UNIX® Network Programming

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Health Systems International

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To Sally, Bill, and Ellen.

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Introduction

1.1 History

Computer networks have revolutionized our use of computers. They pervade our every-day life, from automated teller machines, to airline reservation systems, to electronic mail services, to electronic bulletin boards. There are many reasons for the explosive growth in computer networks.

- The proliferation of personal computers and workstations during the 1980s helped fuel the interest and need for networks.
- Computer networks used to be expensive and were restricted to large universities, government research sites, and large corporations. Technology has greatly reduced the cost of establishing computer networks, and networks are now found in organizations of every size.
- Many computer manufacturers now package networking software as part of the basic operating system. Networking software is no longer regarded as an add-on that only a few customers will want. It is now considered as essential as a text editor.
- We are in an information age and computer networks are becoming an integral part in the dissemination of information.

Computer systems used to be stand-alone entities. Each computer was self-contained and had all the peripherals and software required to do a particular job. If a particular feature was needed, such as line printer output, a line printer was attached to

the system. If large amounts of disk storage were needed, disks were added to the system. What helped change this is the realization that computers and their users need to *share* information and resources.

Information sharing can be electronic mail or file transfer. Resource sharing can involve accessing a peripheral on another system. Twenty years ago this type of sharing took place by exchanging magnetic tapes, decks of punched cards, and line printer listings. Today computers can be connected together using various electronic techniques called *networks*. A network can be as simple as two personal computers connected together using a 1200 baud modem, or as complex as the TCP/IP Internet, which connects over 150,000 systems together. The number of ways to connect a computer to a network are many, as are the various things we can do once connected to a network. Some typical network applications are

- Exchange electronic mail with users on other computers. It is commonplace these days for people to communicate regularly using electronic mail.
- Exchange files between systems. For many applications it is just as easy to distribute the application electronically, instead of mailing diskettes or magnetic tapes. File transfer across a network also provides faster delivery.
- Share peripheral devices. Examples range from the sharing of line printers to the sharing of magnetic tape drives. A large push towards the sharing of peripheral devices has come from the personal computer and workstation market, since often the cost of a peripheral can exceed the cost of the computer. In an organization with many personal computers or workstations, sharing peripherals makes sense.
- Execute a program on another computer. There are cases where some other computer is better suited to run a particular program. For example, a time-sharing system or a workstation with good program development tools might be the best system on which to edit and debug a program. Another system, however, might be better equipped to run the program. This is often the case with programs that require special features, such as parallel processing or vast amounts of storage. The National Science Foundation (NSF) has connected the six NSF supercomputer centers using a network, allowing scientists to access these computers electronically. Years ago, access to facilities such as this would have required mailing decks of punched cards or tapes.
- Remote login. If two computers are connected using a network, we should be able to login to one from the other (assuming we have an account on both systems). It is usually easier to connect computers together using a network, and provide a remote login application, than to connect every terminal in an organization to every computer.

We'll consider each of these applications in more detail in the later chapters of this text.

1.2 Layering

Given a particular task that we want to solve, such as providing a way to exchange files between two computers that are connected with a network, we divide the task into pieces and solve each piece. In the end we connect the pieces back together to form the final solution. We could write a single monolithic system to solve the problem, but experience has shown that solving the problem in pieces leads to a better, and more extensible, solution.

It is possible that part of the solution developed for a file transfer program can also be used for a remote printing program. Also, if we're writing the file transfer program assuming the computers are connected with an Ethernet, it could turn out that part of this program is usable for computers connected with a leased telephone line.

In the context of networking, this is called *layering*. We divide the communication problem into pieces (layers) and let each layer concentrate on providing a particular function. Well-defined interfaces are provided between layers.

1.3 OSI Model

The starting point for describing the layers in a network is the International Standards Organization (ISO) *open systems interconnection* model (OSI) for computer communications. This is a 7-layer model shown in Figure 1.1.

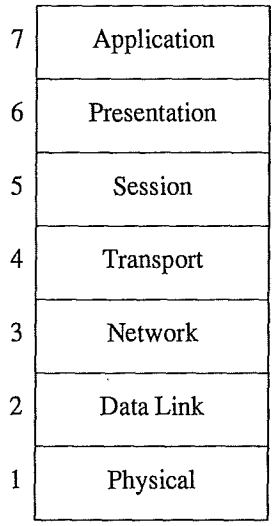

Figure 1.1 OSI 7-layer model.

The OSI model provides a detailed standard for describing a network. Most computer networks today are described using the OSI model. In Chapter 5, each of the networks we describe is shown against the OSI model.

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