appears to be transmitted in a character-by-character fashion, rather than as discreet packets. This transmission consists of a starting point, which opens the connection, the entire transmission in byte order, and an ending point, which closes the connection.

TCP attaches a header onto the transmitted data. This header contains a large number of parameters that help processes on the sending machine connect to peer processes on the receiving machine.

TCP makes an attempt to confirm that a packet has reached its destination by establishing an end-to-end connection between sending and receiving hosts. TCP is therefore considered a "reliable, connection-oriented" protocol.

UDP Protocol

UDP, the other Transport layer protocol, provides datagram delivery service. It does not provide any means of verifying that connection was ever achieved between receiving and sending hosts. Because UDP eliminates the processes of establishing and verifying connections, applications that send small amounts of data use it rather than TCP. NFS is an example of an application that uses UDP for datagram delivery.

Application Layer

The Application layer defines standard Internet services and network applications that anyone can use. These services work with the Transport layer to send and receive data. There are many Applications layer protocols, some of which you probably already use. Some of the protocols include:

- Standard TCP/IP services such as the `ftp`, `tftp`, and `telnet` commands

- UNIX “r” commands, such as `rlogin` and `rsh`
- Name services, such as NIS+ and Domain Name Service (DNS)
- File services, such as NFS
- RIP routing protocol

Standard TCP/IP Services

telnet—The Telnet protocol enables terminals and terminal oriented processes to communicate on a network running TCP/IP. It is implemented as the program `telnet` (on local machines) and the daemon `in.telnet` (on remote machines). Telnet provides a user interface through which two hosts can communicate on a character-by-character or line-by-line basis. The application includes a set of commands that are fully documented in the `telnet`(1) man page.

ftp—The file transfer protocol (`ftp`) transfers files to and from a remote network. The protocol includes the `ftp` command (local machine) and the `in.ftpd` daemon (remote machine). `ftp` lets a user specify the name of the remote host and file transfer command options on the local host’s command line. The `in.ftpd` daemon on the remote host then handles the requests from the local host. Unlike `rcp`, `ftp` works even when the remote computer is running a non-UNIX operating system. A user must log in to the remote computer to make an `ftp` connection unless it has been set up to allow anonymous `ftp`.

The `ftp`(1) man page describes all `ftp` command options, including those invoked through the command interpreter. The `ftpd`(1M) man page describes the services provided by the daemon `in.ftpd`.

tftp—The trivial file transfer protocol (`tftp`) provides functions similar to `ftp`, but it does not establish `ftp`’s interactive connection. As a result, users cannot list the contents of a directory or change directories. This means that a user must know the full name of the file to be copied. The `tftp`(1) man page describes the `tftp` command set.

UNIX “r” Commands

The UNIX “r” commands enable users to issue commands on their local machines that are actually carried out on the remote host that they specify. The r commands include:

- `rcp`
- `rlogin`
- `rsh`

Instructions for using these commands are in the *Solaris Advanced User's Guide* and in the `rcp` (1), `rlogin` (1), and `rsh` (1) man pages.

Name Services

Two name services are available from the Solaris implementation of TCP/IP: NIS+ and DNS.

NIS+

NIS+ provides centralized control over network administration services, such as mapping host names to IP and Ethernet addresses, verifying passwords, and so on. See *Name Services Administration Guide* for complete details.

Domain Name Service

The Domain Name Service (DNS) provides host names to the IP address service. It also serves as a database for mail administration. For a complete description of this service, see *Name Services Administration Guide.* See also the `in.named`(1M) man page.

File Services

The NFS application layer protocol provides file services for the Solaris operating system. You'll find complete information about the NFS service in *NFS Administration Guide.*

Routing Protocols

The Routing Information Protocol (RIP) and the Router Discovery Protocol (RDISC) are two routing protocols for TCP/IP networks. They are described in Chapter 5, "Configuring Routers."

How the TCP/IP Protocols Handle Data Communications

When a user issues a command that uses a TCP/IP application layer protocol, a chain of events is set in motion. The user's command or message passes through the TCP/IP protocol stack on the local machine, and then across the network media to the protocols on the recipient. The protocols at each layer on the sending host add information to the original data.

As the user's command makes its way through the protocol stack, protocols on each layer of the sending host also interact with their peers on the receiving host. Figure 2-1 shows this interaction.

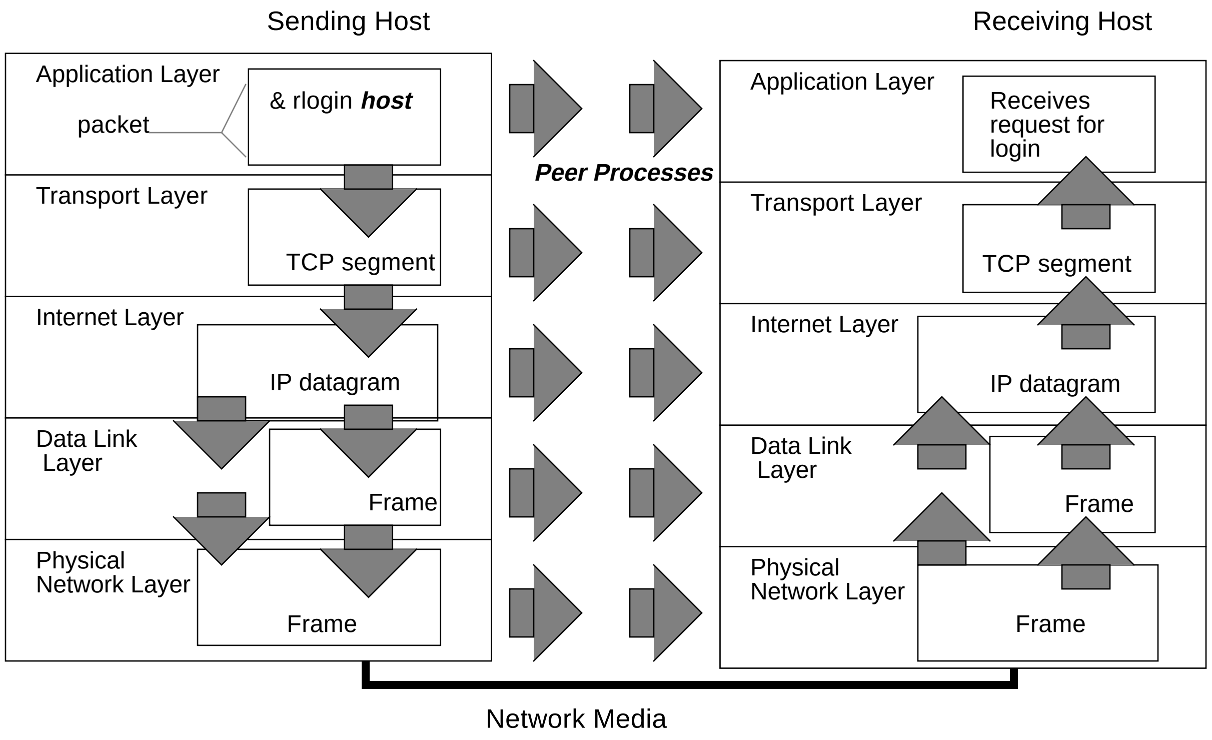


Figure 2-1 How a Packet Travels through the TCP/IP Stack

Data Encapsulation and the TCP/IP Protocol Stack

The packet is the basic unit of information transferred across a network, consisting, at minimum, of a header with the sending and receiving hosts' addresses, and a body with the data to be transferred. As the packet travels through the TCP/IP protocol stack, the protocols at each layer either add or remove fields from the basic header. When a protocol on the sending host adds data to the packet header, the process is called *data encapsulation*. Moreover, each layer has a different term for the altered packet, as shown in Figure 2-1 on page 19.

This section summarizes the life cycle of a packet from the time the user issues a command or sends a message to the time it is received by the appropriate application on the receiving host.

Application Layer—The User Initiates Communication

The packet's history begins when a user on one host sends a message or issues a command that must access a remote host. The application protocol associated with the command or message formats the packet so that it can be handled by the appropriate transport layer protocol, TCP or UDP.

Suppose the user issues an `rlogin` command to log in to the remote host, as shown in Figure 2-1. The `rlogin` command uses the TCP transport layer protocol. TCP expects to receive data in the form of a stream of bytes containing the information in the command. Therefore, `rlogin` sends this data as a *TCP stream*.

Not all application layer protocols use TCP, however. Suppose a user wants to mount a file system on a remote host, thus initiating the NFS application layer protocol. NFS uses the UDP transport layer protocol. Therefore, the packet containing the command must be formatted in a manner that UDP expects. This type of packet is referred to as *a message*.

Transport Layer —Data Encapsulation Begins

When the data arrives at the transport layer, the protocols at the layer start the process of data encapsulation. The end result depends on whether TCP or UDP has handled the information.

TCP Segmentation

TCP is often called a "connection-oriented" protocol because it ensures the successful delivery of data to the receiving host. Figure 2-1 on page 19 shows how the TCP protocol receives the stream from the `rlogin` command. TCP divides the data received from the application layer into *segments* and attaches a header to each segment.

Segment headers contain sender and recipient ports, segment ordering information, and a data field known as a *checksum*. The TCP protocols on both hosts use the checksum data to determine whether data has transferred without error.

Establishing a TCP Connection

In addition, TCP uses segments to determine whether the receiving host is ready to receive the data. When the sending TCP wants to establish connections, it sends a segment called a SYN to the peer TCP protocol running on the receiving host. The receiving TCP returns a segment called an ACK to acknowledge the successful receipt of the segment. The sending TCP sends another ACK segment and then proceeds to send the data. This exchange of control information is referred to as a *three-way handshake.*

UDP Packets

UDP is a "connectionless" protocol. Unlike TCP, it does not check to make sure that data arrived at the receiving host. Instead, UDP takes the message received from the application layer and formats it into *UDP packets.* UDP attaches a header to each packet, which contains the sending and receiving host ports, a field with the length of the packet, and a checksum.

The sending UDP attempts to send the packet to its peer UDP process on the receiving host. The receiving UDP may send a response as an acknowledgment that it received the data. If the sending UDP doesn't get a response, it sends the packet again. UDP does not use the three-way handshake concept.

Internet Layer

As shown in Figure 2-1 on page 19, both TCP and UDP pass their segments and packets down to the Internet layer, where they are handled by the IP protocol. IP prepares them for delivery by formatting them into IP datagrams. Then IP determines the IP addresses for the datagrams, so they can effectively be delivered to the receiving host.

IP Datagrams

IP attaches an *IP header* to the segment or packet's header in addition to the information added by TCP or UDP. Information in the IP header includes the IP addresses of the sending and receiving hosts, datagram length, and datagram sequence order. This is provided in case the datagram exceeds the allowable byte size for network packets and must be fragmented.

Data Link Layer—Framing Takes Place

Data link layer protocols such as PPP format the IP datagram into a *frame*. They attach a third header and a footer to "frame" the datagram. The frame header includes a cyclical redundancy check (*CRC*) field that checks for errors as the frame travels over the network media. Then the data link layer passes the frame to the physical layer.

Physical Network Layer—Preparing the Frame for Transmission

The physical network layer on the sending host receives the frames and converts the IP addresses into the hardware addresses appropriate to the network media. The physical network layer then sends the frame out over the network media.

How the Receiving Host Handles the Packet

When the packet arrives on the receiving host, it travels through the TCP/IP protocol stack in the reverse order from that which it took on the sender. Figure 2-1 on page 19 illustrates this path. Moreover, each protocol on the receiving host strips off header information attached to the packet by its peer on the sending host. Here is what happens.

1. Physical Network Layer
   Receives the packet in its “frame” form. It converts the hardware addresses of the sender and recipient into IP addresses and then sends the frame to the data link layer.

2. Data Link Layer
   Verifies that the CRC for the frame is correct and strips off the frame header and CRC. Finally, the data link protocol sends the frame to the Internet layer.

3. Internet Layer
   Reads information in the header to identify the transmission and determine if it is a fragment. If the transmission was fragmented, IP reassembles the fragments into the original datagram. It then strips off the IP header and passes the datagram on to transport layer protocols

4. Transport Layer (TCP and UDP)
   Reads the header to determine which application layer protocol must receive the data. Then TCP or UDP strips off its related header and sends the message or stream up to the receiving application.

5. Application Layer
   Receives the message and performs the operation requested by the sending host.

Planning Your Network 3

This chapter describes the issues you must resolve in order to create your network in an organized, cost-effective manner. When you have resolved these issues, you can devise a plan for your network to follow as you set it up and administer it in the future.

If you are unfamiliar with TCP/IP fundamentals, refer to Chapter 2, "TCP/IP Protocol Suite."

Designing the Network

The first phase in the life of a network—designing the network—involves making decisions about the type of network that best suits the needs of your organization. Some of the planning decisions you make will involve network hardware, for example:

- Number of host machines your network(s) will support
- Type of network media to use: Ethernet, token ring, FDDI, and so on

- Network topology; that is, the physical layout and connections of the network hardware
- Types of hosts the network will support: standalone, diskless, and dataless

Based on these factors, you can determine the size of your local area network.

Note – Planning the network hardware is outside the scope of this manual. Refer to the manuals that came with the hardware for assistance.

Factors Involved in Network Planning

After you have completed your hardware plan, you are ready to begin network planning, from the software perspective.

As part of the planning process you must:

1. Obtain a network number and, if applicable, register your network domain with the InterNIC.
2. Devise an IP addressing scheme for your hosts, after you receive your IP network number.
3. Create a handwritten or typed list containing the IP addresses and host names of all machines to comprise your network, which you can use as you build network databases.
4. Determine which form of name service to use on your network: NIS, NIS+, DNS, or the network databases in the local `/etc` directory.
5. Establish administrative subdivisions, if appropriate for your network.
6. Determine if your network is large enough to require routers, and, if appropriate, create a network topology that supports them.
7. Set up subnets, if appropriate for your network.

The remainder of Chapter 3 explains how to plan your network with these factors in mind.

Setting Up an IP Addressing Scheme

The number of machines you expect to support will affect several decisions you will need to make at this stage of setting up a network for your site. Your organization may require a small network of several dozen standalone machines located on a floor of a single building. Alternatively, you may need to set up a network with more than 1000 hosts in several buildings. This arrangement may require you to further divide your network into subdivisions called *subnets*. The size of your prospective network will affect the:

- Network class you apply for
- Network number you will receive
- IP addressing scheme you then use for your network

Obtaining a network number and then establishing an IP addressing scheme is one of the most important tasks of the planning phase of network administration.

Parts of the IP Address

Each network running TCP/IP must have a unique network number, and every machine on it must have a unique IP address. It is important to understand how IP addresses are constructed before you register your network and obtain its network number.

The IP address is a 32-bit number that uniquely identifies a network interface on a machine. An IP address is typically written in decimal digits, formatted as four 8-bit fields separated by periods. Each 8-bit field represents a byte of the IP address. This form of representing the bytes of an IP address is often referred to as the *dotted decimal format*.

The bytes of the IP address are further classified into two parts: the network part and the host part. Figure 3-1 on page 28 shows the component parts of a typical IP address, 129.144.50.56.

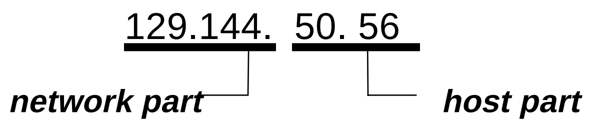


Figure 3-1 Parts of an IP Address

Network Part

This part specifies the unique number assigned to your network. It also identifies the class of network assigned. In Figure 3-1, the network part takes up two bytes of the IP address.

Host Part

This is the part of the IP address that you assign to each host. It uniquely identifies this machine on your network. Note that for each host on your network, the network part of the address will be the same, but the host part must be different.

Subnet Number (optional)

Local networks with large numbers of hosts are sometimes divided into subnets. If you choose to subnet your network, you need to assign a *subnet number* for the subnet. You can maximize the efficiency of the IP address space by using some of the bits from the host number part of the IP address as a network identifier. When used as a network identifier, the specified part of the address becomes the subnet number. You create a subnet number by using a netmask, which is a bit mask that selects the network and subnet parts of an IP address. (Refer to "Creating the Network Mask" on page 55 for full details.)

Network Classes

The first step in planning for IP addressing on your network is to determine which network class is appropriate for your network. After you have done this, you can take the crucial second step: obtaining the network number from the InterNIC addressing authority.

There currently are three classes of TCP/IP networks. Each class uses the 32-bit IP address space differently, providing more or fewer bits for the network part of the address. These classes are Class A, Class B, and Class C.

Class A Network Numbers

A Class A network number uses the first eight bits of the IP address as its "network part." The remaining 24 bits comprise the host part of the IP address, as illustrated in Figure 3-2 below.

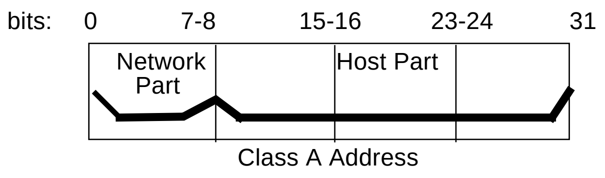


Figure 3-2 Byte Assignment in a Class A Address

The values assigned to the first byte of Class A network numbers fall within the range 0-127. Consider the IP address 75.4.10.4. The value 75 in the first byte indicates that the host is on a Class A network. The remaining bytes, 4.10.4, establish the host address. The InterNIC assigns only the first byte of a Class A number. Use of the remaining three bytes is left to the discretion of the owner of the network number. Only 127 Class A networks can exist. Each one of these numbers can accommodate up to 16,777,214 hosts.

Class B Network Numbers

A Class B network number uses 16 bits for the network number and 16 bits for host numbers. The first byte of a Class B network number is in the range 128-191. In the number 129.144.50.56, the first two bytes, 129.144, are assigned by the InterNIC, and comprise the network address. The last two bytes, 50.56, make up the host address, and are assigned at the discretion of the owner of the network number. Figure 3-3 on page 30 graphically illustrates a Class B address.

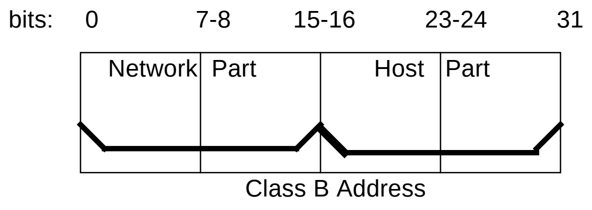


Figure 3-3 Byte Assignment in a Class B Address

Class B typically is assigned to organizations with many hosts on their networks.

Class C Network Numbers

Class C network numbers use 24 bits for the network number and 8 bits for host numbers. Class C network numbers are appropriate for networks with few hosts—the maximum being 254. A Class C network number occupies the first three bytes of an IP address. Only the fourth byte is assigned at the discretion of the network owners. Figure 3-4 graphically represents the bytes in a Class C address.

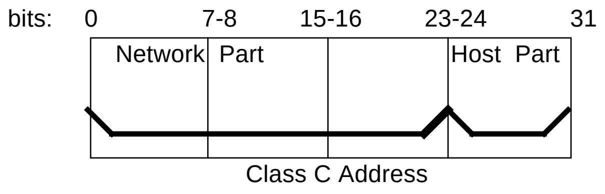


Figure 3-4 Byte Assignment in a Class C Address

The first byte of a Class C network number covers the range 192-223. The second and third each cover the range 1 to 255. A typical Class C address might be 192.5.2.5. The first three bytes, 192.5.2, form the network number. The final byte in this example, 5, is the host number.

Administering Network Numbers

If your organization has been assigned more than one network number, or uses subnets, appoint a centralized authority within your organization to assign network numbers. That authority should maintain control of a pool of assigned network numbers, assigning network, subnet, and host numbers as required. To prevent problems, make sure that duplicate or random network numbers do not exist in your organization.

Designing Your IP Addressing Scheme

After you have received your network number, you can then plan how you will assign the host parts of the IP address.

Table 3-1 shows the division of the IP address space into network and host address spaces. For each class, Range specifies the range of decimal values for the first byte of the network number. Network Address indicates the number of bytes of the IP address that are dedicated to the network part of the address, with each byte represented by "*xxx*". Host Address indicates the number of bytes dedicated to the host part of the address. For example, in a Class A network address, the first byte is dedicated to the network, and the last three are dedicated to the host. The opposite is true for a Class C network.

Table 3-1 Division of IP Address Space

Class	**Range**	**Network Address**	**Host Address**
A	0-127	*xxx*	*xxx.xxx.xxx*
B	128-191	*xxx.xxx*	*xxx.xxx*
C	192-223	*xxx.xxx.xxx*	*xxx*

The numbers in the first byte of the IP address define whether the network is Class A, B, or C and are always assigned by the InterNIC. The remaining three bytes have a range from 0-255. The numbers 0 and 255 are reserved; you can assign the numbers 1-254 to each byte *depending on the network number assigned to you.*

Table 3-2 shows which bytes of the IP address are assigned to you and the range of numbers within each byte that are available for you to assign to your hosts.

Table 3-2 Range of Available Numbers

Network Class	**Byte 1 Range**	**Byte 2 Range**	**Byte 3 Range**	**Byte 4 Range**
Class A	0-127	1-254	1-254	1-254
Class B	128-191	Preassigned by Internet	1-254	1-254
Class C	192-223	Preassigned by Internet	Preassigned by Internet	1-254

How IP Addresses Apply to Network Interfaces

In order to connect to the network, a computer must have at least one network interface, as explained in "Network Interfaces" on page 6. Each network interface must have its own unique IP address. The IP address that you give to a host is assigned to its network interface, sometimes referred to as the *primary network interface*. If you add a second network interface to a machine, it must have its own unique IP number. Adding a second network interface converts a machine from a host to a router, as explained in Chapter 5, "Configuring Routers."

Each network interface has a device name, device driver, and associated device file in the `/devices` directory. The network interface might have a device name such as `le0` or `smc0`, device names for two commonly-used Ethernet interfaces.

Note – This document assumes that your machines have Ethernet network interfaces. If you plan to use a different network media, refer to the manuals that came with the network interface for configuration information.

Naming Entities on Your Network

After you have received your assigned network number and given IP addresses to your hosts, the next task is to assign names to the hosts and determine how you will handle naming services on your network. You will use these names when you initially set up your network and later, for expanding your network through routers or PPP.

The TCP/IP protocols locate a machine on a network by using its IP address. However, humans find it much easier to identify a machine if it has an understandable, alphabetic name. Therefore, the TCP/IP protocols (and the Solaris operating system) require both the IP address and the host name to uniquely identify a machine.

From a TCP/IP perspective, a network is a set of named entities. A host is an entity with a name. A router is an entity with a name. The network is an entity with a name. A group or department in which the network is installed can also be given a name, as could a division, a region, or a company. In theory, there is virtually no limit to the hierarchy of names that can be used to identify a network and its machines. The term for these named entities is *domain*.

Administering Host Names

Many sites let the user pick the host name for his or her machine. Servers also require at least one host name, which is associated with the IP address of its primary network interface.

As network administrator, you must ensure that each host name on your network is unique. In other words, no two machines on your network could both have the name "fred."

When planning your network, make a list of IP addresses and their associated host names for easy access during the setup process. The list can help you verify that all host names are unique.

Selecting a Name Service

The Solaris operating system gives you the option of using four types of *name services*: local files, NIS, NIS+, and DNS. Name services maintain critical information about the machines on a network, such as the host names, IP addresses, Ethernet addresses, and the like.

Network Databases

When you install the operating system, you supply the host name and IP address of your server, clients, or standalone machine as part of the procedure. The Solaris installation program enters this information into a *network database* called the `hosts` database. The `hosts` database is one of a set of network databases that contain information necessary for TCP/IP operation on your network. These databases are read by the name service you select for your network.

Setting up the network databases is a critical part of network configuration. Therefore, you need to decide which name service to use as part of the network planning process. Moreover, the decision to use name services also affects whether or not you organize your network into an administrative domain. Chapter 4, “Configuring TCP/IP on the Network,” has detailed information on the set of network databases.

Using NIS, NIS+, or DNS for Name Service

The NIS, NIS+, or DNS name services maintain network databases on several servers on the network. The manual *Name Services Configuration Guide* fully describes these name services and explains how to set them up. It also explains the “namespace” and “administrative domain” concepts in complete detail. If you are changing name services from NIS to NIS+, refer to *NIS+ Transition Guide*. You should refer to these manuals to help you decide whether to use these name services on your network.

Using Local Files for Name Service

If you do not implement NIS, NIS+, or DNS, the network will use *local files* to provide name service. The term “local files” refers to the series of files in the `/etc` directory that the network databases use. The procedures in this book assume you are using local files for your name service, unless otherwise indicated.

Note – If you decide to use local files as the name service for your network, you can set up another name service at a later date.

Domain Names

Many networks organize their hosts and routers into a hierarchy of administrative domains. If you are going to use NIS, NIS+, or the DNS name services, you must select a domain name for your organization that is unique world-wide. To ensure that your domain name is unique, you should register it with the InterNIC. This is especially important if you plan to use DNS.

The domain name structure is hierarchical. A new domain typically is located below an existing, related domain. For example the domain name for a subsidiary company may be located below the domain of the parent company. If it has no other relationship, an organization can place its domain name directly under one of the existing top-level domains.

Examples of top-level domains include:

- .COM—Commercial companies (international in scope)
- .EDU—Educational institutions (international in scope)
- .GOV—U.S. government agencies
- .FR—France

The name that identifies your organization is one that you select, with the provision that is unique.

Administrative Subdivisions

The question of administrative subdivisions deals with matters of size and control. The more hosts and servers you have in a network, the more complex your management task. You may wish to handle such situations by setting up additional administrative divisions in the form of more additional networks of a particular class or by dividing existing networks into subnets. The decision whether to set up administrative subdivisions for your network hinges on the following factors:

- How large is the network?

  A single network of several hundred hosts, all in the same physical location and requiring the same administrative services, could be handled by a single administrative division. On the other hand, a network of fewer machines, divided into a number of subnets and physically scattered over an extensive geographic area, would most likely benefit from the establishment of several administrative subdivisions.

- Do users on the network have similar needs?

  For example, you may have a network that is confined to a single building and supports a relatively small number of machines. These machines are divided among a number of subnetworks, each supporting groups of users whose needs differ widely. Such a case could call for an administrative subdivision for each subnet.

  The *Name Services Administration Guide* discusses administrative subdivisions in detail.

Registering Your Network

Before you assign IP addresses to the machines on your Solaris network, you must obtain a network number from the InterNIC. Moreover, if you plan to use administrative domains, you should register them with the InterNIC.

InterNIC and InterNIC Registration Services

The InterNIC was created in 1993 to act as a central body where users of the global Internet could go for information such as:

- What the Internet's policies are
- How to access the Internet, including training services
- What resources are available to Internet users, such as anonymous `ftp` servers, Usenet user groups, and so on.

The InterNIC also includes the InterNIC Registration Services, the organization with which you register your TCP/IP network. The InterNIC Registration Services provide templates for obtaining a network number and for registering your domain. Two points to remember about registration are:

1. The InterNIC assigns network numbers.

Note – Do not arbitrarily assign network numbers to your network, even if you do not plan to attach it to other existing TCP/IP networks.

Subnet numbers are not assigned by the InterNIC. Rather, they are composed partly of the assigned network number and numbers that you define, as explained in ”What Subnetting Is” on page 54.

2. You determine the domain name for your network and then register it with the InterNIC. They do not assign domain names.

How to Contact the InterNIC

You can reach the InterNIC Registration Services by:

- Telephone
  The phone number as of this writing is 1-703-742-4777. Phone service is available from 7 am to 7 pm United States Eastern Standard Time.
- Electronic Mail
  Send email regarding network registration to:

  HOSTMASTER@RS.INTERNIC.NET
- United States postal services

  Network Solutions
  Attn: InterNIC Registration Services
  505 Huntmar Park Drive
  Herndon, Virginia 22070
- Anonymous `ftp` or TELNET inquiries, through the Gopher and Wais interfaces. The host you want to connect to `is rs.internic.net`. (Anonymous ftp and TELNET are outside the scope of this guide; however, excellent books on these subjects are available in computer bookstores.)

Adding Routers

Recall that in TCP/IP, two types of entities exist on a network: hosts and routers. All networks must have hosts, while not all networks require routers. Whether you use routers should depend on the physical topology of the network. This section introduces the concepts of network topology and routing, important concepts when you decide to add another network to your existing network environment.

Network Topology

Network topology describes how networks fit together. Routers are the entities that connect networks to each other. From a TCP/IP perspective, a router is any machine that has two or more network interfaces. However, the machine cannot function as a router until properly configured, as described in Chapter 5, "Configuring Routers."

Two or more networks can be connected together by routers to form larger *internetworks*. The routers must be configured to pass packets between two adjacent networks. They also should be able to pass packets to networks that lie beyond the adjacent networks.

Figure 3-5 on page 39 shows the basic parts of a network topology. The first illustration shows a simple configuration of two networks connected by a single router. The second shows a configuration of three networks, interconnected by two routers. In the first case, network 1 and network 2 are joined into a larger internetwork by the router R. In the second case, router R1 connects networks 1 and 2 together, and router R2 connects networks 2 and 3, thus forming a network made up of networks 1, 2, and 3.

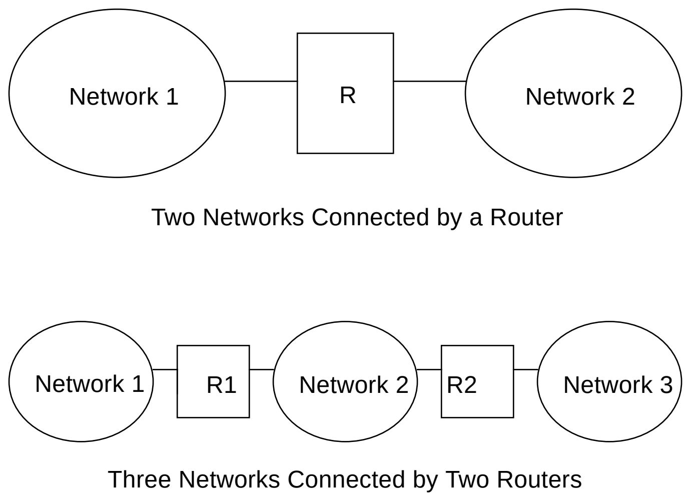

Network 1
R
Network 2
Two Networks Connected by a Router
Network 1
R1
Network 2
R2
Network 3
Three Networks Connected by Two Routers

Figure 3-5 Basic Network Topology

Routers join networks into internetworks and route packets between them based on the addresses of the destination network. As internetworks grow more complex, each router must make more and more decisions regarding where packets are to be sent.

A step up in complexity is the case shown in Figure 3-6. Networks 1 and 3 are directly connected by a router R3. The reason for such redundancy is reliability. If network 2 goes down, router R3 still provides a route between networks 1 and 3. Any number of networks can be interconnected and can communicate as long as they all adhere to the same network protocols.

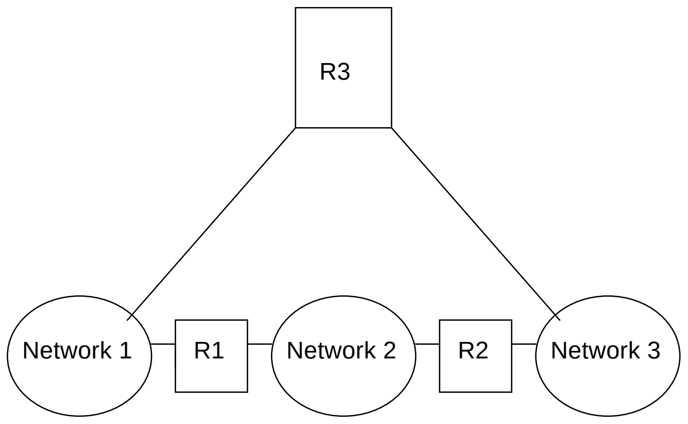


Figure 3-6 Providing an Additional Path Between Networks

How Routers Transfer Packets

Routing decisions on a network are based on the network portion of the IP address of the recipient that is contained in the packet header. If this address includes the network number of the local network, the packet goes directly to the host with that IP address. If the network number is not the local network, the packet goes to the router on the local network

Routers maintain routing information in *routing tables*. These tables contain the IP address of the hosts and routers on the networks to which the router is connected. The tables also contain pointers to these networks. When a router gets a packet, it consults its routing table to see if it lists the destination address in the header. If the table does not contain the destination address, the router forwards the packet to another router listed in its routing table. Refer to Chapter 5, "Configuring Routers," for detailed information on routers.

Figure 3-7 on page 41 shows a network topology with three networks connected by two routers.

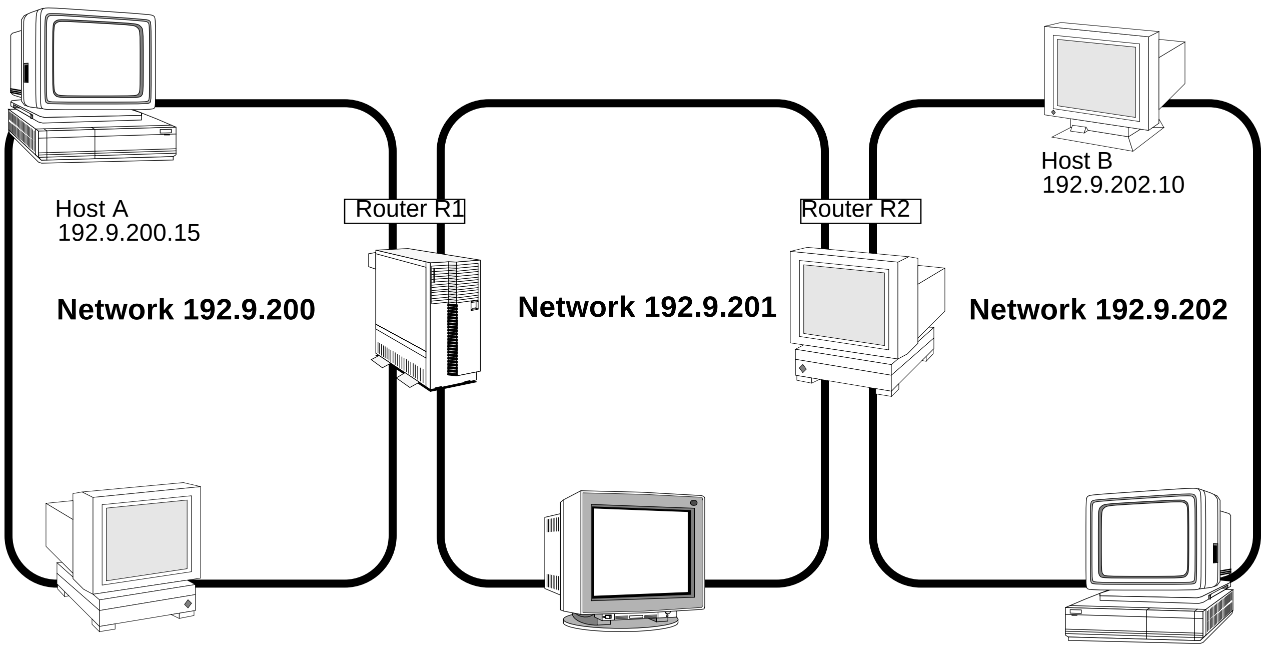


Figure 3-7 Three Interconnected Networks

Router R1 connects networks 192.9.200 and 192.9.201. Router R2 connects networks 192.9.201 and 192.9.202. Suppose host A on network 192.9.200 wants to send a message to host B on network 192.9.202. Here is what happens.

1. Host A sends a packet out over network 192.9.200. The packet header contains the IP address of the recipient host B, 192.9.202.10.
2. None of the machines on network 192.9.200 have the IP address 192.9.202.10. Therefore, Router R1 accepts the packet.
3. Router R1 examines its routing tables. No machine on network 192.9.201 has the address 192.9.202.10. However, the routing tables do list Router R2.
4. R1 then selects R2 as the "next hop" router and sends the packet to R2.

5. Because R2 connects network 192.9.201 to 192.9.202, it has routing information for host B. Router R2 then forwards the packet to network 192.9.202, where it is accepted by Host B.

Configuring TCP/IP on the Network 4

The second phase of network administration involves setting up the network. This consists of assembling the hardware that makes up the physical part of the network and configuring TCP/IP. This chapter explains how to configure TCP/IP, including:

- Determining the host configuration mode for each machine on your network
- Setting up the subnet mask for your network (optional)
- Configuring TCP/IP on the machines that will run in local files mode
- Configuring a network configuration server
- Configuring TCP/IP on machines that will run in network client mode
- Editing the network databases, based on the name service you have selected for your network
- Configuring the name service switch file

4

Before You Configure TCP/IP

Before configuring the TCP/IP software, you should have:

1. Designed the network topology, if you are the network designer. (See ”Network Topology” on page 38 for details.)
2. Obtained a network number from your Internet addressing authority. (See ”Network Classes” on page 28.)
3. Assembled the network hardware according to the topology designed and assured that the hardware is functioning. (See the hardware manuals and ”Network Topology” on page 38.)
4. Run any configuration software required by network interfaces and routers, if applicable. (See Chapter 3, “Planning Your Network,” and Chapter 5, “Configuring Routers,” for information on routers. If you have purchased network interfaces for your machines, refer to the manuals that came with them for software configuration requirements.)
5. Planned the IP addressing scheme for the network, including subnet addressing, if applicable. (See ”Designing Your IP Addressing Scheme” on page 31.)
6. Assigned IP numbers and host names to all machines involved in the network. (See ”Designing Your IP Addressing Scheme” on page 31.)
7. Determined which name service your network will use: NIS, NIS+, DNS, or local files. (See *Name Services Administration Guide*.)
8. Selected a domain name(s) for your network, if applicable. (See *Name Services Administration Guide*.)
9. Installed the operating system on at least one machine on the prospective network (*SPARC: Installing Solaris Software* or *x86: Installing Solaris Software*).

Determining Host Configuration Modes

One of the key functions you will carry out as a network administrator is configuring TCP/IP to run on hosts and routers (if applicable). You can set up these machines to obtain configuration information from two sources: files on the local machine or files located on other machines on the network. Configuration information includes:

- host name of a machine
- IP address of the machine
- domain name to which the machine belongs
- default router
- netmask in use on the machine's network

A machine that obtains TCP/IP configuration information from local files is said to be operating in *local files mode*. A machine that obtains TCP/IP configuration information from a remote machine is said to be operating in *network clien*t mode.

Machines That Should Run in Local Files Mode

To run in local files mode, a machine must have local copies of the TCP/IP configuration files. These files are described in "TCP/IP Configuration Files" on page 49. The machine should have its own disk, though this is not strictly necessary.

Most servers should run in local file mode. This requirement includes:

- Network configuration servers
- NFS servers
- Name servers supplying NIS, NIS+, or DNS services
- Mail servers

Additionally, routers should run in local files mode.

Machines that exclusively function as print servers do not need to run in local files mode. Whether individual hosts should run in local files mode depends on the size of your network.

If you are running a very small network, the amount of work involved in maintaining these files on individual hosts is manageable. If your network serves hundreds of hosts, the task becomes difficult, even with the network divided into a number of administrative subdomains. Thus, for large networks, using local files mode usually is not efficient. On the other hand, because routers and servers must be self-sufficient, they should be configured in the local files mode.

Network Configuration Servers

Network configuration servers are the machines that supply the TCP/IP configuration information to hosts configured in network client mode. These servers support three booting protocols:

- RARP–Reverse Address Resolution Protocol (RARP) maps known Ethernet addresses (48 bits) to IP addresses (32 bits), the reverse of ARP. When you run RARP on a network configuration server, this enables hosts running in network client mode to obtain their IP addresses and TCP/IP configuration files from the server. The `in.rarpd` daemon enables RARP services. Refer to the `in.rarpd`(1M) man page for complete details.
- TFTP–Trivial File Transfer Protocol (TFTP) is an application that transfers files between remote machines. The `in.tftpd` daemon carries out TFTP services, enabling file transfer between network configuration servers and their network clients.
- bootparams–The bootparams protocol supplies parameters for booting that are required by diskless clients. The `rpc.bootparamd` daemon carries out these services.

Network configuration servers may also may function as NFS file servers.

If you are going to configure any hosts as network clients, then you must also configure at least one machine on your network as a network configuration server. If your network is subnetted, then you must have at least one network configuration server for each subnet with network clients.

Machines That Are Network Clients

Any host that get its configuration information from a network configuration server is said to be “operating” in network client mode. Machines configured as network clients do not require local copies of the TCP/IP configuration files.

Network client mode greatly simplifies administration of large networks. It minimizes the number of configuration tasks that must be performed on individual hosts and assures that all machines on the network adhere to the same configuration standards.

You can configure network client mode on all types of computers, from fully standalone systems to diskless and dataless machines. Although it is possible to configure routers and servers in network client mode, local files mode is a better choice for these machines. Routers and servers should be as self-sufficient as possible.

Diskless Booting

Setting up systems for diskless booting is described in *x86: Installing Solaris Software* and *SPARC: Installing Solaris Software*.

Mixed Configurations

Due to the flexibility of the system, configurations are not limited to either an all local hosts mode or an all network client mode. The configuration of routers and servers typifies this, in that routers and servers should always be configured in local mode. For hosts, you can use any combination of local and network client mode you wish.

Sample Network

Figure 4-1 on page 48 shows the hosts of a fictional network with the network number 192.9.200. The network includes one network configuration server, the machine `sahara`. It serves the diskless client `ahaggar`. Machines `tenere` and `nubian` have their own disks and run in local files mode. Machine `faiyum` also has a disk but operates in network client mode.

Finally, the machine `timbuktu` is configured as a router. It includes two network interfaces, one named `timbuktu` on network 192.9.200 and one named `timbuktu-201` on network 192.9.201. Both networks are in the organizational domain deserts.worldwide.COM. The domain uses local files as its name service.

Most examples in this chapter use the network shown in Figure 4-1 on page 48 as their basis.

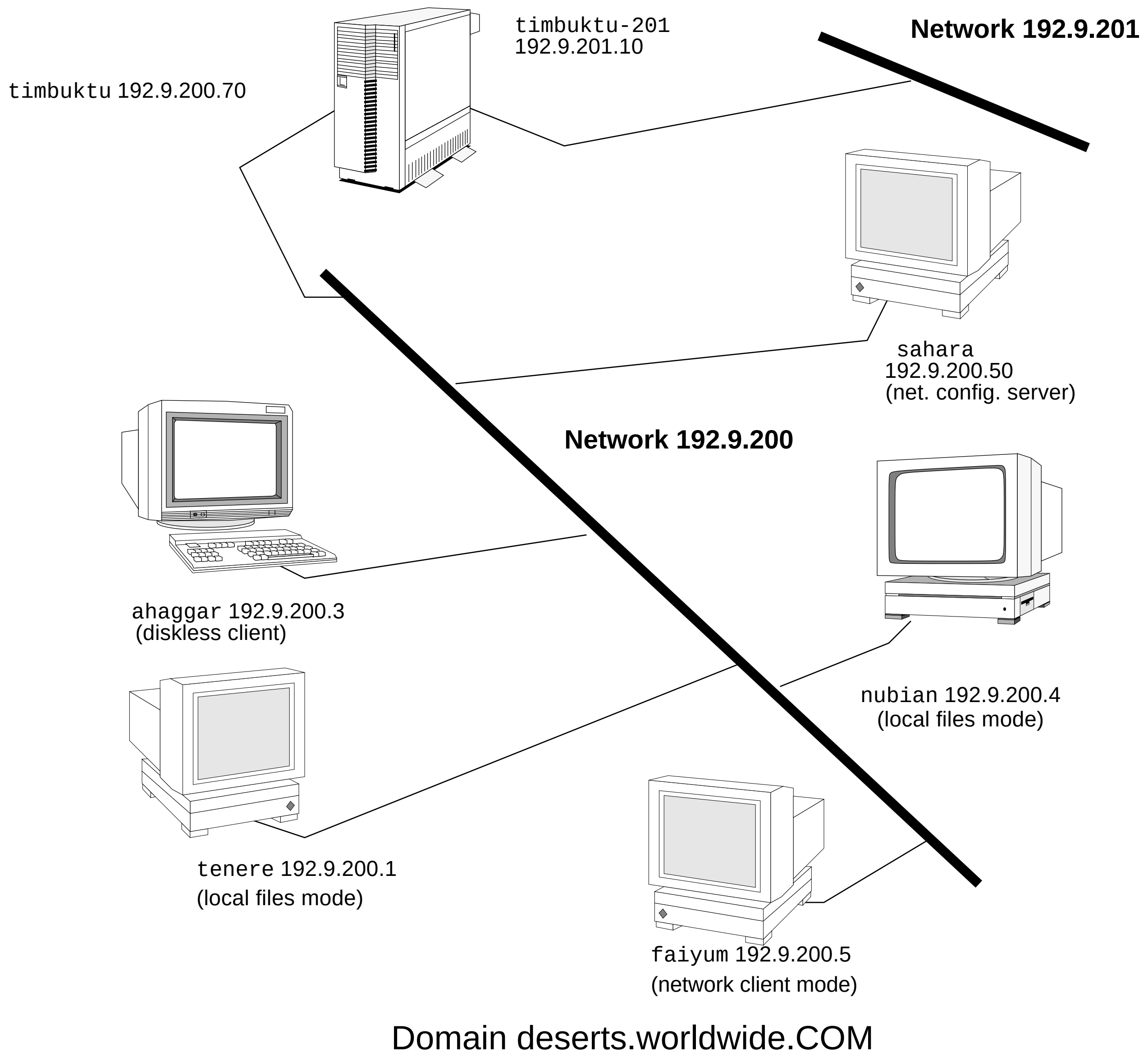


Figure 4-1 Hosts in a Sample Network

TCP/IP Configuration Files

Each machine on the network gets its TCP/IP configuration information from the following TCP/IP configuration files and network databases:

- `/etc/hostname.`*interface* file
- `/etc/nodename` file
- `/etc/defaultdomain` file
- `/etc/defaultrouter` file (optional)
- `hosts` database
- `netmasks` database (optional)

The Solaris installation program creates these files as part of the installation process. You can also edit the files manually, as explained in "TCP/IP Configuration Files". The `hosts` and `netmasks` databases are two of the network databases read by the name services available on Solaris networks. "Network Databases and nsswitch.conf File" on page 58 describes the concept of network databases in detail.

`/etc/hostname.`*interface* File

This file defines the network interfaces on the local host. At least one `/etc/hostname.`*interface* file should exist on the local machine. The Solaris installation program creates this file for you. In the file name, *interface* is replaced by the device name of the primary network interface.

The file contains only one entry: the host name or IP address associated with the network interface. For example, suppose `smc0` is the primary network interface for a machine called `ahaggar.` Its `/etc/hostname.`*interface* file would have the name `/etc/hostname.smc0`; the file would contain the entry `ahaggar.`

For Multiple Network Interfaces

If a machine contains more than one network interface, you must create additional `/etc/hostname.`*interface* files for the additional network interfaces. You must create these files with your preferred text editor; the Solaris installation program will not create them for you.

For example, consider the machine `timbuktu` shown in Figure 4-1 on page 48. It has two network interfaces and therefore is considered a router. The primary network interface `le0` is connected to network 192.9.200. It has an IP address 192.9.200.70 and the host name `timbuktu`.The Solaris installation program creates the file `/etc/hostname.le0` for the primary network interface and enters the host name `timbuktu` in the file.

The second network interface is `le1`; it is connected to network 192.9.201. Although this interface is physically installed on machine `timbuktu`, it must have a separate IP address. Therefore, you have to manually create the `/etc/hostname.le1` file for this interface; the entry in the file would be the router‘s name `timbuktu-201`.

`/etc/nodename` *File*

This file should contain one entry: the host name of the local machine. For example, on machine `timbuktu`, the file `/etc/nodename` would contain the entry `timbuktu`.

`/etc/defaultdomain` *File*

This file should contain one entry, the fully qualified domain name of the administrative domain to which the local host's network belongs. You can supply this name to the Solaris installation program or edit the file at a later date.

In Figure 4-1 on page 48, the networks are part of the domain deserts.worldwide, which was classified as a .COM domain. Therefore, `/etc/defaultdomain` should contain the entry `deserts.worldwide.COM`. For more information on network domains, refer to *Name Services Administration Guide.*

`/etc/defaultrouter` *File*

This file should contain an entry for each router directly connected to the network. The entry should be the name for the network interface that functions as a router between networks.

In Figure 4-1 on page 48, the network interface `le1` connects machine `timbuktu` with network 192.9.201. This interface has the unique name `timbuktu-201`. Thus, the machines on network 192.9.200 that are configured in local files mode have the name `timbuktu-201` as the entry in `/etc/defaultrouter`.

`hosts` *Database*

The `hosts` database contains the IP addresses and host names of machines on your network. If you use the NIS, NIS+, or DNS name services, the `host` database is maintained in a database designated for host information. For example, on a network running NIS+, the `hosts` database is maintained in the host table.

If you use local files for name service, the `hosts` database is maintained in the `/etc/inet/hosts` file. This file contains the host names and IP addresses of the primary network interface, other network interfaces attached to the machine, and any other network addresses that the machine must know about.

Note – For compatibility with BSD-based operating systems, the file `/etc/hosts` is a symbolic link to `/etc/inet/hosts`.

`/etc/inet/hosts` *File Format*

The `/etc/inet/hosts` file uses this basic syntax: (Refer to the `hosts`(4) man page for complete syntax information.)

IP-address hostname [nicknames] [#comment]

IP-address
contains the IP address for each interface that the local host must know about.

hostname
contains the host name assigned to the machine at setup, plus the host names assigned to additional network interfaces that the local host must know about.

[nickname]
is an optional field containing a nickname for the host.

[# comment]
is an optional field where you can include a comment.

Initial `/etc/inet/hosts` *File*

When you run the Solaris installation program on a machine, it sets up the initial `/etc/inet/hosts` file. This file contains the minimum entries that the local host requires: its loopback address, its IP address, and its host name.

For example, the Solaris installation program might create the following `/etc/inet/hosts` file for machine `ahaggar` shown in Figure 4-1 on page 48:

Code Example 4-1 `/etc/inet/hosts` File for Machine `ahaggar`.

```
127.0.0.1       localhost         loghost    #loopback address
192.9.200.3     ahaggar                      #host name
```

Loopback Address

In Code Example 4-1, the IP address 127.0.0.1 is the *loopback address*, the reserved network interface used by the local machine to send packets to itself. The `ifconfig` command uses the loopback address for configuration and testing, as explained in "ifconfig Command" on page 88. Every machine on a TCP/IP network has the IP address 127.0.0.1 for the local host.

Host Name

The IP address 192.9.200.3 and the name `ahaggar` are the address and host name of the local machine. They are assigned to the machine's primary network interface.

Multiple Network Interfaces

Machines functioning as routers have at least two network interfaces. Each additional network interface attached to the machine requires its own IP address and associated name. When you configure a router, you must manually add this information to the router's `/etc/inet/hosts` file.

Here is the `/etc/inet/hosts` file for machine `timbuktu` shown in Figure 4-1 on page 48.

```
 127.0.0.1       localhost     loghost
192.9.200.70     timbuktu      #This is the local host name
192.9.201.10     timbuktu-201  #Interface to network 192.9.201
```

With these two interfaces, `timbuktu` connects networks 192.9.200 and 192.9.201 as a router.

How Name Services Affect the `hosts` *Database*

The NIS, NIS+, and DNS name services maintain host names and addresses on one or more servers. These servers maintain `hosts` databases containing information for every host and router (if applicable) on the servers' network. Refer to *Name Services Administration Guide* for more information about these services.

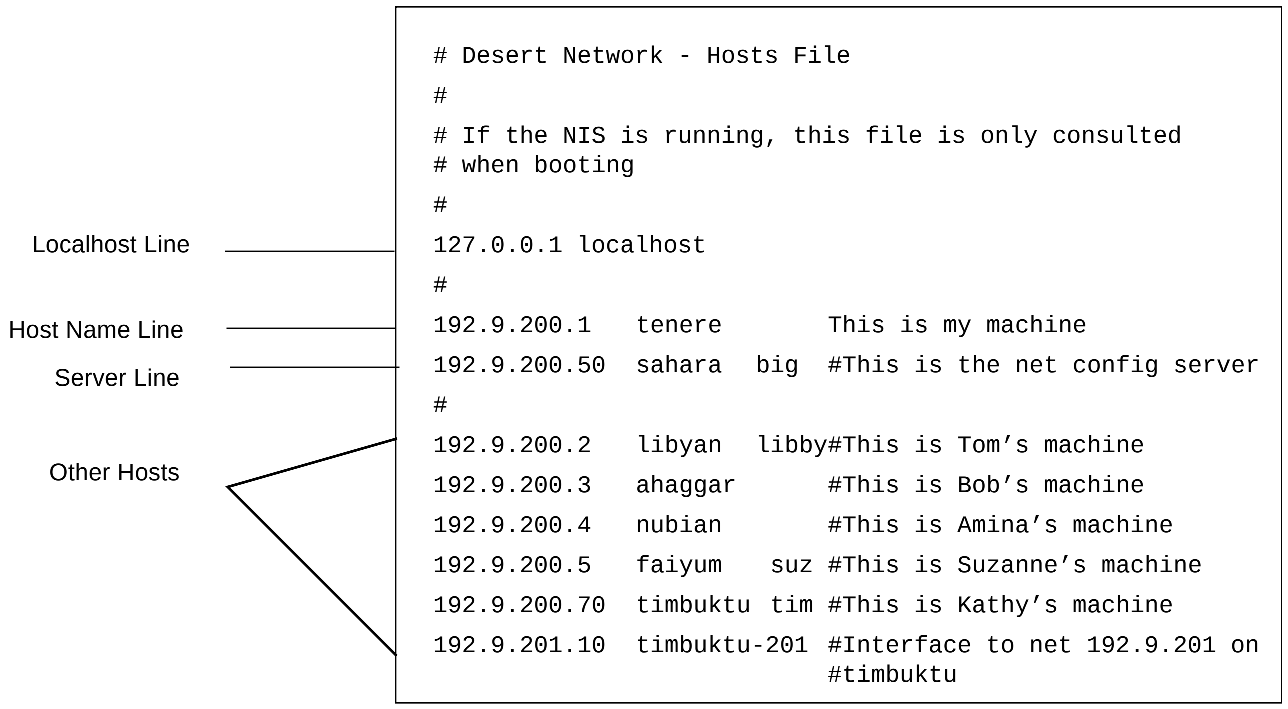
When Local Files Provide Name Service

On a network using local files for name service, machines running in local files mode consult their individual `/etc/inet/hosts` files for IP addresses and host names of other machines on the network. Therefore, their `/etc/inet/hosts` files must contain the:

- Loopback address
- IP address and host name of the local machine (primary network interface)
- IP address and host name of additional network interfaces attached to this machine, if applicable
- IP addresses and host names of all hosts on the network
- IP addresses and host names of any routers this machine must know about, if applicable
- IP address of any machine your machine wants to refer to by its host name

Code Example 4-2 on page 54 shows the `/etc/inet/hosts` file for machine `tenere`, a machine that runs in local files mode. Notice that the file contains the IP addresses and host names for every machine on the 192.9.200 network. It also contains the IP address and interface name `timbuktu-201`, which connects the 192.9.200 network to the 192.9.201 network.

A machine configured as a network client uses the local `/etc/inet/hosts` file for its loopback address and IP address.



```
# Desert Network - Hosts File
#
# If the NIS is running, this file is only consulted
# when booting
#
127.0.0.1 localhost
#
192.9.200.1   tenere       This is my machine
192.9.200.50  sahara   big #This is the net config server
#
192.9.200.2   libyan  libby#This is Tom’s machine
192.9.200.3   ahaggar      #This is Bob’s machine
192.9.200.4   nubian       #This is Amina’s machine
192.9.200.5   faiyum   suz #This is Suzanne’s machine
192.9.200.70  timbuktu  tim #This is Kathy’s machine
192.9.201.10  timbuktu-201 #Interface to net 192.9.201 on
                           #timbuktu
```

Code Example 4-2 `/etc/inet/hosts` File for Machine Running in Local Files Mode

`netmasks` *Database*

You need to edit the `netmasks` database as part of network configuration *only* if you have set up subnetting on your network. The `netmasks` database consists of a list of networks and their associated subnet masks.

Note – When you create subnets, each new network must be a separate physical network. You cannot apply subnetting to a single physical network.

What Subnetting Is

Subnetting is a method for getting the most out of the limited 32-bit IP addressing space and reducing the size of the routing tables in a large internetwork. With any address class, subnetting provides a means of allocating a part of the host address space to network addresses, which lets you have more networks. The part of the host address space allocated to new network addresses is known as the *subnet* number.

In addition to making more efficient use of the IP address space, subnetting has several administrative benefits. Routing can get very complicated as the number of networks grows. A small organization, for example, might give each local network a class C number. As the organization grows, administering a number of different network numbers could become complicated. A better idea is to allocate a few class B network numbers for each major division in an organization. For instance, you could allocate one for Engineering, one for Operations, and so on. Then, you could divide each class B network into additional networks, using the additional network numbers gained by subnetting. This can also reduce the amount of routing information that must be communicated among routers.

Creating the Network Mask

As part of the subnetting process, you will need to select a network wide netmask. The netmask determines how many and which bits in the host address space will represent the subnet number and how many and which will represent the host number. Recall that the complete IP address consists of 32 bits. Depending on the address class, as many as 24 bits and as few as 8 bits can be available for representing the host address space. The netmask is specified in the `netmasks` database.

If you plan to use subnets, you must determine your netmask before you configure TCP/IP. You then need to carry out the procedures in ”How to Add a Subnet to an Existing Network” on page 58. If you plan to install the operating system as part of network configuration, the Solaris installation program will request the netmask for your network.

As described in ”Parts of the IP Address” on page 27, 32-bit IP addresses consist of a network part and a host part. The 32 bits are divided into 4 bytes. Each byte is assigned either to the network number or the host number, depending on the network class.

For example, in a class B IP address, the 2 left–hand bytes are assigned to the network number, and the 2 right–hand bytes are assigned to the host number. In the class B IP address 129.144.41.10, you can assign the 2 right–hand bytes to hosts.

If you are going to implement subnetting, you will need to use some of the bits in the bytes assigned to the host number to apply to subnet addresses. For example, a 16-bit host address space provides addressing for 65,534 hosts. If you apply the third byte to subnet addresses and the fourth to host addresses, you can address up to 254 networks, with up to 254 hosts on each.

Which bits in the host address bytes will be applied to subnet addresses and which to host addresses is determined by a subnet mask. Subnet masks are used to select bits from either byte for use as subnet addresses. Although netmask bits must be contiguous, they need not align on byte boundaries.

The netmask can be applied to an IP address using the bitwise logical AND operator. This operation selects out the network number and subnet number positions of the address.

It is easiest to explain netmasks in terms of their binary representation. You can use `calctool` from the OpenWindows™ desktop environment for binary to decimal conversion. The following examples show both the decimal and binary forms of the netmask.

If a netmask 255.255.255.0 is applied to the IP address 129.144.41.101, the result is the IP address of 129.144.41.0.

129.144.41.101 & 255.255.255.0 = 129.144.41.0

In binary form, the operation is:

11111111.11111111.11111111.00000000 (netmask)

AND

10000001.10010000.00101001.01100101 (IP address)

Now the system will look for a network number of 129.144.41 instead of a network number of 129.144. If you have a network with the number 129.144.41, that is what the system will look for and find. Since you can assign up to 254 values to the third byte of the IP address space, subnetting lets you create address space for 254 networks where previously there was room for only one.

If you want to provide address space for only two additional networks, you could use a subnet mask of:

255.255.192.0

This netmask provides a result of:

11111111.11111111.1100000.00000000

This still leaves 14 bits available for host addresses.

Editing the `/etc/inet/netmasks` *File*

If your network runs NIS or NIS+, the servers for these name services maintain `netmasks` databases. For networks that use local files for name service, this information is maintained in the `/etc/inet/netmasks` file.

Note – For compatibility with BSD-based operating systems, the file `/etc/netmasks` is a symbolic link to `/etc/inet/netmasks`.

Here is a sample `/etc/inet/netmasks` file for a Class B network.

```
## The netmasks file associates Internet Protocol (IP) address
# masks with IP network numbers.
#
#    network-numbernetmask
#
# Both the network-number and the netmasks are specified in
# “decimal dot” notation, e.g:
#
#        128.32.0.0   255.255.255.0
         129.144.0.0  255.255.255.0
```

If the file does not exist, create it. Use the following syntax:

```
network-number        netmask-number
```

Refer to the `netmasks`(4) man page for complete details.

When creating netmask numbers, type the network number assigned by the InterNIC (not the subnet number) and netmask number in `/etc/inet/netmasks`. Each subnet mask should be on a separate line.For example:

```
128.78.0.0    255.255.248.0
```

You also can type symbolic names for network numbers in the `/etc/inet/hosts` file. You can then use these network names instead of the network numbers as parameters to commands.

▼ How to Add a Subnet to an Existing Network

If you are changing from a network that does not use subnets to one that is subnetted, perform the following steps:

1. **Decide on the new subnet topology, including considerations for routers and locations of hosts on the subnets.**
2. **Assign all subnet and host addresses.**
3. **Modify the** `/etc/inet/netmasks` **file, if you are manually configuring TCP/IP, or supply the netmask to the Solaris installation program.**
4. **Modify the** `/etc/inet/hosts` **files on all hosts to reflect the new host addresses.**
5. **Reboot all machines.**

Network Databases and `nsswitch.conf` *File*

The network databases are files that provide information needed to configure the network. The network databases are:

- `hosts`
- `netmasks`
- `ethers`
- `bootparams`
- `protocols`
- `services`
- `networks`

As part of the configuration process, you edit the `hosts` database and the `netmasks` database, if your network is subnetted. Two network databases, `bootparams` and `ethers`, are used to configure machines as network clients. The remaining databases are used by the operating system and seldom require editing.

Although it is not a network database, the `nsswitch.conf` file needs to be configured along with the relevant network databases. `nsswitch.conf` specifies which name service to use for a particular machine: NIS, NIS+, DNS, or local files.

How Name Services Affect Network Databases

The form a network database takes depends on the type of name service you select for your network. For example, the `hosts` database contains, at minimum, the host name and IP address of the local machine and any network interfaces directly connected to the local machine. However, the `hosts` database could contain other IP addresses and host names, depending on the type of name service in use on your network.

The network databases are used as follows:

- Networks that use local files for their name service use files in the `/etc/inet` and `/etc` directories
- NIS+ uses databases called NIS+ tables
- NIS uses databases called NIS maps
- DNS uses records with host information

Note – DNS boot and data files do not correspond directly to the network databases.

Figure 4-2 on page 60 shows the forms of the `hosts` database used by these name services:

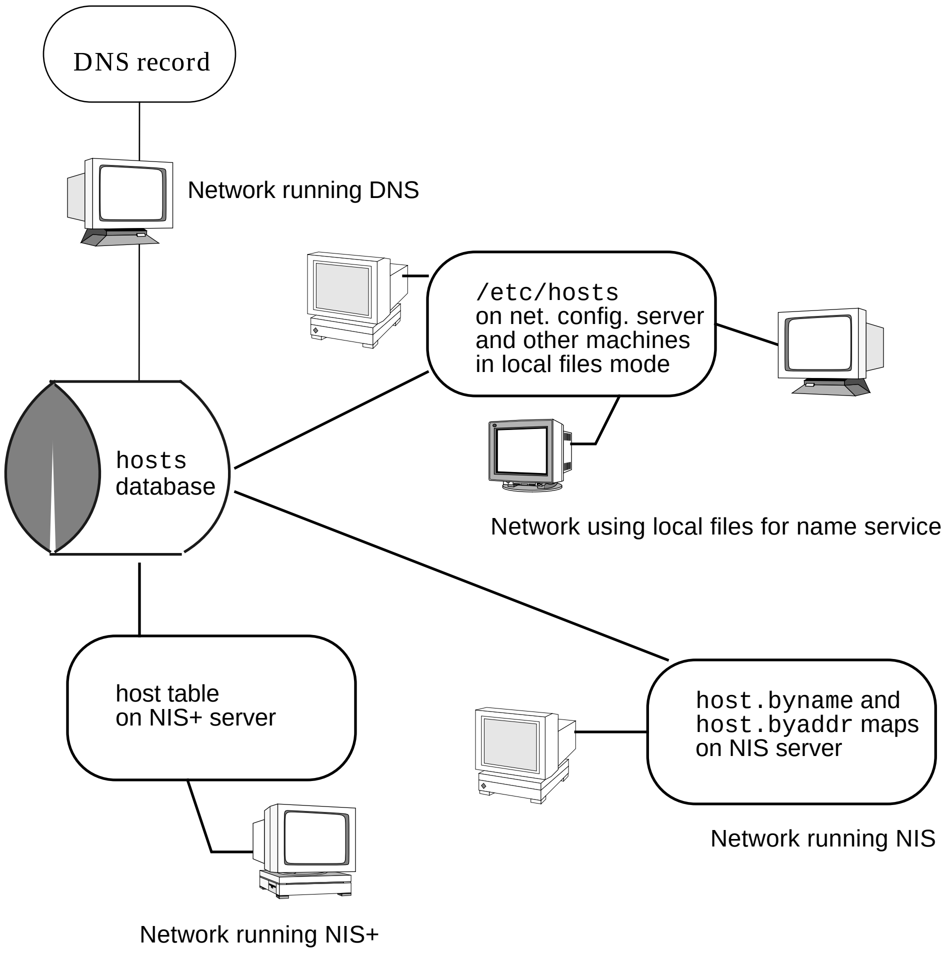


Figure 4-2 Forms of the `hosts` Database Used by Name Services

Table 4-1 on page 61 lists the network databases and how they are used by local files, NIS+, DNS, and NIS.

Table 4-1 Network Databases and Corresponding Name Service Files

Network Database	Local Files	NIS+ Tables	NIS Maps
`hosts`	`/etc/inet/hosts`	hosts	`hosts.byaddr` `hosts.byname`
`netmasks`	`/etc/inet/netmasks`	netmasks	`netmasks.byaddr`
`ethers`	`/etc/ethers`	ethers	`ethers.byname` `ethers.byaddr`
`bootparams`	`/etc/bootparams`	bootparams	`bootparams`
`protocols`	`/etc/inet/protocols`	protocols	`protocols.byname` `protocols.bynumber`
`services`	`/etc/inet/services`	services	`services.byname`
`networks`	`/etc/inet/networks`	networks	`networks.byaddr` `networks.byname`

This book discusses network databases as they are used by networks using local files for name services. Information regarding the `hosts` database is in ”hosts Database” on page 51; information regarding the `netmasks` database is in ”netmasks Database” on page 54. Refer to *Name Services Administration Guide* for information on network databases correspondences in NIS, DNS, and NIS+.

`nsswitch.conf` *File—Specifying Which Name Service to Use*

The `/etc/nsswitch.conf` file defines the search order of the network databases. The Solaris installation program creates a default `/etc/nsswitch.conf` file for the local machine, based on the name service you indicate during the installation process. If you selected the “None” option, indicating local files for name service, the resulting `nsswitch.conf file` will resemble Figure 4-3 on page 62.

:

```
# /etc/nsswitch.files:
#
# An example file that could be copied over to /etc/nsswitch.conf;
it
# does not use any naming service.
#
# "hosts:" and "services:" in this file are used only if the
/etc/netconfig
# file contains "switch.so" as a nametoaddr library for "inet"
transports.

passwd:     files
group:      files
hosts:      files
networks:   files
protocols:  files
rpc:        files
ethers:     files
netmasks:   files
bootparams: files
publickey:  files
# At present there isn't a 'files' backend for netgroup; the
system will
#   figure it out pretty quickly, and won't use netgroups at all.
netgroup:   files
automount:  files
aliases:    files
services:   files
sendmailvars:   files
```

Figure 4-3 `nsswitch.conf` for Networks Using Files for Name Service

The `nsswitch.conf`(4) man page describes the file in detail. Its basic syntax is:

database *name_service_to_search*

The *database* field can list one of many types of databases searched by the operating system. For example, it could indicate a database affecting users, such as `passwd` or `aliases`, or a network database. The parameter *name_service_to_search* can have the values `files`, `nis`, or `nis+` for the network databases. (The `hosts` database can also have `dns` as a name service to search.) You can also list more than one name service, such as `nis+` and `files`.

In Figure 4-3 on page 62, the only search option indicated is `files`. Therefore, the local machine gets security and automounting information, in addition to network database information, from files located in its `/etc` and `/etc/inet` directories.

Changing `nsswitch.conf`

The `/etc` directory contains the `nsswitch.conf` file created by the Solaris installation program. It also contains template files for the following name services:

- `nsswitch.files`
- `nsswitch.nis`
- `nsswitch.nis+`

If you want to change from one name service to another, you can copy the appropriate template to `nsswitch.conf`. You can also selectively edit the `nsswitch.conf` file, and change the default name service to search for individual databases.

For example, on a network running NIS, you may have to change the `nsswitch.conf` file on diskless clients. The search path for the `bootparams` and `ethers` databases must list `files` as the first option, and then `nis`. Figure 4-4 on page 64 shows the correct search paths.

.

```
## /etc/nsswitch.conf:
#
.
.
passwd:     files nis
group:      files nis

# consult /etc "files" only if nis is down.
hosts:      nis [NOTFOUND=return] files
networks:   nis [NOTFOUND=return] files
protocols:  nis [NOTFOUND=return] files
rpc:        nis [NOTFOUND=return] files
ethers:     files [NOTFOUND=return] nis
netmasks:   nis [NOTFOUND=return] files
bootparams: files [NOTFOUND=return] nis
publickey:  nis [NOTFOUND=return] files

netgroup:   nis

automount:  files nis
aliases:    files nis

# for efficient getservbyname() avoid nis
services:   files nis
sendmailvars:   files
```

Figure 4-4 `nsswitch.conf` for a Diskless Client on a Network Running NIS

For complete details on the name service switch, refer to the *Name Services Administration Guide.*

`bootparams` *Database*

The `bootparams` database contains information used by diskless clients and machines configured to boot in the network client mode. You will have to edit it if your network will have network clients. (See ”Configuring Network Clients” on page 73 for procedures.) The database is built from information entered into the `/etc/bootparams` file.

The `bootparams`(4) man page contains complete syntax for this database. Its basic syntax is

machine-name file-key-server-name:pathname

For each diskless or network client machine, the entry may contain the following information: the name of the client, a list of keys, the names of servers, and path names.

The first item of each entry is the name of the client machine. Next is a list of keys, names of servers, and path names, separated by tab characters. All items but the first are optional. The database can contain a wildcard entry that will be matched by all clients.

Here is an example `bootparams` database:

```
myclient   root=myserver : /nfsroot/myclient  \
swap=myserver : /nfsswap//myclient \
dump=myserver : /nfsdump/myclient
```

The term `dump=:` tells diskless hosts not to look for a dump file.

Wildcard Entry for `bootparams`

In most cases, you will want to use the wildcard entry when editing the `bootparams` database to support diskless clients. This entry is:

```
*  root=server:/path dump=:
```

The asterisk (*) wildcard indicates that this entry applies to all clients not specifically named within the `bootparams` database.

ethers Database

The ethers database is built from information entered into the /etc/ethers file. It associates host names to their Ethernet addresses. You need to create an ethers database only if you are running the RARP daemon; that is, if you are configuring network clients or diskless machines.

RARP uses the file to map Ethernet addresses to IP addresses. If you are running the RARP daemon in.rarpd, you need to set up the ethers file and maintain it on all hosts running the daemon to reflect changes to the network.

The ethers(4) man page contains complete syntax information for this database. Its basic format is:

Ethernet-address hostname #comment

Ethernet-address
is the Ethernet address of the host.

hostname
is the official name of the host.

#comment
is any kind of note you want to append to an entry in the file.

The equipment manufacturer provides the Ethernet address. If a machine does not display the Ethernet address when you power up, see your hardware manuals for assistance.

When adding entries to the ethers database, make sure that host names correspond to the primary names in the hosts database, not to the nicknames.

In this /etc/ethers file, note that entries are in alphabetical order by machine name.

```
8:0:20:1:40:16    fayoum
8:0:20:1:40:15    nubian
8:0:20:1:40:7     sahara          # This is a comment
8:0:20:1:40:14    tenere
```

Other Network Databases

The remaining network databases seldom need to be edited.

`networks` *database*

The `networks` database associates network names with network numbers, enabling some applications to use and display names rather than numbers. The `networks` database is based on information in the `/etc/inet/networks` file. It contains the names of all networks to which your network connects via routers.

The Solaris installation program sets up the initial `networks` database. The only time you need to update it is when you add a new network to your existing network topology.

The `networks`(4) man page contains full syntax information for `/etc/inet/networks`. Here is its basic format:

network-name network-number nickname(s) #comment

network-name
is the official name for the network.

network-number
is the number assigned by the InterNIC.

nickname
is any other name by which the network is known.

#comment
is any kind of note you want to append to an entry in the file.

It is particularly important that you maintain the `networks` file. The `netstat` program uses the information in this database to produce status tables.

Here is a sample `/etc/networks` file:

```
#ident"@(#)networks1.492/07/14 SMI"/* SVr4.0 1.1*/
#
# The networks file associates Internet Protocol (IP) network
numbers with network names. The format of this file is:
#
#   network-namenetwork-numbernicnames . . .

# The loopback network is used only for intra-machine
communication
#
loopback127

# Internet networks
#
arpanet 10     arpa# Historical
ucb-ether 46ucbether
#
# local networks
eng          193.9.0   #engineering
acc          193.9.1   #accounting
prog         193.9.2   #programming
```

`protocols` *Database*

The `protocols` database lists the TCP/IP protocols installed on your system and their numbers; the Solaris installation program automatically creates it. It is rare when this file requires administrative handling.

The `protocols` database contains the names of the TCP/IP protocols installed on the system. Its syntax is completely described in the `protocols`(4) man page. Here is an example of the `/etc/inet/protocols` file:

```
#
# Internet (IP) protocols
#
ip  0   IP  # internet protocol, pseudo protocol number
icmp1   ICMP# internet control message protocol
tcp 6   TCP # transmission control protocol
udp 17  UDP # user datagram protocol
```

`services` *Database*

The `services` database lists the names of TCP and UDP services and their well known port numbers; it is used by programs that call network services. The Solaris installation automatically creates the `services` database; it generally requires no administrative handling.

The services(4) man page contains complete syntax information. Here is an excerpt from a typical `/etc/inet/services` file:

```
#
# Network services
#
echo      7/udp
echo      7/tcp
discard   9/udp     sink null
discard   9/tcp     sink null
systat    11/tcp
daytime   13/udp
daytime   13/tcp
netstat   15/tcp
ftp-data  20/tcp
ftp       21/tcp
telnet    23/tcp
time      37/tcp    timeserver
time      37/udp    timeserver
name      42/udp    nameserver
whois     43/tcp    nickname
```

4

Network Configuration Procedures

Network software installation takes place along with the installation of the operating system software. At that time, certain IP configuration parameters must be stored in appropriate files so they can be read at boot time.

The procedure is simply a matter of creating or editing the network-configuration files. How configuration information is made available to a machine's kernel depends on whether these files are stored locally (local files mode) or acquired from the network configuration server (network client mode).

Parameters supplied during network configuration are:

- IP address of each network interface on every machine.
- Host names of each machine on the network. You can type the host name in a local file or a name service database.
- NIS, NIS+, or DNS domain name in which the machine resides, if applicable.
- Default router addresses. You supply this only if you have a simple network topology with only one router attached to each network, or your routers don't run routing protocols such as the Router Discovery Server Protocol (RDISC) or the Router Information Protocol (RIP). (See Chapter 5, "Configuring Routers," for more information about these protocols.)
- Subnet mask (required only for networks with subnets).

This chapter contains complete information on creating and editing local configuration files. See *Name Services Administration Guide* for information on working with name service databases.

▼ How to Configure a Host for Local Files Mode

Use the following procedures for configuring TCP/IP on a machine that will run in local files mode.

1. **Become superuser and change to the `/etc` directory.**
2. **Type the host name of the machine in the file `/etc/nodename`.**
   For example, if the name of the host is `tenere`, type `tenere` in the file.

3. **Create a file named `/etc/hostname.`*interface* for each network interface.** (The Solaris installation program automatically creates this file for the primary network interface.)

   Refer to "/etc/hostname.interface File" on page 49 for complete details.

4. **Type either the interface IP address or the interface name in each`/etc/hostname.`*interface* file.**
   For example, create a file named `hostname.ie1`, and type either the IP address of the host's interface or the host's name.

5. **Edit the `/etc/inet/hosts` file to add:**

Note – The Solaris installation program creates the default `/etc/inet/hosts` for the local machine. If the file does not exist, create it as shown in "hosts Database" on page 51.

---

   a. **IP addresses that you have assigned to any additional network interfaces in the local machine, along with the corresponding host name for each interface.**
      The Solaris installation program will already have created entries for the primary network interface and loopback address.

   b. **IP address or addresses of the file server, if the `/usr` file system is NFS mounted.**

6. **Type the host's fully qualified domain name in the `/etc/defaultdomain` file.**

   For example, suppose host `tenere` was part of the domain deserts.worldwide.COM. Therefore, you would type `deserts.worldwide.COM` in `/etc/defaultdomain`. See "/etc/defaultdomain File" on page 50 for more information.

7. **Type the router's name in `/etc/defaultrouter`.**
   See "/etc/defaultrouter File" on page 50 for information about this file.

8. **Type the name of the default router and its IP addresses in `/etc/inet/hosts`.**

   Additional routing options are available. Refer to the discussion on routing options in "How to Configure Hosts for Network Client Mode" on page 73. You can apply these options to a local files mode configuration.

9. **If your network is subnetted, type the network number and the netmask in the file** `/etc/inet/netmasks`**.**

   If you have set up a NIS or NIS+ server, you can type `netmask` information in the appropriate database on the server as long as server and clients are on the same network.

10. **Reboot each machine on the network.**

Setting Up a Network Configuration Server

If you plan to configure certain hosts as network clients, you must configure at least one machine on your network as a network configuration server. (Refer to ”Network Configuration Servers” on page 46 for an introduction.)

Setting up a network configuration server involves:

1. Turning on the network configuration daemons:
   - `in.tftpd`
   - `in.rarpd`
   - `rpc.bootparamd`
2. Editing and maintaining the network configuration files on the configuration server.

”How to Set Up a Network Configuration Server” assumes that you have already set up the network configuration server for local files mode.

▼ How to Set Up a Network Configuration Server

1. **Become superuser and change to the root directory of the prospective network configuration server.**
2. **Turn on the** `in.tftpd` **daemon by creating the directory** `/tftpboot`:

```
# mkdir /tftpboot
```

   This configures the machine as a TFTP, bootparams, and RARP server.

3. **Edit the** `hosts` **database, and add the host names and IP addresses for every client on the network.**

4. **Edit the `ethers` database, and create entries for every host on the network to run in network client mode.**
5. **Edit the `bootparams` database.**
   See ”bootparams Database” on page 65. Use the wildcard entry or create an entry for every host that will run in network client mode.
6. **Reboot the server.**

Information for setting up diskless clients, install servers, and boot servers can be found in *SPARC: Installing Solaris Software* and *x86: Installing Solaris Software*.

Configuring Network Clients

Network clients receive their configuration information from network configuration servers. Therefore, before you configure a host as a network client you must ensure that at least one network configuration server is set up for the network.

▼ How to Configure Hosts for Network Client Mode

Do the following on each host to be configured in network client mode:

1. **Become superuser.**
2. **Check the directory for the existence of an `/etc/nodename` file. If one exists, delete it.**
   Eliminating `/etc/nodename` causes the system to use the `hostconfig` program to obtain the host name, domain name, and router addresses from the network configuration server. See ”Network Configuration Procedures” on page 70.
3. **Create the file `/etc/hostname.`*interface*, if it does not exist.**
   Make sure that the file is empty. An empty `/etc/hostname.`*interface* file causes the system to acquire the IP address from the network configuration server.
4. **Ensure that the `/etc/inet/hosts` file contains only the host name and IP address of the loopback network interface.**
   (See ”Loopback Address” on page 52). The file should not contain the IP address and host name for the local machine (primary network interface).

EXCEPTION: For a diskless client (a machine with an NFS-mounted root file system), type the name and IP address of the server that provides the client's root file system (usually, but not always, the network configuration server).

5. **Check for the existence of an `/etc/defaultdomain` file. If one exists, delete it.**
   The `hostconfig` program will set the domain name automatically. If you wish to override the domain name set by `hostconfig`, type the substitute domain name in the file `/etc/defaultdomain`.

6. **Ensure that the search paths in the client's `/etc/nsswitch.conf` reflects the name service requirements for your network.**

▼ How to Specify a Router for the Network Client

1. **If you have only one router on the network and you want the network configuration server to automatically specify its name, ensure that the network client does not have a `/etc/defaultrouter` file.**

2. **To override the name of the default router provided by the network configuration server:**

   a. **Create `/etc/defaultrouter` on the network client.**

   b. **Type the host name and IP address of the machine you have designated as the default router.**

   c. **Add the host name and IP address of the designated default router to the network client's `/etc/inet/hosts`.**

3. **If you have multiple routers on the network, create `/etc/defaultrouter` on the network client, but leave it empty.**

Creating `/etc/defaultrouter` and leaving it empty causes one of the two dynamic routing protocols to run: ICMP Router Discovery protocol (RDISC), or Routing Information Protocol (RIP). The system first runs the program `in.rdisc`, which looks for routers that are running the router discovery protocol. If it finds one such router, `in.rdisc` continues to run and keeps track of the routers that are running the RDISC protocol.

If the system discovers that routers are not responding to the RDISC protocol, it uses RIP and runs the daemon `in.routed` to keep track of them.

After Installing a Network Client

After you have finished editing the files on each network client machine, do the following on the network configuration server.

1. **Add entries for the hosts in the `ethers` and `hosts` databases.**
2. **Add entries for the hosts to the `bootparams` database.**
   To simplify matters, you can type a wild card in the `bootparams` database in place of individual entries for each host. For an example, see "bootparams Database" on page 65.
3. **Reboot the server.**

Overview of the Booting Processes

The following information is provided for your reference. It is a brief overview of the network booting processes to help you better visualize what is happening during configuration.

Note – The names of startup scripts may change from one release to another.

---

1. You start the operating system on a host.
2. The kernel runs `/sbin/init`, as part of the booting process.
3. `/sbin/init` runs the `/etc/rcS.d/S30rootusr.sh`. startup script.
4. The script runs a number of system startup tasks, including establishing the minimum host and network configurations for diskless and dataless operations. `/etc/rcS.d/S30rootusr.sh` also mounts the `/usr` file system.
   a. If the local database files contain the required configuration information (host name and IP address), the script uses it.
   b. If the information is not available in local host configuration files, `/etc/rcS.d/S30rootusr.sh` uses RARP to acquire the host's IP address.

5. If the local files contain domain name, host name, and default router address, the machine uses them.
   If the configuration information is not in local files, then the system uses the Bootparams protocol to acquire the host name, domain name, and default router address.

   Note that the required information must be available on a network configuration server that is located on the same network as the host. This is necessary because no internetwork communications exist at this point.

6. After `/etc/rcS/S30rootusr.sh` completes its tasks and several other boot procedures have executed, `/etc/rc2.d/S69inet` runs. This script executes startup tasks that must be completed before the name services (NIS, NIS+, or DNS) can start. These tasks include configuring the IP routing and setting the domain name.

7. At completion of the `S69inet` tasks, `/etc/rc2.d/S71rpc` runs. This script starts the NIS, NIS+, or DNS name service.

8. After `/etc/rc2.d/S71` runs, `/etc/rc2.d/S72inetsvc` runs. This script starts up services that depend on the presence of the name services. `S72inetsvc` also starts the daemon `inetd`, which manages user services such as Telnet.

See *Common Administration Tasks* for a complete description of the booting process.

Configuring Routers 5

This chapter describes procedures for configuring routers on TCP/IP networks. A router is any machine that has two or more network interfaces and forwards packets. Its purpose is to pass information from one network to another. Two common types of routers are computers with additional network interfaces in their card slots and dedicated routers sold by various manufacturers.

You should read this chapter only if you are configuring a router on your network. The text assumes that you have already assembled the network hardware, including adding the additional network interface, if appropriate. ”Network Topology” on page 38 and ”How Routers Transfer Packets” on page 40 cover basic topics regarding routing.

Routing Protocols

Solaris system software supports two routing protocols: Routing Information Protocol (RIP) and ICMP Router Discovery (RDISC). RIP and RDISC are both standard TCP/IP protocols.

Routing Information Protocol (RIP)

RIP is implemented by `in.routed`, the routing daemon, which automatically starts when the machine boots. When run on a router with the `-s` option specified, `in.routed` fills the kernel routing table with a route to every reachable network and advertises "reachability" through all network interfaces.

When run on a host with the `-q` option specified, `in.routed` extracts routing information but does not advertise reachability. On hosts, routing information can be extracted in two ways:

- Do *not* specify the `-S` flag (capital "S": "Space-saving mode") and `in.routed` will build a full routing table exactly as it does on a router.
- Specify the `-S` flag and `in.routed` will create a minimal kernel table, containing a single default route for each available router.

ICMP Router Discovery (RDISC) Protocol

Hosts used RDISC to obtain routing information from routers. Thus, when hosts are running RDISC, routers must also run another protocol, such as RIP, in order to exchange router information among themselves.

RDISC is implemented by `in.rdisc`, which should run on both routers and hosts. Normally, when `in.rdisc` runs on a host, it enters a default route for each router that is also running `in.rdisc`. Note that a host that is running `in.rdisc` will not discover routers that are running only RIP. Note also that when routers are running `in.rdisc` (rather than `in.routed`), they can be configured to have a different preference, which causes hosts to select a better router. See the `rdisc`(1M) man page.

Configuring Routers

TCP/IP's first requirement for a router is that the machine must have at least two network interfaces installed, as introduced in "Network Interfaces" on page 6. Its. As long as one of the network interfaces is not disabled, the router will automatically "talk" to the RDISC and RIP protocols. These protocols keep track of routers on the network and advertise the router to the hosts on the network.

After the router is physically installed on the network, configure it to operate in local files mode, as described in ”How to Configure a Host for Local Files Mode” on page 70. This assures that routers will boot in case the network configuration server is down. Remember that unlike a host, a router has at least two interfaces to configure.

Configuring Both Router Network Interfaces

Since a router provides the interface between two or more networks, you must assign a unique name and IP address to each of the router’s network interface cards. Thus, each router will have a host name and IP address associated with its primary network interface, plus at least one more unique name and IP address for each additional network interface.

▼ How to Configure a Machine as a Router

Become superuser on the machine that will be configured as a router and do the following:

1. **Create an `/etc/hostname.`*interface* file or each network interface installed.**
   For example, create `hostname.ie0` and `hostname.ie1`. (See ”/etc/hostname.interface File” on page 49 for more information.)

2. **Type in each file the host name you have selected for that interface.**
   For example, you could type the name `timbuktu` in the file `hostname.ie0` and then type the name `timbuktu-201` in the file `hostname.ie1`. Both interfaces would be located on the same machine.

3. **Type the host name and IP address of each interface into** `/etc/inet/hosts`**.**
   For example:

```
# These machines are in the SPEC lab
192.9.200.20   timbuktu          #interface for network 192.9.200
192.9.201.20   timbuktu-201      #interface for network 192.9.201
192.9.200.9    gobi
192.9.200.10   mojave
192.9.200.110  saltlake
192.9.200.12   chilean
```

   The interfaces `timbuktu` and `timbuktu-201` are on the same machine. Note that the network address for `timbuktu-201` is different than that of `timbuktu`. That is because the medium for network 192.9.201 is connected to the `timbuktu-201` network interface while the media for network 192.9.200 is connected to the `timbuktu` interface.

4. **If router is connected to any subnetted network, edit** `/etc/inet/netmasks` **and type the local network number (129.9.0.0, for example) and associated netmask number (255.255.255.0, for example).**

How a Machine Determines If It Is a Router

The `/etc/rc2.d/S69inet` startup script, which runs when the machine boots, determines whether a machine is a router or a host. This decision also determines whether the routing protocols (RIP and RDISC) should run in router mode or host mode.

The `/etc/rc2.d/S69inet` script concludes that a machine is a router if the following two conditions exist:

- More than one `/etc/hostname.`*interface* file exists.
- More than one interface was configured “up” by the `ifconfig` command. (See the `ifconfig`(1M) man page).

If only one interface is found, the script concludes that the machine is a host. See "Configuring Both Router Network Interfaces" on page 79. Any interface that is configured by any means other than an `/etc/hostname.`*interface* file will not be taken into account.

Automatic Routing Protocol Selection

The startup script then must determine whether to start up a routing protocol (RIP or RDISC) on the machine or use static routing

To Select Static Routing on a Host

If the host is a diskless client or network client, you simply add an entry for a router on the network into `/etc/defaultrouter`. (See "/etc/defaultrouter File" on page 50.) A single static default route is then installed in the routing table. Under this condition, the host will not run any dynamic routing protocol (such as RIP and RDISC).

To Select Dynamic Routing on a Host

To force a diskless client or network client to select a dynamic routing protocol, its `/etc/defaultrouter` file should be empty. The type of dynamic routing used is selected according to the following criteria:

- If the `/usr/sbin/in.rdisc` program exists, the startup script will start `in.rdisc`. Any router on the network that is running RDISC will then respond to any RDISC queries from the host. If at least one router responds, the host will select RDISC as its routing protocol.
- If the network router is not running RDISC or fails to respond to the RDISC queries, then `in.rdisc` on the host exits. The host then starts `in.routed`, which runs RIP.

Forcing a Machine to Be a Router

You can force a machine that has only one `/etc/hostname.`*interface* file (by default a host) to be a router. To do so, create a file named `/etc/gateways` and leave it empty. This is important if you decide to configure PPP links, as explained in "Routing Considerations" on page 122.

Forcing a Machine to Be a Host—the "Firewall" Gateway

For security reasons, you may wish to create what is known as a nonrouting router, called a *firewall* gateway. When configured as a firewall, a machine cannot pass packets between the networks attached to it. On the other hand, it can still provide standard TCP/IP services, such as `telnet` or `rlogin`, to authorized users.

▼ How to Force a Router to Be a Host

You can force a machine that has two or more `/etc/hostname.`*interface* files (by default a router) to be a host.

1. **Edit** `/etc/rc2.d/S69inet`**.**

2. **Comment out the following two lines.**

```
numifs=`ifconfig -au | grep inet | wc -1`
numptptifs=`ifconfig -au | grep inet | egrep -e ‘ -->’ | wc -1`
```

3. **Add the lines** `numifs=1` **and** `numptptifs=0`**.**
   The completed file will resemble:

```
#numifs=`ifconfig -au | grep inet | wc -1`
#numptptifs=`ifconfig -au | grep inet | egrep -e ‘ -->’ | wc -1`
numifs=1
numptptifs=0
```

Turning On Space-Saving Mode

Space-saving mode provides the host with a table that contains only the default routes. On a host, `in.routed` runs with space saving mode turned off by default.

If you do not want the host to have a full routing table (which provides increased protection against misconfigured routers), turn space saving mode on. To do so, edit the `/etc/rc2.d/S69inet` startup script by changing the line:

```
/usr/sbin/in.routed -q
```

to

```
/usr/sbin/in.routed -q -S
```

Turning Off ICMP Router Discovery on the Host

For reasons involving router reliability, you may not want your hosts to use RDISC. To turn RDISC off, change the name of the host's `/usr/sbin/in.rdisc` to some other name, such as `/usr/sbin/in.rdisc.saved`, and then reboot the host.

Turning Off ICMP Router Discovery on the Router

If the automatic selection of RIP rather than RDISC by a host is to work reliably, the routers in the network (particularly those running RDISC) also must work reliably.

If your routers are not running RDISC and you install a single Solaris router, by default all hosts connected to that router will rely on it alone. To have the hosts on that network use the other routers as well, turn off RDISC on the new router. To do this, change the name of the router's `/usr/bin/in.rdisc` file to some other file name and reboot the router.

Configuring Standard TCP/IP Services

Services such as `telnet`, `ftp`, and `rlogin` are started by the `inetd` daemon, which runs automatically at boot time. Like the name service ordering specified in `nsswitch.conf`, you can configure TCP/IP services in the file `/etc/inetd.conf` by using the `inetd -t` flag.

For example, you can use `inetd` to log the IP addresses of all incoming TCP connections (remote logins and `telnet`). To turn the logging on, kill the running `inetd` and type the following:

```
# /usr/sbin/inetd -t -s
```

The `-t` switch turns on TCP connection-tracing in `inetd`.

Refer to the `inetd` (1M) and `inetd.conf` (4) man pages.

See *Name Services Administration Guide* and *Name Services Configuration Guide* for further information on name services.

Troubleshooting TCP/IP 6

This chapter describes general methods for troubleshooting TCP/IP networks and some of the tools available for doing so. These tools include `ping`, `ifconfig`, `netstat`, and `route`.

General Troubleshooting Methods

One of the first signs of trouble on the network is a loss of communications by one or more hosts. If a host refuses to come up at all the first time it is added to the network, the problem may lie in one of the configuration files, or in the network interface. If a single host suddenly develops a problem, the network interface may be the cause. If the hosts on a network can communicate with each other but not with other networks, the problem could lie with the router, or it could lie in another network.

You can use the `ifconfig` program to obtain information on network interfaces and `netstat` to display routing tables and protocol statistics. Third-party network diagnostic programs provide a number of troubleshooting utilities. Refer to third-party documentation for information.

Less obvious are the causes of problems that degrade performance on the network. For example, you can use tools like `ping` to quantify problems like the loss of packets by a host.

Running Software Checks

If there is trouble on the network, some actions that you can take to diagnose and fix software-related problems include:

1. Using the `netstat` command to display network information.
2. Checking the `hosts` database to make sure that the entries are correct and up-to-date.
3. If you are running RARP, checking the Ethernet addresses in the `ethers` database to make sure that the entries are correct and up to date.
4. Trying to `telnet` to the local host.
5. Ensuring that the network daemon `inetd` is running. To do this, log in as superuser and type the following:

```
# ps -ef | grep inetd
```

Here is an example of output displayed if the `inetd` daemon is running:

```
root 57 1 0 Apr 04 ? 3:19 /usr/sbin/inetd -s
root 4218 4198 0 17:57:23 pts/3 0:00 grep inetd
```

`ping` *Command*

Use the `ping` command to find out whether there is IP connectivity to a particular host. The basic syntax is:

/usr/sbin/ping *host [timeout]*

where *host* is the host name of the machine in question. The optional *timeout* argument indicates the time in seconds for `ping` to keep trying to reach the machine—20 seconds by default. The `ping`(1M) man page describes additional syntaxes and options.

When you run `ping`, the ICMP protocol sends a datagram to the host you specify, asking for a response. (ICMP is the protocol responsible for error handling on a TCP/IP network. See "ICMP Protocol" on page 15 for details.)

Suppose you type:

```
$ ping elvis
```

If host `elvis` is up, this message is displayed:

```
elvis is alive
```

indicating that `elvis` responded to the ICMP request. However, if `elvis` is down or cannot receive the ICMP packets, you receive the following response from `ping`:

```
no answer from elvis
```

If you suspect that a machine may be losing packets even though it is up, you can use the `-s` option of `ping` to try and detect the problem. For example, type:

```
$ ping -s elvis
```

ping continually sends packets to elvis until you send an INTERRUPT character or a timeout occurs. The responses on your screen will resemble:

```
PING elvis: 56 data bytes
64 bytes from 129.144.50.21: icmp_seq=0. time=80. ms
64 bytes from 129.144.50.21: icmp_seq=1. time=0. ms
64 bytes from 129.144.50.21: icmp_seq=2. time=0. ms
64 bytes from 129.144.50.21: icmp_seq=3. time=0. ms
.
.
.
----elvis PING Statistics----
4 packets transmitted, 4 packets received, 0% packet loss
round-trip (ms) min/avg/max = 0/20/80
```

The packet-loss statistic indicates whether the host has dropped packets.

If ping fails, check the status of the network reported by ifconfig and netstat, as described in ”ifconfig Command” and ”netstat Command” on page 89.

ifconfig *Command*

The ifconfig command displays information about the configuration of an interface that you specify. (Refer to the ifconfig(1M) man page for complete details.) The syntax of ifconfig is:

ifconfig *interface*-name [*protocol_family*]

If you want information about a specific interface, for example le0, type:

```
$ ifconfig le0
```

For an le0 interface, your output will resemble the following:

```
le0: flags=863<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
   inet 129.144.44.140 netmask ffffff00 broadcast 129.144.44.255
ether 8:0:20:8:el:fd
```

The flags section above shows that the interface is configured “UP,” capable of broadcasting, and not using “trailer” link level encapsulation. The `mtu` field tells you that this interface has a maximum transfer rate of 1500. Information on the second line includes the IP address of the host you are using, the netmask being currently used, and the IP broadcast address of the interface. The third line gives the machine address (Ethernet, in this case) of the host.

A useful `ifconfig` option is `-a`, which provides information on all interfaces on your network. For example, typing `ifconfig -a` produces:

```
le0:  flags=49<UP,LOOPBACK,RUNNING> mtu 8232
     inet 127.144.44.140 netmask ff000000
le0:flags=863<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
    inet 129.144.44.140 netmask ffffff00 broadcast 129.144.44.255
ether 8:0:20:8:el:fd
```

Output that indicates an interface is not running might mean a problem with that interface. In this case, see the `ifconfig`(1M) man page.

`netstat` *Command*

The `netstat` command generates displays that show network status and protocol statistics. You can display the status of TCP and UDP endpoints in table format, routing table information, and interface information.

`netstat` displays various types of network data depending on the command line option selected. These displays are the most useful for system administration. The syntax for this form is:

netstat [-m] [-n] [-s] [-i | -r] [-f *address_family*]

The most frequently used options for determining network status are: `-s`, `-r`, and `-i`. See the `netstat`(1M) man page for a description of the options.

Displaying Per Protocol Statistics

The `netstat -s` option displays per protocol statistics for the UDP, TCP, ICMP, and IP protocols. The result resembles the display shown in the example below. (Parts of the output have been truncated.) The information can indicate areas where a protocol is having problems. For example, statistical information from ICMP can indicate where this protocol has found errors.

```
UDP
       udpInDatagrams      =  3928   udpInErrors         =     0
       udpOutDatagrams     =  2455
TCP
       tcpRtoAlgorithm     =     4   tcpRtoMin           =   200
       tcpRtoMax           = 60000   tcpMaxConn          =    -1
       tcpActiveOpens      =     4   tcpPassiveOpens     =     2
       tcpAttemptFails     =     3   tcpEstabResets      =     1
       tcpCurrEstab        =     1   tcpOutSegs          =   315
       tcpOutDataSegs      =   288   tcpOutDataBytes     = 10547
       tcpRetransSegs      =    29   tcpRetransBytes     =  8376
       tcpOutAck           =    27   tcpOutAckDelayed    =    23
       tcpOutUrg           =     2   tcpOutWinUpdate     =     2
       tcpOutWinProbe      =     0   tcpOutControl       =     8
       tcpOutRsts          =     0   tcpOutFastRetrans   =     1
       tcpInSegs           =   563
       tcpInAckSegs        =   289   tcpInAckBytes       = 10549
       tcpInDupAck         =    27   tcpInAckUnsent      =     0
       tcpInInorderSegs    =   254   tcpInInorderBytes   =   673
       tcpInUnorderSegs    =     0   tcpInUnorderBytes   =     0
       tcpInDupSegs        =     0   tcpInDupBytes       =     0
       tcpInPartDupSegs    =     0   tcpInPartDupBytes   =     0
       tcpInPastWinSegs    =     0   tcpInPastWinBytes   =     0
       tcpInWinProbe       =     0   tcpInWinUpdate      =   237
       tcpInClosed         =     0   tcpRttNoUpdate      =    21
       tcpRttUpdate        =   266   tcpTimRetrans       =    26
       tcpTimRetransDrop   =     0   tcpTimKeepalive     =     0
       tcpTimKeepaliveProbe=     0   tcpTimKeepaliveDrop =     0
IP
       ipForwarding        =     2   ipDefaultTTL        =   255
       ipInReceives        =  4518   ipInHdrErrors       =     0
       ipInAddrErrors      =     0   ipInCksumErrs       =     0
       ipForwDatagrams     =     0   ipForwProhibits     =     0
       ipInUnknownProtos   =     0   ipInDiscards        =     0
       ipInDelivers        =  4486   ipOutRequests       =  2805
```

```
        ipOutDiscards       =     5   ipOutNoRoutes       =     0
        ipReasmTimeout      =    60   ipReasmReqds        =     2
        ipReasmOKs          =     2   ipReasmFails        =     0
        ipReasmDuplicates   =     0   ipReasmPartDups     =     0
        ipFragOKs           =    20   ipFragFails         =     0
        ipFragCreates       =   116   ipRoutingDiscards   =     0
        tcpInErrs           =     0   udpNoPorts          =    33
        udpInCksumErrs      =     0   udpInOverflows      =     6
        rawipInOverflows    =     0
ICMP
        icmpInMsgs          =     0   icmpInErrors        =     0
        icmpInCksumErrs     =     0   icmpInUnknowns      =     0
        icmpInDestUnreachs  =     0   icmpInTimeExcds     =     0
        icmpInParmProbs     =     0   icmpInSrcQuenchs    =     0
        icmpInRedirects     =     0   icmpInBadRedirects  =     0
        icmpInEchos         =     0   icmpInEchoReps      =     0
        icmpInTimestamps    =     0   icmpInTimestampReps =     0
        icmpInAddrMasks     =     0   icmpInAddrMaskReps  =     0
        icmpInFragNeeded    =     0   icmpOutMsgs         =     7
        icmpOutDrops        =     5   icmpOutErrors       =     0
        icmpOutDestUnreachs =     1   icmpOutTimeExcds    =     0
        icmpOutParmProbs    =     0   icmpOutSrcQuenchs   =     6
        icmpOutRedirects    =     0   icmpOutEchos        =     0
        icmpOutEchoReps     =     0   icmpOutTimestamps   =     0
        icmpOutTimestampReps=     0   icmpOutAddrMasks    =     0
        icmpOutAddrMaskReps =     0   icmpOutFragNeeded   =     0
        icmpInOverflows     =     0
IGMP:
           0 messages received
           0 messages received with too few bytes
           0 messages received with bad checksum
           0 membership queries received
           0 membership queries received with invalid field(s)
           0 membership reports received
           0 membership reports received with invalid field(s)
           0 membership reports received for groups to which we
           belong
           0 membership reports sent
```

Displaying Network Interface Status

The `-i` option of `netstat` shows the state of the network interfaces that are configured with the machine where you ran the command. Here is a sample display produced by `netstat -i`.

```
Name   Mtu  Net/Dest      Address   Ipkts    Ierrs  Opkts    Oerrs  Collis Queue
le0    1500 b5-spd-2f-cm  tatra     14093893 8492   10174659 1119   2314178 0
lo0    8232 loopback      localhost 9299762  5442   12451748 0      775125  0
```

Using this display, you can find out how many packets a machine thinks it has transmitted and received on each network. For example, the input packet count (`Ipkts`) displayed for a server may increase each time a client tries to boot, while the output packet count (`Opkts`) remains steady. This suggests that the server is seeing the boot request packets from the client, but does not realize it is supposed to respond to them. This might be caused by an incorrect address in the `hosts` or `ethers` database.

On the other hand, if the input packet count is steady over time, it means that the machine does not see the packets at all. This suggests a different type of failure, possibly a hardware problem.

Displaying Routing Table Status

The `-r` option of `netstat` displays the IP routing table. Here is a sample display produced by `netstat -r` run on machine `tenere`.

```
Routing tables
Destination   Gateway Flags   Refcnt  Use     Interface
temp8milptp   elvis   UGH     0       0
irmcpeb1-ptp0 elvis   UGH     0       0
route93-ptp0  speed   UGH     0       0
mtvb9-ptp0    speed   UGH     0       0
              .
mtnside       speed   UG      1       567
ray-net       speed   UG      0       0
mtnside-eng   speed   UG      0       36
mtnside-eng   speed   UG      0       558
mtnside-eng   tenere  U       33      190248    le0
```

The first column shows the destination network, the second the router through which packets are forwarded. The U flag indicates that the route is up; the G flag indicates that the route is to a gateway. The H flag indicates that the destination is a fully qualified host address, rather than a network.

The Refcnt column shows the number of active uses per route, and the Use column shows the number of packets sent per route. Finally, the Interface column shows the network interface that the route uses.

Logging Network Problems

If you suspect a routing daemon malfunction, you can log its actions, including all packet transfers. To create a log file of routing daemon actions, supply a file name when you start up the routed daemon. For example:

```
# /usr/sbin/in.routed /var/routerlog
```

Caution – On a busy network, this may generate almost continuous output.

Displaying Packet Contents

Snoop captures network packets and displays their contents. Packets can be displayed as they are received, or saved to a file. For complete information, refer to the snoop(1M) man page.

Part 2 — Expanding Your Network With PPP

Part 2 explains how to set up and administer asynchronous PPP communications links on the network. The text assumes that you are an experienced network administrator who is familiar with TCP/IP.

Understanding PPP 7

This chapter presents an overview of Solaris PPP, a data-link protocol included in the TCP/IP protocol suite. The text includes product specifications, introductions to the most typical PPP configurations, and definitions of the terms related to PPP.

Overview

PPP enables you to connect computers and networks at separate physical locations by using modems and telephone lines. With PPP, users with computers at home or in remote offices can connect to your site's network. You can also use the combination of PPP software, a modem, and telephone lines as a router connecting networks in different places. PPP offers strategies for configuring these machines and networks, which are introduced in this chapter.

Solaris PPP Specifications

Solaris PPP is an asynchronous implementation of the standard data-link level Point-to-Point Protocol (PPP) included in the TCP/IP protocol suite and provided by a number of router system vendors and terminal concentrators. It includes a standard encapsulation protocol, making datagram transmission transparent to network layer protocols.

The major characteristics of the Solaris PPP protocol are:

- Implements the Internet Point-to-Point Protocol, as defined in RFC 1331
- Provides error detection through CRC
- Supports full duplex transmission

The major functions of the protocol are:

- Interface for IP to forward packets over asynchronous serial lines
- Connection establishment on demand
- Configurable options negotiation
- Connection termination (automatic hang-up)

Transmission Facilities Used by PPP

PPP supports interfaces to RS-232-C (V.24) facilities through the CPU serial ports included on most machines running the Solaris software. In addition, PPP will run over optional asynchronous serial ports supplied or supported by many manufacturers of machines that run the Solaris software. PPP supports the maximum data rates that your serial ports can achieve. Consult the manufacturer of your computer system for more details on the speeds supported by your machine's serial hardware.

Note – Machines of the x86 architecture require UARTs that run above a certain speed.   See the *x86 Device Configuration Guide* for details.

Standards Conformance

PPP, and the routing functions in the Solaris software, use industry-standard conventions for performing their tasks. These conventions support:

- Forwarding of IP datagrams

- Reception of packets for forwarding from any IP-compatible networked system
- Delivery of packets to any IP-compatible networked system on local area network media, such as Ethernet, Token Ring, and FDDI
- Use of standard routing protocols, enabling users to exchange packets with equipment that supports the PPP protocol from many manufacturers

PPP Network Interfaces

PPP enables asynchronous devices, such as modems, to become network interfaces. Solaris PPP enables you to configure two types of *virtual network interfaces*, `ipdptp`*n* and `ipd`*n*. (The letter *n* represents the device number you assign to the interface.)

PPP network interfaces are considered virtual network interfaces because they do not involve network hardware, as does, for example, an Ethernet interface. Moreover, they are not associated with any particular serial port. The PPP network interfaces reside in the `/devices` directories along with the physical network interfaces. (For information on physical network interfaces, see ”Network Interfaces” on page 6.)”

The type of network interface you use depends on the PPP communications link you want to set up. The `ipdptp` interface supports point-to-point PPP links; the `ipd` interface supports point-to-multipoint links (hereafter referred to as multipoint links).

Extending Your Network With PPP

This section introduces PPP-related communications concepts used. It also explains the most typical PPP configurations that you are likely to set up.

Point-to-Point Communications Links

The most common use of Solaris PPP is to set up a point-to-point communications link. A generic *point-to-point* communications configuration consists of two endpoints connected by a communications link. In a generic configuration, an *endpoint* system could be a computer or terminal, either in an isolated location or physically connected to a network. The term *communications link* refers to the hardware and software connecting these endpoint systems. Figure 7-1 on page 100 illustrates these concepts.

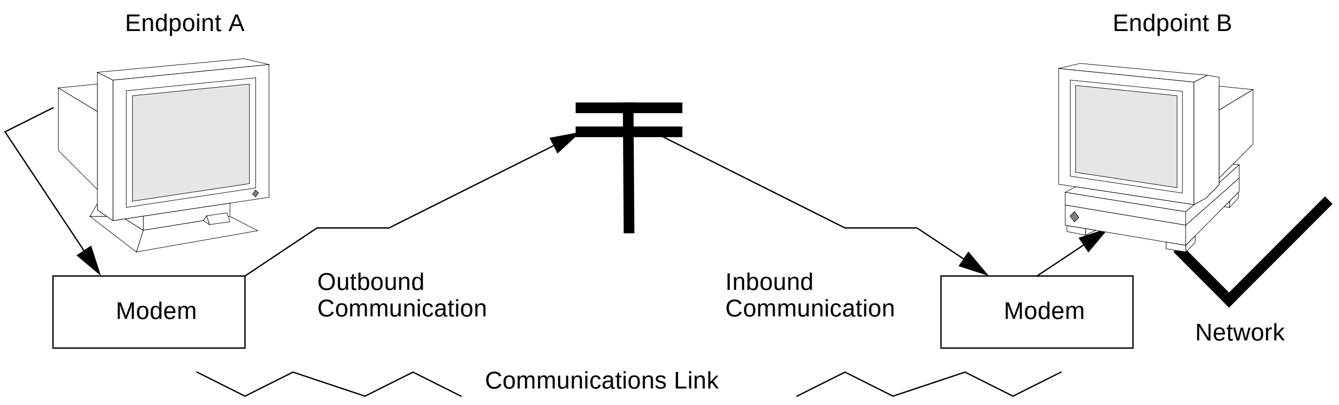


Figure 7-1 Basic Point-to-Point Link

Dial-out Operations and Outbound Communications

When an endpoint system wants to communicate with the end point on the other side of the communications link, it begins a *dial-out operation*. For example, to communicate with endpoint B, a user at its peer host, endpoint A, types `rlogin` *end-point-B*. This causes endpoint A to "dial out" over the communications link. In this instance, endpoint A functions as a *dial-out* machine. The `rlogin` command causes its modem to dial the phone number of endpoint B. The action it starts and information it passes are considered *outbound communication*s.

Dial-ins and Inbound Communications

When the data travels over the link to endpoint B, this system receives incoming data and sends an acknowledgment signal to endpoint A to establish communications. In this instance, endpoint B functions as a *dial-in* machine, since it permits other systems to dial in to it. The information passed to the communications recipient and the actions the recipient takes are considered *inbound communication*s.

Point-to-Point Configurations Supported by Solaris PPP

Solaris PPP supports four types of point-to-point configurations:

- Host in one location connected to a host at another physical location, as shown in Figure 7-1 on page 100
- Dial-in server(s) with dynamic point-to-point links to remote hosts, as shown in Figure 7-2 on page 102
- Network connected to another physically distant network, as shown in Figure 7-3 on page 104
- Computers connected to a multipoint dial-in server physically attached to a distant network, as shown in Figure 7-4 on page 105

These PPP links provide essentially the same type of connectivity provided by a local area network but without broadcast capability. The sections below summarize the configuration types; Chapter 8, "Preparing Your PPP Configuration," gives information for setting up each configuration type.

Two Isolated Hosts Connected by a Point-to-Point Link

PPP enables you to set up a point-to-point link to connect two standalone machines in separate locations, effectively creating a network consisting solely of these two machines. This is the simplest point-to-point configuration because it involves only the two endpoints. The generic configuration shown in Figure 7-1 on page 100 also uses the host-to-host configuration.

Nomadic Machines Connected to a Dial-in Server

In the past, standard dial-up connections permitted only ASCII terminals to connect to a network. With Solaris PPP, an individual machine can become part of a physically distant network by configuring it as one end point of the PPP link. The advantage of this *nomadic* connection is particularly apparent if your network includes users who travel frequently or work from home.

Figure 7-2 on page 102 shows nomadic computers, each with a point-to-point link to an endpoint system on the network. The endpoint on the network is a dial-in server.

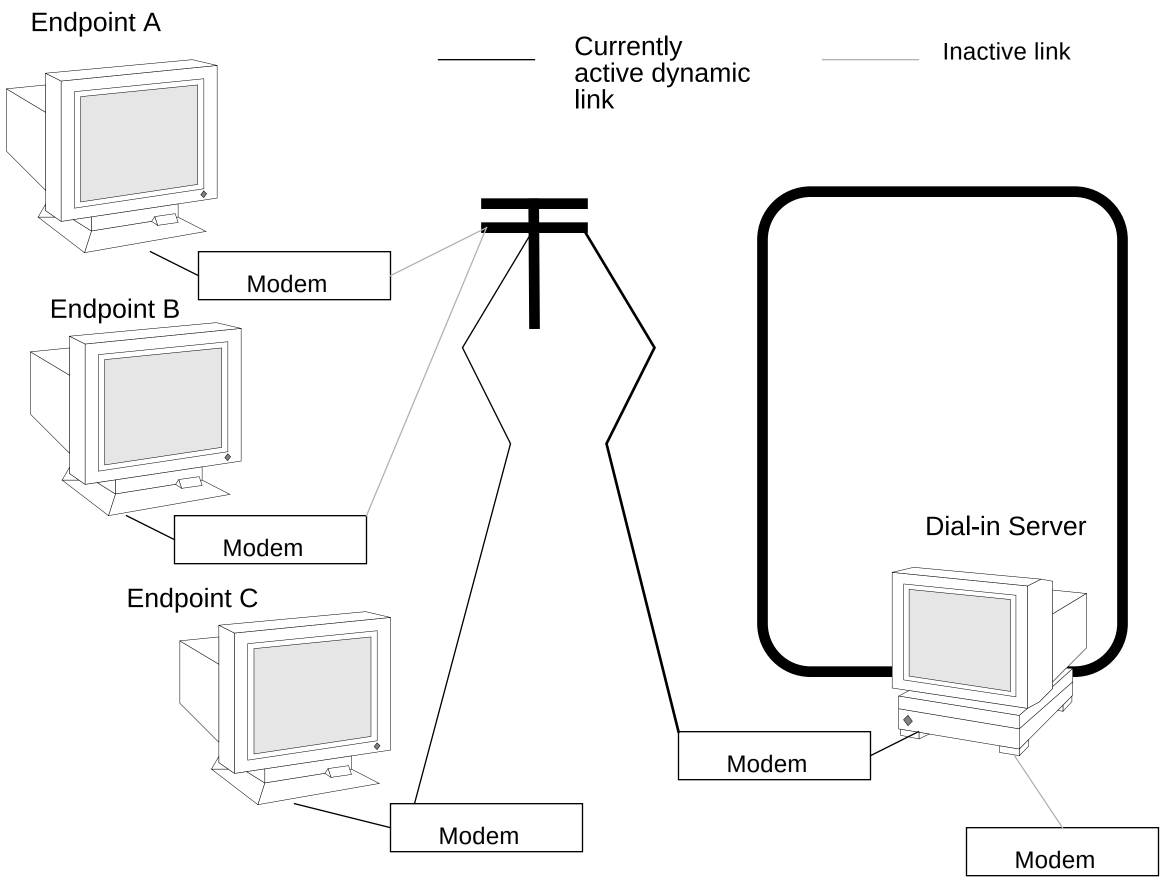


Figure 7-2 Nomadic Computers and Dynamic Link Dial-in Server

Dial-in Server With Dynamic Point-to-Point Link

The endpoint machine on the network shown in Figure 7-2 on page 102 functions as a dial-in server with dynamic point-to-point links. It is called a *dial-in server* because remote machines can dial in to it to reach the network. When the server receives a request to dial in from a machine, the server allocates the PPP link to the machine on an as-needed basis.

A dial-in server can communicate with the remote hosts through a dynamic point-to-point link or through a multipoint link, as explained in ”Multipoint Communications Links” on page 105. The dynamic point-to-point link has the advantages of point-to-point communications: RIP can run over the link, and broadcasting is enabled. Perhaps most importantly, more than one machine on the physical network can function as the dial-in server. This allows you to configure backup servers, thus enabling redundancy and easier administration. Although the machines in Figure 7-2 can directly communicate with the network endpoint, they cannot directly communicate with each other. They must pass information to each other through the dial-in server endpoint.

Two Networks Connected by Point-to-Point Link

You can use PPP to connect two separate networks through a point-to-point link, with one system on each network serving as an endpoint. These endpoints communicate through modems and phone lines, essentially in the same fashion as shown in Figure 7-1 on page 100. But in this setup, the endpoints, modems, and PPP software become routers for their physical networks. Using this type of configuration scheme, you can create an internetwork with wide geographic reach.

Figure 7-3 on page 104 shows two networks in different locations connected by a point-to-point link.

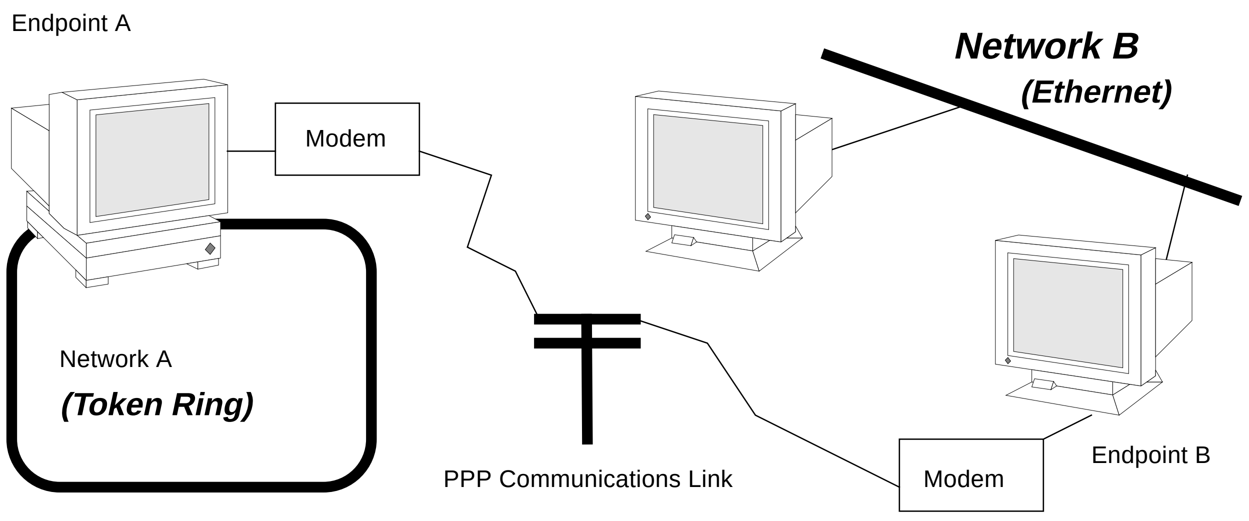


Figure 7-3 Two Networks Connected by a PPP Link

In this example, endpoints A and B, their modems, public telephone lines, and the PPP software act as a router between the networks. These networks may have other hosts serving as routers between physical networks. Sometimes, the host functioning as the PPP router may have an additional network interface board, thus also serving as a router for a physical network.

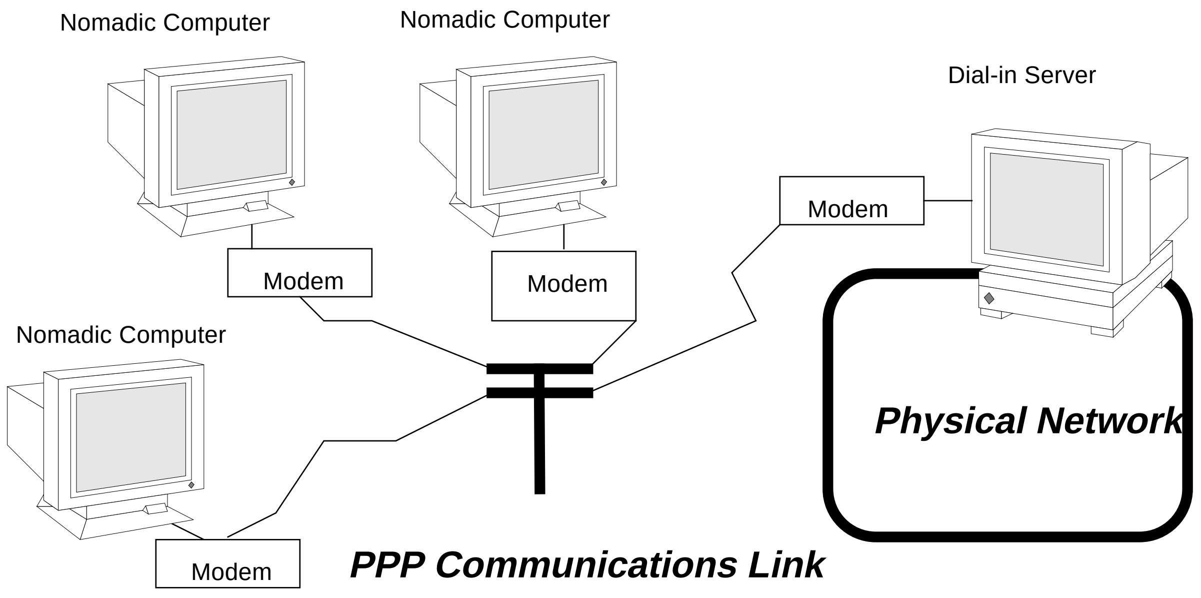


Figure 7-4 Nomadic Computers and Multipoint Dial-in Server

Multipoint Communications Links

You can use Solaris PPP to set up a multipoint communications link. In this type of configuration, an individual machine functions as one endpoint on the communications link. At the other end of the link may be several endpoint machines. This differs from point-to-point configurations, with a single endpoint system at either side of the communications link.

Multipoint Configurations Supported by PPP

Two types of multipoint links you can configure with PPP are

- Dial-in server with multipoint connections to remote machines, as shown in Figure 7-4

- Logical, or *virtual*, network consisting of three or more nomadic computers as shown in Figure 7-5 on page 107

The sections below summarize these configurations; Chapter 8, "Preparing Your PPP Configuration," explains how to set up the configuration.

Multipoint Dial-in Servers

Figure 7-4 on page 105 shows three geographically isolated computers communicating through a point-to-point link to an endpoint machine on a network. However, the network endpoint machine can communicate with the nomadic computers through a *multipoint* link, thus making it a multipoint dial-in server. (You can also set up a dial-in server with dynamic point-to-point connections, as explained on page 103.)

The dial-in server can communicate with all the machines on the other end of its multipoint PPP link. Though the machines in Figure 7-4 can directly communicate with the multipoint dial-in server, they cannot directly communicate with each other directly. They must pass information to each other through the dial-in server.

Virtual Networks

You can use PPP to set up a *virtual network* wherein the modems, PPP software, and telephone wires become the "virtual" network media. In a physical network, such as Ethernet or Token Ring, computers are directly cabled to the network media. In a virtual network, no true network media exist.

Machines become peer hosts on the virtual network when you configure each with a multipoint communications link. Then each host can dial out through its modem over phone lines to reach another endpoint machine. Each computer also functions as a dial-in machine, permitting its peer hosts on the virtual network to dial in to it.

Figure 7-5 on page 107 depicts a virtual network consisting of nomadic computers connected to each other through modems and telephone lines.

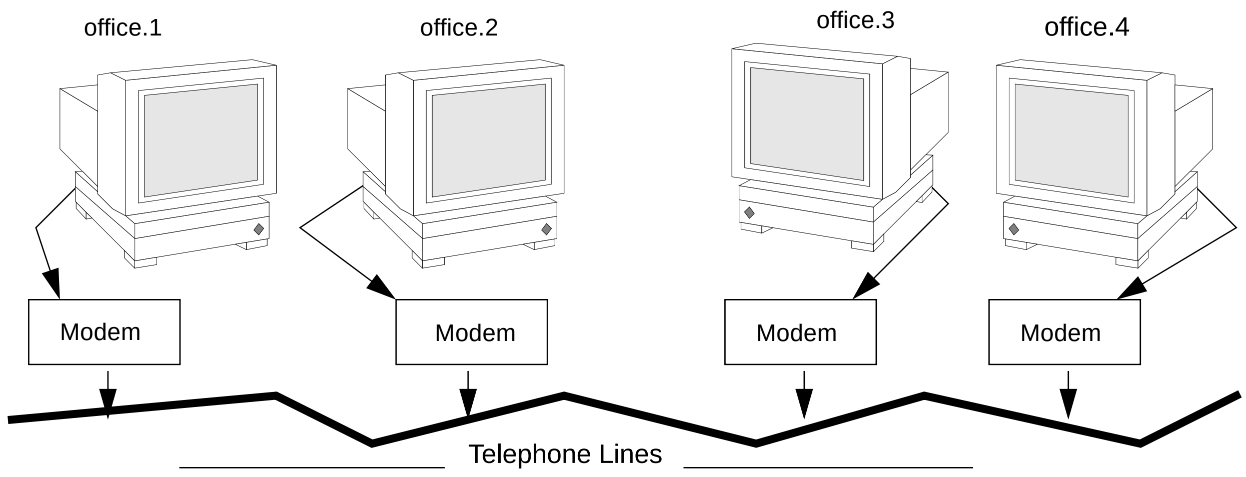


Figure 7-5 Virtual Network of Nomadic Computers

Each machine exists in a different office, perhaps in a different town from other members of the virtual network. However, each machine can establish communications with its peer hosts over its multipoint communications links.

Introducing the PPP Software

The PPP component software includes the

- Link manager (`/usr/sbin/aspppd`)
- Login service (`/usr/sbin/aspppls`)
- Configuration file (`/etc/asppp.cf`)
- Log file (`/var/adm/log/asppp.log`)
- FIFO file (`/tmp/.asppp.fifo`)

After you install the PPP software, you will find the `/etc/init.d/asppp` file, which is the run-control script for PPP. It is linked to several other files in the run-control directories.

Figure 7-6 on page 108 shows the software components of PPP and how they interact.

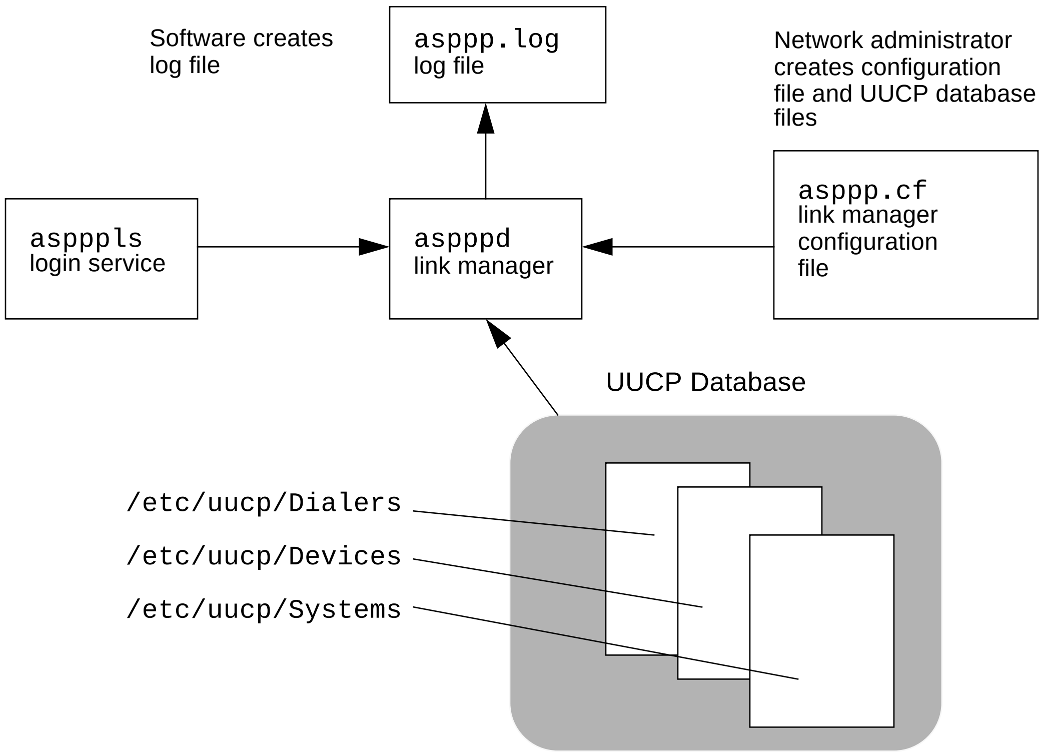

Software creates log file
asppp.log
log file
Network administrator creates configuration file and UUCP database files
aspppls
login service
aspppd
link manager
asppp.cf
link manager configuration file
UUCP Database
/etc/uucp/Dialers
/etc/uucp/Devices
/etc/uucp/Systems

Figure 7-6 PPP Component Software

Link Manager

The `/usr/sbin/aspppd` link manager is a user-level daemon that automates the process of connecting to a remote host when PPP service is required. This automated process starts whenever any activity that generates IP traffic takes place (for example, a user logs in to a remote machine, accesses an NFS-mounted file, and so on). If a remote host tries to establish a connection, the link manager on the local host will complete the connection.

Refer to the `aspppd` (1m) man page for specific information about the link manager.

Login Service

The /usr/sbin/aspppls login service is invoked as a login shell that starts PPP after you dial up and log in. Its function is similar to the /usr/lib/uucp/uucico command described in ”Software Comprising UUCP” on page 178.” When configuring a machine as a dial-in server, you must specify aspppls as the login shell in the /etc/passwd file in the entries for every nomadic computer allowed to dial in to the local host.

Configuration File

The asppp.cf file provides the link manager with information about each remote endpoint with which the local host will communicate. You define this information in a section of the configuration file called a *path*. The path section also defines the PPP interface to be used and, optionally, other attributes determining how communications will take place. ”Parts of Basic Configuration File” on page 136 explains the sections of the asppp.cf file in detail.

The unmodified asppp.cf file looks like:

```
#ident"@(#)asppp.cf1093/07/07 SMI"
#
# Copyright (c) 1993 by Sun Microsystems, Inc.
#
# Sample asynchronous PPP /etc/asppp.cf file
#
#

ifconfig ipdptp0 plumb mojave gobi up

path
    inactivity_timeout 120    # Approx. 2 minutes
    interface ipdptp0
    peer_system_name Pgobi    # The name this system logs in with when
                             # it dials this server
                             # *OR* the entry we look up in
                             # /etc/uucp/Systems when we dial out.
```

Log File

The link manager produces messages and logs them in the log file `/var/adm/log/asppp.log`. The level of detail reported into the file is controlled by the `-d` option of `aspppd` or the `debug_level` keyword in the configuration file. See ”Configuration Keywords” on page 172 and the `aspppd` (1m) man page for more information.

FIFO File

The PPP FIFO file `/tmp/.asppp.fifo` is a named pipe used to communicate between `aspppd` and `aspppls`. This file must be present in `/tmp` for the PPP login service to connect to the link manager. The `/tmp/.asppp.fifo` file is created, managed, and deleted by the link manager.

UUCP Databases

Besides its component software, Solaris PPP uses information in three UUCP files, `/etc/uucp/Systems`, `/etc/uucp/Dialers`, and `/etc/uucp/Devices` to help it establish the communications link.You must modify these files to enable a host to dial out over the PPP link. Alternatively, you can use the file `/etc/uucp/Sysfiles` to specify different names for the `Systems`, `Devices`, and `Dialers` files.

Refer to Chapter 12, “UUCP Databases and Programs,” for full descriptions of these UUCP files.

How the Components Work Together

This section describes how the components of PPP function for outbound and inbound connections.

Outbound Connections Scenario

Outbound communications begin when a user on one endpoint host initiates an activity involving the peer host on the other end of the PPP link. The following activities take place when a user types an `rcp` command to copy a file from a host on the other side of the link

1. `rcp` sends the data through the levels of the TCP/IP protocol stack.
2. A virtual network interface (`ipd`*n* or `ipdptp`*n)* receives the data in the form of IP packets.
3. The interface sends the `aspppd` link manager a connection request that initiates an outbound connection.
4. The link manager then:
   a. Verifies that the connection request corresponds to a configured path in the `/etc/asppp.cf` configuration file.
   b. Consults the UUCP database files (`/etc/uucp/Systems`, `/etc/uucp/Devices`, and `/etc/uucp/Dialers`) for specific information about the modem and destination system.
   c. Places a phone call to the destination host or attaches to the appropriate hardwired serial line.
5. The physical link to the peer host is established.
6. The link manager configures and initiates PPP.
7. The data-link layer is established, and the PPP modules on the peer hosts start communicating.
8. The link manager enables IP over the link.

The link manager then monitors the connection until an event such as an idle time out, line disconnect, or error condition occurs. When any of these events occur, the link manager disconnects from the peer host and returns to the idle state.

Inbound Connections Scenario

The host initiating the inbound communication logs in, which invokes the `/usr/sbin/aspppls` login service. Then the following events occur:

1. The login service connects to the link manager through the `/tmp/.asppp.fifo` file.
2. The login service provides the link manager with information such as the login name used by the endpoint at the other end of the link.

3. The link manager uses this login name to find a corresponding configured path in the configuration file.
4. The link manager then configures and initiates PPP.
5. The data-link layer is established, and the PPP modules on the peer hosts start communicating.
6. The link manager enables IP over the link.

The link manager then monitors the connection until an event such as an idle timeout, line disconnect, or error condition occurs. When any of these events occur, the link manager disconnects from the peer and returns to the idle state.

Preparing Your PPP Configuration 8

Before configuring the PPP software, you need to prepare the hardware and software involved and gather some information that is needed during the configuration process. This chapter explains the tasks you have to perform prior to configuration, such as:

- Determining your network addressing scheme
- Ensuring that your hardware meets the requirements for PPP
- Preparing your software to meet the requirements for PPP

The chapter concludes with a checklist to help you organize this information before you configure your PPP link.

Determining Requirements for Your Configuration Type

Solaris PPP supports many configuration options, including:

- Remote computer-to-network over a point-to-point link
- Remote computer-to-remote computer over a point-to-point link
- Network-to-network over a point-to-point link
- Dial-in server-to-multiple remote computers through one or more dynamic point-to-point links
- Dial-in server-to-multiple remote computers through a multipoint link
- Multiple remote computers comprising a virtual network, all communicating through multipoint links

These configurations are introduced in “Extending Your Network With PPP” in Chapter 7, “Understanding PPP.”

This section describes the information you need to gather and tasks you have to perform for each configuration type before beginning the configuration process. Read the section that describes the configuration you want to set up.

Areas you need to consider are:

- Network interface
- Addressing method
- Name service used, if any
- Dial in as well as dial-out support
- Routing requirements

Remote Computer-to-Network Configuration

The remote computer-to-network is the most common asynchronous PPP configuration. Use it to configure machines in remote offices or user’s homes that will dial out over a point-to-point PPP link to a dial-in server on a network

- *Network interface*–This point-to-point link uses the `ipdptp`*n* virtual network interface. You will need to specify it in the configuration files of all remote machines that dial out to a network.

- *Addressing method*–The configuration file must include the host names or IP addresses of the machines that will communicate over the link. For remote hosts, you probably should use existing host names and IP addresses. Refer to ”Determining IP Addressing for Your PPP Link” on page 119 for complete details.

- *Name service*–NIS and NIS+ name services are not recommended for remote hosts. These services generate a great deal of network traffic, often at unexpected times. The DNS name service is more efficient for this type of configuration. You may want to set up DNS, as described in *Name Services Administration Guide*, on each remote host. If you don't use DNS, PPP will use the `/etc/inet/hosts` file on the remote machine.
- *Dial-in and dial-out Support*–Remote hosts usually implement dial-out communications only. They do not allow other machines to dial in to them directly. Therefore, you will have to update the UUCP files on each to support dial-out communications, as explained in "Editing UUCP Databases" on page 132.
- *Routing requirements*–Because RIP is part of the Solaris TCP/IP protocol stack, it runs by default on remote hosts. You should turn off RIP to improve performance, if necessary, and instead use static routing. See "To Select Static Routing on a Host" on page 81 and "Turning off RIP" on page 123 for details.

Remote Host-to-Remote Host Configuration

Use the host-to-host configuration to establish point-to-point communications between two remote hosts in different physical locations. This configuration is useful for two standalone machines in remote offices that need to exchange information. No physical network is involved.

- *Network interface*–This basic point-to-point link uses the `ipdptp`*n* virtual network interface. You must specify the interface in the configuration files of both endpoints.
- *Addressing method*–The configuration file must include the host names or IP addresses of the machines that will communicate over the link. Use the existing host names and the IP addresses assigned to the primary network interface, if they already exist. Otherwise, create IP addresses for the endpoints. Refer to "Determining IP Addressing for Your PPP Link" on page 119 for complete details.
- *Name service*–Because only two peer hosts are involved, you don't need a true name service. The `/etc/inet/hosts` files on both peer hosts are used for address resolution.

- *Dial-in and Dial-out Support*–Both machines need to perform dial-in and dial-out operations. You will have to modify the UUCP databases and `/etc/passwd` on both endpoints.
- *Routing requirements*–Because RIP is part of the Solaris TCP/IP protocol stack, it runs by default on remote hosts. You should turn off RIP to improve performance, if necessary, and instead use static routing. See ”To Select Static Routing on a Host” on page 81 and ”Turning off RIP” on page 123 for details.

Network-to-Network Configuration

Use the network-to-network PPP configuration to create an internetwork joining two networks in physically separate locations. In this case, modems and PPP software function as the router connecting the networks.

- *Network interface*–The point-to-point link uses the `ipdptp`*n* virtual network interface. You must specify `ipdptp`*n* in the configuration files for both endpoint machines joining the two networks.
- *Addressing method*–The configuration file must include the host names or IP addresses of the machines that will communicate over the link. Two possible addressing scenarios exist for this type of configuration; they are explained in ”Determining IP Addressing for Your PPP Link” on page 119.
- *Name service*–NIS and NIS+ name services can function over this type of PPP link; however, each network should be a separate domain. If you use DNS, both networks can be part of a single domain. Refer to *Name Services Administration Guide* for details. If you use local files for name service, the `/etc/inet/hosts` files on both endpoint machines are used for address resolution. They must contain the host names and IP addresses of every host on each network that will be allowed to communicate over the link.
- *Dial-in and Dial-out Support*–Both network endpoint machines need to perform dial-in and dial-out operations, so you should update their UUCP and `/etc/passwd` files.
- *Routing requirements*–The endpoints in a network-to-network link usually run RIP in order to exchange routing information. Do not disable RIP for this configuration.

Dial-in Server With Dynamic Point-to-Point Links

A dynamic point-to-point link is one of two types of configurations that you can use for a dial-in server functioning as the network endpoint that remote hosts will access. In this configuration scheme, the server connects to its remote hosts over a dynamically allocated point-to-point link. The dial-in server uses its dynamic links on an as-needed basis to establish communications with the remote hosts it serves.

- *Network interface*–The dynamic point-to-point link uses the `ipdptp*` virtual network interface with an asterisk wildcard character. The asterisk enables the link to be allocated dynamically. You must specify this interface in the configuration file.
- *Addressing method*–The configuration file must include the host names or IP addresses of the machines that will communicate over the link. Refer to ”Determining IP Addressing for Your PPP Link” on page 119 for complete details.
- *Name service*–Although NIS and NIS+ are not recommended for remote hosts, the dial-in server in a remote host-to-network configuration can be an NIS client on the network to which it is physically connected. If NIS is on the server's physical network, make sure that the NIS maps are updated with the host names and IP addresses of the remote hosts. You can use DNS on the dial-in server and its remote hosts. For more information regarding DNS and name services in general, refer to *Name Services Administration Guide*. If you use local files for name service, PPP will use the `/etc/inet/hosts` file on the dial-in server for address resolution.
- *Dial-in support*–You must update the `/etc/passwd` file on the dynamic point-to-point dial-in server. The dynamic link server does not directly dial-out to the remote hosts.
- *Routing requirements*–Because RIP is part of the Solaris TCP/IP protocol stack, it runs by default on remote hosts. You should turn off RIP to improve performance, if necessary, and instead use static routing. See ”To Select Static Routing on a Host” on page 81 and ”Turning off RIP” on page 123 for details.

Multipoint Dial-in Server

A multipoint link is one of two types of configurations that you can use for a dial-in server functioning as the network endpoint that remote machines will access. In this configuration scheme, the dial-in server connects to multiple remote hosts over the same multipoint link**.** The remote hosts always connect to the dial-in server over a point-to-point link, as explained on page 114.

Use this configuration when you want to define a separate network of remote hosts and their dial-in server.

- *Network interface*–The multipoint link uses the `ipd`*n* virtual network interface. You must specify this interface in the configuration file for the dial-in server.
- *Addressing method*–The configuration file must include the host names or IP addresses of the machines that will communicate over the link. Refer to "Determining IP Addressing for Your PPP Link" on page 119 for complete details. You must create a separate network for the machines on the multipoint link. See "Assigning a Network Number to the PPP Link" on page 122 for more information.
- *Name service*–Although NIS and NIS+ are not recommended for remote hosts, the dial-in server in a remote host-to-network configuration can be an NIS client on the physical network to which it is connected. If NIS is on the server's physical network, make sure that the NIS maps are updated with the host names and IP addresses of the remote hosts. You can use DNS on the dial-in server and its remote hosts. For more information regarding DNS and name services in general, refer to *Name Services Administration Guide*. If you use local files for name service, PPP will use the `/etc/inet/hosts` file on the dial-in server for address resolution.
- *Dial-in and Dial-out Support*–The multipoint dial-in server functions as a network router between its PPP virtual network and the physical network to which it is connected. It dials out to its remote hosts whenever it receives IP traffic from the physical network destined for its PPP network. Therefore, you must configure the multipoint dial-in server for both dial-in and dial-out support, and update its UUCP and `/etc/passwd` files.
- *Routing requirements*–The `ipd`*n* interface does not support RIP; there is no need to disable it.

Hosts on a Virtual Network

Use a virtual network configuration to connect three or more physically separated computers into a virtual network of phone lines, modems, and PPP software.

- *Network interface*–This type of configuration requires a multipoint link, which uses the `ipd`*n* virtual network interface. This interface connects each endpoint system with the other endpoints on the virtual network.
- *Addressing method*–The configuration file must include the host names or IP addresses of the machines that will communicate over the link. Refer to ”Determining IP Addressing for Your PPP Link” on page 119 for more information. You must assign a network number to the virtual network. Refer to ”Creating a Unique IP Address and Host Name” on page 121 for complete details.
- *Name Service*–You can run NIS and NIS+ for the virtual network; however, this may affect the performance of the link. DNS is a better alternative. Refer to *Name Services Administration Guide* for instructions on setting up these name services. If you use files for name service, be sure to update `/etc/inet/hosts` on each machine with the host names and IP addresses of all machines comprising the virtual network.
- *Dial-in and Dial-out Support*–All machines in the virtual network must be configured for both dial-in and dial-out operations, so you should update their UUCP and `/etc/passwd` files.
- *Routing Requirements*–The `ipd`*n* interface does not support RIP; you do not need to disable it.

Determining IP Addressing for Your PPP Link

To enable communications over the PPP link, the machine at one end of the link must know the host name and IP address of the peer host on the other end of the link. The PPP configurations often require a particular addressing scheme. This section explains the addressing schemes and where each should be used.

Specifying IP Addresses

On each endpoint machine, you specify addressing information in these places:

- `/etc/asppp.cf` configuration file
- `/etc/inet/hosts` file
- NIS+, NIS, or DNS databases, if applicable

When you edit the local machine's `asppp.cf` file, you must provide the host names and, in certain cases, the IP addresses for each endpoint machine to be on the link. For example, you must type either the IP addresses or host names for each endpoint as arguments in the `ifconfig` section in the configuration file:

```
ifconfig ipdptp0 plumb 192.99.44.01 192.99.44.02 up
```

See Chapter 9, "Configuring PPP" for information regarding the format of `/etc/asppp.cf`.

Additionally, to enable communications, you must add the IP address and host name of the remote endpoints to the `hosts` database on the local end point by editing `/etc/inet/hosts`. This process is explained in "Configuring Network Clients" on page 73.

Types of Addressing Schemes

You have a choice of several addressing schemes for PPP, depending on your configuration type. Before you edit the `asppp.cf` file and `hosts` database, you must decide on the appropriate addressing scheme for your configuration. These schemes include

- Using the same IP addresses for the PPP end points as is assigned to their primary network interface in their local `/etc/inet/hosts` files
- Assigning a unique IP address for each PPP endpoint
- Assigning a new network number for the network created by the PPP link

Using the Same IP Address as the Primary Network Interface

This addressing scheme is appropriate for point-to-point links only. In this scheme, you specify the addresses of the primary network interface for each endpoint. (See Chapter 1, "Overview of Network Administration," for more information about the primary network interface.) These endpoints might be:

- Two standalone machines communicating over the PPP link (if they have existing IP addresses)
- Two network endpoints communicating over the PPP link
- Remote host connecting to a network dial-in server through a point-to-point link
- Dial-in server connecting to remote hosts through a dynamically allocated point-to-point link

When you edit the `/etc/inet/hosts` file on a local endpoint, supply the IP address of its primary network interface and host name and the IP address of the peer host on the other end of the link.

Creating a Unique IP Address and Host Name

In this method, you assign a unique host name and IP address to the PPP network interface. (You might want to call the interface *hostname*-ppp.) Use this addressing scheme for:

- Endpoint machine on a network used as a multipoint dial-in server.
- Machines on a virtual network.
- Remote host that uses a dedicated IP address for communicating with a dial-in server over a dynamically allocated PPP link. (Note that this is not a requirement for the dynamic link configuration.)
- Machine that is also configured as a router for a physical network, such as Ethernet or Token Ring.
- Machine in a standalone-to-standalone configuration that does not have an existing IP address. (The PPP interface becomes the primary network interface.)

You must specify the unique address and host name for the PPP network interface in the `asppp.cf` configuration file.

To create the new host name and IP address, simply add it to the `/etc/inet/hosts` file on the endpoint machines, as described in ”hosts Database” on page 51.

Assigning a Network Number to the PPP Link

You create a new network number for the PPP configuration when it involves:.

- Virtual networks of computers communicating through PPP multipoint links (required)
- A multipoint dial-in server and its remote hosts (required)
- The PPP link between two networks, particularly when one or both of the network endpoint machines are also routers for a physical network (optional)

(See Chapter 3, “Planning Your Network,” for information on network numbers.)

The PPP link becomes a *virtual network*, since it does not involve any physical network media. You need to type its network number in the `networks` database on all endpoint machines, along with the network numbers of the networks being linked.

Here is a sample `/etc/inet/networks` file for an internetwork with PPP:

```
kalahari     192.9.253
negev        192.9.201
nubian-ppp   192.29.15
```

In the sample file, `kalahari` and `negev` are two local area networks, and `nubian-ppp` is the name of the PPP link.

Routing Considerations

The RIP routing protocol runs on Solaris TCP/IP networks by default. In most cases, you should leave RIP running on point-to-point links. However, if you are having performance problems with the link, you may want to disable RIP on the point-to-point link.

Note – RIP will not be started on multipoint links. Therefore, you must set up static routing for the multipoint link. Refer to ”To Select Static Routing on a Host” on page 81 for instructions.

Turning off RIP

You can disable RIP on a point-to-point link through the file `/etc/gateways`. This file does not come with your operating system. You must create it with a text editor.

To turn off RIP, `/etc/gateways` must have the following entry:

```
norip ipdptpn
```

where `ipdptp`*n* represents the device name of the point-to-point PPP interface used.

For more information, refer to the `in.routed`(1M) man page.

PPP Hardware Requirements

The basic PPP configuration involves a computer, a modem, and RS-232 telephone lines. However, before you configure, you need to verify whether the hardware you selected can support PPP. This section describes the hardware requirements for PPP.

- *Modem requirements*–To run PPP, each endpoint machine must have a modem that supports at least 9600 bps or faster bidirectional connections. Such a modem would implement the V.32 or V.32bis specification.
- *Serial port selection (for dial-in servers only*)–You can configure either serial port A or serial port B on most CPUs for PPP usage. Use the Solaris Serial Port Manager to initialize the ports on the dial-in server. *Peripherals Administration* contains instructions for selecting the appropriate port. If you have additional serial cards installed, you can also use their serial ports for PPP connections
- *Disk space*–You must have 300 Kbytes of free space in `/usr` to install PPP.

File Space Requirements

You will need sufficient space in the following directories for the PPP software:

- `/usr`
- `/usr/kernel/drv`

- /usr/kernel/strmod
- /usr/sbin

PPP occupies approximately 243 Kbytes in `/usr` and 4 Kbytes in `/` (root).

Checklist for Configuring PPP

Use this checklist to prepare for configuring PPP. It lists the information you will need to gather and the tasks you need to do before starting the configuration process.

1. Do you have 300 Kbytes of free space available in `/usr`? ____________
2. Do you have 4 Kbytes of free space available in `/` root? ____________
3. Do the modems for each endpoint support V.32 or V.32bis or higher? ____________
4. Have you used the Serial Port Manager on the dial-in server to designate the serial port for the modem? ____________
5. Have you ensured that Solaris PPP is installed on each endpoint machine? (If PPP hasn't been installed, you can use the `pkgadd` program or `swmtool` to install it. Refer to *SPARC: Installing Solaris Software* or *x86: Installing Solaris Software*for instructions) ____________
6. Have you ensured that there are no other versions of PPP running on each endpoint. (If there are, disable them, as explained in their documentation.) ____________
7. Have you determined which IP addresses to use for all computers involved in the PPP link? ____________
   List the host names and IP addresses of these machines here. ____________
   ____
   ____
   ____

8. Write the name and IP address of the dial-in server (if applicable). ___________

9. Write the name of the network interface that you need to use. ___________

Configuring PPP 9

This chapter contains procedures and information for configuring PPP. The example used in the text is for the configuration with both types of PPP links—remote hosts–to–multipoint dial-in server. Chapter 11, “Tailoring Your PPP Link,.” contains information for setting up other PPP configuration types.

Overview of the Configuration Process

You have completed the pre-installation activities noted in Chapter 8, “Preparing Your PPP Configuration.” Now you can begin the PPP configuration process.

To configure PPP, you

1. Install the PPP software, if it isn’t already installed.
2. Edit the `/etc/inet/hosts` files on all machines involved.

3. Edit the UUCP database files for all dial-out machines.
4. Edit the `/etc/passwd` and `/etc/shadow` files for the dial-in machine.
5. Edit the `/etc/asppp.cf` file on each machine on the link.
6. Start the link manager `aspppd` on each machine on a link.
7. Verify that PPP is running successfully.

Although you don't have to perform Tasks 1–4 in order, you must complete them before you can edit the PPP configuration file.

The sections in this chapter explain the procedures for configuring PPP.

Installing the PPP Software

The PPP software is automatically included when you run the Solaris installation program and select the entire distribution. If you did not select the entire distribution, you need to install PPP as a separate package.

Verifying Installation

Before proceeding further, you must check that the Solaris version of PPP is installed on all machines to be involved in the PPP link. On each endpoint involved in the link, type the following:

```
# pkginfo | grep ppp
```

If PPP is installed, the following package names will be displayed:

```
SUNWpppk       # Contains kernel modules
SUNWapppu      # Contains the link manager and login service
SUNWapppr      # Contains configuration files
```

If PPP is not installed on an endpoint system, install it using either the `pkgadd` program or `swmtool` menu-driven interface.

Note – When using pkgadd to install PPP, you must install the packages in the order listed in the preceding screen box.

Refer to *Common Administration Tasks* for more information about pkgadd and swmtool.

Sample PPP Configuration

This section and the following show you how to edit the appropriate files to support the most common PPP configuration: remote hosts and their dial-in server. Figure 9-1 on page 130 illustrates the configuration used as the example for this chapter. It depicts three remote machines (nomada, nomadb, nomadc) and their dial-in server nubian, which compose the network 192.41.43. This is a separate network from the local area network 192.41.40, to which dial-in server nubian is directly attached. Network 192.41.40 runs NIS as its name service.

The IP number shown for each remote host is the address of its PPP network interface. However, the dial-in server has a specially created IP address for the PPP interface, 192.41.43.10, in addition to the IP address for its primary network interface, 192.41.40.45.

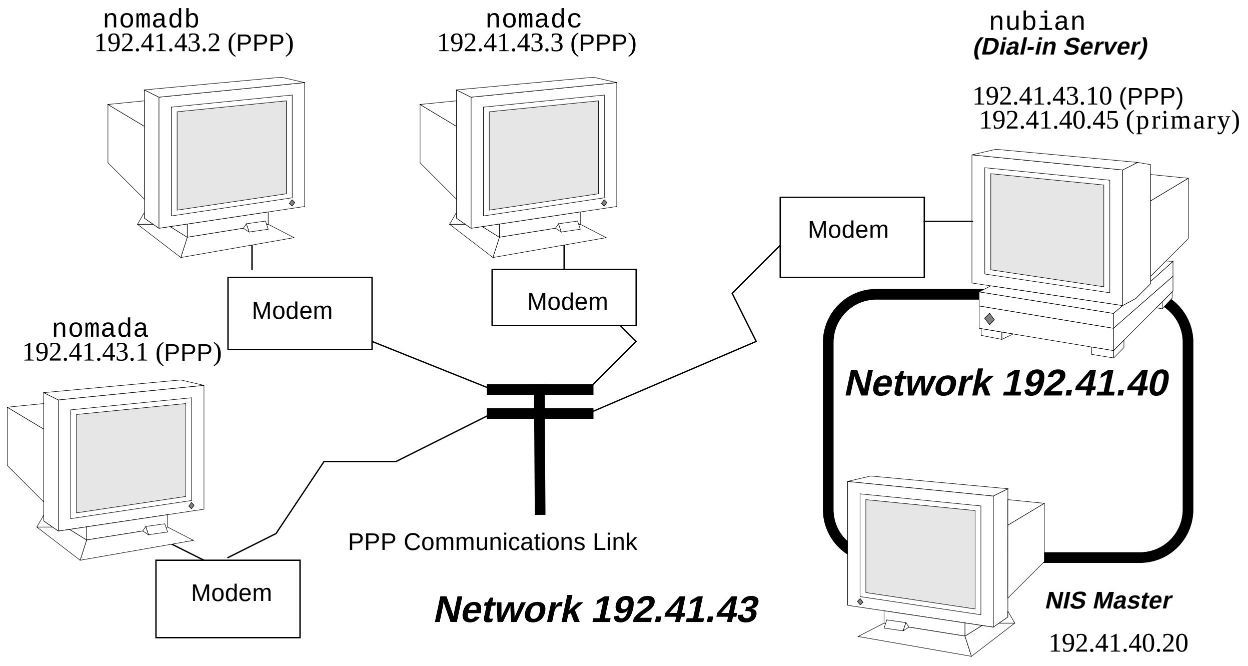


Figure 9-1 Sample Network of Remote Hosts and Multipoint Dial-in Server

Editing the `/etc/inet/hosts` *File*

After ensuring that PPP is installed on every machine involved in your configuration, your next task is to edit the `/etc/inet/hosts` files on each machine. You must add host information to the `hosts` database for every machine on the other end of the PPP link that the local machine needs to communicate with.

Note – You must update `/etc/inet/hosts` regardless of the name service in use on the physical network. This is necessary because PPP starts before the name service daemons during the booting process.

▼ How to Configure the Remote Machine‘s hosts Database

1. **Become superuser and edit the `/etc/inet/hosts` file:**
2. **Add an entry with the IP address and host name of the PPP network interface for the dial-in server on the other end of the link.**

   In Figure 9-1 on page 130, `nomada` will have in its `/etc/inet/hosts` file an entry with the IP address for dial-in server `nubian`'s PPP network interface. This would be true also for the `/etc/inet/hosts` files for `nomadb` and `nomadc`.

3. **Add entries with the IP addresses of any machines on the dial-in server‘s physical network that the remote host can remotely log in to.**
   The `/etc/inet/hosts` file on `nomadc` would look like:

```
# Internet host table
#
127.0.0.1           localhost       loghost
192.41.43.3        nomadc
192.41.43.10        nubian-ppp
192.41.40.20        nismaster
```

4. **Update the databases on the name server (if the network has one) with the host names and IP addresses of the remote hosts.**

Multipoint Dial-in Server hosts *Database*

Multipoint dial-in servers must have a unique IP address for the PPP interface, besides the local IP address for the primary network interface. When configuring the `hosts` database for the dial-in server, you need to do the following procedure:

▼ How to Configure the Dial-In Server's `hosts` Database

1. **Add an entry with the IP address for the PPP interface to the `/etc/inet/hosts` file for the dial-in server.**
   For example, the `/etc/hosts` file on dial-in server `nubian` in Figure 9-1 on page 130 would have these entries.

```
# Internet host table
#
127.0.0.1           localhost      loghost
192.41.43.10        nubian-ppp
192.41.40.45        nubian
```

2. **For configurations where the server's physical network does not use a name service:**

   a. **Add entries to the server's `/etc/inet/hosts` files for each remote host served.**

   b. **Add entries for the remote hosts to the `/etc/inet/hosts` files of every machine on the physical network permitted to communicate with the remote machines.**

3. **Add a new network number to the dial-in server's `/etc/inet/networks` file for the network comprised of the server and its remote hosts.**
   Refer to "Assigning a Network Number to the PPP Link" on page 122 for more information.

Editing UUCP Databases

Before a machine can dial out over the PPP link, you must edit these files in its UUCP database:

- `/etc/uucp/Devices`
- `/etc/uucp/Dialers`
- `/etc/uucp/Systems`

You must edit these files for remote hosts serving as PPP dial-out machines. Additionally, you must edit these files on the dial-in server if it is to dial out to the remote hosts (a requirement for multipoint dial-in servers). Chapter 12, "UUCP Databases and Programs," describes these files in detail.

Updating `/etc/uucp/Devices` *for PPP*

The `/etc/uucp/Devices` file must contain entries for every communications device that a particular host uses or must know about. For example, if a machine uses a US Robotics V.32bis modem as part of the PPP link, you should ensure that `/etc/uucp/Devices` has an entry similar to the following:

```
# Use these if you have a USrobotics V.32bis modem on Port B.
ACUEC   cua/b - 9600 usrv32bis-ec
ACUEC   cua/b - 19200 usrv32bis-ec
ACUEC   cua/b - 38400 usrv32bis-ec
```

Be sure that the `Devices` file on each PPP endpoint machine has an entry describing its modem. For more information about `/etc/uucp/Devices`, refer to "/etc/uucp/Devices File" on page 190.

Updating `/etc/uucp/Dialers` *for PPP*

The `/etc/uucp/Dialers` file must have an entry describing the conversation with the modem attached to your PPP endpoint machine. Here is a sample entry for a US Robotics V.32bis modem that will be part of a PPP link:

```
usrv32bis-ec =,-,  "" \dA\pT&FE1V1X1Q0S2=255S12=255&A1&H1&M5&B2&&B1W\r\c OK\r \EATDT\T\r\c
CONNECT\s14400/ARQ STTY=crtscts
```

The first parameter in the entry, `usrv32bis`, corresponds to the last parameter in the `/etc/uucp/Devices` file, linking them together. The remainder of the entry describes the characters that the modem will send, those that it expects to receive, and so on. Table 12-16 on page 204 defines the control codes used in the `Dialers` file.

Be sure that an entry is in the `Dialers` file for the modem attached to each dial-out endpoint on your link. If you are unsure of the correct conversation for a particular modem, refer to *Peripherals Administration* and the operating manual for the modem.

Updating /etc/uucp/Systems for PPP

The /etc/uucp/Systems file contains entries for every machine to which the local host can dial out. Information in an entry might include the remote host's phone number, the line speed, and so on. Here is an example that host nomadb in Figure 9-1 on page 130 might have for its dial-in server:.

```
nubian-ppp  Any ACUEC 38400 5551212 "" P_ZERO "" \r\n\c login:-\r\n\c-login:-\r\n\c-login:-
EOT-login: bnomad password: Secret-Password
```

The first field gives the server's host name, nubian-ppp, a value used by the asppp.cf file keyword peer_system_name. ACUEC and 38400 refer to the device and speed, and are used to select an entry from the /etc/uucp/Devices file. The remaining information includes the phone number of the machine that nomadb wants to dial in to, the login name that nomadb will use to log in, and so on. "/etc/uucp/Systems File" on page 183 fully defines the parameters you need to supply to the Systems file.

On each remote host in your configuration, you must add an entry for its dial-in server. Note that you can have additional entries in the /etc/uucp/Systems file for other machines to which the host will dial out for UUCP communications and for other PPP dial-in servers.

If the dial-in server will also directly dial out to remote hosts, you must add entries to its Systems file describing each of these remote hosts.

Modifying the /etc/passwd File

To configure a dial-in server, you must also edit the /etc/passwd and /etc/shadow files.

You must add entries to the /etc/passwd file on the dial-in server for each user on a remote host authorized to log in to the server. When a remote host calls the dial-in server, it reads its UUCP databases and passes the server a user name or user ID for the host initiating the call. The server then verifies this user information in its /etc/passwd file.

If the user's password is authenticated, the server then logs the user in to a special shell for PPP hosts, `/usr/sbin/aspppls`. The server gets this information from the login shell entry in its `/etc/passwd` file. Using the example in Figure 9-1 on page 130, dial-in server `nubian` might have the following entries in its `/etc/passwd` file:

```
bin:*:3:3::/bin:
uucp:*:4:8::/var/spool/uucppublic:
news:*:6:6::/var/spool/news:/bin/csh
sync::1:1::/:/bin/sync
sundiag:*:0:1:System Diagnostic:/usr/diag/sundiag:/usr/diag/sundiag/sundiag
lily:6ZAHAy5xMYVwQ:20:99:Dial-in Operator:/home/nubian/lily:/bin/csh
nomada:jk29cl3uc5123:21:99:R. Burton:/:/usr/sbin/aspppls
nomadb:duiehxl298dls:22:99:T. Sherpa:/:/usr/sbin/aspppls
nomadc:nkeis63jdksg3:23:99:S. Scarlett:/:/usr/sbin/aspppls
```

Refer to *User Accounts, Printers, and Mail Administration* for information about the `/etc/passwd` file.

Note – In addition to the information in the `/etc/passwd` file, you update the `/etc/shadow` file with the passwords for the login names used by each endpoint machine permitted to dial in to the server. For more information, refer to *User Accounts, Printers, and Mail Administration*.

Editing the `/etc/asppp.cf` *Configuration File*

The `/etc/asppp.cf` configuration file provides the PPP link manager on one endpoint machine with information about the machine on the other end of the link—or the machines on the other end of a multipoint (or dynamic point-to-point) link. When the machine boots, the link manager uses this information to establish and maintain communication with a remote endpoint.

Parts of Basic Configuration File

The basic `asppp.cf` configuration file must contain at least two main sections: an `ifconfig` line and at least one `path` section. It can also contain a `defaults` section, which you use when you want to set the default values for an endpoint. (Refer to Chapter 11, "Tailoring Your PPP Link," for a description of key words used in the `defaults` section.)

Code Example 9-1 shows a basic configuration file such as you would create for a remote host to establish a point-to-point link with a dial-in server

Code Example 9-1 Basic Configuration File

```
ifconfig ipdptp0 plumb nomada nubian-ppp up
   path
      interface ipdptp0
     peer_system_name nubian-ppp     # The name in the /etc/uucp/Systems file
      inactivity_timeout 300          # Allow five minutes before timing out
```

`ifconfig` *Section of the* `asppp.cf` *File*

The `asppp.cf` file must contain an `ifconfig` section. It has the following syntax:

`ifconfig` *interface-number* `plumb` *local-machine remote-machine* up

Here is a description of the fields:

- `ifconfig`–Tells the link manager to run the `ifconfig` command and begin configuring the PPP interface.
- *interface-number*–Identifies the PPP interface `ipdptp`*n* for a point-to-point link or `ipd`*n* for a multipoint link. (Replace the *n* with the number of the interface.)
- `plumb`–Option of `ifconfig` that enables IP to recognize the interface.
- *local-machine*–Gives the name of the local endpoint, which can be the local host name or IP address.
- *remote-machine*–Gives the name of the remote endpoint, which can be the remote host name or IP address.

- up–Option of ifconfig that marks the interface just described as up.

The link manager first runs the ifconfig command on the local machine to configure the ipdptp0 point-to-point interface. The zero in ipdptp0 gives the device number of the interface. The plumb option performs various activities necessary for IP to recognize the ipdptp0 interface. nomada is the name of the local host. nubian-ppp is the name of the dial-in server to which nomada will connect through the point-to-point link. The ifconfig option up marks the ipdptp0 interface as up.

Note – For more information about ifconfig, see Chapter 10, "Troubleshooting PPP" and the ifconfig(1M) man page.

path *Section of the* asppp.cf *File*

The path section of the configuration file tells the link manager the name of the remote endpoint and the name of the interface linking the endpoint machines. At a minimum the path section should contain the following lines:

```
path
   interface inteface.no
   peer_system_name endpoint.name
```

interface ***Keyword***

This keyword defines the PPP interface (either ipdptp*n* or ipd*n*). In Code Example 9-1 on page 136, the following information appears in the path section:

```
        interface ipdptp0
         peer_system_name nubian-ppp
```

The interface keyword identifies ipdptp0 as the point-to-point interface that local end point nomada will use to communicate with the remote endpoint in the manner described in this path section. It associates the peer_system_name with the interface.

`peer_system_name` *Keyword*

On a dial-out machine such as a remote host, the `peer_system_name` keyword takes the host name of the remote endpoint as its argument. This is the name of the remote endpoint given in `/etc/uucp/Systems`. The name need not be the same as the host name on the corresponding `ifconfig` line.

Note – The argument to the `peer_system_name` keyword for a dial-in server has a different value. See "Configuration File for Multipoint Dial-in Server" on page 138 for details.

In the example on Code Example 9-1 on page 136, `peer_system_name` identifies dial-in server `nubian-ppp` as the remote endpoint at the other end of this link. When the link manager reads the `asppp.cf` file, it then looks for the entry for `nubian-ppp` in the `/etc/uucp/Systems` file. (Recall that the `Systems` file contains information about how to set up communications with the remote endpoint, including that machine's telephone number. Refer to "Updating /etc/uucp/Systems for PPP" on page 134.)

`inactivity_timeout` *Keyword*

The `inactivity_timeout` keyword is optional. It tells the link manager that the link can remain inactive for the interval designated. When that interval is passed, the link manager knows to automatically disconnect the link. The default interval is two minutes; you do not have to use `inactivity_timeout` unless you require a different inactivity interval.

Additional Keywords

You can supply other keywords in the `asppp.cf` file to define how endpoint machines should communicate. Chapter 11, "Tailoring Your PPP Link," has complete information about these keywords.

Configuration File for Multipoint Dial-in Server

The `asppp.cf` configuration file for a multipoint dial-in server contains the same basic sections as that for a point-to-point link: an `ifconfig` section, at least one `path` section, and, if desired, a `defaults` section.

Code Example 9-2 shows a configuration file for the dial-in server `nubian` introduced in Figure 9-1 on page 130.

Code Example 9-2 Configuration File for a Multipoint Dial-in Server

```
ifconfig ipd0 plumb nubian-ppp up

path
    interface ipd0
    peer_system_name tamerlane  # The user name this remote
                                # machine logs in with when it
                                # dials this server
    peer_ip_address nomada
                                # nomada is a remote machine that
                                # dials in to this server

# nomadb is another remote machine that dials in to nubian

path
    interface ipd0
    peer_system_name lawrence
    peer_ip_address nomadb

# nomadc is another remote machine that dials in to nubian

path
    interface ipd0
    peer_system_name azziz
    peer_ip_address nomadc
```

`ifconfig` *Section for Multipoint Dial-in Server*

The `ifconfig` section for a multipoint dial-in server has a slightly different syntax than that for a point-to-point link. This syntax is:

`ifconfig` ipd*n* `plumb` *server-name* `up`

The major difference is that no destination end points are listed as arguments to `ifconfig`. Instead, the link manager picks up this information from the `path` section of the `asppp.cf` file.

In Code Example 9-2 on page 139, the link manager first runs the `ifconfig` command on the dial-in server to configure multipoint interface `ipd0`. The zero in `ipd0` gives the device number of the interface. The option `plumb` performs various activities necessary for IP to recognize the `ipd0` interface. The `ifconfig` option `up` marks interface `ipd0` as up.

Note – You may have to supply a netmask + parameter on the `ifconfig` line if you use subnetting.

`path` *Section for Multipoint Dial-in Server*

The `path` section of the `asppp.cf` file tells the link manager the name of the remote endpoint and the name of the interface linking the endpoint machines. However, on a multipoint dial-in server, you can include more than one `path` section. Additionally, some of the arguments to the keywords are used differently with multipoint links.

```
path

      interface inteface.no
      peer_system_name endpoint_username
      peer_ip_address endpoint_hostname
```

You need to define a `path` section for each nomadic endpoint with which the dial-in server will establish connections.

`interface` ***Keyword***

For a multipoint dial-in server, the `interface` keyword defines the PPP interface `ipd`*n*. You must specify the same PPP interface in the `path` section for every endpoint that will communicate with the server through this interface.

`peer_system_name` ***Keyword***

The `peer_system_name` keyword takes a slightly different argument for a dial-in machine than a dial-out machine. For a dial-in server, this argument is the login name used by the remote host when it tries to establish communications with the server. This user name must already be present in the server's `/etc/passwd` file. When the login service reads this name, it verifies the user name in the `/etc/passwd` and `/etc/shadow` files enabling communications.

In the following excerpt from Code Example 9-2:

```
path
    interface ipd0
    peer_system_name scarlett
    peer_ip_address nomadc
```

the argument to `peer_system_name` is `scarlett`, indicating that when `nomadc` logs in to `nubian-ppp`, it uses the login name `scarlett`.

`peer_ip_address` *Keyword*

The `peer_ip_address` keyword is required for multipoint links. It takes the host name or IP address of the remote end point as its argument. The example above uses the host name `nomads` as the argument to keyword `peer_ip_address`.

Additional Keywords

You can supply other keywords in the `asppp.cf` file to define how endpoint machines should communicate. Refer to Chapter 11, "Tailoring Your PPP Link," for a complete list of keywords.

Editing the Configuration File

When editing `asppp.cf`:

- Separate keywords in the configuration file by white space (blanks, tabs, and newlines).
- Use a # sign before all character strings meant as comments. All characters placed between a # sign and the next new line are considered comments and ignored.

There are no other format requirements for the placement of the keywords in the file.

▼ How to edit the `asppp.cf` Configuration File

1. **Become superuser on one endpoint machine, and change to the `/etc` directory.**
2. **Edit the generic `asppp.cf` file to add the information defining the PPP link for this machine.**
3. **Save the file, making sure the permissions are `600`.**
4. **Change to the `/etc` directories on the remaining endpoints, and repeat Steps 2 and 3.**

Starting Up Your New PPP Link

You can start PPP either automatically, at boot time, or manually from the command line.

Manually Starting PPP

You can start PPP manually, although this is not normally required. Become superuser and type:

```
# /etc/init.d/asppp start
```

▼ How to Verify that PPP Is Running

Run the `ps` command as follows:

```
 # ps -e | grep asppp
```

The resulting output from `grep` should list the `aspppd` daemon, indicating that PPP is running.

If you do get results, verify that you can reach the remote PPP link by typing:

```
# ping remote_host 300
```

This version of ping sets a timeout value of 5 minutes (300 seconds). You should receive output similar to *remote-host* is alive. If you receive a different notice, such as *remote-host* unreachable, route configuration has failed.

Check for errors in the configuration process by examining the log file.

```
# tail /var/adm/log/asppp.log
```

The asppp.log will contain error messages if any errors were encountered during configuration.

Go to Chapter 10, "Troubleshooting PPP," for information on troubleshooting and problem solving.

Stopping PPP

To stop PPP operations on your network, type:

```
# /etc/init.d/asppp stop
```

Troubleshooting PPP 10

This chapter is organized as a series of checks to make after you have configured PPP on your network. Thereafter, whenever you have trouble communicating over the PPP link, you can use PPP diagnostics to help troubleshoot problems.

In summary, you should do these checks in the following order:

1. Hardware
2. Interface status
3. Connectivity
4. Network interface activity
5. Local routing tables

6. Permissions
7. Checking packet flow

If PPP passes all the tests, you should be able to use TCP and UDP services such as `rlogin`, `telnet`, and `ftp` over the link. If the link still fails, turn on PPP diagnostics for assistance in troubleshooting.

The next subsections describe these checks in detail.

Checking Hardware

Make sure that all modem and power cables are tightly seated. If you are having problems with PPP, always check the modems, cables, serial card, and phone lines first.

Checking Interface Status

After PPP is started, you can use `ifconfig` to monitor the current state of the line, using only the PPP interface name as an argument. Following are sample outputs from `ifconfig` for PPP links that are running.

Code Example 10-1 `ifconfig` Output for Point-to-Point Link

```
nomadb# ifconfig ipdptp0

ipdptp0: flags=28d1<UP,POINTOPOINT,RUNNING,NOARP,MULTICAST,UNNUMBERED> mtu 1500
        inet 129.144.111.26 --> 129.144.116.157 netmask ffff0000
        ether 0:0:0:0:0:0
```

You will receive output similar to that in Code Example 10-1 for both standard and dynamic point-to-point links.

Code Example 10-2 `ifconfig` Output for Multipoint Link

```
nubian# ifconfig ipd0

ipd0: flags=c1<UP,RUNNING,NOARP> mtu 1500
        inet 129.144.201.191 netmask ffffff00
        ether 0:0:0:0:0:0
```

If ifconfig does not display UP and RUNNING, you did not configure PPP correctly. For more information on ifconfig, see ”ifconfig Command” on page 88and the ifconfig(1M) man page.

Checking Connectivity

Use the ping command to verify that the connection is up or can be established. For example, consider the following simple round-trip test:

```
# ping elvis
```

where elvis is the name of the PPP interface on the remote host. If the resulting display is

```
elvis is alive
```

then packets can be sent to and received from elvis. If not, a routing problem exists at some point between the local and remote hosts. For more information on ping, refer to ”ping Command” on page 86 and the ping(1M) man page.

Checking Interface Activity

Use the netstat command as follows to check that packets are being sent and received correctly: .

```
# netstat –i
```

Refer to ”netstat Command” on page 89 and the netstat(1M)man page.

Checking the Local Routing Tables

Use the netstat command to display the local routing tables:

```
# netstat –r
```

The following is sample output:

```
Routing tables

Destination   Gateway   Flags  Refcnt  Use     Interface


sahara        deserted  UGH    0       0       ie1
karakum       labia     UGH    0       0       ie1
frodo         bilbo     UGH    1       12897   ipdptp0
route7        route7    UGH    0       0       ie0
eastgate      route71   UGH    0       158     ie0
backbone      pitstopbb U       1     16087     ie1
dresdenpc     route1    UG     0       0       ie1
loopback      localhost U      2       113436  lo0
swan-bb       pitstop   U      4063    146044  ie0
dallas2       route7    UG     0       0       ie0
trainingpc    route62   UG     0       0        ie1
```

Make sure there is a routing table entry for each possible destination network. In particular, PPP devices, listed under `Interface`, should be matched with the appropriate host names listed under `Gateway`. The `Gateway` entry should, in turn, be matched with the correct entry under `Destination`.

Otherwise, if you are using *static routing*, add the appropriate static routes. If you are using *dynamic routing* with `in.routed`:

1. **Verify that `in.routed` is running by typing:**

```
# ps -e | grep route
```

   If the routing tables still don't look correct, become superuser, and continue with the next steps.

2. **Kill `in.routed` by typing the process ID you got from `ps -e` as the argument to `kill`. For example, if 1384 was the process ID, you would type:**

```
# kill 1384
```

3. **Flush the routing tables as follows:**

```
# /usr/sbin/route -f
```

4. **Restart** `in.routed`**.:**

```
#/usr/sbin/in.routed
```

Checking Permissions

If you attempt to use `rsh` and receive the message `Permission denied`, the remote system's `/etc/hosts.equiv` or `/.rhosts` file does not contain the sending system's host name or does not contain the line '+'.

Checking Packet Flow

Check the packet flow next. Use the `snoop` command to observe packets from the network and observe their contents. For example:

Code Example 10-3 Sample Output from `snoop`

```
# snoop -d ipdptp0
Using device ipdptp0 (promiscuous mode)
corey -> pacifica7    RLOGIN C port=1019
       hugo -> ponc3         RPC R XID=22456455 Success
       ponc3 -> hugo         NFS C WRITE FH=1B29 at 32768

    commlab3 -> commlab4     TELNET R port=34148
    commlab4 -> commlab3     IP  D=129.144.88.3 S=129.144.88.4 LEN=46, ID=41925
    commlab3 -> commlab4     TELNET R port=34148
    commlab4 -> commlab3     ICMP Echo request
    commlab3 -> commlab4     ICMP Echo reply
    commlab4 -> commlab3     FTP C port=34149
    commlab4 -> commlab3     FTP C port=34149
    commlab3 -> commlab4     FTP R port=34149
    commlab4 -> commlab3     FTP C port=34149
```

The `ipdptp0` device name mentioned in the first line of the output ”`Using device ipdptp0`” indicates a point-to-point connection.

Note – You need to have the link up and some traffic generated in order to use `snoop` to check the line status.

`snoop` captures packets from the network and displays their contents. It uses both the network packet filter and streams buffer modules to provide efficient capture of packets from the network. Captured packets can be displayed as they are received or saved to a file for later viewing.

`snoop` can display packets in a single-line summary form or in verbose multi-line forms. In summary form, only the data pertaining to the highest-level protocol is displayed. For example, an NFS packet will have only NFS information displayed. The underlying RPC, UDP, IP and Ethernet frame information is suppressed but can be displayed if either of the verbose options is chosen.

For more information about the `snoop` command, refer to the `snoop`(1M) man page.

Using PPP Diagnostics for Troubleshooting

If you have problems with a link after successfully establishing modem connections, you can use PPP level diagnostics for troubleshooting. PPP level diagnostics report detailed information about the activities of a link to help you determine where it is failing.

To obtain diagnostic information, you add the line `debug_level 8` to the `path` section of the `asppp.cf` file. (If you are very knowledgeable about data communications, you may want to use debug level 9, which provides very detailed information.) Here is a sample configuration file that invokes PPP diagnostics.

```
ifconfig ipdptp0 plumb nomada nubian-ppp up
   path
      interface ipdptp0
      peer_system_name nubian-ppp      #The name in the /etc/uucp/Systems file
      inactivity_timeout 300            #Allow five minutes before timing out
      debug_level 8                    #Start up PPP diagnostics for this link
```

For complete details about the `aspppd.conf` file, refer to "Editing the /etc/asppp.cf Configuration File" on page 135.

▼ How to Set Diagnostics for Your Machine

Set diagnostics on the host you want to monitor as follows:

1. **Become superuser and change to the `/etc` directory.**
2. **Edit the current `asppp.cf` file and add the following to the `path` section:**

   `debug_level 8`

3. **Save the file, making sure the permissions are `600`.**
4. **Kill the current `aspppd` daemon and restart it.**

```
#kill -HUP PID
#aspppd
```

   where *PID* is the process ID for `aspppd`.

PPP will now report diagnostic information in `/var/adm/log/asppp.log`.

Analyzing Diagnostic Output

When a PPP link runs correctly, the asppp.log file includes diagnostic information in addition to its normal output. This section explains what the diagnostic messages mean. If your output is different, refer to RFC 1331.

Host and Modem Set Up

This section contains messages that occur as the local host sends configuration information to the modem, and then as the modem tries to dial the remote host. These initial activities are actually handled by the UUCP daemon. You might think of them as the UUCP portion of asynchronous PPP communications. (Refer to Chapter 12, "UUCP Databases and Programs," for complete details on UUCP.)

The two messages below should always appear at the beginning of the session. They indicate that the aspppd daemon has started successfully.

```
11:53:33 Link manager (1057) started 04/14/94
11:53:33 parse_config_file: Successful configuration
```

The next line indicates that a packet was routed to the ipdptp0 interface on the local host. It helps you to determine if a dial-out is occurring correctly. For example, if you tried to ping the remote machine and this message isn't in asppp.log, the packet was lost, probably due to a routing problem.

Next, UUCP looks for an entry that matches Ppac7 in a chat script in the /etc/uucp/Systems file. It then reports that it found an entry that had a device type ACUTEC. (For more information on the Systems file, refer to "/etc/uucp/Systems File" on page 183.)

```
11:53:46 process_ipd_msg: ipdptp0 needs connection
conn(Ppac7)
Trying entry from '/etc/uucp/Systems' - device type ACUTEC.
```

UUCP then finds the dialing information for an ACUTEC dialer in the `/etc/uucp/Devices` file. When it find the information, it opens the appropriate serial port on the local host and sets it with a speed of 9600. (For more information on `/etc/uucp/Devices`, see "/etc/uucp/Devices File" on page 190.)

```
Device Type ACUTEC wanted
Trying device entry ‘cua/a’ from ‘/etc/uucp/Devices’.
processdev: calling setdevcfg(ppp, ACUTEC)
fd_mklock: ok
fixline(8, 9600)
gdial(tb9600-ec) calle
```

UUCP looks for the entry `tb9600` in the `/etc/uucp/Dialers` file and then sends out these messages.

```
Trying caller script ‘tb9600-ec’ from ‘/etc/uucp/Dialers’
expect: (““)
```

The host waits a couple seconds and then sets the registers on the modem. The information shown in the log below is modem-specific. It comes from the `/etc/uucp/Dialers` file.

```
got it
sendthem (DELAY)
APAUSE
APAUSE
APAUSE
T&D2E1V1X1Q0S2=255S12=255S50=6S58=2^M<NO CR>)
```

The next lines are the dialog between the modem and the host machine. `expect (OK^M)` means that the host expects the modem to send an okay. The words `got it` at the end of the second line indicate that the host got the okay from the modem.

```
expect: (OK^M)
AAAT&D2E1V1X1Q0S2=255S12=255S50=6S58=2^M^M^JOK^Mgot it
```

Next, the host sends the string below to modem, which does the actual dialing. The phone number in the second line is retrieved from the entry for the remote host in the `/etc/uucp/Systems` file..

```
sendthem (ECHO CHECK ON
A^JATTDDTT99003300887744^M^M<NO CR>)
```

The line beginning with `expect` indicates that the local host expects to get a response from the modem at a speed of 9600 bps. The next line indicates that the modem responded.

```
expect: (CONNECT 9600)
^M^JCONNECT 9600got it
```

This line indicates that hardware flow control has started on the link. The host obtains flow control information from the `/etc/uucp/Dialers` file.

```
STTY crtscts
```

In the next series of messages, the local host waits for the remote host to send it a standard UNIX login prompt.

```
getty ret 8
expect: (““)
got it
sandiest (^J^M)
expect: (login:)
```

The next messages indicate that the local host has received the login prompt from the remote. It then retrieves the appropriate login sequence from the chat script in the `/etc/uucp/Systems` entry for the remote host. This sequence is `Ppong^M`, which is required for login by the remote host.

```
^M^J^M^Jlogin:got it
sendthem (Ppong^M)
```

In these messages, the local host waits for the `ssword` prompt from the remote host. Upon receipt of the prompt, the local host sends the password retrieved from the chat script in the `/etc/uucp/Systems` entry for the remote host.

```
expect: (ssword:)
login: Ppong^M^JPassword:got it
```

The following messages indicate that dialing and modem connection completed successfully.

```
sendthem (ppptest1^M)
call cleanup(0)^M
```

Communications between the Local and Remote Hosts

At this point, PPP communications start, as the link between local and remote hosts is now established.

The first lines in this part of the session constitute a *configuration request* (Config-Req). This is the first PPP packet sent to the remote host. The configuration request is one example of a Link Control Protocol (LCP) packet. It requests that configuration be set up and then sets up the PPP link between endpoint machines.

```
11:54:20 004298 ipdptp0 SEND PPP ASYNC 29 Octets LCP Config-Req
ID=4c LEN=24 MRU=1500 ACCM=00000000 MAG#=69f4f5b2 ProtFCOMP
AddrCCOMP
```

Code Example 10-4 Configuration Request

Here is a description of the configuration request shown in Code Example 10-4.

- `11:54:20`–Time stamp field, indicating the time when the packet was sent
- `004298`–Number of the packet
- `ipdptp0`–Network interface used
- `SEND PPP ASYNC`–Indicates that the modem is sending asynchronous PPP
- `29 Octets`–Amount of data the host sent.

- `LCP`– Packet type to send.
- `ID=4c`–Identifier associated with the packet. It is actually part of the packet.
- `LEN=24`–Length of the LCP part of the packet

The remaining items are a list of options to be negotiated between hosts.

- `MRU`=1500–Maximum Receive Unit (MRU), the largest packet size the calling host can receive from the remote host
- `ACCM`=00000000–Asynchronous Character Map (ACCM), the mask sent to the remote host that tells what control characters to escape on transmission.
- `MAG#=69f4f5b2`–Magic number field. Used for loopback detection mechanism
- `ProtFCOMP AddrCCOMP`–Asks for the remote host to compress certain parts of the frame header (protocol field, address field).

The next lines are reporting invalid PPP packets. They come from the remote host, which actually is sending out UNIX text. This does not indicate a problem with PPP.

```
11:54:20 004299 ipdptp0 RECEIVE {Invalid ppp packet}PPP ASYNC 7
Octets [BAD FCS} {Unrecognized protocol:    1}

11:54:20 004299 ipdptp0 RECEIVE PPP ASYNC 73 Octets [BAD FCS}
{Unrecognized protocol:    880a}
```

In these packets, the local host receives the remote host's request for configuration, and then sends out another configuration request.The packets are identical except for their ID fields. The ID field helps to distinguish between the two packets.

```
11:54:21 004301 ipdptp0 RECEIVE PPP ASYNC 29 Octets LCP Config-
Req  ID=35 LEN=24 MRU=1500 ACCM=00000000 MAG#=a8562e5f ProtFCOMP
AddrCCOMP
11:54:21 004302 ipdptp0 SEND PPP ASYNC 29 Octets LCP Config-Req
ID=4d LEN=24 MRU=1500 ACCM=00000000 MAG#=69f4f5b2 ProtFCOMP
AddrCCOMP
```

In this packet, the local host acknowledges the remote request by sending it a configuration acknowledgment (Config-ACK).

```
11:54:21 004303 ipdptp0 SEND PPP ASYNC 29 Octets LCP Config-ACK
ID=35 LEN=24 MRU=1500 ACCM=00000000 MAG#=a8562e5f ProtFCOMP
AddrCCOMP
```

The local host receives a configuration request (Config-Req) from the remote host.

```
11:54:21 004304 ipdptp0 RECEIVE PPP ASYNC 29 Octets LCP Config-
Req  ID=36 LEN=24 MRU=1500 ACCM=00000000 MAG#=a8562e5f ProtFCOMP
AddrCCOMP
```

In these packets, the local host acknowledges the second packet sent by the remote host and receive the remote host's acknowledgment.

```
11:54:21 004305 ipdptp0 SEND PPP ASYNC 29 Octets LCP Config-ACK
ID=36 LEN=24 MRU=1500 ACCM=00000000 MAG#=a8562e5f ProtFCOMP
AddrCCOMP
11:54:21 004306 ipdptp0 RECEIVE PPP ASYNC 29 Octets LCP Config-
ACK  ID=4d LEN=24 MRU=1500 ACCM=00000000 MAG#=69f4f5b2 ProtFCOMP
AddrCCOMP
```

Here the local host negotiates parameters about IP transmission. `LEN=16` gives the packet size. `VJCOMP` indicates Van Jacobsen header compression. `IPADDR` is followed by the calling host's IP address.

```
11:54:21 004307 ipdptp0 SEND PPP ASYNC 21 Octets IP_NCP Config-
Req  ID=4e LEN=16 VJCOMP MAXSID=15 Sid-comp-OK IPADDR=192.9.68.70
```

This packet indicates that the local host has received IP configuration from the remote host, including its IP address.

```
11:54:22 004308 ipdptp0 RECEIVE PPP ASYNC 21 Octets IP_NCP
Config-Req  ID=37 LEN=16 VJCOMP MAXSID=15 Sid-comp-OK
IPADDR=192.9.68.71
```

The local host sends this ACK to the remote host and receives an ACK from the remote host.

```
11:54:22 004309 ipdptp0 SEND PPP ASYNC 21 Octets IP_NCP Config-
ACK  ID=37 LEN=16 VJCOMP MAXSID=15 Sid-comp-OK IPADDR=192.9.68.71

11:54:22 004310 ipdptp0 RECEIVE PPP ASYNC 21 Octets IP_NCP
Config-ACK  ID=4e LEN=16 VJCOMP MAXSID=15 Sid-comp-OK
IPADDR=192.9.68.70
```

The first message below indicates that IP has started on the link.The next message indicates that the local host is sending IP traffic over the link.

```
11:54:22 start_ip: IP up on interface ipdptp0, timeout set for
120 seconds

11:54:24 004311 ipdptp0 SEND PPP ASYNC 89 Octets IP_PROTO
```

In the first message below the local host receives IP traffic from the remote host. The subsequent messages indicate that the interface was disconnected because of an idle timeout.

```
11:54:25 004312 ipdptp0 RECEIVE PPP ASYNC 89 Octets IP_PROTO

11:56:25 process_ipd_msg: interface ipdptp0 has disconnected

11:56:25 disconnect: disconnected connection from  ipdptp0
```

The next messages begin the termination sequence. The first message indicates that the remote host has sent a packet to terminate the IP layer. The second is the local host's acknowledgment of the request to terminate.

```
11:56:25 004313 ipdptp0 RECEIVE PPP ASYNC 9 Octets IP_NCP Term-
REQ  ID=38 LEN=4

11:56:25 004314 ipdptp0 SEND PPP ASYNC 9 Octets IP_NCP Term-ACK
ID=38 LEN=4
```

The local host receives a request to terminate the LCP layer. The second message is an acknowledgment of the request, causing a graceful shutdown.

```
11:56:25 004315 ipdptp0 RECEIVE PPP ASYNC 9 Octets LCP Term-REQ
ID=39 LEN=4
11:56:25 004316 ipdptp0 SEND PPP ASYNC 9 Octets LCP Term-ACK
ID=39 LEN=4
```

This message indicates that the link has closed.

```
11:56:29 004317 ipdptp0 PPP DIAG CLOSE
```

Tailoring Your PPP Link 11

This chapter contains information you will need to configure PPP links less commonly used than the basic links described in Chapter 9, “Configuring PPP.” The text includes instructions for configuring two types of PPP links: the dial-in server with dynamic point-to-point links and the virtual network, which uses multipoint links. The chapter concludes with tables listing all available keywords for the `asppp.cf` configuration file.

Configuring Dynamically Allocated PPP Links

A dial-in server with a dynamic point-to-point link gives your site all the advantages of point-to-point communications. Chapter 7, “Understanding PPP,” introduces this configuration type. It consists of remote hosts communicating with at least one dial-in server that dynamically allocates point-to-point links on an as-needed basis. The sample configuration shown in Figure 11-1 on page 162 will be used throughout this section.

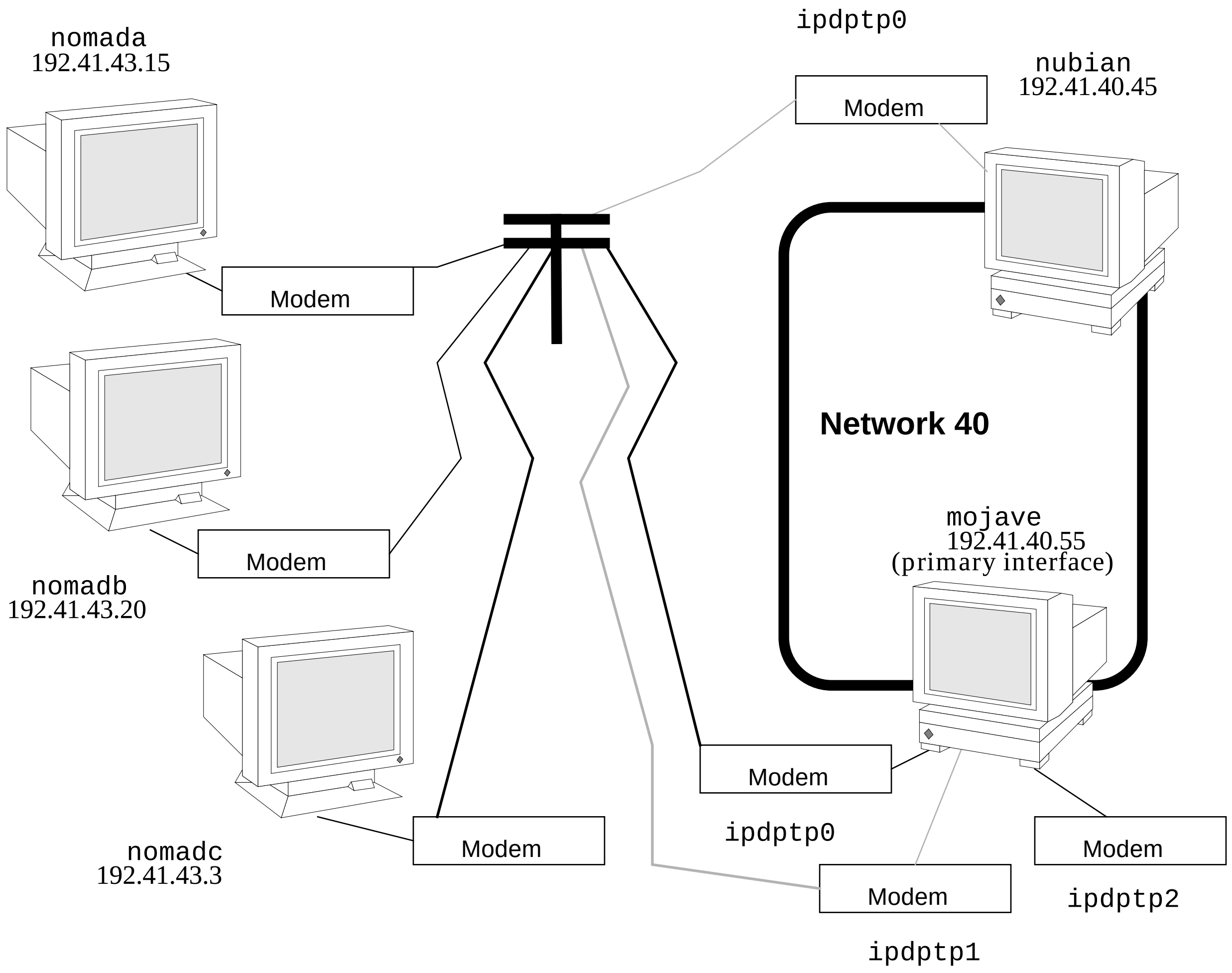


Figure 11-1 Network of Remote Hosts and Dynamic Link Dial-in Servers

Each remote host communicates with the dial-in server using a standard point-to-point link. However, unlike the multipoint dial-in server in Figure 9-1 on page 130, dial-in servers `mojave` and `nubian` connect to a calling host over a dynamic point-to-point link. One of the servers allocates an available link whenever a remote host attempts to establish a connection.

You use the same generic procedures for configuring dynamic links as you do for the remote host–to–multipoint dial-in server link, as described in "Overview of the Configuration Process" on page 127. However, the dynamic point-to-point link has its own set of issues and requires slightly different modifications to the files involved in configuration.

Addressing Issues for Dynamically Allocated Links

You must add host information to the `/etc/inet/hosts` file for each machine that will use the dynamically allocated PPP link. The IP addresses for the PPP endpoints should follow these conventions:

- For the dial-in servers, you must use the IP address of the server's primary network interface (for example `le0` or `smc0`) as the address of the dynamic link.
- For a remote host, you can use the IP address of the host's primary network interface as the address of its point-to-point link, or you can designate a PPP-specific IP address for its point-to-point link.

Updating the `hosts` *Database for Dynamic Links*

You must update the `hosts` database on all machines involved in the dynamic-link configuration.

▼ How to Update a Remote Host

When configuring the `hosts` databases on the remote machines, do the following:

1. **Add to the** `/etc/inet/hosts` **file the IP address and host name of the *primary network interface* for each dial-in server on the other end of the link.**
   For example, in Figure 11-1 on page 162, `nomada` will have in its `/etc/inet/hosts` file the IP addresses of the primary network interfaces of dial-in servers `nubian` and `mojave`. The `/etc/inet/hosts` files for `nomadb` and `nomadc` would contain the same information about the dial-in servers.

The `/etc/inet/hosts` file on `nomadc` might look like:

```
# Internet host table
#
127.0.0.1          localhost       loghost
192.41.43.3        nomadc
192.41.40.45       nubian
192.41.40.55       mojave
```

2. **Add to the `/etc/inet/hosts` file the IP addresses of any machines on the dial-in server's physical network that the remote host can remotely log in to.**

3. **Update the databases on any name server on the physical network with the host names and IP addresses of the remote hosts.**

▼ How to Update the Dial-in Server(s)

You do not have to add any PPP-specific address to the `hosts` database for the dial-in server. The dynamically allocated link must use the server's primary network interface. Therefore, when configuring the `hosts` database for the dial-in server, do the following:

1. **Add entries to the server's `/etc/inet/hosts` files for each remote host served.**

2. **Add to the `/etc/inet/hosts` files of every machine on the physical network entries for any remote hosts they are permitted to communicate with.**

Considerations for Other Files

The next steps in the configuration process involve editing the `/etc/passwd` file and the `/etc/shadow` file. Edit these files for the dynamic–link configurations just as you would for the remote host–to–multipoint dial-in server configuration. Refer to "Modifying the /etc/passwd File" on page 134 for information regarding the `/etc/passwd` and `/etc/shadow` files.

Editing `asppp.cf` *for Dynamic Link*

The `asppp.cf` configuration file for a dynamic–link configuration must contain information about remote hosts and the interfaces to use for the PPP link. After the dial-in server boots, its link manager uses this information to establish communications whenever the server is called by a remote endpoint.

Note – Each remote host sets up the point-to-point link described in ”Parts of Basic Configuration File” on page 136.

Dial-in Server With Dynamic Link

When the dial-in server receives an incoming packet, the link manager reads the `path` sections of its configuration file to identify the remote endpoint and determine the interface to use. The configuration file shown in Code Example 11-1 does not contain an interface keyword. Instead, the link manager uses interface information established in the `defaults` section.

The `asppp.cf` configuration file for a dial-in server with dynamically allocated links might resemble Code Example 11-1 on page 166:

Code Example 11-1 Configuration File for Server With Dynamically Allocated Link

```
ifconfig ipdptp0 plumb mojave down
ifconfig ipdptp1 plumb mojave down
ifconfig ipdptp2 plumb mojave down

# This means grab whatever interface is available (not in use)
defaults
    interface ipdptp*

# Each path specifies a machine that might dial up / log
# in to this server

path
    peer_system_name tamerlane   # nomada uses the login name
                               # tamerlane
    peer_ip_address nomada

path
    peer_system_name lawrence   # nomadb uses the name lawrence
                              # for login
    peer_ip_address nomadb

path
    peer_system_name nomadc
    peer_ip_address azziz
```

`ifconfig` *Section for Server With Dynamic Links*

The `ifconfig` section for a dial-in server with a dynamically allocated link has the syntax:

`ifconfig ipdptp`*n* `plumb` *server-name* `down`

Code Example 11-1 contains three `ifconfig` lines, each initializing a point-to-point interface.

```
ifconfig ipdptp0 plumb mojave down
ifconfig ipdptp1 plumb mojave down
ifconfig ipdptp2 plumb mojave down
```

Each interface has a corresponding modem attached to the dial-in server `mojave`, as shown in Figure 11-1 on page 162. This enables `mojave` to have up to three point-to-point links active at one time. Note that since PPP interfaces are virtual (not associated with any hardware), you could just as easily configure three `ipdptp` interfaces on a server with only one modem, as shown on `nubian`.

`defaults` *Section for Server With Dynamic Links*

When you configure a dynamically allocated link, you may want to include a `defaults` section in the `asppp.cf` file. This section sets the defaults for the value replacing *keyword*, wherever *keyword* subsequently appears in the `asppp.cf` file. The syntax for the `defaults` section is:

```
default
        keyword
```

Code Example 11-1 on page 166 uses the keyword `interface` to define the interface as `ipdptp*`, indicating a dynamic link. The asterisk wildcard tells the link manager to use any available `ipdptp` interface defined in the `ifconfig` section. Thus the link manager on server `mojave` will use either `ipdptp0`, `ipdptp1`, or `ipdptp2`—whichever is the first interface configured down that it finds.

`path` *Section for Server with Dynamic Links*

The configuration file for the server with dynamic links must contain `path` sections for every remote host permitted to establish connections with the server. The path section has the following syntax:

```
path
        peer_system_name endpoint-username
        peer_ip_address endpoint-hostname
```

Note that there is no `interface` keyword defined in the `path` section because this value is defined in the defaults section.

The `peer_system_name` and `peer_ip_address` keywords have the same meaning here as they do in the configuration file for the multipoint server. See ”path Section for Multipoint Dial-in Server” on page 140 for more information.

Additional Keywords

You can supply other keywords in the `asppp.cf` file to define how endpoint machines should communicate, as explained in "Configuration Keywords" on page 172.

Configuring a Virtual Network

Virtual networks consist of a group of standalone computers, each in an isolated location, that can connect to each other through PPP multipoint links. "Virtual Networks" on page 106 introduces virtual network concepts. This section explains how to configure a virtual network.

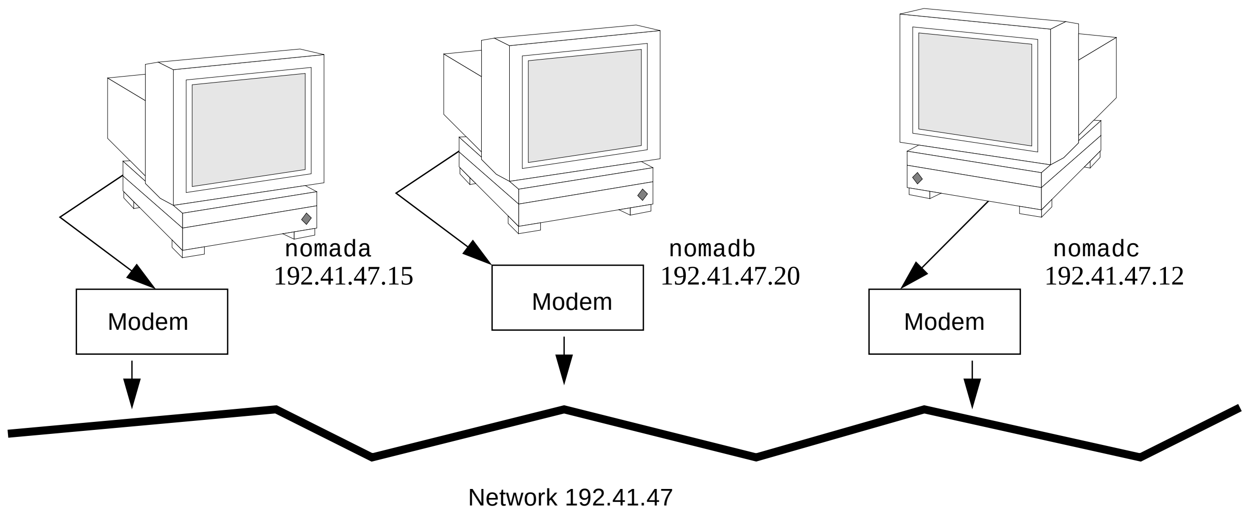


Figure 11-2 Sample Virtual Network

The network shown in Figure 11-2 consists of three isolated computers. Each member of the network connects to the other members of the network through a multipoint PPP link. Therefore, to create such a network, you (and perhaps other network administrators at the remote location) have to configure a multipoint PPP link on each participating host.

You use the same generic process for configuring multipoint links as you do for configuring a multipoint dial-in server link, as described in ”Overview of the Configuration Process” on page 127. However, the virtual network has its own set of issues and requires you to configure each host in the network accordingly.

Addressing Issues for Virtual Networks

You must add host information to the `/etc/hosts` file for each machine in the virtual network. When typing the IP addresses used for the PPP endpoints,

- Designate a PPP-specific IP address for its point-to-point link. Note that if the machine was not previously configured in a physical network, you will have to create an IP address for the PPP link. This address becomes the host’s primary network interface.
- Create a network number for the virtual network. See ”Assigning a Network Number to the PPP Link” on page 122 for more information.

Updating `hosts` *and* `networks` *Databases*

The first step in the configuration process involves updating the `hosts` and `networks` databases with information about your virtual network.

`/etc/inet/hosts` *File for the Virtual Network*

The `/etc/inet/hosts` file on each machine must contain the addressing information for every member of the network that this host has permission to access. For example, each host in the network in Figure 11-2 on page 168 would have this information:

.

```
# Internet host table
#
127.0.0.1          localhost      loghost
192.41.47.15        nomada
192.41.47.20        nomadb
192.41.47.12        nomadc
```

/etc/inet/networks File for the Virtual Network

Since the virtual network requires a unique IP address, you will have to type this address in the `networks` database. For example, the network shown in Figure 11-2 has the number 192.41.47. Moreover, if the hosts on the network need to communicate with other networks, you should register the network with the InterNIC addressing authority. See Chapter 4, "Configuring TCP/IP on the Network," for information on editing the `networks` database.

Each host on the virtual network must have an entry with the network's address in the `/etc/inet/networks` file. For example, each host on network 192.41.47 might have the following in `/etc/inet/networks`:

```
# Internet networks
#
# arpanet   10          arpa
# ucb-ether 46          ucbether
#
# local networks
loopback    127
ppp         192.41.47   #remote sales offices
```

Considerations for Other Files

The next steps in the configuration process involve editing the UUCP databases, the `/etc/passwd` file, and the `/etc/shadow` file. You edit these files for the machines in the virtual network just as you would for the multipoint dial-in server configuration. Refer to "Editing UUCP Databases" on page 132 for UUCP-related information and "Modifying the /etc/passwd File" on page 134 for information regarding the `passwd` file.

asppp.cf Configuration File for a Virtual Network

The configuration file for a local machine on a virtual network must contain information about all remote hosts on the network that the local host can access. Moreover, each machine on the virtual network must be configured for both dial-in and dial-out functions. After the local machine boots, its link manager reads the `asppp.cf` file to establish communications.

Code Example 11-2 shows a configuration file such as you would set up for nomada on a virtual network 192.41.47.

Code Example 11-2 Configuration File for nomada

```
# /etc/asppp.cf for hosta

ifconfig ipd0 plumb nomada netmask + up
defaults
    interface ipd0
path
    peer_ip_address  nomadb
    peer_system_name lawrence   # name machine logs in with
path
    peer_ip_address nomadc
    peer_system_name azziz
```

Code Example 11-3 shows a configuration file such as you would set up for nomadb on virtual network 192.41.47.

Code Example 11-3 Configuration File for nomadb

```
# /etc/asppp.cf for nomadb

ifconfig ipd0 plumb nomadb netmask + up
defaults
    interface ipd0
path
    peer_ip_address   nomada
    peer_system_name  tamerlane  # name the machine logs in with
path
    peer_ip_address   nomadc
    peer_system_name  azziz
```

Configuration Keywords

This section describes the configuration keywords available for the `asppp.cf` configuration file and the values you must define for them. Most of these keywords are optional. The required ones are indicated. For further explanations of the keywords, refer to RFCs 1331, 1332, 1333, and 1334.

Table 11-1 lists required keywords that must appear in all `asppp.cf` configuration files.

Table 11-1 Required Keywords for `asppp.cf`

Keyword(s)	**Value Definitions**
`ifconfig` *parameters*	Tells the link manager to run the `ifconfig` command with the values supplied by *parameters*. See ”ifconfig Section of the asppp.cf File” on page 136, ”ifconfig Section for Multipoint Dial-in Server” on page 139, and the `ifconfig` (1M) man page for more information.
`path`	Specifies the beginning of the token sequences that are grouped together as attributes of this (current) path. The collection of attributes comprising the current path are terminated by the occurrence of a subsequent `path` keyword, `defaults` keyword, or by the end–of–file.

Table 11-1 Required Keywords for `asppp.cf`

Keyword(s)	Value Definitions
`interface` (`ipdptp`*n*, `ipdptp*`, or `ipd`*n*)	Specifies either an `ipdptp` (static point-to-point), `ipdptp*` (dynamic point-to-point), or `ipd` (multipoint) device for each interface in your network. For `ipdptp`*n* and `ipd`*n*, this keyword associates the specific interface defined by *n* with the current path. *n* must be a nonnegative integer. It matches the interface defined in the `path` section with the interface stated in the `ifconfig` section. For the `ipdptp*` interface, the * indicates that the interface will match any point-to-point interface that is configured down.
`peer_system_name` *hostname* `peer_system_name` *username*	On dial-out machines, specifies the *hostname* of the remote endpoint that the local machine wants to call. This is the same as the system name in the `/etc/uucp/Systems` file. Associates the remote system name with the current path. This name is used to look up modem- and peer-specific information for outbound connections in the `/etc/uucp/Systems` file. On dial-in machines, this specifies the *username* that remote machines will use when logging in to the dial-in machine. The appropriate path is determined by matching *username* with the login name that was used to obtain the connection.
`peer_ip_address` *hostname* `peer_ip_address` *ip-address*	Specifies the destination host address. It is required only for multipoint links. This address is associated with the current path. The value is ignored if the path specifies a point-to-point interface. The address format may be dotted decimal, hexadecimal, or symbolic.

Table 11-2 contains optional keywords for `asppp.cf` that you can use to further define your PPP configuration

Table 11-2 Optional Keywords for `asppp.cf`

Keyword(s)	Value Definitions
`debug_level` *0–9*	The integer between 0–9 defines how much debugging information should be written to the log file. The higher the number, the more output is generated.
`defaults`	Indicates that all following token sequences up to the next `path` keyword, or the end-of-file character, set default attributes that affect subsequently defined paths.
`default_route`	Tells the link manager to add the path's peer IP address to the route table as the default destination when the IP layer corresponding to the current path is fully operational. The route is removed when the IP layer is brought down.
`inactivity_timeout` *seconds*	Specifies the maximum number of seconds that the connection for the current path can remain idle before it is terminated. A zero may be specified to indicate no timeout. The default is 120 seconds.

Table 11-2 Optional Keywords for `asppp.cf`

Keyword(s)	**Value Definitions**
`ipcp_async_map` *hex-number*	Specifies the asynchronous control-character map for the current path. *hex-number* indicates the natural (big endian) form of the four octets that comprise the map. The default value is 0x FFFFFFFF.
`ipcp_compression` (`vj` or `off`)	Specifies whether IP compression is enabled. The Van Jacobson compression algorithm (`vj`) is the default.
`lcp_compression` (`on` or `off`)	Specifies whether PPP address, control, and protocol field compression is enabled. The default is `on`.
`lcp_mru` *number*	Specifies the value of the desired maximum receive unit packet size. The number is the size in octets. The default is 1500.
`peer_ip_address` *hostname* `peer_ip_address` *ip-address*	Specifies the destination host address. This keyword is optional for point-to-point links only. *address* is associated with the current path. The address format may be dotted decimal, hexadecimal, or symbolic.
`version` *n*	Specifies that the contents of the configuration file correspond to format version *n*. If this keyword is present, it must be the first keyword in the file. If absent, the version is assumed to be 1. This book contains the definition of the version 1 format for the configuration file.

Part 3 — Administering UUCP Communications

The UUCP file transfer system enables you to send files and electronic mail from one UNIX-based system to another. This part explains how to administer the complex UUCP system.

The materials in this part assume that you are a very experienced network administrator with some practical knowledge of modem administration and wide area networks. The text assumes that if you are going to use UUCP over a telephone line, you are familiar with the procedures for adding hardware to your computer, have already connected modems to your machines, and are able to use `tip` or `cu` to dial out.

UUCP Databases and Programs 12

The UNIX-to-UNIX Copy Program (UUCP) enables computers to transfer files and exchange mail with each other. It also enables computers to participate in large networks such as Usenet.

The Solaris environment provides the Basic Network Utilities (BNU) version of UUCP, also known as HoneyDanBer UUCP. The term *UUCP* denotes the complete range of files and utilities that comprise the system, of which the program `uucp` is only a part. The UUCP utilities range from those used to copy files between computers (`uucp` and `uuto`) to those used for remote login and command execution (`cu` and `uux`)..

This chapter introduces the UUCP programs and daemons. It then provides complete information for setting up the UUCP database files as part of UUCP configuration. Chapter 13, “Configuring and Maintaining UUCP,” explains how to configure UUCP after the databases have been created.

12

UUCP Hardware Configurations

UUCP supports the following hardware configurations:

- *Direct links*–You can create a direct link to another computer by running RS-232 cables between serial ports on the two machines. Direct links are useful where two computers communicate regularly and are physically close—within 50 feet of each other. You can use a limited distance–modem to increase this distance somewhat.
- *Telephone lines*–Using an automatic call unit (ACU) such as a high-speed modem, your machine can communicate with other computers over standard phone lines. The modem dials the telephone number requested by UUCP. The recipient machine must have a modem capable of answering incoming calls.
- *Network*–UUCP can also communicate over a network running TCP/IP or other protocol family. Once your computer is established as a host on a network, it can contact any other host connected to the network.

This chapter assumes that your UUCP hardware has already been assembled and configured. If you need to set up a modem, refer to *Peripherals Administration* and the manuals that came with the modem for assistance.

Software Comprising UUCP

The UUCP software is automatically included when you run the Solaris installation program and select the entire distribution. The UUCP programs can be divided into three categories: daemons, administrative programs, and user programs.

Daemons

The UUCP system has four daemons: `uucico`, `uuxqt`, `uusched` and `in.uucpd`. These daemons handle UUCP file transfers and command executions. You can also run them manually from the shell.

- `uucico`–Selects the device used for the link, establishes the link to the remote computer, performs the required login sequence and permission checks, transfers data and execute files, logs results, and notifies the user by mail of transfer completions. uucico acts as the “login shell” for UUCP login accounts. When the local uucico daemon calls a remote machine, it communicates directly with the remote uucico daemon during the session.

uucp, uuto, and uux programs execute the uucico daemon after all the required files have been created, to contact the remote computer. uusched and Uutry all execute uucico. (See the uucico(1M) man page for details.)

- uuxqt–Executes remote execution requests. It searches the spool directory for execute files (always named X.*file*) that have been sent from a remote computer. When an X.*file* file is found, uuxqt opens it to get the list of data files that are required for the execution. It then checks to see if the required data files are available and accessible. If the files are available, uuxqt checks the Permissions file to verify that it has permission to execute the requested command. The uuxqt daemon is executed by the uudemon.hour shell script, which is started by cron. (See the uuxqt(1M) man page for details.)
- uusched–Schedules the queued work in the spool directory. uusched is initially run at boot time by the uudemon.hour shell script, which is started by cron. (See the uusched(1M) man page for details.) Before starting the uucico daemon, uusched randomizes the order in which remote computers will be called.
- in.uucpd–Supports UUCP connections over networks. The inetd on the remote host invokes in.uucpd whenever a UUCP connection is established. uucpd then prompts for a login name. uucico on the calling host must respond with a login name. in.uucpd will then prompt for a password, unless one is not required. (See the in.uucpd(1M) man page for details.)

Administrative Programs

Most UUCP administrative programs are in /usr/lib/uucp. Most basic database files are in /etc/uucp. The only exception is uulog, which is in /usr/bin. The home directory of the uucp login ID is /var/spool/uucppublic. When running the administrative programs through cu or login, use the uucp user ID. It owns the programs and spooled data files.

- uulog–Displays the contents of a specified computer's log files. Log files are created for each remote computer with which your machine communicates. The log files record each use of uucp, uuto, and uux. (See the uucp(1C) man page for details.)
- uucleanup–Cleans up the spool directory. It is normally executed from the uudemon.cleanup shell script, which is started by cron. (See the uucleanup(1M) man page for details.)
- Uutry–Tests call processing capabilities and does moderate debugging. It invokes the uucico daemon to establish a communication link between your machine and the remote computer you specify. (See the Uutry(1M) man page for details.)
- uucheck–Checks for the presence of UUCP directories, programs, and support files. It can also check certain parts of the /etc/uucp/Permissions file for obvious syntactic errors. (See the uucheck(1M) man page for details.)

User Programs

The UUCP user programs are in /usr/bin. You do not need special permission to use these programs.

- cu–Connects your machine to a remote computer so that you can log in on both at the same time. cu enables you to transfer files or execute commands on either machine without dropping the initial link. (See the cu(1C) man page for details.)
- uucp–Lets you copy a file from one machine to another. It creates work files and data files, queues the job for transfer, and calls the uucico daemon, which in turn attempts to contact the remote computer. (See the uucp(1C) man page for details.)
- uuto– Copies files from the local machine to the public spool directory /var/spool/uucppublic/receive on the remote machine. Unlike uucp, which lets you copy a file to any accessible directory on the remote machine, uuto places the file in an appropriate spool directory and tells the remote user to pick it up with uupick. (See the uuto(1C) man page for details.)
- uupick–Retrieves files in /var/spool/uucppublic/receive when files are transferred to a computer using uuto. (See the uuto(1C) man page.)

- `uux`–Creates the work, data, and execute files needed to execute commands on a remote machine. (See the `uux`(1C) man page for details.)
- `uustat`–Displays the status of requested transfers (`uucp`, `uuto`, or `uux`). It also provides a means of controlling queued transfers. (See the `uustat`(1C) man page for details.)

Note that typically you use `uuto`, `uupick`, and `uux` programs only for debugging.

Introducing the UUCP Database Files

A major part of UUCP setup is the configuration of the files comprising the UUCP database. These files are in the `/etc/uucp` directory. You need to edit them to set up UUCP or PPP on your machine. The files include:

- `Config`–Contains a list of variable parameters. You can manually set these parameters to configure the network.
- `Devconfig`–Used to configure network communications.
- `Devices`–Contains information concerning the location and line speed of automatic call unit (modem), direct links, and network devices. It is used by PPP as well as UUCP
- `Dialers`–Contains character strings required to negotiate with modems to establish connections with remote computers. It is used by PPP as well as UUCP
- `Dialcodes`–Contains dial-code abbreviations that may be used in the phone number field of `Systems` file entries. Though not required, it can be used by PPP as well as UUCP.
- `Grades`– Defines job grades, and the permissions associated with each job grade, that users may specify to queue jobs to a remote computer.
- `Limits`–Defines the maximum number of simultaneous `uucico`s, `uuxqt`s, and `uusched`s permitted on your machine.
- `Permissions`–Defines the level of access granted to remote hosts that attempt to transfer files or execute commands on your machine.
- `Poll`–Defines machines that are to be polled by your system and when they are polled.

- `Sysfiles`–Assigns different or multiple files to be used by `uucico` and `cu` as `Systems`, `Devices`, and `Dialers` files.
- `Sysname`–Enables you to define a unique UUCP name for a machine in addition to its TCP/IP host name.
- `Systems`–Contains information needed by the `uucico` daemon, `cu,` and PPP to establish a link to a remote computer. This information includes the name of the remote host, the name of the connecting device associated with the remote host, time when the host can be reached, telephone number, login ID, and password.

Several other files may be considered part of the supporting database but are not directly involved in establishing a link and transferring files.

Configuring UUCP Files

The UUCP database consists of the files shown in ”Introducing the UUCP Database Files”. However, basic UUCP configuration involves only the following critical files:

- `/etc/uucp/Systems`
- `/etc/uucp/Devices`
- `/etc/uucp/Dialers`

Because PPP uses some of the UUCP databases, you should understand at least these critical database if you plan to configure PPP. Once these databases are configured, UUCP administration is fairly straightforward.Typically, you edit the `Systems` file first, and then edit the `Devices` file. You usually can use the default `/etc/uucp/Dialers` file, unless you plan to add dialers that aren’t in the default. In addition, you may also want to use the following files for basic UUCP and PPP configuration:

- `/etc/uucp/Sysfiles`
- `/etc/uucp/Dialcodes`
- `/etc/uucp/Sysname`

Because these files work closely with each other, you should understand the contents of them all before you change any of them. A change to an entry in one file may require a change to a related entry in another file. The remaining files listed in ”Introducing the UUCP Database Files” on page 181 are not as critically intertwined.

Note – PPP uses only the files described in this section. It does not use the other UUCP database files.

The remaining sections of this chapter explain the UUCP databases in detail.

`/etc/uucp/Systems` *File*

The `/etc/uucp/Systems` file contains the information needed by the `uucico` daemon to establish a communication link to a remote computer. It is the first file you need to edit to configure UUCP.

Each entry in the `Systems` file represents a remote computer that your host calls. A particular host may have more than one entry. The additional entries represent alternative communication paths that will be tried in sequential order. In addition, by default UUCP prevents any computer that does not appear in `/etc/uucp/Systems` from logging in to your host.

Using the `Sysfiles` file, you can define several files to be used as `Systems` files. See the description of the `Sysfiles` file for details.

Each entry in the `Systems` file has the following format:

System-Name Time Type Speed Phone Chat Script

Here is an example showing the fields of the `Systems` file.

Table 12-1 Fields in /etc/uucp/Systems

System-Name	**Time**	**Type**	**Speed**	**Phone**	**Chat Script**
arabian	Any	ACUEC	`38400`	1112222	`ogin: Puucp ssword:beledi`

System-Name Field

This field contains the node name of the remote computer. On TCP/IP networks, this may be the machine's host name or a name created specifically for UUCP communications through the `/etc/uucp/Sysname` file. See "/etc/uucp/Sysname File" on page 206. In Table 12-2 on page 184, the System-Name field contains an entry for remote host `arabian`.

Time Field

This field specifies the day-of-week and time-of-day when the remote computer can be called.The format of the Time field is:

```
daytime[;retry]
```

The *day* portion may be a list containing some of the following entries:

Table 12-2 Time Field

Su Mo Tu We Th Fr Sa	For individual days
Wk	For any weekday
Any	For any day
Never	Your host will never initiate a call to the remote computer; the call must be initiated by the remote computer. Your host is then operating in *passive mode*.

Table 12-2 on page 184 shows `Any` in the Time field, indicating that host `arabian` can be called at any time.

The *time* portion should be a range of times specified in 24-hour notation. (For example: `0800–1230` for 8:30 a.m. to 12:30 p.m.) If no *time* portion is specified, any time of day is assumed to be allowed for the call.

A time range that spans 0000 is permitted. For example, `0800-0600` means all times are allowed other than times between 6 a.m. and 8 a.m.

Retry Subfield

The Retry subfield enables you to specify the minimum time (in minutes) before a retry, following a failed attempt. The default wait is 60 minutes. The subfield separator is a semicolon (;). For example, `Any;9` is interpreted as call any time, but wait at least 9 minutes before retrying after a failure occurs.

If you do not specify a *;retry* entry, an exponential back off algorithm is used. What this means is that UUCP will start with a default wait time that grows larger as the number of failed attempts increases. For example, suppose the initial retry time is 5 minutes. If there is no response, the next retry will be 10 minutes later. The next retry will be 20 minutes later, and so on until the maximum retry time of 23 hours is reached. If `;retry` is specified, that will always be the retry time. Otherwise, the back off algorithm is used.

Type Field

This field contains the device type that should be used to establish the communication link to the remote computer. The keyword used in this field is matched against the first field of `Devices` file entries as shown in Table 12-3. (Note that the fields listed in the table heading are for the `Systems` file and do not apply to the `Devices` file. For a table showing the same correspondences to fields in the `Devices` file, see Table 12-8 on page 193.)

Table 12-3 Type Field and `/etc/uucp/Devices` File

File Name	System-Name Field	Time Field	Type Field	Speed Field	Phone Field	Chat Script Field
`Systems`	arabian	Any	**ACUEC, g**	38400	1112222	`ogin: Puucp ssword:beledi`.
`Devices`	**ACUEC**	cua/a	-	38400	`usrv32bis-ec`	

You can define the protocol used to contact the system by adding it on to the Type field. The example above shows how to attach the protocol `g` to the device type `ACUEC`. (For information on protocols, see ”Protocol Definitions in the Devices File” on page 197.)

Speed Field

This field (also known as the Class Field) specifies the transfer speed of the device used in establishing the communication link. It may contain a letter and speed (for example, `C1200`, `D1200`) to differentiate between classes of dialers (refer to ”Class Field” on page 193).

Some devices can be used at any speed, so the keyword `Any` may be used. This field must match the Class field in the associated `Devices` file entry as shown in Table 12-4:

Table 12-4 Speed Field and `/etc/uucp/Devices` File

File Name	System-Name Field	Time Field	Type Field	Speed Field	Phone Field	Chat Script Field
`Systems`	eagle	Any	ACU, g	**D1200**	NY3251	`ogin:` nuucp ssword: Oakgrass
`Devices`	ACU	tty11	--	**D1200**	`penril`	

If information is not required for this field, use a dash (`-`) as a place holder for the field.

Phone Field

This field allows you to specify the telephone number (token) of the remote computer for automatic dialers (port selectors). The telephone number consists of an optional alphabetic abbreviation and a numeric part. If an abbreviation is used, it must be one that is listed in the `Dialcodes` file, as shown in Table 12-7:

Table 12-5 Phone Field Correspondences

Systems file:	nubian Any ACU 2400 NY5551212 ogin: Puucp ssword: Passuan
Dialcodes file:	`NY 1=212`

In this string, an equals sign (=) tells the ACU to wait for a secondary dial tone before dialing the remaining digits. A dash (–) in the string instructs the ACU to pause 4 seconds before dialing the next digit.

If your computer is connected to a port selector, you may access other computers connected to that selector. The `Systems` file entries for these remote machines should not have a telephone number in the Phone field. Instead, this field should contain the token to be passed on to the switch. In this way, the port selector will know the remote machine with which your host wishes to communicate. (This is usually just the system name.) The associated `Devices` file entry should have a `\D` at the end of the entry to ensure that this field is not translated using the `Dialcodes` file.

Chat Script Field

This field (also called the Login field) contains a string of characters called a *chat script*. The chat script contains the characters the local and remote machines must pass to each other in their initial conversation. Chat scripts have the format:

expect send [expect send] ....

expect represents the string that the local host expects to get from the remote host to initiate conversation. *send* is the string the local host will send after it receives the *expect* string from the remote host. A chat script can have more than one expect send sequence.

A basic chat script might contain:

- Login prompt that the local host expects to get from the remote machine.
- Login name that the local host will send to the remote machine in order to log in.
- Password prompt that the local host expects to get from the remote machine.
- Password that the local host will send to the remote machine.

The *expect* field may be made up of subfields of the form:

expect[-send-expect]...

where the *send* is sent if the prior *expect* is not successfully read, and the *expect* following the *send* is the next expected string.

For example, with strings `login--login`, the UUCP on the local host will expect `login`. If UUCP gets `login` from the remote machine, it will go on to the next field. If it does not get `login`, it will send a carriage return, then look for `login` again. If the local computer initially does not expect any characters, use the characters `""` (null string) in the *expect* field. Note that all *send* fields will be sent followed by a carriage return unless the *send* string is terminated with a `\c`.

Here is an example of a `Systems` file entry that uses an *expect-send* string:

```
sonora Any ACUEC 9600 2223333 "" \r \r ogin:-BREAK-ogin: Puucpx ssword: xyzzy
```

This example tells UUCP on the local host to send two carriage returns and wait for `ogin:` (for `Login:`). If you don't get `ogin:`, send a `BREAK`. When you do get `ogin:` send the login name `Puucpx`. When you get `ssword:` (for `Password:`), send the password `xyzzy`.

Table 12-6 lists some useful escape characters.

Table 12-6 Escape Characters Used in `Systems` File Chat Script

`\b`	Send or expect a backspace character
`\c`	If at the end of a string, suppress the carriage return that is normally sent. Ignored otherwise
`\d`	Delay 1-3 seconds before sending more characters
`\E`	Start echo checking. (From this point on, whenever a character is transmitted, it will wait for the character to be received before doing anything else.)
`\e`	Echo check off
`\H`	Ignore one hangup. Use this option for dialback modems
`\K`	Send a BREAK character
`\M`	Turn on `CLOCAL` flag
`\m`	Turn off `CLOCAL` flag
`\n`	Send or expect a newline character
`\N`	Send a null character (ASCII NUL)
`\p`	Pause for approximately 1/4 to 1/2 second
`\r`	Send or expect a carriage return
`\s`	Send or expect a space character
`\t`	Send or expect a tab character
`EOT`	Send an EOT followed by newline twice
`BREAK`	Send a BREAK character
`\ddd`	Send or expect the character represented by the octal digits (*ddd*)

Enabling Dialback Through the Chat Script

Some companies set up dial-in servers to handle calls from remote computers. For example, your company might have a dial-in server with a dialback modem that employees can call from their home computers. After the dial-in server identifies the remote machine, it disconnects the link to the remote machine and then calls the remote machine back. The communications link is then reestablished.

You can facilitate dialback by using the `\H` option in the `Systems` file chat script at the place where dialback should occur. Include the `\H` as part of an expect string at the place where the dial-in server is expected to hang up.

For example, suppose the chat script that calls a dial-in server contains the following string:

```
INITIATED\Hogin:
```

The UUCP dialing facility on the local machine expects to get the characters `INITIATED` from the dial-in server. After the `INITIATED` characters have been matched, the dialing facility flushes any subsequent characters it receives until the dial-in server hangs up. The local dialing facility then waits until it receives the next part of the expect string, the characters `ogin:,` from the dial-in server. When it receives the `ogin:`, the dialing facility then continues through the chat script.

You need not have a string of characters directly preceding or following the `\H`, as shown in the sample string above.

Hardware Flow Control

You can also use the pseudo-send `STTY=value` string to set modem characteristics. For instance, `STTY=crtscts` enables hardware flow control.

`STTY` accepts all `stty` modes. See the `stty`(1V) and `termio`(4) man pages for complete details.

The following example would enable hardware flow control in a `Systems` file entry:

```
unix Any ACU 2400 12015551212 "" \r login:-\r-login:-\r-login: nuucp password: xxx "" \
STTY=crtscts
```

This pseudo-send string can also be used in entries in the `Dialers` file.

Setting Parity

In some cases, you will have to reset the parity because the system that you are calling checks port parity and drops the line if it is wrong. The expect-send couplet `"" P_ZERO` sets the high order bit (parity bit) to 0. For example:

```
unix Any ACU 2400 12015551212 "" P_ZERO "" \r login:-\r-login:-\r-login: nuucp password: xxx
```

In the same manner, `P_EVEN` sets parity to even (the default), `P_ODD` sets odd parity, and `P_ONE` sets the parity bit to 1.

The parity couplet can be inserted anywhere in the chat script. It applies to all information in the chat script following the `"" P_ZERO`. It can also be used in entries in the `Dialers` file.

`/etc/uucp/Devices` *File*

The `/etc/uucp/Devices` file contains information for all the devices that may be used to establish a link to a remote computer. These devices include ACUs—which includes modern, high-speed modems— direct links, and network connections.

Each entry in the `Devices` file has the following format:

```
Type Line Line2 Class Dialer-Token-Pairs
```

Here is an entry in `/etc/uucp/Devices` for a US Robotics V.32bis modem attached to port A and running at 38,400 bps.

```
ACUEC cua/a - 38400 usrv32bis-ec
```

Each field is described below.

Type Field

This field describes the type of link that the device will establish. It may contain one of the following keywords:

`Direct` ***Keyword***

The `Direct` keyword mainly appears in entries for `cu` connections. This keyword indicates that the link is a direct link to another computer or a port selector. A separate entry should be made for each line that you want to reference through the `-l` option of `cu`.

`ACU` ***Keyword***

The `ACU` keyword indicates that the link to a remote computer (whether through `cu`, UUCP, or PPP) is made through a modem. This modem may be connected either directly to your computer or indirectly through a port selector.

Port Selector

This is a variable that is replaced in the Type field by the name of a port selector. Port selectors are devices attached to a network that prompt for the name of a calling modem and then grant access. The file `/etc/uucp/Dialers` contains caller scripts only for the `micom` and `develcon` port selectors. You can add your own port selector entries to the `Dialers` file. (See ”/etc/uucp/Dialers File” on page 198 for more information.)

Sys-Name

This variable is replaced by the name of a machine in the Type field, indicating that the link is a direct link to this particular computer. This naming scheme is used to associate the line in this Devices entry to an entry in /etc/uucp/Systems for the computer *Sys-Name*.

Type ***Field and*** /etc/uucp/Systems ***File***

Table 12-7 shows a comparison between the fields in /etc/uucp/Devices and fields in /etc/uucp/Systems. The titles of each column apply only to fields in the Devices file.

The keyword used in the *Type* field of the Devices file is matched against the third field of the Systems file entries, as indicated in the shaded fields in Table 12-7. In the Devices file, the Type field has the entry ACUEC, indicating an automatic call unit, in this case a V.32bis modem. This value is matched against the third field in the Systems file, which also contains the entry ACUEC. (See "/etc/uucp/Systems File" on page 183 for more information.)

Table 12-7 Type Field and /etc/uucp/Systems File Equivalent

	Type	**Line**	**Line2**	**Class**	
	Field	**Field**	**Field**	**Field**	**Dialer-Token-Pairs Field**
Devices	**ACUEC**	cua/a	-	38400	usrv32bis-ec
Systems File	nubian	Any	**ACUEC**	38400	9998888 "" \d\d\r\n\c-ogin-\r\n\c-ogin.......

Line Field

This field contains the device name of the line (port) associated with the Devices entry. For instance, if the modem associated with a particular entry was attached to the /dev/cua/a device (serial port A), the name entered in this field would be cua/a. There is an optional modem control flag, M, that can be used in the Line field to indicate that the device should be opened without waiting for a carrier. For example:

```
cua/a,M
```

Line2 Field

This field is a placeholder. Always use a hyphen (–) here. 801 type dialers, which are not supported in the Solaris environment, use the Line2 field. Non-801 dialers will not normally use this configuration, but still require a hyphen in this field.

Class Field

The Class field contains the speed of the device, if the keyword `ACU` or `Direct` is used in the Type field. However, it may contain a letter and a speed (for example, `C1200`, `D1200`) to differentiate between classes of dialers (Centrex or Dimension PBX).

This is necessary because many larger offices may have more than one type of telephone network: one network may be dedicated to serving only internal office communications while another handles the external communications. In such a case, it becomes necessary to distinguish which line(s) should be used for internal communications and which should be used for external communications.

The keyword used in the Class field of the `Devices` file is matched against the Speed field of `Systems` file as shown in Table 12-8. Note that the titles of each column apply only to fields in the `Devices` file.

Table 12-8 Class Field and /etc/uucp/Systems Correspondence

	Type Field	**Line Field**	**Line 2 Field**	**Class Field**	**Dialer-Token-Pairs Field**
`Devices` file:	ACU	cua/b	–	**D2400**	hayes
`Systems` file:	gobi	Any	ACU	**D2400**	3251 ogin: nuucp ssword: taheya

Some devices can be used at any speed, so the keyword `Any` may be used in the Class field. If `Any` is used, the line will match any speed requested in the Speed field of the `Systems` file. If this field is `Any` and the `Systems` file Speed field is `Any`, the speed defaults to 2400 bps.

Dialer-Token-Pairs Field

The Dialer-Token-Pairs (DTP) field contains the name of a dialer and the token to pass it. The DTP field has the following syntax:

dialer token [dialer token]

The dialer portion may be the name of a modem, a port monitor, or it may be `direct` or `uudirect` for a direct link device. You can have any number of dialer-token pairs; if not present, it will be taken from a related entry in the `Systems` file. The token portion may be supplied immediately following the dialer portion.

The last dialer token pair may not be present, depending on the associated dialer. In most cases, the last pair contains only a dialer portion. The token portion is retrieved from the `Phone` field of the associated `Systems` file entry.

A valid entry in the *dialer* portion may be defined in the `Dialers` file or may be one of several special dialer types. These special dialer types are compiled into the software and are therefore available without having entries in the `Dialers` file. The special dialer types include:

Table 12-9 Dialer Token Pairs

TCP	TCP/IP network
TLI	Transport Level Interface Network (without STREAMS)
TLIS	Transport Level Interface Network (with STREAMS)

See ”Protocol Definitions in the Devices File” on page 197 for more information.

Structure of the Dialer-Token-Pairs Field

The DTP field may be structured four different ways, depending on the device associated with the entry:

1. Directly Connected Modem

   If a modem is connected directly to a port on your computer, the DTP field of the associated `Devices` file entry will have only one pair. This pair would normally be the name of the modem. This name is used to match the particular `Devices` file entry with an entry in the `Dialers` file. Therefore, the Dialer field must match the first field of a `Dialers` file entry as shown in Table 12-10. (The titles of each column apply only to fields in the `Devices` file.)

*Table 12-10*Dialers Field and `/etc/uucp/Dialers` Correspondence

	Type Field	**Line Field**	**Line2 Field**	**Clas s**	**Dialer-Token-Pairs**
`Devices`	`ACU`	`cua/b`	`-`	`2400`	**`hayes`**
`Dialers`	**`hayes`**	`=,-,`	`""`		`\\dA\pTE1V1X1Q0S2=255S12=255\r\c \EATDT\T\r\c CONNECT`

Notice that only the dialer portion (`hayes`) is present in the DTP field of the `Devices` file entry. This means that the *token* to be passed on to the dialer (in this case the phone number) is taken from the `Phone` field of a `Systems` file entry. (`\T` is implied, as described on page 197.)

2. Direct Link

   For a direct link to a particular computer, the `DTP` field of the associated entry would contain the keyword `direct`. This is true for both types of direct-link entries, `Direct` and *Sys-Name* (refer to ”Type Field” on page 191).

3. Computers on the Same Port Selector

   If a computer with which you wish to communicate is on the same port selector switch as your computer, your computer must first access the switch. The switch will then make the connection to the other computer. This type of entry has only one pair. The dialer portion is used to match a `Dialers` file entry as shown in Table 12-11 on page 196. (The titles of each column apply only to fields in the `Devices` file.

)

Table 12-11 Dialers Field Using a Port Selector

	Type Field	Line Field	Line2 Field	Class	Dialer-Token-Pairs
Devices	develcon	cua/a	-	1200	**develcon**
Dialers	**develcon**	,""	""		\pr\ps\c est:\007 \E\D\e \007

As shown, the *token* portion is left blank. This indicates that it is retrieved from the `Systems` file. The `Systems` file entry for this computer will contain the token in the Phone field, which is normally reserved for the phone number of the computer. (Refer to "`/etc/uucp/Systems File`" on page 183.) This type of DTP contains an escape character (`\D`), which ensures that the contents of the Phone field will not be interpreted as a valid entry in the `Dialcodes` file.

4. Modems Connected to Port Selector

   If a high-speed modem is connected to a port selector, your computer must first access the port selector switch. The switch will make the connection to the modem. This type of entry requires two dialer-token-pairs. The *dialer* portion of each pair (fifth and seventh fields of entry) will be used to match entries in the `Dialers` file as shown in Table 12-10. (Note that the titles of each column apply only to fields in the `Devices` file.)

Table 12-12 Dialers Field with Two Dialer-Token-Pairs

File	Type Field	Line Field	Line2 Field	Class	Dialer-Token-Pairs		
Devices	ACU	cua/b	-	1200	**develcon**	**vent**	**ventel**
Dialers	**develcon**	""	""	\pr\ps\c	est:\007	\E\D\e	\007
Dialers	**ventel**	=&-%	t""	\r\p\r\c	$	<K\T%\r>\c	ONLINE!

In the first pair, `develcon` is the dialer and `vent` is the token that is passed to the Develcon switch to tell it which device (ventel modem) to connect to your computer. This token would be unique for each port selector since each switch may be set up differently. Once the ventel modem has been connected, the second pair is accessed, where ventel is the dialer and the token is retrieved from the `Systems` file.

Two escape characters may appear in a DTP field:

- `\T`–Indicates that the *Phone* (*token*) field should be translated using the `/etc/uucp/Dialcodes` file. This escape character is normally placed in the `/etc/uucp/Dialers` file for each caller script associated with a modem (hayes, usrobotics, and so on). Therefore, the translation will not take place until the caller script is accessed.
- `\D`–Indicates that the *Phone* (*token*) field should not be translated using the `/etc/uucp/Dialcodes` file. If no escape character is specified at the end of a `Devices` entry, the `\D` is assumed (default). A `\D` is also used in the `/etc/uucp/Dialers` file with entries associated with network switches (`develcon` and `micom`).

Protocol Definitions in the `Devices` *File*

You can define the protocol to use with each device in `/etc/uucp/Devices`. This usually is unnecessary because you can use the default or define the protocol with the particular system you are calling. (Refer to ”/etc/uucp/Systems File” on page 183.) If you do specify the protocol, you must use the form:

Type,Protocol [parameters]

For example, you can use `TCP,te` to specify the TCP/IP protocol.

Table 12-13 shows the available protocols for the `Devices` file:

Table 12-13 Protocols Used in `/etc/uucp/Devices`

Protocol	Description
`t`	This protocol is commonly used for transmissions over TCP/IP and other reliable connections. It assumes error-free transmissions.
g	This is UUCP's native protocol. It is slow, reliable, and good for transmission over noisy telephone lines.
`e`	This protocol assumes transmission over error-free channels that are message-oriented (as opposed to byte stream–oriented like TCP/IP).
`f`	This protocol is used for transmission over X.25 connections. It relies on flow control of the data stream, and it is meant for working over links that can (almost) be guaranteed to be error-free, specifically X.25/PAD links. A checksum is carried out over a whole file only. If a transport fails, the receiver can request retransmission(s).

Here is an example showing a protocol designation for a device entry:

```
TCP,te – – Any TCP –
```

This example indicates that, for device `TCP`, try to use the `t` protocol. If the other end refuses, use the `e` protocol.

Note that neither `e` nor `t` are appropriate for use over modems. Even if the modem assures error-free transmission, data can still be dropped between the modem and the CPU.

`/etc/uucp/Dialers` *File*

The `/etc/uucp/Dialers` file contains dialing instructions for many commonly-used modems. You probably will not need to change or add entries to this file unless you plan to use a nonstandard modem or plan to customize your UUCP environment. Nevertheless, you should understand what is in the file and how it relates to the `Systems` and `Devices` file.

The text specifies the initial conversation that must take place on a line before it can be made available for transferring data. This conversation, often referred to as a *chat script*, is usually a sequence of ASCII strings that is transmitted and expected, and it is often used to dial a phone number

As shown in the examples in "/etc/uucp/Devices File" the fifth field in a `Devices` file entry is an index into the `Dialers` file or a special dialer type (`TCP`, `TLI`, or `TLIS`). The `uucico` daemon attempts to match the fifth field in the `Devices` file with the first field of each `Dialers` file entry. In addition, each odd-numbered `Devices` field, starting with the seventh position is used as an index into the `Dialers` file. If the match succeeds, the `Dialers` entry is interpreted to perform the dialer conversation.

Each entry in the `Dialers` file has the following format:

dialer *substitutions* *expect-send*

Table 12-14 shows the entry for a US Robotics V.32bis modem.:

Table 12-14 /etc/uucp/Dialers File Entry

Dialer	Substitutions	Expect-Send
`usrv32bis-e`	`=,-, ""`	`dA\pT&FE1V1X1Q0S2=255S12=255&A1&H1&M5&B2&W\r\c OK\r \EATDT\T\r\c CONNECT\s14400/ARQ STTY=crtscts`

The Dialer field matches the fifth and additional odd-numbered fields in the `Devices` file. The Substitutions field is a translate string: the first of each pair of characters is mapped to the second character in the pair. This is usually used to translate = and – into whatever the dialer requires for "wait for dial tone" and "pause."

The remaining Expect-Send fields are character strings.

Code Example 12-1 on page 200 shows some sample entries in the `Dialers` file as distributed when you install UUCP as part of the Solaris installation program.

Code Example 12-1 Excerpts from `/etc/uucp/Dialers`.

```
penril=W-P "" \d > Q\c : \d- > s\p9\c )-W\p\r\ds\p9\c-) y\c : \E\TP > 9\c OK

ventel=&-%"" \r\p\r\c $ <K\T%%\r>\c ONLINE!

vadic=K-K"" \005\p *-\005\p-*\005\p-* D\p BER? \E\T\e \r\c LINE

develcon """" \pr\ps\c est:\007 \E\D\e \n\007

micom"" "" \s\c NAME? \D\r\c GO

hayes=,-,"" \dA\pTE1V1X1Q0S2=255S12=255\r\c OK\r \EATDT\T\r\c CONNECT

#   Telebit TrailBlazer

tb1200=W-,"" \dA\pA\pA\pTE1V1X1Q0S2=255S12=255S50=2\r\c OK\r \EATDT\T\r\c CONNECT\s1200
tb2400=W-,"" \dA\pA\pA\pTE1V1X1Q0S2=255S12=255S50=3\r\c OK\r \EATDT\T\r\c CONNECT\s2400
tbfast=W-,"" \dA\pA\pA\pTE1V1X1Q0S2=255S12=255S50=255\r\c OK\r \EATDT\T\r\c CONNECT\sFAST

# USrobotics, Codes, and DSI modems

dsi-ec  =,-,    "" \dA\pTE1V1X5Q0S2=255S12=255*E1*F3*M1*S1\r\c OK\r \EATDT\T\r\c
CONNECT\sEC STTY=crtscts

dsi-nec =,-,    "" \dA\pTE1V1X5Q0S2=255S12=255*E0*F3*M1*S1\r\c OK\r \EATDT\T\r\c CONNECT
STTY=crtscts

usrv32bis-ec =,-,  "" \dA\pT&FE1V1X1Q0S2=255S12=255&A1&H1&M5&B2&W\r\c OK\r \EATDT\T\r\c
CONNECT\s14400/ARQ STTY=crtscts

usrv32-nec =,-, "" \dA\pT&FE1V1X1Q0S2=255S12=255&A0&H1&M0&B0&W\r\c OK\r \EATDT\T\r\c
CONNECT STTY=crtscts

codex-fast =,-, "" \dA\pT&C1&D2*MF0*AA1&R1&S1*DE15*FL3S2=255S7=40S10=40*TT5&W\r\c OK\r
\EATDT\T\r\c CONNECT\s38400 STTY=crtscts

tb9600-ec =W-,  "" \dA\pA\pA\pTE1V1X1Q0S2=255S12=255S50=6\r\c OK\r
\EATDT\T\r\cCONNECT\s9600 STTY=crtscts

tb9600-nec =W-, "" \dA\pA\pA\pTE1V1X1Q0S2=255S12=255S50=6S180=0\r\c OK\r \EATDT\T\r\c
CONNECT\s9600 STTY=crtscts
```

Here is a list of escape characters commonly used in the send strings in the `Dialers` file:

*Table 12-15*Backslash Characters for `/etc/uucp/Dialers`

Characte r	Description
\b	Send or expect a backspace character
\c	No newline or carriage return.
\d	Delay (approximately 2 seconds).
\D	Phone number or token without `Dialcodes` translation.
\e	Disable echo checking.
\E	Enable echo checking (for slow devices).
\K	Insert a Break character.
\n	Send newline.
\nnn	\nnn – Send octal number. Additional escape characters that may be used are listed in the section "/etc/uucp/Systems File" on page 183.
\N	Send or expect a null character (ASCII NUL).
\p	Pause (approximately 12–14 seconds).
\r	Return.
\s	Send or expect a space character.
\T	Phone number or token with `Dialcodes` translation.

Here is a `penril` entry in the `Dialers` file:

```
penril =W-P "" \d > Q\c : \d- > s\p9\c )-W\p\r\ds\p9\c-) y\c : \E\TP > 9\c OK
```

First, the substitution mechanism for the phone number argument is established, so that any `=` will be replaced with a `W` (wait for dial tone) and any `–` with a `P` (pause).

The handshake given by the remainder of the line works as listed:

- `""` – Wait for nothing. (that is, proceed to the next thing.)

- `\d` – Delay 2 seconds, then send a carriage return.
- `>`–Wait for a `>`.
- `Q\c` – Send a `Q` without a carriage return.
- `:` – Expect a `:`.
- `\d-` – Delay 2 seconds, send a `–` and a carriage return.
- `>` – Wait for a `>`.
- `s\p9\c` – Send an `s`, pause, send a `9` with no carriage return.
- `)-W\p\r\ds\p9\c-)` – Wait for a `)`. If it is not received, process the string between the `–` characters as follows. Send a `W`, pause, send a carriage-return, delay, send an `s`, pause, send a `9`, without a carriage return, and then wait for the `)`.
- `y\c` – Send a `y` with no carriage return.
- `:`– Wait for a `:`.
- `\E\TP` - Enable echo checking. (From this point on, whenever a character is transmitted, it will wait for the character to be received before doing anything else.) Then, send the phone number. The `\T` means take the phone number passed as an argument and apply the `Dialcodes` translation and the modem function translation specified by field 2 of this entry. Then send a `P` and a carriage-return.
- `>` – Wait for a `>`.
- `9\c` – Send a `9` without a new line.
- `OK` – Wait for the string `OK`.

Hardware Flow Control

You can also use the pseudo-send `STTY=value` string to set modem characteristics. For instance, `STTY=crtscts` enables hardware flow control.

`STTY` accepts all the stty modes. See the `stty`(1V) and `termio`(4) man pages.

The following example would enable hardware flow control in a `Dialers` entry:

```
dsi =,-, "" \dA\pTE1V1X5Q0S2=255S12=255*E1*F3*M1*S1\r\c OK\r
\EATDT\T\r\c CONNECT\sEC STTY=crtscts
```

This pseudo-send string can also be used in entries in the `Systems` file.

Setting Parity

In some cases, you will have to reset the parity because the system that you are calling checks port parity and drops the line if it is wrong. The expect-send couplet `~~ P_ZERO` sets parity to zero:

```
foo =,-, "" P_ZERO "" \dA\pTE1V1X1Q0S2=255S12=255\r\c OK\r\EATDT\T\r\c CONNECT
```

In the same manner, `P_EVEN` sets it to even (the default); `P_ODD` sets it to odd; and `P_ONE` sets it to one. This pseudo-send string can also be used in entries in the `Systems` file.

Other Basic Configuration Files

The files in this section can be used in addition to the `Systems`, `Devices`, and `Dialers` file when doing basic UUCP configuration.

`/etc/uucp/Dialcodes` *File*

The `/etc/uucp/Dialcodes` file enables you to define *dial-code abbreviations* that can be used in the Phone field in the `/etc/uucp/Systems` file. You can use the `Dialcodes` file to provide additional information about a basic phone number that is used by several systems at the same site.

Each entry has the format:

abbreviation dial-sequence

where *abbreviation* represents the abbreviation used in the Phone field of the `Systems` file and *dial-sequence* represents the dial sequence passed to the dialer when that particular `Systems` file entry is accessed. Table 12-16 shows the correspondences between the two files.

Table 12-16 Correspondences between `Dialcodes` and `Systems` Files

	Field Names					
Dialcodes	**Abbreviation**	Dial Sequence				
Systems	System-Name	Time	Type	Speed	**Phone**	Chat Script

Table 12-17 contains sample entries in a `Dialcodes` file.

Table 12-17 Entries in the Dialcodes File

abbreviation	**dial-sequence**
`NY`	`1=212`
`jt`	`9+847`

In the first row, NY is the abbreviation to appear in the Phone field of the `Systems` file. For example, the `Systems` file might have the entry:

```
NY5551212
```

When `uucico` reads `NY` in the `Systems` file, it searches the `Dialcodes` file for `NY` and obtains the dialing sequence `1=212`. This is the dialing sequence needed for any phone call to New York City. It includes the number `1`, an equal sign (=) meaning pause and wait for a secondary dial tone, and the area code `212`. `uucico` sends this information to the dialer, then returns to the `Systems` file for the remainder of the phone number, `5551212`.

The entry `jt 9=847-`

would work with a Phone field in the `Systems` file such as `jt7867`. When `uucico` reads the entry containing `jt7867` in the `Systems` file, it would send the sequence 9=847-7867 to the dialer if the token in the dialer-token-pair is `\T`.

/etc/uucp/Sysfiles *File*

The /etc/uucp/Sysfiles file lets you assign different files to be used by uucp and cu as Systems, Devices, and Dialers files. (For more information on cu, see the cu(1c) man page.) You may want to use Sysfiles for:

- Different Systems files, so that requests for login services can be made to different addresses than uucp services.
- Different Dialers files, so that you can assign different handshaking for cu and uucp.
- Multiple Systems, Dialers, and Devices files. The Systems file in particular may become large, making it more convenient to split it into several smaller files.

The format of the Sysfiles file is:

service=*w* systems=*x:x* dialers=*y:y* devices=*z:z*

w represents uucico, cu, or both separated by a colon. *x* represents one or more files to be used as the Systems file, with each file name separated by a colon and read in the order presented. *y* represents one or more files to be used as the Dialers file. *z* is one or more files to be used as the Devices file.

Each file name is assumed to be relative to the /etc/uucp directory, unless a full path is given.

Below is a sample /etc/uucp/Sysfiles that defines a local Systems file (Local_Systems) in addition to the standard /etc/uucp/Systems file:

```
service=uucico:cu systems=Systems :Local_Systems
```

When this entry is in /etc/uucp/Sysfiles, both uucico and cu will first look in the standard /etc/uucp/Systems. If the system they are trying to call doesn't have an entry in that file, or if the entries in the file fail, then they look in /etc/uucp/Local_Systems.

Given the above entry, cu and uucico will share the Dialers and Devices files.

When different Systems files are defined for uucico and cu services, your machine will store two different lists of Systems. You can print the uucico list using the uuname command or the cu list using the uuname –c command. Another example of the file, where the alternate files are consulted first and the default files are consulted in case of need is:

```
service=uucico systems=Systems.cico:Systems
  dialers=Dialers.cico:Dialers \
devices=Devices.cico:Devices
  service=cu systems=Systems.cu:Systems \
dialers=Dialers.cu:Dialers \
  devices=Devices.cu:Devices
```

/etc/uucp/Sysname *File*

Every machine that uses UUCP must have an identifying name, often referred to as the *node name*. This is the name that appears in the remote machine's /etc/uucp/Systems file along with the chat script and other identifying information. Normally, UUCP uses the same node name as is returned by the uname -n command, which is also used by TCP/IP.

You can specify a UUCP node name independent of the TCP/IP host name by creating the /etc/uucp/Sysname file. The file have a one line entry containing the UUCP node name for your system.

/etc/uucp/Permissions *File*

The /etc/uucp/Permissions file specifies the permissions that remote computers have with respect to login, file access, and command execution. There are options that restrict the remote computer's ability to request files and its ability to receive files queued by the local machine. Another option is available that specifies the commands that a remote machine can execute on the local computer.

Structuring Entries

Each entry is a logical line with physical lines terminated by a backslash (\) to indicate continuation. Entries are made up of options delimited by blank space. Each option is a name/value pair in the following format:

name=value

*Value*s may be colon-separated lists. Note that no blank space is allowed within an option assignment.

Comment lines begin with a pound sign (#), and they occupy the entire line up to a newline character. Blank lines are ignored (even within multiple-line entries).

There are two types of `Permissions` file entries:

- `LOGNAME`–Specifies the permissions that take effect when a remote computer logs in to (calls) your computer.

Note – When a remote machine calls you, its identity is questionable unless it has a unique login and verifiable password.

- `MACHINE`–Specifies permissions that take effect when your computer logs in to (calls) a remote computer.

`LOGNAME` entries contain a `LOGNAME` option and `MACHINE` entries contain a `MACHINE` option. One entry may contain both options.

Considerations

When using the `Permissions` file to restrict the level of access granted to remote computers, you should consider the following:

- All login IDs used by remote computers to log in for UUCP communications must appear in one and only one `LOGNAME` entry.
- Any site that is called whose name does not appear in a `MACHINE` entry, will have the following default permissions or restrictions:
  - Local send and receive requests will be executed.
  - The remote computer can send files to your computer's `/var/spool/uucppublic` directory.

- The commands sent by the remote computer for execution on your computer must be one of the default commands, usually `rmail`.

`REQUEST` *Option*

When a remote computer calls your computer and requests to receive a file, this request can be granted or denied. The `REQUEST` option specifies whether the remote computer can request to set up file transfers from your computer. The string `REQUEST=yes` specifies that the remote computer can request to transfer files from your computer. The string `REQUEST=no` specifies that the remote computer cannot request to receive files from your computer. This is the default value; it will be used if the `REQUEST` option is not specified. The `REQUEST` option can appear in either a `LOGNAME` (remote computer calls you) entry or a `MACHINE` (you call remote computer) entry.

`SENDFILES` *Option*

When a remote computer calls your computer and completes its work, it may attempt to take work your computer has queued for it. The `SENDFILES` option specifies whether your computer can send the work queued for the remote computer.

The string `SENDFILES=yes` specifies that your computer may send the work that is queued for the remote computer as long as it logged in as one of the names in the `LOGNAME` option. This string is *mandatory* if you have entered `Never` in the Time field of `/etc/uucp/Systems`. This designation sets up your local machine in *passive mode*; it is not allowed to initiate a call to this particular remote computer. (See "/etc/uucp/Systems File" on page 183 for more information.)

The string `SENDFILES=call` specifies that files queued in your computer will be sent only when your computer calls the remote computer. The `call` value is the default for the `SENDFILE` option. This option is only significant in `LOGNAME` entries since `MACHINE` entries apply when calls are made out to remote computers. If the option is used with a `MACHINE` entry, it will be ignored.

MYNAME *Option*

This option enables you to designate a unique UUCP node name for your computer in addition to its TCP/IP host name, as returned by the hostname command. For instance, if you have unknowingly given your host the same name as that of some other system, you might want to set the MYNAME option of the Permissions file. Or if you want your organization to be known as widget but all your modems are connected to a machine with the host name gadget, you can have an entry in gadget's Permissions file that says:

```
LOGNAME=Uworld MYNAME=widget
```

Now the system world will log in to the machine gadget as if it were logging in to widget. In order for machine world to know you also by the aliased name widget when you call it, you can have an entry that says:

```
MACHINE=world MYNAME=widget
```

You can also use the MYNAME option for testing purposes, since it allows your machine to call itself. However, since this option could be used to mask the real identity of a machine, you should use the VALIDATE option, as described in ”VALIDATE Option” on page 213.

READ *and* WRITE *Options*

These options specify the various parts of the file system that uucico can read from or write to. You can designate READ and WRITE options with either MACHINE or LOGNAME entries.

The default for both the READ and WRITE options is the uucppublic directory, as shown in the following strings:

```
READ=/var/spool/uucppublic
WRITE=/var/spool/uucppublic
```

The strings READ=/ and WRITE=/ specify permission to access any file that can be accessed by a local user with Other permissions.

The value of these entries is a colon-separated list of path names. The READ option is for requesting files, and the WRITE option is for depositing files. One of the values must be the prefix of any full path name of a file coming in or going out. To grant permission to deposit files in /usr/news as well as the public directory, use the following values with the WRITE option:

```
WRITE=/var/spool/uucppublic:/usr/news
```

If the READ and WRITE options are used, all path names must be specified because the path names are not added to the default list. For instance, if the /usr/news path name was the only one specified in a WRITE option, permission to deposit files in the public directory would be denied.

You should be careful what directories you make accessible for reading and writing by remote systems. For example, the /etc directory contains many critical system files; remote users should not have permission to deposit files in this directory.

NOREAD *and* NOWRITE *Options*

The NOREAD and NOWRITE options specify exceptions to the READ and WRITE options or defaults. The entry:

```
READ=/ NOREAD=/etc WRITE=/var/spool/uucppublic
```

permits reading any file except those in the /etc directory (and its subdirectories—remember, these are prefixes). It permits writing only to the default /var/spool/uucppublic directory. NOWRITE works in the same manner as the NOREAD option. You can use the NOREAD and NOWRITE options in both LOGNAME and MACHINE entries.

CALLBACK *Option*

You can use the CALLBACK option in LOGNAME entries to specify that no transaction will take place until the calling system is called back. There are two reasons to set up CALLBACK: For security purposes, if you call back a machine, you can be sure it is the right machine. For an accounting purposes, if you are doing long data transmissions, you can choose the machine that will be billed for the longer call.

The string `CALLBACK=yes` specifies that your computer must call the remote computer back before any file transfers will take place.

The default for the `CALLBACK` option is `CALLBACK=no`. If you set `CALLBACK` to `yes`, then the permissions that affect the rest of the conversation must be specified in the `MACHINE` entry corresponding to the caller. Do not specify these permissions in the `LOGNAME`, as well as in the `LOGNAME` entry that the remote machine may have set for your host.

Note that if two sites have the `CALLBACK` option set for each other, a conversation will never get started.

`COMMANDS` *Option*

Caution – The `COMMANDS` option can compromise the security of your system. Use it with extreme care.

You can use the `COMMANDS` option in `MACHINE` entries to specify the commands that a remote computer can execute on your machine. The `uux` program will generate remote execution requests and queue them to be transferred to the remote computer. Files and commands are sent to the target computer for remote execution.

This is an exception to the rule that `MACHINE` entries apply only when your system calls out.

Note that `COMMANDS` is not used in a `LOGNAME` entry; `COMMANDS` in `MACHINE` entries define command permissions whether you call the remote system or it calls you.

The string `COMMANDS=rmail` specifies the default commands that a remote computer can execute on your computer. If a command string is used in a `MACHINE` entry, the default commands are overridden. For instance, the entry

```
MACHINE=owl:raven:hawk:dove COMMANDS=rmail:rnews:lp
```

overrides the COMMAND default so that the computers named owl, raven, hawk, and dove can now execute rmail, rnews, and lp on your computer.

In addition to the names as specified above, there can be full path names of commands. For example,

```
COMMANDS=rmail:/usr/local/rnews:/usr/local/lp
```

specifies that command rmail uses the default search path. The default search path for UUCP is /bin and /usr/bin. When the remote computer specifies rnews or /usr/local/rnews for the command to be executed, /usr/local/rnews will be executed regardless of the default path. Likewise, /usr/local/lp is the lp command that will be executed.

Including the ALL value in the list means that any command from the remote computers specified in the entry will be executed. If you use this value, you give the remote computers full access to your machine.

Caution – This allows far more access than normal users have. You should use this value only when both machines are at the same site, are closely connected, and the users are trusted.

The string:

```
COMMANDS=/usr/local/rnews:ALL:/usr/local/lp
```

illustrates two points:

- The ALL value can appear anywhere in the string
- The path names specified for rnews and lp will be used (instead of the default) if the requested command does not contain the full path names for rnews or lp.

You should use the VALIDATE option whenever you specify potentially dangerous commands like cat and uucp with the COMMANDS option. Any command that reads or writes files is potentially dangerous to local security when executed by the UUCP remote execution daemon (uuxqt).

VALIDATE *Option*

Use the VALIDATE option in conjunction with the COMMANDS option whenever you specify commands that are potentially dangerous to your machine's security. (VALIDATE is merely an added level of security on top of the COMMANDS option, though it is a more secure way to open command access than ALL.)

VALIDATE provides a certain degree of verification of the caller's identity by cross-checking the host name of a calling machine against the login name it uses. The string

```
LOGNAME=Uwidget VALIDATE=widget:gadget
```

ensures that if any machine other than widget or gadget tries to log in as Uwidget, the connection is refused. The VALIDATE option requires privileged computers to have a unique login and password for UUCP transactions. An important aspect of this validation is that the login / password associated with this entry be protected. If an outsider gets that information, that particular VALIDATE option can no longer be considered secure.

Carefully consider which remote computers you will grant privileged login / passwords for UUCP transactions. Giving a remote computer a special login and password with file access and remote execution capability is like giving anyone on that computer a normal login and password on your computer. Therefore, if you cannot trust someone on the remote computer, do not provide that computer with a privileged login and password.

The LOGNAME entry

```
LOGNAME=uucpfriend VALIDATE=eagle:owl:hawk
```

specifies that if one of the remote computers that claims to be eagle, owl, or hawk logs in on your computer, it must have used the login uucpfriend. If an outsider gets the uucpfriend login / password, masquerading is trivial.

But what does this have to do with the COMMANDS option, which only appears in MACHINE entries?

It links the MACHINE entry (and COMMANDS option) with a LOGNAME entry associated with a privileged login. This link is needed because the execution daemon is not running while the remote computer is logged in. In fact, it is an asynchronous process that does not know which computer sent the execution request. Therefore, the real question is, how does your computer know where the execution files came from?

Each remote computer has its own spool directory on your local machine. These spool directories have write permission given only to the UUCP programs. The execution files from the remote computer are put in its spool directory after being transferred to your computer. When the uuxqt daemon runs, it can use the spool directory name to find the MACHINE entry in the Permissions file and get the COMMANDS list. Or, if the computer name does not appear in the Permissions file, the default list will be used.

The following example shows the relationship between the MACHINE and LOGNAME entries:

```
MACHINE=eagle:owl:hawk REQUEST=yes \
COMMANDS=rmail:/usr/local/rnews \
READ=/ WRITE=/
LOGNAME=uucpz VALIDATE=eagle:owl:hawk \
REQUEST=yes SENDFILES=yes \
READ=/ WRITE=/
```

The value in the COMMANDS option means that remote users can execute rmail and /usr/local/rnews.

In the first entry, you must assume that when you want to call one of the computers listed, you are really calling either eagle, owl, or hawk. Therefore, any files put into one of the eagle, owl, or hawk spool directories is put there by one of those computers. If a remote computer logs in and says that it is one of these three computers, its execution files will also be put in the privileged spool directory. You therefore have to validate that the computer has the privileged login uucpz.

MACHINE *Entry for* OTHER

You may want to specify different option values for remote machines that are not mentioned in specific MACHINE entries. The need may arise when many computers are calling your host, and the command set changes from time to time. The name OTHER for the computer name is used for this entry as shown in this example:

```
MACHINE=OTHER \
COMMANDS=rmail:rnews:/usr/local/Photo:/usr/local/xp
```

All other options available for the MACHINE entry may also be set for the computers that are not mentioned in other MACHINE entries.

Combining MACHINE *and* LOGNAME

You can combine MACHINE and LOGNAME entries into a single entry where the common options are the same. For example, the two entries

```
MACHINE=eagle:owl:hawk REQUEST=yes \
READ=/ WRITE=/
```

and

```
LOGNAME=uupz REQUEST=yes SENDFILES=yes \
READ=/ WRITE=/
```

share the same REQUEST, READ, and WRITE options. You can merge them, as shown:

```
MACHINE=eagle:owl:hawk REQUEST=yes \
logname=uucpz SENDFILES-yes \
READ=/ WRITE=/
```

Combining MACHINE and LOGNAME entries makes the Permissions file more manageable and efficient.

Forwarding

When sending files through a series of machines, the intermediary machines must have the command `uucp` among their `COMMANDS` options. That is, if you type the command:

```
% uucp sample.txt oak\!willow\!pine\!/usr/spool/uucppublic
```

this forwarding operation will work only if machine `willow` permits `oak` to execute the program `uucp`, and if `oak` permits your machine to do the same. The machine `pine`, being the last machine designated, does not have to permit the command `uucp`. Machines are not normally set up this way.

`/etc/uucp/Poll` *File*

The `/etc/uucp/Poll` file contains information for polling remote computers. Each entry in the `Poll` file contains the name of a remote computer to call, followed by a tab character or a space, and finally the hours the computer should be called. The format of entries in the `Poll` file are:

sys-name hour ...

For example, the entry

```
eagle 0 4 8 12 16 20
```

provides polling of computer `eagle` every four hours.

The `uudemon.poll` script processes the `Poll` file but does not actually perform the poll. It merely sets up a polling work file (always named `C.`*file*) in the spool directory. The `uudemon.poll` script starts the scheduler, and the scheduler examines all work files in the spool directory.

`/etc/uucp/Config` *File*

The `/etc/uucp/Config` file enables you to override certain parameters manually. Each entry in the `Config` file has the following format:

parameter=value

See the Config file provided with your system for a complete list of configurable parameter names.

The following Config entry sets the default protocol ordering to Gge and changes the G protocol defaults to 7 windows and 512-byte packets.

```
Protocol=G(7,512)ge
```

/etc/uucp/Grades *File*

The /etc/uucp/Grades file contains the definitions for the job grades that may be used to queue jobs to a remote computer. It also contains the permissions for each job grade. Each entry in this file represents a definition of an administrator-defined job grade that lets users queue jobs.

Each entry in the Grades file has the following format:

User-job-grade System-job-grade Job-size Permit-type ID-list

Each entry contains fields that are separated by blank space. The last field in the entry is made up of subfields also separated by spaces. If a entry takes up more than one physical line, then you can use a backslash to continue the entry onto the following line. Comment lines begin with a pound sign (#) and occupy the entire line. Blank lines are always ignored.

User-job-grade Field

This field contains an administrative-defined user job grade name of up to 64 characters.

System-job-grade Field

This field contains a one character job grade to which *User-job-grade* will be mapped. The valid list of characters is A–Z, a–z, with A having the highest priority and z the lowest.

Relationship between User and System Job Grades

The user job grade may be bound to more than one system job grade. It is important to note that the `Grades` file will be searched sequentially for occurrences of a user job grade. Therefore, any multiple occurrences of a system job grade should be listed according to the restriction on the maximum job size.

While there is no maximum number for the user job grades, the maximum number of system job grades allowed is 52. The reason is that more than one *User-job-grade* can be mapped to a *System-job-grade*, but each *User-job-grade* job grade must be on a separate line in the file. Here is an example:

```
mail N Any User Any netnews N Any User Any
```

Given this configuration in a `Grades` file, these two *User-job-grade* grades will share the same *System-job-grade*. Since the permissions for a *Job-grade* are associated with a *User-job-grade* and not a *System-job-grade*, two *User-job-grades* can share the same *System-job-grades* and have two different sets of permissions.

Default Grade

You can define the binding of a default *User-job-grade* to a system job grade. You must use the keyword `default` as user job grade in the *User-job-grade* field of the `Grades` file and the system job grade that it is bound to. The Restrictions and ID fields should be defined as `Any` so that any user and any size job can be queued to this grade. Here is an example:

```
default a Any User Any
```

If you do not define the default user job grade, then the built-in default grade `Z`, will be used. Because the restriction field default is `Any`, multiple occurrences of the default grade are not checked.

Job-size Field

This field specifies the maximum job size that can be entered in the queue. *Job-size* is measured in bytes and may be a list of the options listed in Table 12-18:

Table 12-18 Job-size Field

nnnn	Integer specifying the maximum job size for this job grade
*n*K	Decimal number representing the number of kilobytes (K is an abbreviation for kilobyte)
*n*M	Decimal number representing the number of megabytes (M is an abbreviation for megabyte)
Any	Keyword specifying that there is no maximum job size

Here are some examples:

- `5000` represents 5000 bytes
- `10K` represents 10 kilobytes
- `2M` represents 2 megabytes

Permit-type Field

This field contains a keyword that denotes how to interpret the ID list.Table 12-19 lists the keywords and their meanings:

Table 12-19 Permit-type Field

Keyword	**ID List Contents**
`User`	Login names of users permitted to use this job grade.
`Non-user`	Login names of users not permitted to use this job grade
`Group`	Group names whose members are permitted to use this group
`Non-group`	Group names whose members are not permitted to use this job grade

ID-list Field

This contains a list of login names or group names that are to be permitted or denied queuing to this job grade. The list of names are separated by blank space and terminated by a new line character. The keyword `Any` is used to denote that anyone is permitted to queue to this job grade.

Other UUCP Configuration Files

This section describes three less-frequently modified files that impact the use of UUCP facilities.

`/etc/uucp/Devconfig` File

The `/etc/uucp/Devconfig` file enables you to configure devices by service–`uucp` or `cu`. `Devconfig` entries define the STREAMS modules that are used for a particular device. They have the format:

service=*x* device=*y* push=*z*[:*z*...]

x can be `cu`, `uucico`, or both separated by a colon. *y* is the name of a network and must match an entry in the `Devices` file. *z* is replaced by the names of STREAMS modules in the order that they are to be pushed onto the Stream. Different modules and devices can be defined for `cu` and `uucp` services.

The following entries are for a STARLAN network and would most commonly be used in the file:

```
service=cu       device=STARLAN     push=ntty:tirdwr
service=uucico   device=STARLAN     push=ntty:tirdwr
```

This example pushes `ntty`, and then `tirdwr`.

`/etc/uucp/Limits` File

The `/etc/uucp/Limits` file controls the maximum number of simultaneous `uucico`s, `uuxqt`s, and `uusched`s that are running in the `uucp` networking. In most cases, the default values are fine and no changes are needed. If you want to change them, however, use any standard system text editor.

The format of the `Limits` file is:

service=*x* max=*y*:

x can be `uucico`, `uuxqt` or `uusched`, and *y* is the limit permitted for that service. The fields can be in any order and in lowercase.

The following entries should most commonly be used in the `Limits` file:

```
service=uucico max=5
service=uuxqt max=5
service=uusched max=2
```

The example allows five `uucico`s, five `uuxqt`s, and two `uusched`s running on your machine.

`remote.unknown` *File*

There is one other file that affects the use of communication facilities, the `remote.unknown` file. This file is a binary program that executes when a machine not found in any of the `Systems` files starts a conversation. It will log the conversation attempt and drop the connection.

Caution – If you change the permissions of the `remote.unknown` file so it cannot execute, your system will accept connections from any system.

This program executes when a machine that is not in any of the *`Systems`* starts a conversation. It will log the conversation attempt and fail to make a connection. If you change the permissions of this file so it cannot execute (`chmod 000 remote.unknown`), your system will accept any conversation requests. This is not a trivial change, and you should have very good reasons for doing it.

Administrative Files

The UUCP administrative files are described below. These files are created in spool directories to lock devices, hold temporary data, or keep information about remote transfers or executions.

- Temporary Data Files (`TM`)–These data files are created by UUCP processes under the spool directory `/var/spool/uucp/`*x* when a file is received from another computer. The directory *x* has the same name as the remote computer that is sending the file. The names of the temporary data files have the format:

  `TM.`*pid.ddd*

  where *pid* is a process ID and *ddd* is a sequential three digit number starting at 0.

  When the entire file is received, the `TM.`*pid.ddd* file is moved to the path name specified in the `C.`*sysnxxxx* file (discussed below) that caused the transmission. If processing is abnormally terminated, the `TM.`*pid.ddd* file may remain in the *x* directory. These files should be automatically removed by `uucleanup`.

- Lock Files (`LCK`)–Lock files are created in the `/var/spool/locks` directory for each device in use. Lock files prevent duplicate conversations and multiple attempts to use the same calling device. Table 12-20 shows the different types of UUCP lock files.

*Table 12-20*UUCP Lock Files

File Name	**Description**
`LCK..`*sys*	*sys* represents the name of the computer using the file
`LCK..`*dev*	*dev* represents the name of a device using the file
`LCK.`*LOG*	*LOG* represents a locked UUCP log file

  These files may remain in the spool directory if the communications link is unexpectedly dropped (usually on computer crashes). The lock files will be ignored (removed) after the parent process is no longer active. The lock file contains the process ID of the process that created the lock.

- Work File (`C.`)–Work files are created in a spool directory when work (file transfers or remote command executions) has been queued for a remote computer. The names of work files have the format:

  `C.`*sysnxxxx*

where *sys* is the name of the remote computer, *n* is the ASCII character representing the grade (priority) of the work, and *xxxx* is the four-digit job sequence number assigned by UUCP. Work files contain the following information:

  - Full path name of the file to be sent or requested
  - Full path name of the destination or user/file name
  - User login name
  - List of options
  - Name of associated data file in the spool directory. If the `uucp -c` or `uuto -p` option was specified, a dummy name (`D.0`) is used
  - Mode bits of the source file
  - Remote user's login name to be notified upon completion of the transfer

- data file (`.D`)–Data files are created when you specify on the command line to copy the source file to the spool directory. The names of data files have the following format:
  - `D.`*systmxxxxyyy* `-` Where *systm* is the first five characters in the name of the remote computer, *xxxx* is a four-digit job sequence number assigned by `uucp`. The four digit job sequence number may be followed by a subsequence number, *yyy* that is used when there are several `D.` files created for a work (`C.`) file.

- `X. (execute file) -` Execute files are created in the spool directory prior to remote command executions. The names of execute files have the following format:

  `X.`*sysnxxxx*

  sys is the name of the remote computer. *n* is the character representing the grade (priority) of the work. *xxxx* is a four digit sequence number assigned by UUCP. Execute files contain the following information:
  - Requester's login and computer name
  - Name of file(s) required for execution
  - Input to be used as the standard input to the command string
  - Computer and file name to receive standard output from the command execution
  - Command string
  - Option lines for return status requests

Configuring and Maintaining UUCP 13

This chapter explains how to start up UUCP operations once you have modified the database file relevant to your machines. The chapter contains procedures and troubleshooting information for setting up and maintaining UUCP on machines running the Solaris environment.

Adding UUCP Logins

For incoming UUCP (`uucico`) requests from remote machines to be handled properly, each machine has to have a login on your system.

Here is a typical entry that you might put into the `/etc/passwd` file for a remote machine permitted to access your system with a UUCP connection.:

```
Ugobi:*:5:5:gobi:/var/spool/uucppublic:/usr/lib/uucp/uucico
```

By convention, the login name of a remote machine is the machine name preceded by the letter `U`. Note that the name should not exceed eight characters, so that in some cases you may have to truncate or abbreviate it.

The previous entry shows that a login request by Ugobi is answered by /usr/lib/uucp/uucico. The home directory is /var/spool/uucppublic. The password is obtained from the /etc/shadow file. You must coordinate the password and the login name with the UUCP administrator of the remote machine. The remote administrator must then add an appropriate entry, with login name and unencrypted password, in the remote machine's Systems file.

Similarly, you must coordinate your machine's name and password with the UUCP administrators of all machines that you want to reach through UUCP.

Starting UUCP

UUCP comes with four shell scripts that poll remote machines, reschedule transmissions, and clean up old log files and unsuccessful transmissions. The scripts are:

- uudemon.poll
- uudemon.hour
- uudemon.admin
- uudemon.cleanup

These shell scripts should execute regularly to keep UUCP running smoothly. The crontab file to run the scripts is automatically created in /usr/lib/uucp/uudemon.crontab as part of Solaris installation process, if you select the Full installation. Otherwise, it is created when you install the UUCP package.

You can also run the UUCP shell scripts manually.The following is the prototype uudemon.crontab file that you can tailor for a particular machine

```
#
#ident "@(#)uudemon.crontab 1.3 93/02/02 SMI"
#
48 8,12,16 * * * /usr/libuucp/uudemon.admin
45 23 * * * /usr/lib/uucp/uudemon.cleanup
0 * * * * /usr/lib/uucp/uudemon.poll
11,41 * * * * /usr/lib/uucp/uudemon.hour
```

To activate the `uudemon.crontab` file, become superuser and type:

```
# su uucp
# crontab < /usr/lib/uucp/uudemon.crontab
```

`uudemon.poll` *Shell Script*

The default `uudemon.poll` shell script reads the `/etc/uucp/Poll` file once an hour. If any machines in the `Poll` file are scheduled to be polled, a work file (`C.sysnxxxx`) is placed in the `/var/spool/uucp/`*nodename* directory, where *nodename* represents the UUCP node name of the machine.

The shell script is scheduled to run once an hour, before `uudemon.hour`, so that the work files will be there when `uudemon.hour` is called.

`uudemon.hour` *Shell Script*

The default `uudemon.hour` shell script does the following:

1. Calls the `uusched` program to search the spool directories for work files (`C.`) that have not been processed and schedules these files for transfer to a remote machine.
2. Calls the `uuxqt` daemon to search the spool directories for execute files (`X.`) that have been transferred to your computer and were not processed at the time they were transferred.

By default, `uudemon.hour` runs twice an hour. You may want it to run more often if you expect high failure rates of calls to remote machines.

`uudemon.admin` *Shell Script*

The default `uudemon.admin` shell script does the following:

1. Runs the `uustat` command with `–p` and `–q` options. The `–q` reports on the status of work files (`C.`), data files (`D.`), and execute files (`X.`) that are queued. The `–p` prints process information for networking processes listed in the lock files (`/var/spool/locks`).

2. Sends resulting status information to the `uucp` administrative login via mail.

`uudemon.cleanup` Shell Script

The default `uudemon.cleanup` shell script does the following:

1. Takes log files for individual machines from the `/var/uucp/.Log` directory, merges them, and places them in the `/var/uucp/.Old` directory with other old log information.
2. Removes work files (`C.`) 7 days old or older, data files (`D.`) 7 days old or older, and execute files (`X.`) two days old or older from the spool files.
3. Returns mail that cannot be delivered to the sender.
4. Mails a summary of the status information gathered during the current day to the UUCP administrative login (`uucp`).

Running UUCP Over TCP/IP

To run UUCP on a TCP/IP network, you need to make a few modifications, as described in this section

Activating UUCP in `/etc/inetd.conf`

Make sure that the following entry in `/etc/inetd.conf` is not preceded by a comment mark (#):

```
uucp stream tcp nowait root /usr/sbin/in.uucpd in.uucpd
```

Tailoring `Systems` File Entries for TCP/IP

Entries in the `/etc/uucp/Systems` file should have the following fields:

System-Name Time TCP *Port networkname Standard-Login-Chat*

A typical entry would look like this:

```
rochester Any TCP - ur-seneca login: Umachine password: xxx
```

Notice that the fifth field, `networkname`, permits you to specify explicitly the TCP/IP host name. This is important for some sites. In the example above, the site has a UUCP node name like `rochester` that is different from its TCP/IP host name `ur-seneca`. Moreover, there could easily be a completely different machine running UUCP that has a TCP/IP host name of `rochester`.

The Port field in the `Systems` file should have the entry –. This is equivalent to listing it as `uucp`. In almost every case, the networkname will be the same as the system name, and the Port field will be –, which says to use the standard `uucp` port from the `services` database. The `in.uucpd` daemon expects the remote machine to send its login and password for authentication, and it prompts for them much as `getty` and `login` do.

Checking `/etc/inet/services` *for UUCP*

The following entry in `/etc/inet/services` sets up a port for UUCP:

```
uucp 540/tcp uucpd # uucp daemon
```

You should not have to change the entry. However, if your machine runs NIS or NIS+ as its name service, you should change the `/etc/nsswitch.conf` entry for `/etc/services` to check `files` first, and then check `nis` or `nisplus`.

Security, Maintenance, and Troubleshooting

Once you have set up UUCP, its maintenance is straightforward. This section explains ongoing UUCP tasks with regard to security, maintenance, and troubleshooting.

Setting Up UUCP Security

The default /etc/uucp/Permissions file provides the maximum amount of security for your UUCP links. The default Permissions file contains no entries.

You can set additional parameters for each machine to define:

- Ways it can receive files from your machine
- Directories for which it has read and write permission
- Commands it can use for remote execution

A typical Permissions entry is:

```
MACHINE=datsun LOGNAME=Udatsun VALIDATE=datsun COMMANDS=rmail REQUEST=yes SENDFILES=yes
```

This entry allows files to be sent and received (to and from the ‘‘normal’’ UUCP directories, not from anywhere in the system) and causes the UUCP user name to be validated at login time. For more information, see

Regular UUCP Maintenance

UUCP does not require much maintenance. Apart from making sure that the crontab file is in place, as described in the section ”uudemon.poll Shell Script” on page 227. All you have to worry about is the growth of mail files and the public directory.

email for UUCP

All email messages generated by the UUCP programs and scripts go to the user ID uucp. If you do not log in frequently as that user, you may not realize that mail is accumulating (and consuming disk space). To solve this, make an alias in /etc/aliases, and redirect that email either to root or to yourself and others responsible for maintaining UUCP. Don’t forget to run the newaliases command after modifying the aliases file.

Public Directory

The directory `/var/spool/uucppublic` is the one place in every system to which UUCP by default is able to copy files. Every user has permission to change to `/var/spool/uucppublic` and read and/or write files in it. However, its sticky bit is set, so its mode is 01777. As a result, users cannot remove files that have been copied to it and that belong to `uucp`. Only you, as UUCP administrator logged in as `root` or `uucp`, can remove files from this directory. To prevent the uncontrolled accumulation of files in this directory, you should make sure to clean it up periodically.

If this is inconvenient for users, encourage them to use `uuto` and `uupick` rather than removing the sticky bit, which is set for security reasons. (See the `uuto`(1C) man page for instructions for using `uuto` and `uupick`.) You can also make the mode of the directory more restrictive, perhaps just to a group of people. If you do not want to run the risk of having someone fill your disk, you can even deny UUCP access to it.

Troubleshooting UUCP

These procedures describe how to solve common UUCP problems.

Checking for Faulty Modems or ACUs

You can check if the modems or other ACUs are not working properly in several ways.

- Run `uustat –q`. This will give counts and reasons for contact failure.
- Run `cu –d –l`*line*, where *line* is `/dev/cua/a`. This will let you call over a particular line and print debugging information on the attempt. The line must be defined as `direct` in the `/etc/uucp/Devices` file. (You must add a telephone number to the end of the command line if the line is connected to an autodialer or the device must be set up as `direct`.)

Checking the `/etc/uucp/Systems` File

Verify that you have up-to-date information in your `Systems` file if you are having trouble contacting a particular machine. Some things that may be out of date for a machine are its:

- Phone number
- Login
- Password

Debugging Transmissions

If you cannot contact a particular machine, you can check out communications to that machine with `Uutry` and `uucp`.

1. **To try to make contact, type** `/usr/lib/uucp/Uutry –r` *machine* **and press Return.**
   Replace *machine* with the host name of the machine you are having problems contacting. This command:

   a. Starts the transfer daemon (`uucico`) with debugging. You will get more debugging information if you are `root`.

   b. Directs the debugging output to `/tmp/`*machine*.

   c. Prints the debugging output to your terminal (`tail –f`).
   Press Control-c to end output. You can copy the output from `/tmp/`*machine* if you want to save it.

2. **If** `Uutry` **doesn't isolate the problem, try to queue a job by typing** `uucp -r` *file machine*`\!`*/dir/file* **and press Return.**
   Replace *file* by the file you want to transfer, *machine* by the machine you want to copy to, and */dir/file* where the file will be placed on the other machine. The `-r` option queues a job but does not start the transfer.

3. **Now use** `Uutry` **again.**
   If you still cannot solve the problem, you may need to call your local support representative. Save the debugging output; it will help diagnose the problem.

You may also want to decrease or increase the level of debugging provided by `Uutry` through the `–x` *n* option, where *n* indicates the debug level. The default debug level for `Uutry` is 5.

Debug level 3 provides basic information as to when and how the connection is established, but not much information about the transmission itself. Debug level 9, on the other hand, provides exhaustive information about the transmission process. Be aware that debugging occurs at both ends of the transmission. If you intend to use a level higher than 5 on a moderately large text, get in touch with the administrator of the other site and agree on a time for doing so.

Checking Error Messages

UUCP has two types of error messages: `ASSERT` and `STATUS`.

When a process is aborted, `ASSERT` error messages are recorded in `/var/uucp/.Admin/errors`. These messages include the file name, `sccsid`, line number, and text. These messages usually result from system problems.

STATUS error messages are stored in the `/var/uucp/.Status` directory. The directory contains a separate file for each remote machine your computer attempts to communicate with. These files contain status information on the attempted communication and whether it was successful.

Checking Basic Information

There are several commands you can use to check for basic networking information.

- `uuname`– Use this command to list those machines your machine can contact.
- `uulog`–Use this command to display the contents of the log directories for particular hosts.
- `uucheck -v` – Run this command to check for the presence of files and directories needed by `uucp`. This command also checks the `Permissions` file and outputs information on the permissions you have set up.

UUCP Error Messages

This section lists the error messages associated with UUCP.

UUCP ASSERT Error Messages

Table 13-1 lists ASSERT error messages.

Table 13-1 ASSERT Error Messages

Error Message	Description/Action
`CAN'T OPEN`	An `open()` or `fopen()` failed.
`CAN'T WRITE`	A `write()`, `fwrite()`, `fprint()`, or similar ccommand, failed.
`CAN'T READ`	A `read(),fgets()`, or similar command failed.
`CAN'T CREATE`	A `creat()` call failed.
`CAN'T ALLOCATE`	A dynamic allocation failed.
`CAN'T LOCK`	An attempt to make a `LCK` (lock) file failed. In some cases, this is a fatal error.
`CAN'T STAT`	A `stat()` call failed.
`CAN'T CHMOD`	A `chmod()` call failed.
`CAN'T LINK`	A `link()` call failed.
`CAN'T CHDIR`	A `chdir()` call failed.
`CAN'T UNLINK`	An `unlink()` call failed.
`WRONG ROLE`	This is an internal logic problem.
`CAN'T MOVE TO CORRUPTDIR`	An attempt to move some bad `C.` or `X.` files to the `/var/spool/uucp/.Corrupt directory` failed. The directory is probably missing or has wrong modes or owner.
`CAN'T CLOSE`	A `close()` or `fclose()` call failed.
`FILE EXISTS`	The creation of a `C.` or `D.` file is attempted, but the file exists. This occurs when there is a problem with the sequence file access. Usually indicates a software error.
No `uucp` service number	A TCP/IP call is attempted, but there is no entry in `/etc/services` for UUCP.
`BAD UID`	The user ID is not in the `/etc/passwd` file. The file system is in trouble, or the `/etc/passwd` file is inconsistent.
`BAD LOGIN_UID`	Same as previous.
`BAD LINE`	There is a bad line in the `Devices file`; there are not enough arguments on one or more lines.

Table 13-1 ASSERT Error Messages (Continued)

Error Message	Description/Action
`SYSLST OVERFLOW`	An internal table in `gename.c` overflowed. A big or strange request was attempted. Contact your local representative.
`TOO MANY SAVED C FILES`	Same as previous.
`RETURN FROM fixline ioctl`	An `ioctl`(2), which should never fail, failed. There is a system driver problem.
`BAD SPEED`	A bad line speed appears in the `Devices`/`Systems` files (Class/Speed field).
`BAD OPTION`	There is a bad line or option in the `Permissions` file. It must be fixed immediately.
`PKCGET READ`	The remote machine probably hung up. No action need be taken.
`PKXSTART`	The remote machine aborted in a nonrecoverable way. This can usually be ignored.
`TOO MANY LOCKS`	There is an internal problem. Contact your system vendor.
`XMV ERROR`	There is a problem with some file or directory. It is likely the spool directory, since the modes of the destinations were suppose to be checked before this process was attempted.
`CAN'T FORK`	An attempt to make a `fork` and `exec` failed. The current job should not be lost but will be attempted later (`uuxqt`). No action need be taken.

UUCP STATUS Error Messages

Table 13-2 is a list of the most common STATUS error messages.

Table 13-2 UUCP STATUS Messages

Error Message	Description/Action
`OK`	Status is okay.
`NO DEVICES AVAILABLE`	There is currently no device available for the call. Check to see that there is a valid device in the `Devices` file for the particular system. Check the `Systems` file for the device to be used to call the system.
`WRONG TIME TO CALL`	A call was placed to the system at a time other than what is specified in the `Systems` file.
`TALKING`	Self-explanatory.
`LOGIN FAILED`	The login for the given machine failed. It could be a wrong login or password, wrong number, a very slow machine, or failure in getting through the Dialer-Token-Pairs script.
`CONVERSATION FAILED`	The conversation failed after successful startup. This usually means that one side went down, the program aborted, or the line (link) was dropped.
`DIAL FAILED`	The remote machine never answered. It could be a bad dialer or the wrong phone number.
`BAD LOGIN/MACHINE COMBINATION`	The machine called us with a login / machine name that does not agree with the `Permissions` file. This could be an attempt to masquerade!
`DEVICE LOCKED`	The calling device to be used is currently locked and in use by another process.
`ASSERT ERROR`	An `ASSERT` error occurred. Check the `/var/uucp/.Admin/errors` file for the error message and refer to the section "UUCP Error Messages" on page 233.
`SYSTEM NOT IN Systems FILE`	The system is not in the `Systems` file.
`CAN'T ACCESS DEVICE`	The device tried does not exist or the modes are wrong. Check the appropriate entries in the `Systems` and `Devices` files.
DEVICE FAILED	The device could not be opened.

Table 13-2 UUCP STATUS Messages (Continued)

Error Message	Description/Action
`WRONG MACHINE NAME`	The called machine is reporting a different name than expected.
`CALLBACK REQUIRED`	The called machine requires that it calls your machine.
`REMOTE HAS A LCK FILE FOR ME`	The remote machine has a `LCK` file for your machine. It could be trying to call your machine. If it has an older version of UUCP, the process that was talking to your machine may have failed, leaving the `LCK` file. If it has the new version of UUCP and is not communicating with your machine, then the process that has a `LCK` file is hung.
`REMOTE DOES NOT KNOW ME`	The remote machine does not have the node name of your machine in its `Systems` file.
`REMOTE REJECT AFTER LOGIN`	The login used by your machine to login does not agree with what the remote machine was expecting.
`REMOTE REJECT, UNKNOWN MESSAGE`	The remote machine rejected the communication with your machine for an unknown reason. The remote machine may not be running a standard version of UUCP.
`STARTUP FAILED`	Login succeeded, but initial handshake failed.
`CALLER SCRIPT FAILED`	This is usually the same as `DIAL FAILED`. However, if it occurs often, suspect the caller script in the `Dialers` file. Use `Uutry` to check.

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