A Brief History of PC Networking

The desire to communicate with others is a driving force among human beings, and the sophisticated means we have developed to communicate sets us apart from other species. From the moment it became possible to link two computers and get them to talk to one another, the concept of the Internet was inevitable.

In the early days of computing, computers were enormous machines that filled entire rooms—sometimes entire city blocks—and cost hundreds of thousands of dollars. Although these expensive behemoths had less processing power and memory than today's tiny handheld computers, they were state-of-the-art technology in the 1950s and 1960s. In a world in which human beings who were slow and prone to error had done calculations manually, the capabilities of the computer were amazing.

At the midpoint of the twentieth century, computers were still rare, exotic, mysterious machines owned only by large companies, governmental bodies, and educational institutions. For the most part, computers were standalone systems, isolated from one another.

In the 1940s, Thomas Watson, the chairman of IBM, said that a market existed in the world for approximately five computers. Even as recently as 1977, Ken Olson, president of Digital Equipment Corporation, said, "There is no reason anyone would want a computer in their home" (ISBC [International Small Business Consortium], www.isbc.com/isbc/business/wisdom.cfm). Of course, both have been proven not just wrong, but *very* wrong. However, no one would have predicted, even a decade ago, that PCs would proliferate as they have or that computer networking would become a mainstream topic.

The First Communications Networks

By the mid-1900s, electronic communications had been around for over a century and was being implemented in both Europe and the United States. These early networks took many forms and sent only coded signals. They later became capable of sending voice across the wire.

This section provides a rough time line of how the first networks were developed.

Telegraph Cables

In the early 1800s, the French developed the first optical telegraph network, which sent information at the blazing speed of 20 characters per second, and Samuel Morse demonstrated the electrical telegraph, which spurred the development of networked communications in the United States.

The Telephone Network: Circuit-Switching Technology

In the late 1800s, a vast telephone network began to be built. Technology leaders of the day, however, were no more farsighted than those of the early computer age. In 1876 an internal memo at Western Union stated that "This

'telephone' has too many shortcomings to be seriously considered as a means of communication. The device is inherently of no value to us" (www.isbc.com/isbc/business/wisdom.cfm).

Despite that attitude, there were more than 50,000 telephone lines in the U.S. by 1880, and by 1960, telephone lines covered urban areas, and the telephone network became a global communications network.

A telephone system uses circuit-switching technology, in which a circuit, or virtual pathway, is established when one telephone connects to another on a network. This works well for voice transmission because the sounds being transferred over the wire flow at a relatively constant rate.

In a circuit-switched network, a connection is established, as shown in Figure 1-1. All signals are passed over this circuit for the duration of the session. If you disconnect and reconnect, a different circuit can be used, as represented by the dotted line.

Figure 1-1. In a circuit-switched network, a connection is established, as represented by the solid line.

The technology works less well for transfer of computer data, which has a tendency to be sent in bursts; that is, periods of high activity are interspersed with intervals of low activity or inactivity.

Packet-Switching Technology

During the 1960s, the U.S. government became interested in developing a computer network that would enable systems at military installations and major educational institutions to communicate with one another. Because this was during the middle of the Cold War, they wanted the network to have robustness, reliability, and redundancy so that the network would survive a nuclear war.

Researchers working at the Massachusetts Institute of Technology (MIT), the RAND Institute, and the National Physical Laboratory (NPL) in England invented a new technology called *packet switching*, which worked better for bursty transmissions than did the traditional circuit-switching technologies. Their work created a foundation for the communications technology used on the Internet today.

In a packet-switched network, as shown in Figure 1-2, a connection is not established for the entire transmission. Instead, each individual packet of data can take a different path.

Figure 1-2. Networked computers share data, software, and hardware resources.

Communications from different sources can share the same line, rather than the line being dedicated to one end-to-end communication for the duration of a session, as is the case with circuit switching.

Circuit Switching Versus Packet Switching

The terms *circuit switching* and *packet switching* sound alike but have different meanings.

The public telephone system, sometimes referred to as POTS (plain old telephone service), is a switched-circuit communications network. When you place a telephone call in this type of network, only one physical path from your telephone to the one you're dialing is used for the duration of that call. This pathway, or *circuit,* is maintained for your exclusive use, until you end the connection by hanging up your telephone.

Note, however, that if you call the same friend at the same number tomorrow, and do so at the same location from which you placed today's call, the path is not necessarily the same. That's why the circuit is referred to as *switched.* It also explains why you can get a clear connection one day and noise and static on another.

With a packet-switching network, no dedicated pathway or circuit is established. Packet switching is sometimes referred to as a *connectionless* technology because of the lack of a dedicated pathway. If you transfer data, such as a word processing file, from your computer to another using a packet-switched network, each individual *packet* (that is, each small chunk of data) can take a different route. Although it all arrives at the same destination, it doesn't all travel the same path to get there. Internet traffic generally uses packet-switching technology.

The difference between circuit and packet switching can be compared to the different ways in which a large group of people traveling from Dallas to San Francisco can reach their destination. For example, circuit switching is similar to loading the entire group on a bus, a train, or an airplane. The route is plotted out, and the whole group travels over that same route.

Packet switching is like having each person travel in an automobile. The group is broken down into individual components as the data communication is broken into packets. Some travelers can take interstate highways, and others can use back roads. Some can drive straight through, and others can take a more roundabout path. Eventually, they all end up at the same destination. The group is put back together, just as packets are reassembled at the endpoint of the communication.

The ARPAnet

The first packet-switched computer network was conceived in the late 1960s, under the auspices of the U.S. Department of Defense (DoD). It was christened the ARPAnet (for Advanced Research Projects Agency network). The ARPAnet's first *node,* or connection point, was installed at the University of California at Los Angeles in 1969.

In just three years, the network spread across the United States, and two years after that, it spread to Europe.

As the network grew, it split into two parts. The military called its part of the internetwork *Milnet*, and ARPAnet continued to be used to describe the part of the network that connected research and university sites. In the 1980s the Defense Data Network (a separate military network) and NSFNet (a network of scientific and academic sites funded by the National Science Foundation) replaced ARPAnet. Eventually this WAN grew into what we today call the Internet.

Yesterday's Networks

Computer networking didn't begin on such a large scale as the ARPAnet project; that is, the LAN came before the WAN. As computers became less expensive and more powerful, businesses of all sizes more commonly used them. Although the first machines were useful for only very limited types of data processing, as software development flourished, new programs enabled users to do much more than just collect and sort data.

With early mainframe systems, for instance, multiple users could access the same stored data from *terminals*, which were stations with input and output devices (for example, keyboards and monitors). These stations had no computing power of their own; they were points from which the mainframe computer could be accessed.

Using mainframes worked well in many respects, but they had several disadvantages when compared to smaller computers (then called microcomputers). Expense was one disadvantage; large mainframe systems cost far more than the so-called "personal" computers designed to sit on a desktop and function independently.

Another disadvantage of mainframes was the *single point of failure* concept. With mainframe computing, if the computer was down, it was down for everyone. Nobody could access data, and nobody who depended on the computer could get any work done. The use of individual PCs, on the other hand, circumvented this problem.

PCs were full-fledged computers that ran programs and performed tasks entirely on their own. They also provided some measure of *fault tolerance*, which is the capability of a system to continue to function and ensure data integrity when failures occur. If one employee's computer crashed, it didn't affect the capability of the rest of the employees, who had their own PCs, to continue working. In fact, if an employee had saved data to a floppy disk, he or she could move to a functioning machine and continue working.

These factors contributed to the increased popularity of PCs as a computing solution for small and large businesses (and everything in between). However, once everyone had a PC on the desktop, companies were faced with a dilemma: How could workers share information as they had with the old mainframe computing model? The solution was networking.

Disadvantages of Standalone Systems

In the early days of desktop PCs, networking hardware and software were not readily available, and many businesses used the machines as standalone systems. If all users needed to print documents on occasion, there were three possible ways to provide that ability:

- A printer could be attached to each machine. This was a costly solution because it necessitated buying multiple printers, even though it was unlikely that they all would be in use at the same time.
- The file to be printed could be saved to floppy disk and transferred to a machine that had an attached printer. This was a less-expensive option, but it was an inconvenience both to the person who had to go begging for a printer and to the person with the printer, whose work was interrupted while someone else used his or her machine to print.
- A printer could be moved from one workstation to another, depending on who needed to print. This was a somewhat cumbersome solution; nonetheless, it was widely implemented, using rolling printer carts that were wheeled around the office. Each move required that cables be disconnected and reconnected, and sometimes, a move involved software reconfiguration as well.

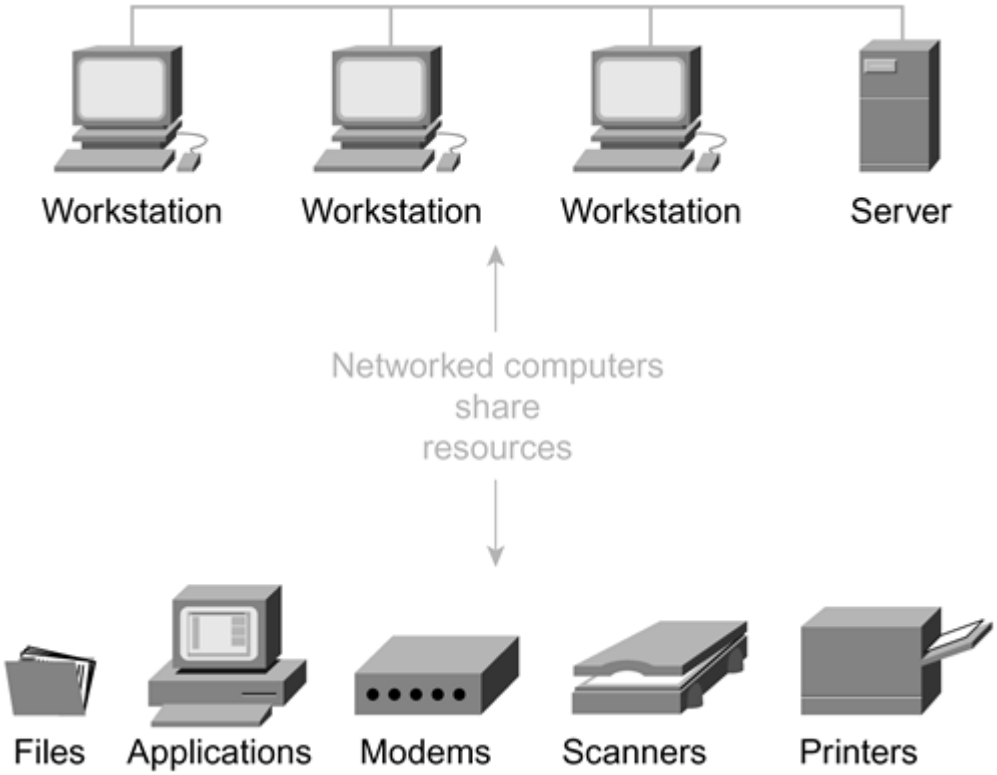
High cost, inconvenience, and extra work are the primary disadvantages of standalone, or non-networked, solutions.

What Is a Network, Anyway?

The *American Heritage Dictionary* defines a *network* as "a system of lines or channels that cross or interconnect." Earlier we mentioned the telegraph and telephone networks, and of course, we've all heard references to the television networks. Using the dictionary definition, we can call even the state highway system, or the railways that crisscross the country, a network.

That being said, what is a computer network? Simply, it is two or more devices linked for the purpose of sharing information, resources, or both. The link can be through cable (coaxial, twisted-pair, or fiber optics, as you'll learn later in this chapter), or it can be a wireless connection that uses radio signals, laser or infrared technology, or satellite transmission. The information and resources shared can be data files, application programs, printers, modems, or other hardware devices. See Figure 1-3 for an illustration.

Figure 1-3. This time line shows significant events in PC networking history.



Why Network Computers?

If the advantage of PCs were each user having an independent computer, why would we want to turn around and link them again? We link them because networked PCs give us, in many ways, the best of both worlds. Each user has independent processing power, but still can enjoy all the benefits of sharing. On the other hand, a company sees a significant cost savings when expensive, occasionally used peripherals are shared over the network. For example, an expensive color laser printer might be used only for special projects, yet many different members of the organization will need to print to it from time to time. With network access, it's easy for them to do so.

Benefits of Getting Connected

Many business owners and managers state that the primary reason for networking their PCs was the need to share printers, as described in the earlier example. Of course, once the systems were linked, people discovered the usefulness of being able to share much more than printers.

The cost involved in linking computers in a LAN—the network interface cards (NICs) for the computers, the cabling or wireless media, the hubs and other connectivity devices—often pays for itself many times over by

reducing expenditures and lost production time.

Sharing Output Devices

As discussed, printers and other output devices can be shared on a network, saving time, money, and a great deal of aggravation. Items that can be shared include plotters, which are devices used to draw diagrams, and charts. They also include line-based graphics devices that use pens or electrostatic charges and toner. Fax machines, which can be either input or output devices, also are easy to share.

Sharing Input Devices

You can share scanners, digital cameras, and other input devices across the network. Because these devices, even more so than printers, are generally used on an occasional basis and are often relatively expensive, it makes sense to configure them for multiple users on the network.

Sharing Storage Devices

Networked computers can share the use of hard disks and floppy and CD-ROM drives. With this type of sharing, you can save files to the disk of another computer across the network if you run out of hard disk space on your computer. In addition, if your computer doesn't have a CD-ROM drive installed, you can access the shared CD drive of another computer. This ability to share also occurs with Zip and Jaz drives, magneto-optical drives, tape drives, and just about any other type of storage device that can be connected to a PC.

Sharing Modems and Internet Connections

Another important feature of networking is the ability of networked PCs to share modems, ISDN lines, cable modems, and DSL adapters. With the proper software—such as proxy or Network Address Translation (NAT) software, which we discuss in detail in Chapter 9, "The Widest Area Network: The Global Internet"—an entire LAN can connect to the Internet through one phone line and a single ISP account.

Sharing Data and Applications

Hardware devices are not the only, or even the most important, resources that can be shared on a network. Data files and application programs also can be made available to multiple users. This sharing results in the efficient use of disk space and easier collaboration on multiuser projects. For example, if several managers need to access and revise a spreadsheet containing a department's budget, the file can be stored in a central location. After each manager makes the desired changes, the file can be saved to the network location so that the updated version is available for the next manager.

Application programs, such as word processing programs, can be installed to a network server. Users can connect to the share and run the application on their own machines, without using space on their local hard disks for the program files.

Be aware that software vendors' licensing agreements can require that you purchase additional licenses for each workstation that uses a network application, even though only one copy is actually installed and all users are accessing that same copy.

The Birth of the Internet

As mentioned previously, back in the 1960s, usable networking technologies became available, and in the early 1970s, the ARPAnet was created by a collaborative effort between the U.S. government (primarily the DoD) and several large universities.

The Role of the DoD

As the Cold War between the United States and the Soviet Union intensified in the 1960s, the DoD recognized the need to establish communications links between major U.S. military installations. The primary motivation was to maintain communications if a nuclear war resulted in mass destruction and breakdown of traditional communications channels. Major universities, such as the University of California and MIT, were already involved

in networking projects too.

The DoD funded research sites throughout the United States, and in 1968, ARPA contracted with BNN, a private company, to build a network based on the packet-switching technology that had been developed for better transmission of computer data.

The 1970s: The Growth Spurt Begins

When the ARPAnet project began, no one anticipated that the network would grow to the extent it did. Throughout the 1970s, more nodes were added, both domestically and abroad.

The 1980s: More Is Better

In 1983, the ARPAnet network was split, and 68 of the 113 existing nodes were taken by Milnet, which was integrated with the Defense Data Network. The Defense Data Network had been created the previous year.

The Domain Name System (DNS) was introduced in 1984, providing a way to map "friendly" host names to IP addresses that was much more efficient and convenient than previous methods. We discuss these previous methods in Chapter 8, "Networking Protocols and Services." In 1984, there were more than 1000 host computers on the network.

During the last half of the 1980s, the networking picked up considerably. For instance, the NSF created supercomputer centers at Princeton, in Pittsburgh, at the University of California at San Diego, at the University of Illinois at Urbana-Champaign, and at Cornell. The Internet Engineering Task Force (IETF) also came into being during this time. By 1987, there were 10,000 hosts on the network, and by 1989, that number increased to over 100,000.

The 1990s: The Net Becomes Big Business

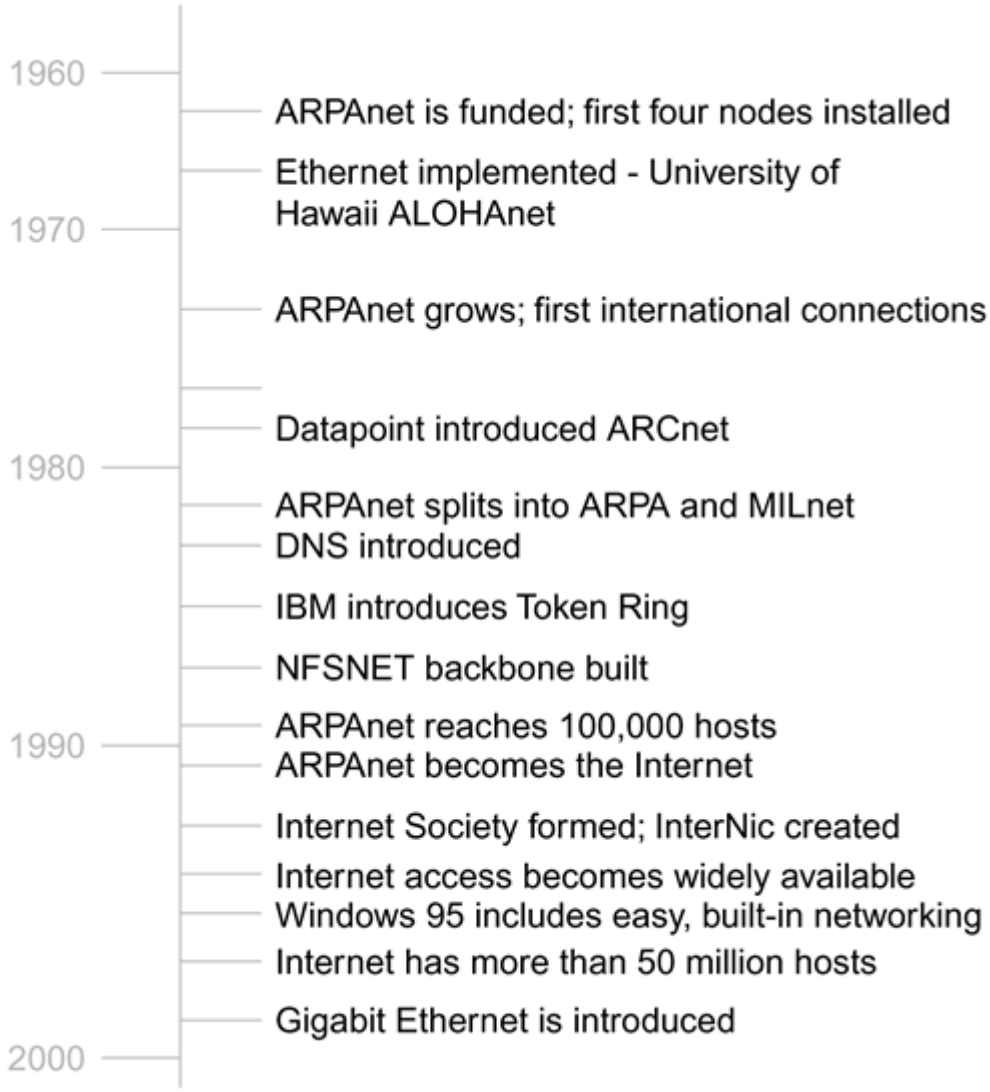
The phenomenal growth rate of the 1980s was nothing compared to what came in the 1990s. ARPAnet ceased to exist, and the Internet was "invented," with the U.S. government getting involved in pushing the development of the so-called information superhighway. The NSFnet backbone was upgraded to T3 speed (that is, 44.736 Mbps), and in 1991 it sent more than 1 trillion bytes per month. The Internet Society (ISOC) was formed, and in 1992 more than 1 million hosts existed on the Internet.

The 1990s was the decade that the Internet went commercial. As more and more college students and faculty, individual home users, and companies of all sizes got connected, the business world recognized the opportunity to reach a large and expanding affluent market. By 1995, online advertising had caught on, online banking had arrived, and you could even order a pizza over the Internet.

The last half of the last decade of the century ushered in new major developments almost on a daily basis. Streaming audio and video, "push" technologies, and Java and ActiveX scripting took advantage of higher-performance connectivity available at lower and lower prices. Domain names became big business, with particularly desirable names selling for upwards of $1 million. In December 1999, almost 1 billion sites existed on the Word Wide Web, with well over 50 million host computers participating in this great linking.

Figure 1-4 shows a time line of significant events in PC networking history.

Figure 1-4. The global network began in the 1960s and continues to grow today.



The Cost of Technology: More and More for Less and Less

As computer and networking technology have advanced over the past few decades, the cost of that increasingly sophisticated technology has fallen dramatically. Those falling prices are at least partially responsible for the rising popularity of connectivity solutions in the business world and in personal lives.

In the 1970s and 1980s, a PC that was considered state of the art for the time cost several thousand dollars. Online services existed, but with fees of $25 or more *per hour* of access, only big businesses and the wealthy could afford them. PC veterans still can remember the announcement of Prodigy's "bargain rates" of only $9.95 an hour for online access. This was at blazing speeds of 1200 or 2400 baud.

Today, of course, for under $1000, you can buy a computer system capable of doing much more, and doing it better and faster, than the $500,000 mainframe of 20 years ago. Internet access at speeds equivalent to T1 is available through DSL or cable modem for $30 to $40 per month, and the price is falling all the time. Basic Internet access at 56 kbps can be had for much less—even for free, if you can tolerate a bit of advertising taking up space on your screen.

URL http://proquest.safaribooksonline.com/1587130386/ch01lev1sec1