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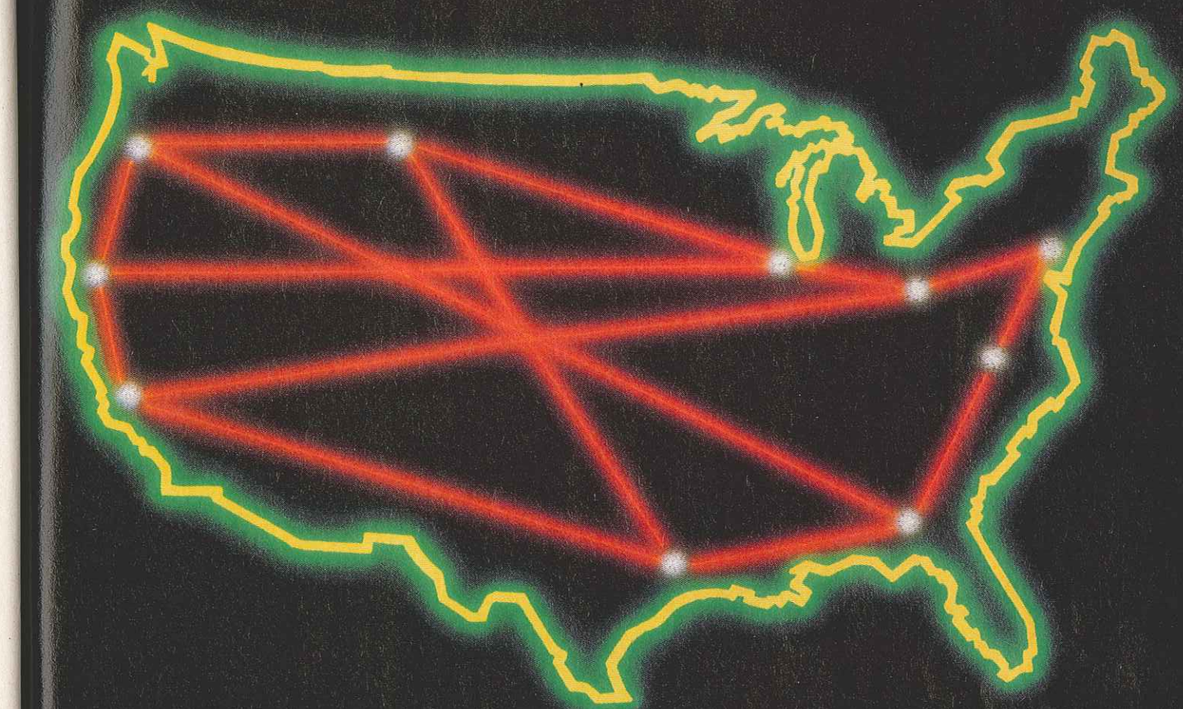

Communications Networks for Computers

BY STAN VEIT

THE American telephone system spans the nation and reaches into almost every home, store, factory and office. It's also connected by cable and satellite into an international network that enables us to talk with people all over the world just by dialing a number. This familiar communications network was originally designed for voice transmission, but nowadays it's also used to transmit digital data.

In this article we'll explore the communication networks that use telephone lines to transmit digital information. We'll take a look at the companies that provide the information, learn how to use their services, find out what they cost, and how to access them. Finally, we'll investigate other avenues of communications like television cable and local computer networks.

Data-Communication Networks. There are many data-communication networks that transmit digital data across the country. They receive the data from local sources and compress it into "packets" that are sent in a continuous stream from point to point. At the destination, the data is routed over local lines to receiving terminals. As a result of this efficient utilization of transmission time, the data networks can charge much less than if an individual leased a line from AT&T for computer-to-computer communication.

The principal companies in this business are Tymnet, which is part of a computer time-sharing company called Tymshare, and G.T.E. Telenet. It's expected that American Bell, the new data-communications subsidiary of AT&T,

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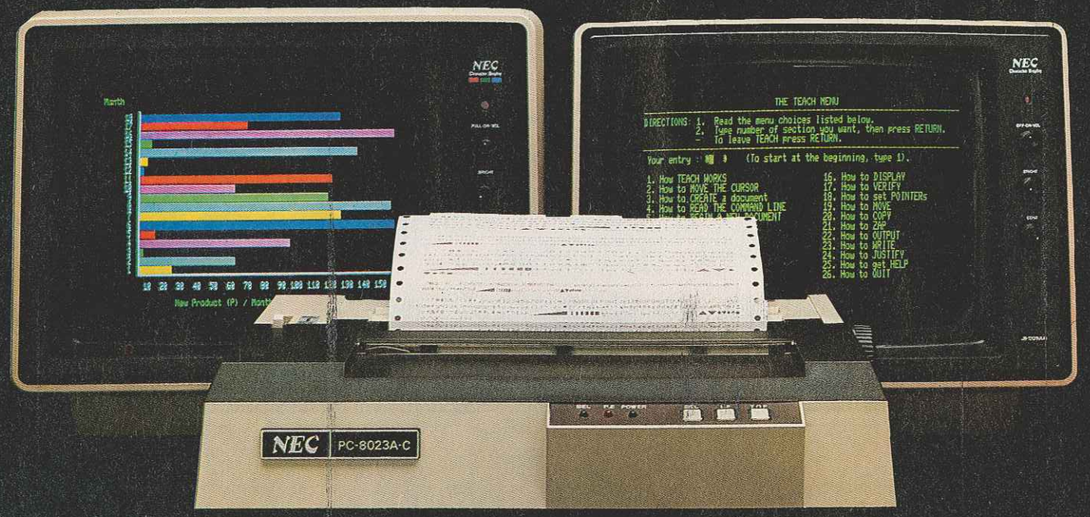

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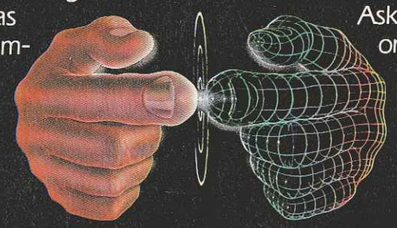

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and IBM will become very active in this field. Telenet and Tymnet are providing most of the data-communication services for the computer information networks.

Computer Networks. In general, computer networks are groups of computers connected by wires, sharing large resources such as printers and data storage devices. However, the term "networks" has become one of the buzzwords of the decade and has been used to describe several very different operations. For example, computer networks are quite different from time-sharing systems. A time-sharing system has one or more large computers at a central location. Clients use remote terminals to access the computers and then use them as if they were in the same office. The computer network also has one or more large computers accessed by remote terminals. However, the large computers provide predetermined information services and some computing services. Typical of the information services they provide are newspapers and magazines, electronic mail, banking and purchasing, reservations and travel, games and personal communications.

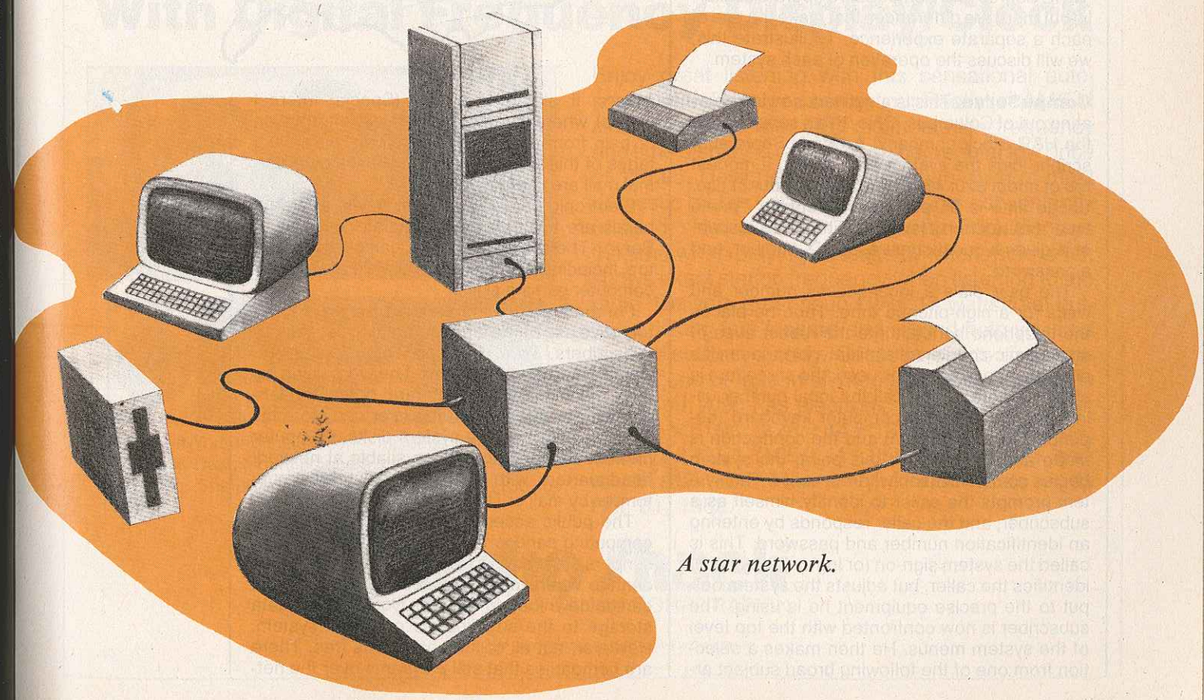
Two of the largest networks were started several years ago by time-sharing services as a method of using their large computer and communications resources during the hours when businesses were closed. The Source (1616 Anderson Road, McLean, VA 22102) and CompuServe (5000 Arlington Centre Blvd., Columbus, OH 43220) were the first of the public computer information networks and are still the most prominent.

On a smaller scale, Dow Jones Electronic News Service, once a local service for Wall Street users, is now a national information network providing a variety of financial services.

Lockheed Information Services, Palo Alto, CA, started a "data base of data bases" and it has grown to be the largest source of research information in the world. Called Dialog, it provides index information on the contents of thousands of data bases.

There are many other specialized networks, some of which are described later in this article. Furthermore, new companies are entering the field every month. American Bell says it will provide services that are extensions of the business of moving data. It is thought that they may offer information services.

Another new company has been started by Kemmons Wilson, the founder of Holiday Inn. He will franchise local outlets for a new computer information utility called INC Telecommunications, which will use the satellite facilities of National Public Radio. Steven G. Wozniak, one of the founders of Apple Computer, has been engaged to write the software needed for the new system.



A star network.

Network Costs. Naturally, these computer services all cost money. The subscriber pays an initial fee when he joins the network. An ID number is assigned and the subscriber chooses a secret password for his account. The charges for use of the network are calculated by the length of time that the subscriber is connected and for any extra services he orders. There are higher charges for service during "prime time" business hours.

In addition, when special commercial and financial services are accessed, extra charges are common. For example, Dow Jones may be accessed from CompuServe at an extra charge. Other special services are extra, too. For instance, most of the computer language manuals are charged to the subscriber's account, as are special printing services and diskette copies of software. Payment for the network service is charged to the subscriber's credit card. Moreover, the initial registration fee covers only a minimum amount of disk storage, with extra storage available at additional cost. Also remember that, in addition to the network's fees, the user must pay for telephone service.

Network Operation

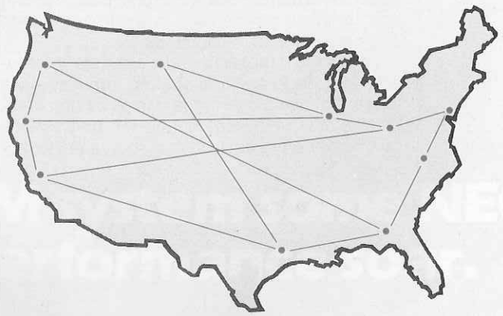
THE Source and CompuServe operate similarly, but there are differences that make the use of each a separate experience. To illustrate this, we will discuss the operation of each system.

CompuServe. This is a network service operating out of Columbus, Ohio. It is a subsidiary of the H&R Block company. A CompuServe subscriber joins the system after paying a modest fee of about $20, which includes an hour of use. Usage time is $5 per hour except for "prime time" hours when it is higher. The new subscriber is given a questionnaire, an I.D. number, and a password.

The user dials a local-access number and waits for a high-pitched tone. Then he places the telephone handset into the rubber cups of an acoustic-coupler (or similar type) modem. If a direct-connect modem is used, the procedure is slightly different. You call the local number using the phone or the computer keyboard (depending on the modem) and the connection is made automatically. At this point, the system begins communication with the caller. The system prompts the caller to identify himself as a subscriber; and the caller responds by entering an identification number and password. This is called the system sign-on (or log-on). It not only identifies the caller, but adjusts the system output to the precise equipment he is using. The subscriber is now confronted with the top level of the system menus. He then makes a selection from one of the following broad subject areas: Business And Financial Services, Personal Computing Services, or Home Services.

The business services include stock and commodity data bases and quotation services. Electronic mail service is also provided. The home services provide computerized banking, buying and selling of merchandise, local and national news, and schedules for airlines, trains, buses and theaters. You can make reservations and purchase tickets through this service. A subscriber can also contact other subscribers all over the country in a simulation of CB radio. He can use the free noncommercial classified ads on the system. In addition, there are bulletin boards maintained by publications or by the various computer manufacturers. They use this service to inform owners of the latest fixes and modifications to their equipment, and sometimes provide software support.

This magazine, as a pioneer in electronic publishing, maintains an edition of POPULAR ELECTRONICS on CompuServe. To access it, enter GO PEM-1. Besides columns by the staff editors and writers, it also has a SIG (Special Interest Group) where people can request information or help from the magazine's staff. The advantages of this "quick reaction" service over normal mail are obvious.



Electronic communications, news, and data bases are not the only attractions of CompuServe. There are computer games available, too, including nationwide contests that test your computer gaming skills.

Personal computing services involve the interactive use of the large computing facilities by subscribers. To a user connected to the network computer, it seems as if he were using his own machine. Many different computer languages are offered and the user can store his work and data on the system disks. Computer printout services are also available at network headquarters, with the results delivered to customers by mail or UPS.

The public access area is another personal computing service that can be utilized by subscribers. It features a user-donated software exchange where programs in the public domain can be downloaded from the CompuServe data storage to the subscriber's own disk system. However, not all of the software is free. There are companies that sell programs over the net-

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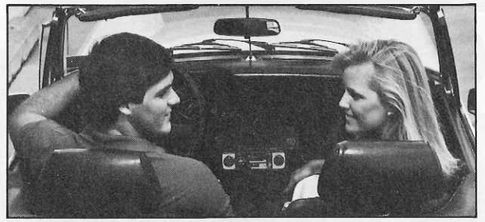

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work. The advantage to buying software this way is that you can try a demo program before you buy, and you can get delivery at once.

There is a feeling of excitement that you get when using CompuServe because there's so much to try and to learn. Some of this enthusiasm is generated by personal messages from the "sysops" (system operators). These are volunteers who run the various bulletin boards. They act as moderators, instructing newcomers and helping them become part of the group. Sysops develop a following who may "tune-in" to listen and talk with them just as people follow talk shows on radio and TV. In any event, the sysops are an attraction on CompuServe because they humanize an otherwise regimented process of menu selection from one level to another.

To heighten subscriber's interest, CompuServe publishes a monthly magazine, *Today*, that all members receive at no additional cost along with a newsletter called *Update*. These publications generate interest in using the network and the many services that are available.

The Source. This is a public information utility operated by The Source Telecomputing Corporation, a subsidiary of The Readers Digest Association. It operates from a bank of large Prime computers in McLean, VA, and it is accessed over the facilities of Telenet and Tymnet in much the same way as CompuServe. The initial fee to join the Source is $100. The evening, weekend, and holiday hourly rate is $7.75 while after midnight the rate drops to $5.75. Prime time hourly rates are significantly higher.

The sign-on procedures for The Source are almost identical to those on CompuServe, except that the subscriber always uses either Telenet or Tymnet to access the system. The only direct access is in the area around Washington, D.C. and Northern Virginia, where the main computer is located.

The Source offers the same type of services as CompuServe but there is less variety. For example, the only local newspaper on The Source is the N.Y. Times. The Source is a network of data bases that are accessible in two ways. You can call a database after obtaining its address from The Source index; or you can find information through a command level from which other levels are connected through a hierarchy of menus.

The Source features communications, information, and computer services. In the communications area they offer electronic mail, "Chat," and "Post." The electronic mail service allows you to send messages to any other subscriber, while Chat allows you to have an interactive dialog with another subscriber who is on line the same time you are. Post is a free classified ad bulletin board. Information abounds on The Source. It features 36 categories of news and commentary on business and financial markets, plus abstracts from leading financial publications. Prices on stocks, bonds, commodities, metals, money-market certificates, federal notes, and bills are given from all the major markets and from the over-the-counter market. Compu-U-Star is a discount shopping service that is accessed on The Source and offers savings to members on high-ticket items such as cars, appliances, furniture, and electronic equipment.

Through the The Source you can get airline schedules, travel tips, and reservations for airlines, hotels, and tours. They also have restaurant reviews that can be a big help to a business person who wants to know where to eat and entertain while traveling. The Source also offers subscribers games, bulletin boards, and personal computing services. An unusual service is called the User Publishing section. In this area, users are encouraged to publish anything they want, provided they do not exceed the standards of decency or violate the rights of others.

If you access The Source through the index, it's like being all by yourself in a big library where you can use the card catalog to find out where the book you need is located. You can then go to the correct stack where you locate the right shelf and find the book you want.

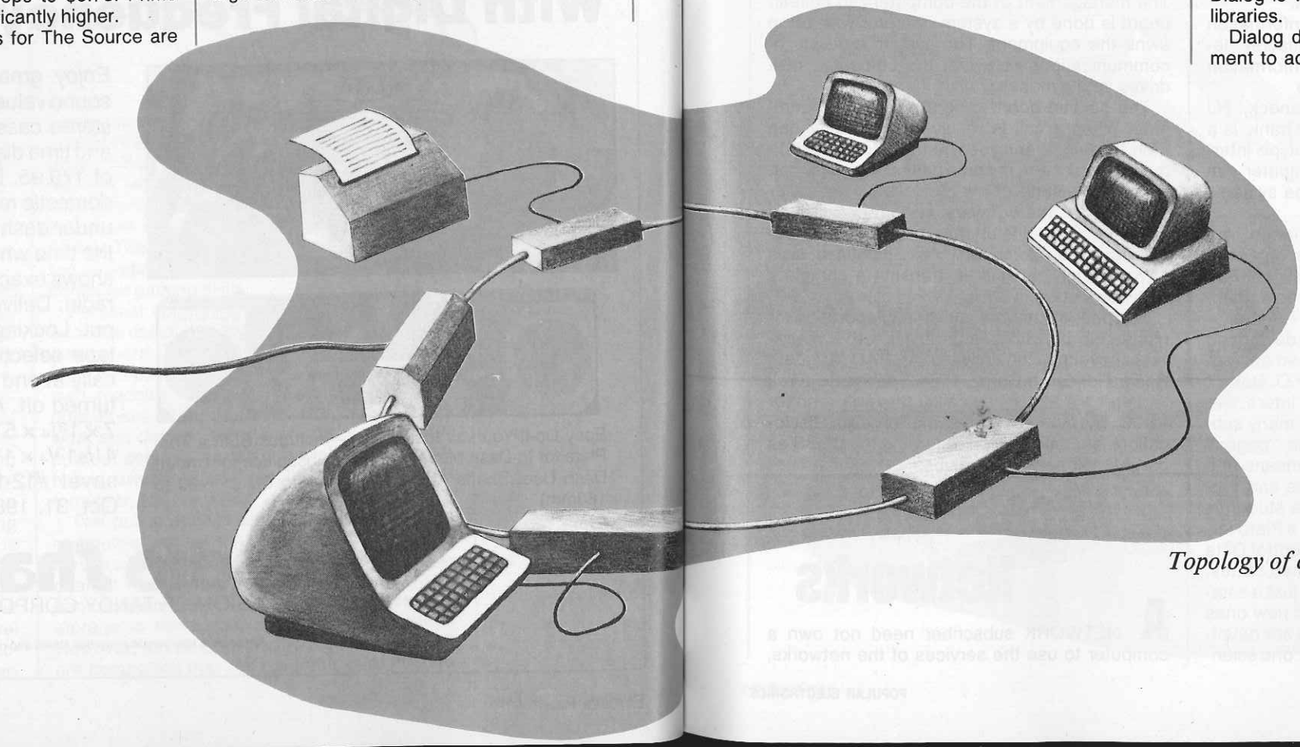
The Source doesn't seem to be as interactive as CompuServe. True, The Source has the Chat area where you can talk to others, but I have never found anyone home to talk to! When you want specific information such as airline schedules, The Source may be quicker to use, and it has been said that the data bases available on The Source are more complete and thorough. But CompuServe seems to be a bit more friendly, a place where you not only can find information but also interact with others.

Dow Jones News/Retrieval. This service offers subscribers prices, news, and analysis of all major security and commodity markets. It provides in-depth information on all factors that affect the financial community and enables subscribers to evaluate the performance of their own portfolio against that of the leading money managers. Many subscribers prefer the expertise that Dow Jones is known for. The Dow Jones service not only provides the market activity of a company, but gives all the news about that company. Stock prices are maintained on a current basis, and past performance information is available, too. The Dow Jones service is available through Apple dealers, Commodore dealers, and Radio Shack stores.

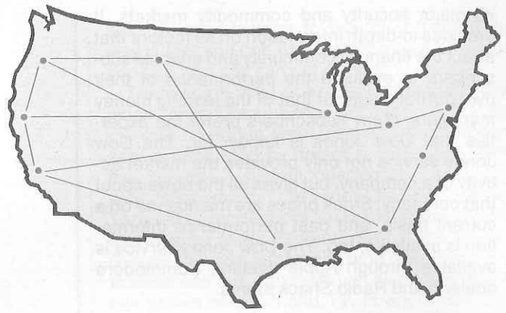
Lockheed's Dialog. Many of the largest information networks are devoted to the retrieval of scientific, medical, and legal information. The largest and oldest of these is Lockheed's Dialog (3460 Hillview Ave., Palo Alto, CA 94304). It is the key to hundreds of data bases on every subject from agriculture to zoology. These data bases contain information concerning business/economics, government and foundation grants, current research, research papers, humanities, arts, law, medicine, science, technology, engineering, and just about every other subject known to mankind.

A researcher skilled in the use of Dialog can find bibliographical references and abstracts on any subject. Actually, these references to database information are all that the system contains, but normally that's all that is needed. The actual documents can be ordered once the researcher knows where they are. A minute with Dialog is worth hours, or days, of research in libraries.

Dialog does not require complicated equipment to access it. Simple personal computers



Topology of a loop network.



or dumb terminals can be used. However, the researcher must know how to use the system, and that is not simple. In fact, there are people who research Dialog for others for a fee. There is a database of databases, called Dialindex, used in Dialog to find the proper data base to conduct a search for a subject. In addition there is a related service called Dialorder used to order the documents you find with Dialog.

Other Networks. Mead's Lexus is a law database which requires a special terminal to access it. A database in a much different subject area is Aero Net of Titusville, FL, which connects aircraft dealers all over the United States in a trading and multi-listing nework. The development of business information and sales networks like these may become the most important marketing concept of the 1980's.

The *New York Times* owns The Information Bank which provides on-line information derived from the newspapers. This information bank is now available on The Source.

Graphnet (329 Alfred Ave., Teaneck, NJ 07666), although not an information bank, is a service that provides electronic teletype interface to subscribers. A personal computer can be used to access the major teletype systems and to send and receive messages.

EIES (Electronic Information Exchange System) is a nationwide independent computerized network originally funded by the National Science Foundation. It is now operated on a membership basis. Users sign in through Telenet.

The Plato network was originally developed at the University of Illinois. Now owned and operated by The Control Data Corp. (P.O. Box O, Minneapolis, MN 55440), it is an interactive learning system that has courses on many subjects. Plato produces its lessons on "pages" with which the student interacts by means of a keyboard. Each page asks questions and produces new pages as the result of the student's answers. Because of the high cost of a Plato terminal (around $5000), it is used at Control Data Learning Centers throughout the United States.

The networks mentioned here are just a sampling of those that are available; and new ones are added every month. Since some are devoted to one industry, one profession, or one scientific discipline, they rarely come to our attention. However, we will become more aware of them in the future as colleges and public libraries make their services available to the general public.

Computer Bulletin Boards. Some computer hobbyists are also radio amateurs who have a tradition of regular interactive communication. Because of an FCC ban on the transmission of ASCII code by ham radio, these hobbyists established computer bulletin boards. The development of the TRS-80, Apple II, and PET personal computers provided the other necessary element for the spread of computer bulletin boards. Here for the first time were large groups of identical computers. This meant that standard bulletin board programs could be used and anyone with the proper equipment could call in and use the service.

The software to operate these bulletin boards was developed by a number of individuals. Ward Christensen and Randy Seuss were the original developers of the Computerized Bulletin Board™ software. Their concepts were extended in the formation of ABBS (Apple Bulletin Board System) for Apple, Forum-80 for Radio Shack TRS-80 computers, PAN for PET computers, and RBBS (Remote Bulletin Board System) for CP/M-based computers. The services provided by these computer bulletin boards, in addition to message transmission, include the distribution of public-domain software collected by Apple, TRS-80, and CP/M user groups.

Most of the computer bulletin boards are sponsored by computer clubs and user groups. The management of the computerized bulletin board is done by a system operator who often owns the equipment. The system consists of communications software, the computer, disk drives, and a modem.

The bulletin board program starts the computer when a call is received. The caller can then "sign-on" and receive the information on the bulletin board. In some cases, the caller can leave a message of his own. When the caller disconnects, the software system detects the disconnect, "hangs up the phone," and awaits the next call. Some of these bulletin boards have enough capacity to transmit a complete club newsletter.

Telephone numbers and time of operation for many club bulletin boards are listed in magazines covering club activites. AMRAD (Amateur Radio Research Corp., 1524 Springdale Ave., McLean, VA 22101) has a list they will send for $1.00. The Source and CompuServe also list locations and information regarding the CBBS as part of their services to clubs.

Accessing Networks

A NETWORK subscriber need not own a computer to use the services of the networks. All that's necessary is a "dumb" terminal and a communication interface. Several advertisers in this magazine offer low-cost terminals capable of connecting to the various services.

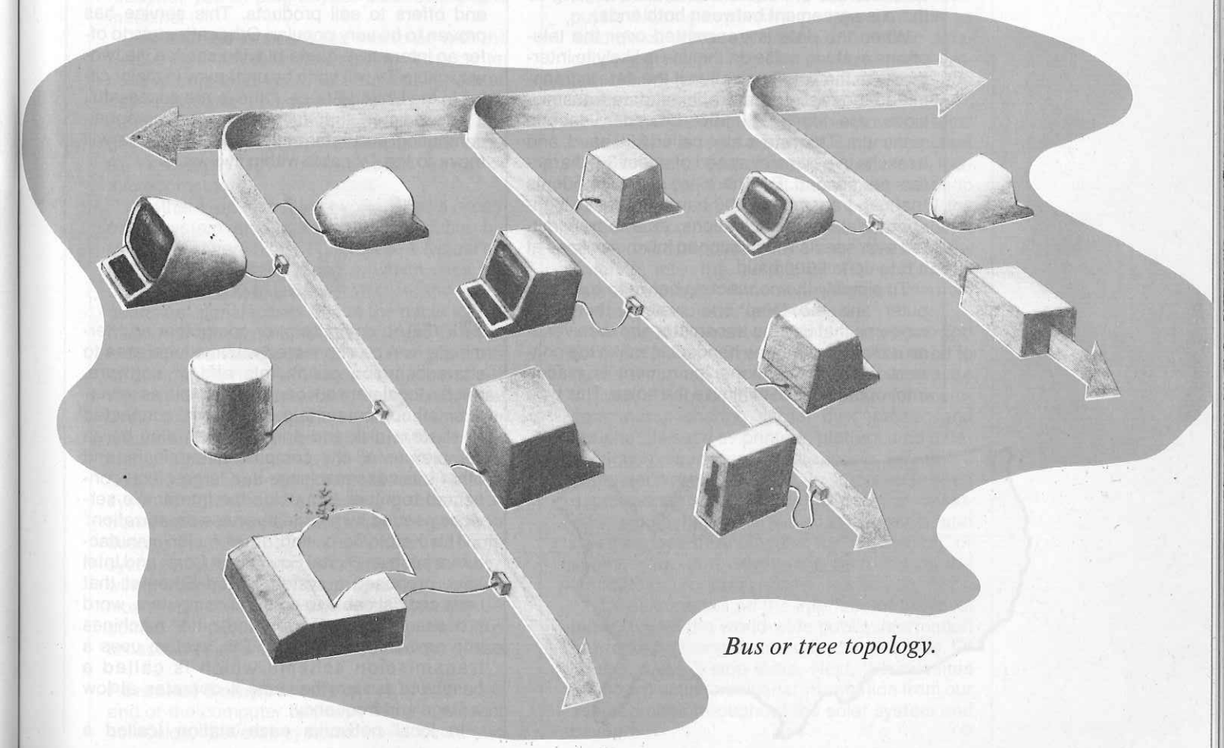
In addition, low-cost computers such as the Radio Shack Color Computer, the Commodore VIC-20, and TI-99/4A can be used with communications peripherals. Timex/Sinclair plans to offer a modem for its Model 1000/ZX81 $99.95 computer. The Panasonic/Quasar hand-held computer has a communication interface and other pocket models like those from Casio, Epson, Radio Shack/Sharp, and others are expected to follow suit. A pocket terminal was recently introduced by IXO. A network subscriber can now carry the terminal, or computer, in an attache case and communicate with the network from a telephone booth anywhere in the country.

The small computer owner can use his equipment without a disk drive, using the mass storage of the network, or he can obtain software that will permit loading of data from the network onto his own disk. This is called downloading. Data stored on the local computer disk can also be transmitted to the network. This is called uploading. Both techniques extend the capabilities of the subscriber's computer. A typical application might consist of transmitting programs or data from a subscriber in New York to one in Los Angeles. The NY subscriber would upload the data to the network and give permission for the LA user to access it. The LA user can then download the information or program. It is that simple.

Modems. Modems are the connecting link for all of the services we have discussed in this article. A modem is the translating element between the computer and the telephone system. It would be very convenient to be able to directly transmit or receive information on our computers (or terminals) via the telephone. The trouble is that the output from computers or terminals is a series of digital pulses. Our telephone system was only designed to transmit human speech.

This problem is solved by converting the digital output into a series of audio tones that can be transmitted over the telephone line. The same thing is done to record computer data on an audio cassette. Converting the data from digital pulses into audio tones is called modulation. Going from audio tones back to digital pulses is called demodulation. The device that does this is called a "modulator/demodulator" or modem for short. This is the device we need to communicate digital data over the standard telephone lines.

In most systems, we use tones of one frequency to signify a logic "one" and tones of a



Bus or tree topology.

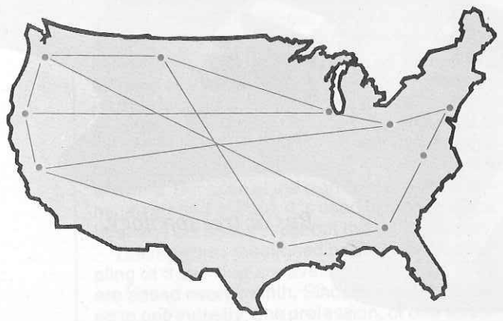
different frequency to signify a logic "zero." When we change or shift the tones to correspond to the ones and zeros in the data stream, it is called frequency-shift-keyed modulation (FSK).

With an audio-cassette system, data travels in only one direction at a time and, therefore, only one set of tones is required. However, in a bi-directional telephone transmission there would be a problem with only one set of tones. Data can be sent both ways over the same set of wires (called full-duplex) but it wouldn't work if the same set of tones were used to transmit data in both directions. Therefore a modem uses two sets of tones. One set of tones (1070 Hz for zero and 1270 Hz for one) is used for originating data. Another set of tones (2025 Hz and 2225 Hz) is used for receiving data. If your computer were connected to The Source, for example, you would be the originating system and your data would be sent with tones of 1070 Hz for zeros and 1270 Hz for ones. The Source computer would answer you with tones of 2025 Hz for zeros and 2225 Hz for ones.

If you use your modem to call up network systems you need an "Originate Only Modem" which has a 1070/1270-Hz modulator, and a 2025/2225-Hz demodulator. If you also receive calls, you might need an answer modem with a modulator using 2025/2225 Hz and a demodulator using 1070/1270 Hz. It really doesn't matter which set of frequencies is used as long as there is agreement between both ends.

When the data is transmitted over the telephone system, noise on the line is likely to interfere with the communication if the data is transmitted too fast. Therefore, most data transmissions are done at 300 bits per second maximum. This rate is also called 300 baud, and it results in a transfer speed of about 30 characters per second. But there are special modems that can transmit at 1200 baud. For really high-speed data communications, data is transmitted over specially conditioned low-noise lines at a rate up to 9600 baud.

To simplify the connection between the computer and the telephone system, there are modems that use the transmitter and receiver of an ordinary telephone handset to make the connection. The telephone instrument is placed into rubber cups to minimize the noise. This type is called an acoustic-coupler modem. The other type of modem connects directly into the telephone line and is called a direct-connect modem. The acoustic couplers are cheaper but are more likely to pick up noise interference.



Cable Networks

TODAY, many homes have a second set of communication wires coming into the house—the TV cable. Cable services provide many more channels than vhf and uhf stations make available. Since at least one-half of a terminal exists in the TV set, it isn't difficult to provide the keyboard and additional parts to make one or more cable channels interactive computer networks. This has already been tried on an experimental basis and it is just a matter of time before television and home computers will merge. Cable companies charge a flat rate for a month's service, which is an incentive to use the TV cable instead of the telephone system.

The Warner Communications Corp. and American Express have been experimenting with a prototype two-way, interactive cable TV network in Columbus, OH. The QUBE system uses simple pushbutton terminals to provide yes/no/multiple choices to televised questions and offers to sell products. This service has proven to be very popular. Other attempts to offer an interactive game-playing service via two-way cable TV will soon be underway in major cities in the United States. If these are successful, it is predicted that fully interactive personal-computing and information-utility services will move to the TV cable within five years.

Local Networks

SEVERAL computers, or computers and terminals, can be connected within a local area to share common peripherals and/or software. Such a local network can be as simple as several small computers in a classroom, connected to share a disk and printer. It can also be as complex as all the computers, terminals, and other business machines in a large office connected together to provide the interactive services needed by a large business organization.

The Xerox Corp. and other major manufacturers such as Digital Equipment Corp. and Intel have proposed a system called Ethernet that uses coaxial cable to connect computers, word processors, copiers, fax, and other machines into an automated office. This system uses a transmission scheme which is called a *baseband system* because it operates at low voltage and frequency.

In local networks each station (called a "node") can communicate with every other node without requiring a special management node (or processor). The signals are broadcast along the wire in the same way that a radio broadcasts—every other station can listen—but a reply is expected only from the node addressed. Each node can detect when another node is "talking" so that it refrains from sending and thus avoids collisions that would lose data. There are various methods of designing the network, as shown in the accompanying diagrams.

The most common design (or topology) is the *star*, where the branches radiate from a central node. This is the design of the telephone switchboard and, since many offices have PBXs, they can be used for wiring. The trouble with the star design is that if the central node goes down, the net is no longer connected.

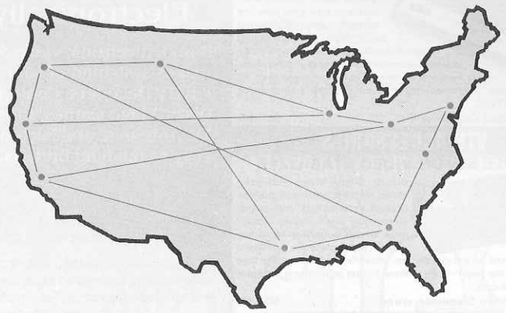
Another design is the *ring* or *loop*. Here the nodes are connected to each other through repeaters. When a signal is received, it is amplified and passed to the next node. If a node fails, it opens the loop and the net fails.

The third topology is the *bus*, which is simply a long piece of cable that runs past the node locations. When a device is to be added, it is merely tapped in through a plug-in socket. If a node fails, it does not bring down the entire net, and additional nodes can be added without reconfiguring the system. This is why Xerox advertises Ethernet with a picture of a wall socket ready for you to plug-in your electronic staple machine.

The expression *baseband* has to do with the frequency of the data transmission. If the center conductor is referenced to zero volts, and then raised to some non-zero value, another node can detect the change in voltage condition and decode the information. These changes occur at relatively low frequencies used by microcomputers.

Another type of local network called a *broadband system* also uses a coaxial cable but transmits at very high frequencies. A typical example is the television cable, which uses frequencies of 50 MHz to 100 MHz. At these frequencies, signal losses due to the cable almost disappear and the signal can be sent for miles rather than a few thousand feet. Wang and other companies have developed broadband network systems for connecting computers. However, the argument between baseband and broadband systems continues and there is no sign of agreement. Since the outcome is uncertain, it has limited the growth of local network systems. IBM and AT&T have yet to be heard from and the method they choose will greatly influence the outcome. The use of the telephone system and its requirement for simple, low-cost wiring seems to favor the baseband systems. However, if the primary connecting medium becomes TV cable and/or satellites, then local broadband systems seem to make more sense.

Personal Computer Networks. At the low end of the computer business there is no such confusion. Several systems have been successfully sold. These are all slow-speed baseband networks. Some of them use twisted-pair wires rather than coaxial cable.



The Clustar One system from Nestar ties groups of Apple computers together to provide complex financial-information networks. The Omninet from Corvus also works with Apple. Commodore and Radio Shack each have a network system and there are several for CP/M-based computers. North Star Computer has announced a new network system which is the first to permit different types of computers to operate on the same network.

Schools, as well as automated offices, seem to be the targets of microcomputer networking. Here the network offers the use of many computers sharing expensive peripherals such as hard disks, printers, plotters, and analog-data-collecting equipment. The network offers system control while providing the flexibility to add equipment as the system grows.

We have just begun to see the growth of local networks. As long as small 8-bit computers were limited to 64K of memory and small, low-cost floppy disks, it didn't make much sense to connect them. In fact, the very concept of the personal computer called for a cheap stand-alone unit operated by one user. We are now entering into the period of 16- and 32-bit microprocessors with megabytes of memory and large hard-disk data storage.

We are also developing single-chip video and communications circuits. These can be used to build very cheap terminals. All the elements are in place for local networks of powerful microcomputers, sharing large disk drives and peripherals such as printers, plotters, and data-collection equipment. Perhaps we will see a computer network in each classroom, or in each department of a school. In this case, each student would have an individual terminal and could access the computer for information, or submit work for review by the instructor (or the instructor's program!).

The ultimate will be the interface of the local network with the world-wide public information networks beaming their data from satellites. Of course, it won't stop there. Next, the satellites will be collecting additional information from our space probes throughout the solar system and beyond. ◇