

1 *Using This Manual to Plan Your Network*

Whether you want to use your NeXT™ computer as a standalone system or connect it to a network, this manual contains information you need. If you want to set up your NeXT computer for multiple users, attach it to a peripheral device, or incorporate it into a mixed network, you'll find the procedures to follow in this guide. It's not a comprehensive reference for all aspects of system administration; rather, it's a basic guide—a starting point—for setting up NeXT computers in a variety of configurations.

This chapter is designed to help you get started with this manual. It's also intended to help you create a network plan, which is the first step in setting up a network. You can use this chapter as an introduction to networking and as a planning resource when you're ready to design your network.

How to Use This Manual

This section gives you a synopsis of each chapter and describes some of the conventions used.

Chapter Descriptions

What follows is a brief description of the information each chapter contains:

- Chapter 1, "Using This Manual to Plan Your Network," discusses issues you should consider when designing your network and gives an overview of some available hardware configurations.
- Chapter 2, "Setting Up a NetInfo Network," covers the steps you perform to set up a simple network, including configuring servers, sharing files, and creating user accounts.
- Chapters 3 through 6 describe in detail how to set up a network. Chapter 3, "NetInfo Networking," introduces NetInfo™, the NeXT administrative database service, and describes how to configure various aspects of your network. Chapter 4, "Setting Up the Network File System," describes how to share files over the network. Chapter 5, "Managing User Accounts and User Groups," covers creating and deleting user accounts and user groups. Chapter 6, "Managing Electronic Mail," covers configuring mail service and creating mail aliases.
- Chapters 7 through 9 cover the administration of NeXT computers—whether they're standalone systems or part of a network. Chapter 7, "Attaching Peripherals," presents information about connecting external disk drives, modems, and other peripherals. Chapter 8, "Managing System Backups," explains how to back up and restore data. Chapter 9, "System Startup and Shutdown," describes what happens when you start up and shut down your computer.
- Chapter 10, "Configuring a Large Network," describes how to work with a large NetInfo network, including subnetting and NetInfo hierarchies of more than two levels.
- Chapters 11 and 12 contain information about integrating NeXT and non-NeXT computers in networks and setting up internetwork communication using electronic mail. Chapter 11, "NeXT Computers in a Mixed Network," explores how to integrate NeXT computers with several types of networks that include non-NeXT computers. Chapter 12, "Using UUCP," is about UUCP and how to set it up on a NeXT computer.
- Chapter 13, "NetBooting," describes how to set up NetBoot clients, which can boot over the network.
- Chapter 14, "Security," is a detailed discussion of security issues and how they affect the administration of your system.
- Chapter 15, "General Troubleshooting," discusses several UNIX® commands that can be useful when you're tracking down a problem.
- Appendix A, "The Manager Applications," is a command reference for the administration applications.
- Appendix B, "Cable and Modem Configuration," describes several cables for use with a NeXT computer and also provides some sample modem settings.
- Appendix C, "Internet Addressing," explains how to obtain and assign an appropriate Internet address.

- Appendix D, ^aThe **sendmail** Program,^o describes the contents of the configuration files used to manage electronic mail.
- Appendix E, ^aSystem Test Error Codes,^o defines the error codes you might encounter when starting up a NeXT computer.
- Appendix F, ^aUUCP Overview,^o gives a brief overview of the components of the UUCP facility.
- Appendix G, ^aAnnotated **uucico** Debugging Output,^o provides an example of a debugging session used to track down problems with UUCP.
- Appendix H, ^aSuggested Reading,^o describes sources of additional information.

Conventions

In certain places in this manual, you're directed to enter a command in a shell window. You use the Terminal application to do this. In this manual, the word *directory* is used in place of the word *folder* found in other NeXT documentation.

Planning Your Network

Networking is a way of sharing computer resources among users. These shared resources can include equipment (such as printers and fax modems), files, and data or administrative services. Network servers provide users with access to these resources. For example, a print server lets a work group share a printer. An NFS[®] file server allows users throughout the network to share data as if it were on their own local computers. A NetInfo server lets you store administrative data for multiple systems in a single place, reducing the time required to maintain the database.

NeXT computers come with a set of uncomplicated yet powerful networking applications. These applications let you design your network to meet your requirements. For example, you can set up your network as a hierarchy—perhaps based on your company organization—that lets you share some resources with small groups and make other resources available throughout the network. A printer might be shared among four computers,

while a single mail server could route electronic mail to the entire company.

When designing your network, you need to consider:

- GoalsÐWhat resources do you want to share, and with whom? What resources do you want to keep private? What level of security do you want to maintain?
- LimitationsÐWhat limitations do you need to consider in implementing your design? These might include budget, physical location, available space, or convenience of use and administration.
- ResourcesÐWhat can you use to implement your design? NeXT computers are compatible with a wide variety of network options, allowing you the flexibility to choose from several possible solutions.

For example, suppose your goal is to connect your NetInfo network to an existing network in another division of your company. Your NetInfo network is based on Ethernet while the other is based on token ring. One solution to this problem would be a gateway to translate messages from one architecture to the other.

If you intend to use your NeXT computer as a standalone system, little planning is neededÐyou simply set it up and it runs. However, when creating a network serving multiple users, your decision-making process can be complex.

Through careful network design, you can:

- Create the correct load balancing of server systems and client systems.
- Design the right mix of computers and peripherals for maximum efficiency.
- Choose the best location of servers for optimum use of office space.
- Choose the best positioning of client systems to satisfy the needs of users.
- Avoid wasting time and resources with unsuitable configurations.

This chapter presents an overview of the available networking alternatives and provides guidelines for making decisions. However, it's not intended to offer specific solutions for your particular network configuration and equipment requirements. For specific recommendations, contact your NeXT distributor and the manufacturers of the equipment you're considering or already own.

Determining Equipment Needs

The first step in planning your network is to determine what equipment you will need. For example, you might consider:

- How will you connect one system to another to transmit data?
- How many computers do you need, and how close together must they be?
- How far apart are the most distant computers on the network?
- Will you need to purchase additional equipment (for example, concentrators, repeaters, gateways, or routers) to facilitate data transmission on your network?
- Will your network be located in a single building, or must there be a means of transmission between buildings or over longer distances?
- What are your network's peripheral requirements?

For information about the servers you need for your network, see ^aDetermining Which Servers Are Needed,^o later in this chapter.

Cabling

NeXT computers are designed to communicate over an Ethernet network. Every NeXT computer comes with built-in connectors for both thin Ethernet and twisted-pair Ethernet cables. You can attach your computer to either type of cable. This section explains the advantages and disadvantages of each.

Thin Ethernet Cable

Thin Ethernet coaxial cables consist of a single wire surrounded by an insulator and a shield. With a network based on thin Ethernet cables, your equipment needs are minimal. All you have to do is string the cables, attach the appropriate terminators, and plug in your computer. If cable installation for your system can be done without difficulty, then this solution may be best.

The main disadvantage of thin Ethernet is that you must install the cables, which require both expense and effort. Often, cables must be installed through walls. If you have fewer computers, you might find this approach more flexible. If you have many computers, you might find the cost excessive. However, each site has its unique

requirements.

Observe the following guidelines for thin Ethernet:

- You can attach a maximum of 30 computers to each thin cable segment.
- The maximum cable segment length is 185 meters. After 185 meters, you can use a repeater to join additional cable (a maximum of four repeaters can be used for this purpose).
- Computers are connected to cable segments using a BNC ^aT^o adapter.
- An Ethernet terminator must be attached to each end of the cable.

Twisted-Pair Ethernet Cable

With twisted-pair Ethernet, cables run from each computer to a central network hub. This cable consists of two pairs of wires—one pair for transmitting data and one for receiving data. (The wires in each pair are twisted together—hence the name *twisted pair*.)

To operate this network, you must purchase and maintain the network hub equipment, which can be costly. However, you can use existing telephone wiring, which reduces overall expense since you usually don't have to install many cables. If you have several systems spread out in a building, or if you have a pre-existing twisted-pair network, this solution may be best for you.

Observe the following guidelines for twisted-pair Ethernet:

- Only one computer can be attached to a twisted-pair cable segment.
- The maximum cable length from the computer to the network hub is 100 meters. After 100 meters, you can use a repeater to join an additional cable length.

Networking Equipment

Since networking needs vary tremendously between sites, a wide variety of networking equipment is available. This section describes some of the types of equipment you might use on your network; it also discusses some of the possible solutions you might choose in different situations. Most of this equipment can be obtained from third-party vendors, who can assist you in determining the equipment needs for your network.

The following equipment is commonly used for extending or joining networks (these are the basic types; available equipment varies widely and may combine several functions into one machine):

- *Repeaters* are used to join lengths of network cables, or to split a network cable into multiple segments. You might also find repeaters useful if you want to use different types of cable in your network. For example, you could connect an Ethernet network on a thin cable to one on a thick-coaxial cable with a repeater.
- *Concentrators* permit you to position computers closer together on the network cable than you could otherwise. If you use a twisted-pair cable, you need a concentrator.
- *Bridges* filter traffic within a single network. They work like a traffic cop to direct messages toward a destination and to exclude messages that are intended for other destinations. Like repeaters, they can join network segments. Unlike repeaters, they can extend the network by resending the signal. As traffic on your network increases, you may find you need a bridge.
- *Routers* direct messages between separate networks (for example, an Ethernet network and a token ring network). They make decisions about which path through the network messages will take.
- *Gateways* can transfer information between physically separate networks that are based on different protocols (for example, between Internet and AppleTalk® networks).

With these equipment options, you can set up your local work areas with some flexibility in the types of cable you use. For local networking, you could use repeaters to extend your network, or a bridge to combine two thin Ethernet networks. If the Ethernet network uses different types of cable, you could install a repeater, bridge, or router. You could then run thin cable into one end of your equipment and use twisted-pair cable from there on. You can also join thin or twisted-pair cable to an existing thick-coaxial Ethernet cable.

To operate more complex networks with higher traffic, you might use routers or gateways. Either of these can be used to create *subnets*, which are logical divisions of a network into smaller subnetworks. This equipment can give you better administrative control and network performance as your network grows. See Chapter 10 and Appendix C for more information.

A range of solutions is available if you need to extend your network beyond a single building. One important factor is the distance over which you need to extend the network. If you have buildings located close together, you can install fiber optic or broadband cable between them. For example, fiber optic transceivers installed between buildings will allow you to extend the range of your network to approximately 1 1/2 miles at Ethernet speeds (and farther if you add more transceivers). Since you can't easily string wires through city streets, fiber optic transceivers are most useful in a ^acampus^o type of building arrangement, where you can install them away

from public areas.

If you have tall buildings that are in direct line of sight with each other, you can use a microwave transceiver dish to transmit data. This extends data transmission perhaps 10 to 15 miles. However, if any objects (even a large flock of birds) intrude between the transmitting transceivers, the signal can be interrupted.

Phone lines are a ready solution to data transmission beyond a single building. They go anywhere, and dedicated lines are available for lease. Many networking software applications are available, such as UNIX-to-UNIX Copy (UUCP) and **tip**, that can be used to transmit data over phone lines. You can transmit data on normal phone lines at speeds from 300 baud to 19200 baud and higher. See Chapter 7 and Chapter 12 for details.

If you have the budget and the need, satellites can be used to transmit your data worldwide.

You should also consider linking to existing networks to make use of their resources. A modem and a phone line will put you in touch with the international UNIX-based UUCP network. NeXT computers also support the TCP/IP (Transmission Control Protocol/Internet Protocol) network that links sites worldwide. The most inexpensive way to access the Internet is to connect to an existing site. In addition, some vendors offer Internet mail gateway services.

Peripheral Devices

Peripheral devices offer a range of services that expand the capabilities of your network. These peripherals include external hard disks, printers, modems, and graphics tablets, among others.

In addition to the information in this manual, you'll find instructions for attaching and configuring your peripheral devices in the documentation that comes with each device. Consult the manufacturer for guidance in determining network configuration requirements.

External Hard Disks

Depending on your data storage requirements, you may want to add an external SCSI hard disk to your computer. For use on a NeXT computer, a drive must be terminated correctly (for a discussion of SCSI disk termination, see the *Owner's Guide*).

For information about adding SCSI hard disks, see Chapter 7, ^aAttaching Peripherals.^o

Printers

In addition to the NeXT 400 dpi Laser Printer and NeXT Color Printer, numerous printers are compatible with NeXT computers. Because NeXT computers can be used with client software for Novell NetWare® and AppleTalk networks, you can make use of any printers attached to an existing network.

To determine how many printers you need, decide if you want one printer per computer, or if you want to share a printer among several users. In considering these questions, keep in mind that printer needs vary widely among users. For example, a technical publications department uses printers heavily, while some other departments might use printers much less frequently. You might decide to give each writer an individual printer, while setting up a print server for low-use departments.

For more information about connecting non-NeXT printers, see Chapter 7.

Modems

To be compatible with a NeXT computer, a modem should be Hayes®-compatible. For more information about modems, see Chapter 7, “Attaching Peripherals,” Chapter 12, “Using UUCP,” and Appendix B, “Cable and Modem Configuration.”

You can also attach a fax modem to give your system the ability to send and receive fax messages. For information on fax modems, see the *User's Guide*.

Graphics Tablets

Graphics tablets let you turn your NeXT computer into a freehand drawing pad. With a stylus, you have precise control over cursor movement. The graphics tablet must be compatible with SummaSketch® I (MM I format) and must use a 12 × 12 inch size format. Again, more information can be found in Chapter 7.

Determining Which Servers Are Needed

Servers let you share network resources among clients by administering a centralized database for a particular area of responsibility—NetInfo serving, file serving, printer serving, mail serving, NetBoot serving, or fax modem serving. Using servers simplifies administrative tasks, allowing you to administer a single central database rather than a set of smaller ones.

When determining which servers are needed, there's usually no fixed ratio of servers to clients. When determining your server requirements, you should ask the following questions:

- What is the usage pattern for the server? Unusual traffic or heavy local use can increase the need for servers and require a higher server/client ratio. Archiving servers that are accessed only once or twice a day can serve a larger client base than a server that is accessed constantly.
- What are the needs and locations of the groups using the server? It's frequently convenient to assign servers based on company hierarchies (for example, one server per department).
- Should you have a single large server with a very large disk, or several smaller servers? Larger disks may increase boot time, but are typically more cost-effective and easier to administer.
- Do you want to combine types of servers? (See [Combining Servers](#),^o later in this section.)
- Do you want the server to be dedicated, or also to be used as someone's workstation? If a server will be used for several purposes, it may require increased memory and disk space.

You can tailor the memory and disk space of your server computers according to the needs of your individual site. Two popular NeXTcube™ server configurations follow, although many other combinations are possible:

- 32 MB RAM and a 1.4 GB hard disk drive
- 64 MB RAM and two 1.4 GB hard disk drives

These numbers represent heavy usage; in certain circumstances, smaller amounts of memory or disk space may suffice. Although it is generally true that a server should have large amounts of both memory and disk space, some server applications may require only increased memory. Parity memory (which provides error checking) is desirable on servers.

NetInfo Servers

A *NetInfo* server provides storage for and access to a NetInfo database. It keeps track of administrative network

information such as user accounts, group membership, host names and addresses, fax modem information, and so on.

NetInfo servers are a wise addition to a network because multiple computers can share the same administrative data without concern for consistency between them. It also greatly simplifies administration—you can enter information into the centralized database rather than having to update each computer on the network. A network NetInfo server should have a large amount of memory, since it's accessed so frequently. Depending on the complexity of your network, the NetInfo servers may also need increased disk space, though this is less important than memory.

NetInfo administration is based on the concept of *domains*. A NetInfo domain is an abstract collection of administrative information about a group of computers and the resources to which they have access. For example, a NetInfo domain can contain the administrative information for a single computer, a department, or even an entire company. You should associate NetInfo domains with groups of computers that need to be administered together. This is typically along organizational lines—for example, small work groups, departments, or divisions.

NetInfo domains are linked together in a hierarchy much like the UNIX file system. Each level in the hierarchy is called a *domain level*. You can make selected information available to specific domain levels. The size of your network often determines the number of domain levels. For very large networks, a two-level domain may not be sufficient to meet your administrative needs.

This section is only a brief introduction to NetInfo. For more information about setting up NetInfo servers and configuring domains, read the following chapters:

- Chapter 2, “Setting Up a NetInfo Network”
- Chapter 3, “NetInfo Networking”
- Chapter 10, “Configuring a Large Network”

File Servers

File servers supply disk storage space for clients. The Network File System (NFS) is used to share directory trees across the network. To a client, shared directories seem just like the directories on a local disk. Any computer with a hard disk can be used as a file server, but the more disk and memory space it has, the more client requests it can serve.

File servers can provide different types of service, and each type can require somewhat different disk and memory configurations. For example, they might be *home directory servers*, which contain the home directories for the users of their client systems, or they might be *application servers*, which provide a central location for applications.

Due to the frequency of client access and the large amount of data storage needed for each client, home directory servers require either more memory and disk space or fewer users assigned to a single server. Although the requirements may vary, 40 MB of home directory space per person is almost always enough; 25 MB is generally adequate.

Other factors that can increase the disk space and memory needed are the types of applications that the clients use. If users process many documents or use sound frequently, they need more memory and disk space. Similarly, users making heavy use of color or video image processing need additional space.

If you include file servers on your network, you'll probably want to set up network-wide user accounts rather than local accounts (enabling users to log into any computer on the network, rather than restricting them to a single computer). For details, see Chapter 5, *Managing User Accounts and User Groups*.^o

For more information about setting up file servers, see Chapter 4, *Setting Up the Network File System*.^o

Print Servers

Print servers allow computers to share a printer. For best performance, the computer used for print service should be dedicated to this purpose. This is because printing requires many CPU cycles and a great deal of memory, both of which can severely impact normal processing.

Print servers can be available to all computers on the network or available to a subset of computers. In general, a printer should probably be shared by no more than four computers unless printer use is light.

For more information about exporting a printer to the network, see the *User's Guide*.

Mail Servers

Mail servers provide electronic mail storage and processing for a group of client systems. Generally, only one

mail server is needed for an entire company. The mail server should also be configured as a NetInfo server.

Although the mail server will primarily serve internal mail needs, it's also the link to the outside world. It might have a modem link for UUCP hookup, or a leased telephone line, or other outside connections.

When configuring a mail server, use the maximum amount of memory you can afford. Because a mail server will probably be storing all mail messages for the entire network, it will also need a large disk.

For more information on mail servers, see Chapter 6, ^aManaging Electronic Mail.^o

Fax Modem Servers

A fax modem server enables its clients to share fax modem services. It can be combined with a print server since they both require similar configurations.

For more information on fax modem servers, see the *User's Guide*.

Combining Servers

Sometimes you can conserve resources by combining more than one server function on a single computer. If you do combine server functions, you may require extra memory or disk space. For NetInfo servers, you may need to set up additional computers to serve the same NetInfo database (called *clone servers*). You need to weigh the advantages of using a single large server versus the value of spreading service across several computers to improve robustness and performance, which may be necessary on a large network.

Warning: Combining a modem server with another type of server may pose a security risk, since the modem may provide access opportunities to the outside world.

The following table summarizes how different server types may be combined. This table assumes that the servers listed do not provide other types of services. NR stands for ^anot recommended.^o

Combining Servers

NetInfo	Home	Other
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	Clone	Directory	Mail	File	Print	Modem
NetInfo	NO	YES	YES	YES	*	YES
NetInfo Clone	---	YES	YES	YES	*	YES
Home Directory		---	YES	²	NR	YES
Mail			---	YES	NR	YES
Other File				---	NR	YES
Print					---	YES
Modem						---

* NetInfo responses may be delayed during printing.

² An additional hard disk is recommended when combining these types of file servers.

Network Connectivity

NeXT computers provide a high degree of connectivity to multiple platforms:

- UNIX® Since the NeXT Mach operating system is UNIX-compatible, you have access to UNIX networking.
- Ethernet® NeXT systems permit immediate connection to Ethernet networks because the Ethernet connectors are built in. Ethernet has established itself as the industry standard for networking UNIX-based computers due to its reliability and capacity to rapidly transfer large amounts of information.
- Transmission Control Protocol/Internet Protocol (TCP/IP)® This international network is supported by almost all computer vendors. TCP/IP support is included with your NeXT computer.
- IBM® mainframe® You can purchase software applications that let you share data with an IBM mainframe environment using IBM 3270 terminal emulation. Through this emulation, you have access to a wide variety of IBM applications.
- DOS® Outside vendors can supply software to let you exchange data between an IBM PC-compatible computer and a NeXT computer over an Ethernet network. NeXT computers also come with a built-in facility that lets you copy files to and from DOS-compatible floppy disks.

- Macintosh®NeXT computers come with a built-in facility that lets you copy files to and from Macintosh-compatible 1.4MB floppy disks.
- Novell NetWareNeXT computers come with Novell client software, which allows access to files and PostScript®printers on Novell networks running NetWare 286 or 386.
- ISDN (Integrated Services Digital Network)With the appropriate hardware, this service provides the ability to extend a network of NeXT computers at about four times the speed of a 9600-baud modem.

Considering Security

When you plan for the design and installation of your network, you also need to consider security. If security is at all important at your site, you'll want to consider security issues during the planning process. Chapter 14, ^aSecurity,^o gives detailed instructions on practical things you can do to increase the security of your data.

As you plan your network and position your networking hardware, consider the physical security of the cabling and the equipment. It's much easier (and cheaper) to provide security measures *before* the equipment is installed. A couple of questions to consider regarding physical security are:

- Should the network cabling be exposed or run through the walls? (Exposed wire is easier to tap.)
- Who should have access to the servers (or any other computer) and the networking hardware?

Good security takes into account how much work an unauthorized user is willing to do to steal or damage your data. In an office environment, it may be sufficient to protect a document by setting access permissions with the Workspace Manager™. If you feel you need a greater degree of protection, you can encrypt your documents.

Encryption scrambles the data so that it's indecipherable even if an unauthorized user manages to access it. To bypass the security of encryption, an intruder must learn the code word you've used to encrypt the file. Of course, the documents must be decrypted before they can be used again. File encryption is available with the UNIX command **crypt**.

Good security also takes into account the worst case scenario. You'll need to plan how you would go about restoring your computer to a usable state if the security of your system were breached. Sometimes a solid backup strategy is the best security of all. Consider the following points when planning your backup procedures:

- A current backup of all critical files should be available at all times.
- Backups should be stored in a secure location.
- Make sure that you have a plan for reinstalling the system software on your computer.

Remember that good backups are like an insurance policy: you hope you never have to use them. For more information, see Chapter 8, ^aManaging System Backups.^o

For More Information

This manual contains references to other sources of related information. There are two kinds of references made in the chapters:

- Printed documentation—You may be referred to another NeXT document (the *Owner's Guide*, for example).
- UNIX manual pages—UNIX commands to be typed into a shell window are documented in manual pages. These can be accessed through the Digital Librarian™ if you have the extended version of the software.

If you can't find the information you need, or if you just want to know more about system administration, you may want to investigate the publications listed in Appendix H, ^aSuggested Reading.^o