All About Transmission Facilities

An increasing variety of transmission facilities are being offered for data communications. This report provides a summary of available services, as well as the results of our survey of 1,395 users of communications facilities. You'll also find help in choosing facilities that will suit your needs, and brief profiles of the carriers.

Data communications deals with the intangible. Characters are transmitted by electrical currents, light beam pulses, or radio waves. The signals are perceptible to computers, terminals, and other electronic equipment, but the information conveyed by the signals is interpretible to humans only when presented on a CRT or on paper. The duty of data communications is to transmit the signals correctly from one machine to another over a short or a long distance, ultimately as a method of human communication.

Numerous companies provide data transmission services of various types—low, medium, or high speed; analog or digital; switched or dedicated; basic or enhanced; terrestrial or satellite. This report covers the spectrum of services and helps users select those best suited to their needs.

1983 NEWS

The AT&T reorganization plan has dominated the news since the beginning of the year. The plan was endorsed by the U.S. Justice Department near the end of March 1983. If the federal judge who is presiding over the divestiture of the Bell operating companies (BOCs) approves the plan, the divestiture will proceed on January 1, 1984, with assets and personnel divided between AT&T and the operating companies. Figure 1 depicts how the AT&T organization will look when the divestiture takes place. Figure 2 on page -105 depicts how the divested operating companies will be grouped into seven regions.

AT&T is expanding or improving some of the communications facilities that will remain in its ownership. T-1 service, providing 1.544M bps transmission, which had formerly been available only internally for AT&T use, is being made a public offering (Terrestrial Digital Service) that can be used for video teleconferencing, facsimile, and computer-to-computer communications, for those customers who can afford it.

AT&T's first high-capacity, long-haul fiber-optic link was added in February 1983 to the lightwave system that the company has been installing in recent years. The high-capacity link transmits voice, data, and video communications between New York City and Washington, DC. In April, AT&T announced almost 1,200 miles of additional long-distance laser-powered lightwave communications routes, with major construction to begin in the latter part of 1983 and service to be ready by 1986. The new fiber-optics systems will transmit voice, digital data, and video teleconferencing communications between ten cities.

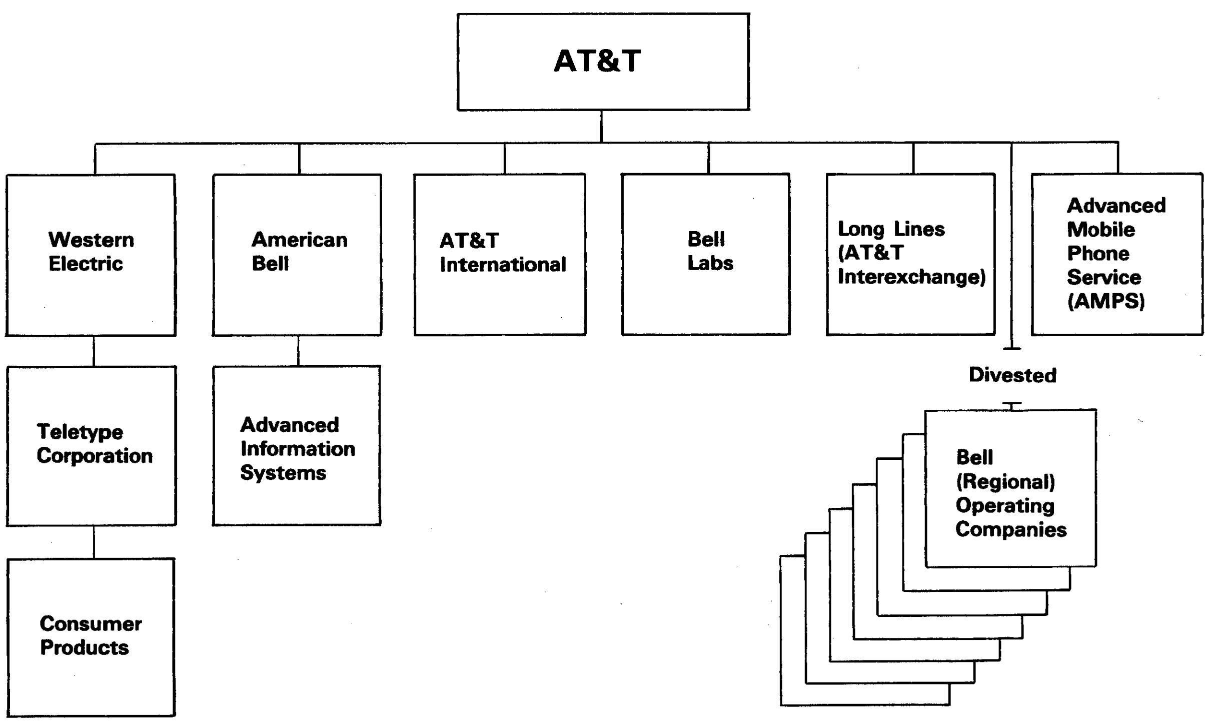

Figure 1. The AT&T Reorganization. If approved by the federal court, AT&T will be divested of its operating companies as of January 1, 1984.

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Bell Laboratories has developed a new laser that transmits light pulses for longer distances between repeaters. This "cleaved coupled-cavity" laser has set a world's record when tested in a transmission experiment. Its unboosted signals, pulsing 420 million times per second, traveled about 75 miles error free.

AT&T is also planning to install the first undersea laser-powered fiber-optics system. Called TAT-8, this lightwave system will be the eighth transatlantic telecommunications system that AT&T has installed or owned in part. AT&T's proposal for TAT-8 is being evaluated by a multi-nation consortium. TAT-7, the most recently installed transatlantic cable system, began service this July.

In the second week of May, the FCC approved AT&T's filing of a construction permit for its Basic Packet-Switching Service (BPSS), which now complies with Section 214 of the FCC regulations. FCC approval of the construction permit was followed by its approval of the BPSS tariff. The previous BPSS tariff, filed in 1982, was rejected because it did not provide for the sharing of switches with vendors other than American Bell, and because it proposed higher prices for circuits that terminated at competitors' packet switches than for those that terminated at ABI's AIS Net/1000 system. The new tariff will allow other carriers as well as American Bell to access the regulated BPSS switches.

AT&T competitors are positioning themselves to take advantage of the AT&T divestiture and anticipated Bell price increases. While AT&T is losing the Bell operating companies, a number of other companies are merging, acquiring subsidiaries, and forming alliances. Among the corporations that have announced plans to merge in 1983 are Tymshare and FTC Communications. Tymshare, an international computer information management and telecommunications company, is the parent organization of the Tymnet public data network. FTC Communications is a New York-based international record carrier (IRC). Tymshare will acquire 80 percent of FTCC, and the present owner (FTC Industries, which in turn is owned by a French bank) will retain 20 percent. The merged corporations will provide telex, teletex, and other services in the U.S. and abroad.

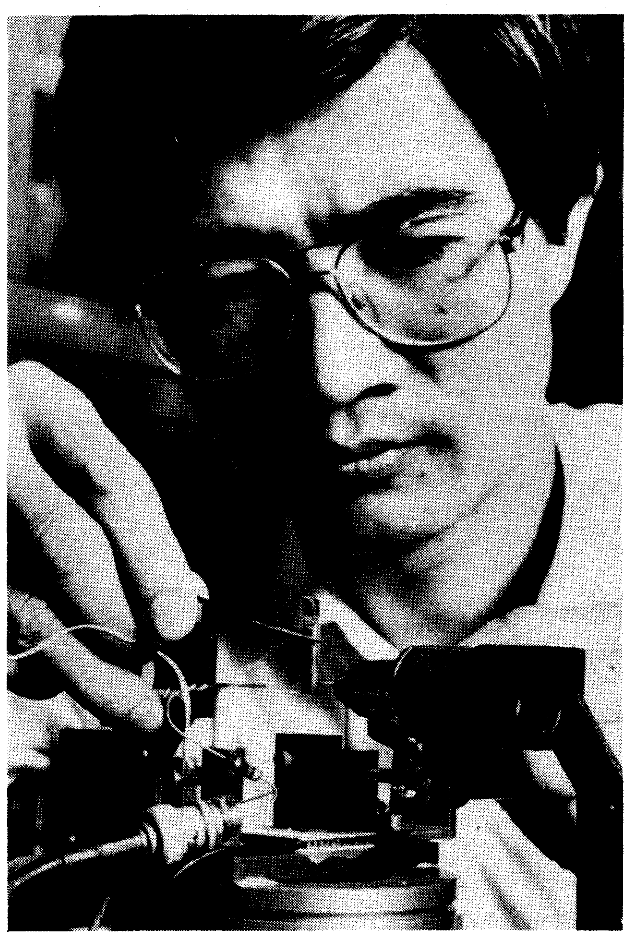
Meanwhile, Tymnet is undergoing a major expansion, enlarging its network from 270 cities to over 400 locations. Besides adding new cities to the network, Tymnet will provide additional access ports in existing cities and increase the number of high-speed ports by upgrading local access facilities.

IBM and GTE Telenet entered into an agreement that allows the IBM Information Network to be accessed via GTE Telenet. The IBM network, which combines remote computing capabilities with enhanced networking, is accessible directly through IBM in 13 cities. Now it will also be able to be accessed through the more than 250 U.S. cities and 40 foreign countries that are on the GTE Telenet network.

Satellite Business Systems (SBS), which is co-owned by IBM, Comsat, and Aetna Life and Casualty, asked the FCC in February to remove the regulation that has prohibited the joint marketing of IBM and SBS equipment and services for the past decade. SBS and Geosource Incorporated have formed a jointly-owned corporation called Geo/Sat Comm, which will provide commercial satellite communication services primarily to remote oil industry sites in the U.S., such as those on the Alaskan North Slope.

GTE Corporation, a leading supplier of telecommunications, electronic, and electrical products and services, has acquired Southern Pacific Communications Company (SPCC) and Southern Pacific Satellite Company. The two acquired companies will be operated separately from GTE's regulated local telephone companies, and will be called GTE Sprint Communications Corporation (referring to the former SPCC's Sprint long-distance services) and GTE Spacenet Corporation, respectively.

MCI Telecommunications Corporation is nearly doubling its capacity for data and voice transmission by constructing an optical fiber network and purchasing 24 satellite transponders from Hughes Communications, which is scheduled to launch the satellites in 1983 and 1984. MCI, a



The cleaved coupled-cavity laser, shown here with its inventor, can be tuned to emit a range of ultrapure frequencies. The laser can transmit at a rate of up to 420M bps over a distance of up to 75 miles without repeaters, a new world's record.

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strong competitor of AT&T in domestic long-distance communications, has also recently begun competing with AT&T internationally by acquiring Western Union International, which provides international telex and data services. MCI has also set up an arrangement with the Trans-Canada Telephone System to provide long-distance international telephone service and transborder satellite-based business communications services. In a separate agreement, American Satellite Company and TransCanada have set up a similar arrangement.

In 1983, the FCC has approved additional companies' applications to provide Digital Termination Services (DTS), which are short-haul, public-access digital communications services using microwave radio technology. Companies the FCC has approved to provide extended DTS networks (30 cities or more) include Isacomm, SBS, Tymnet, MCI, Contemporary Communications, and Digital Termination Services. Companies that have received FCC approval to provide limited networks (less than 30 cities) include National Microwave Interconnect Company, Local Area Telecommunications, Via/Net, Icom, and Federal Express.

Activity in satellite services includes AT&T's announcement that it plans to launch and operate three of its own domestic satellites. The first AT&T satellite is scheduled for launching in July. By operating its own satellites, AT&T would no longer rely solely upon the Comstar satellites of Comsat General, which AT&T would continue to lease temporarily. GTE Spacenet Corporation is expected to launch commercial satellites in 1984. American Satellite Company is planning to orbit two satellites, the first in 1985 and the second a year later.

TYPES OF CARRIERS

Communications network configuring in the data communications environment of today is more complex than it was a year ago—but not as complex as it will be a year from now. Three basic types of domestic transmission facilities suppliers are the common carriers, specialized carriers, and value-added carriers.

The Common Carriers

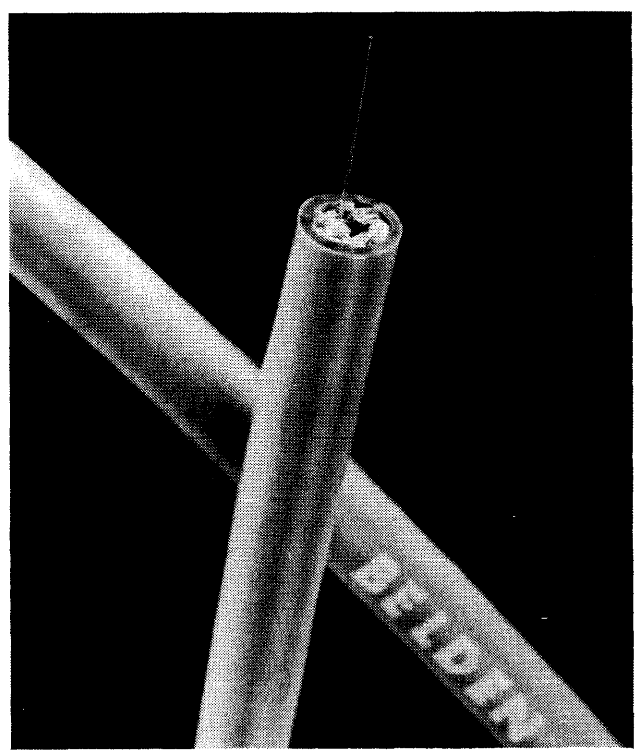
The government began regulating operations of the largest companies to ensure a fairly priced, quality service to the public with a guaranteed profit to the carrier, the profit being intended to promote improvement and wider distribution of communications capabilities. Federal, state, and in some cases city government agencies participate in regulation. Their regulation involves approving or disapproving the companies' services and rates. Usually the regulation defines what the companies cannot do, rather than forcing them into new areas.

The regulated companies are called "common carriers." This term was derived from early railroading and denotes carriers of goods who "hold themselves out to the public in common."

The best-known government regulatory agency on the federal level is the Federal Communications Commission (FCC). This agency was established by Congress in 1934 to regulate interstate and international communications. The FCC requires that at least 30 days prior to the availability of a proposed interstate service, each vendor must submit a schedule, more commonly referred to as a *tariff,* describing those services the vendor intends to offer and their associated costs. The FCC has no jurisdiction over intrastate communications; these are typically regulated by each state's Public Utilities Commission (PUC).

The traditional common carriers can be grouped into three categories: the telephone companies, the telegraph company, and the international record carriers. These carriers provide facilities for transmission of voice, data, video, and facsimile communications. A carrier can lease some or all of its facilities from another carrier. Western Union, for example, has leased its facilities from AT&T for years.

The telephone companies include AT&T's Bell System (to be divested in 1984) and approximately 1500 independents. Up until now, the Bell System has consisted of a number of operating companies, each of which has served either a single state (e.g., New Jersey Bell) or a group of states (such as Southern Bell). AT&T is required to relinquish its controlling interest in these companies, as a result



Fiber optic cables are gradually replacing the copper wire terrestrial telecommunications network. The cables are designed and manufactured by companies such as Belden Corporation and Siecor Optical Cables, who will be able to sell their products not only to AT&T, but also to the Bell regional operating companies, after divestiture.

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of the federal government's antitrust suit against AT&T. The divested Bell operating companies (BOCs) will be grouped into seven separate organizations (see Figure 2), which will no longer be related to AT&T.

AT&T will continue to own and operate its Long Lines Department (renamed the AT&T Interexchange), which provides the bulk of interstate switched network and private line services, as well as its manufacturing arm, Western Electric, which in turn owns Teletype Corporation. In a June reorganization, Western Electric became responsible for marketing as well as developing and manufacturing AT&T consumer equipment, such as telephone sets. All basic AT&T research and product/service design and development will continue to be performed by Bell Laboratories, which is owned 50 percent by AT&T and 50 percent by Western Electric. AT&T's new subsidiary, American Bell, Inc., is responsible for operating and marketing AT&T's value-added network, AIS/Net 1000, and for marketing designated PBX systems, modems, multiplexers, and other business equipment. Finally, AT&T's Advanced Mobile Phone Service (AMPS), a company formed in 1975 to develop and test an experimental public-access cellular radio system in Chicago, is currently part of AT&T, but will be transferred to the BOCs sometime after divestiture.

AT&T and the regional operating companies own a large majority of the telephones installed in the United States. However, MCI Corporation, General Telephone and Electronics (GTE), and several other major independent (non-Bell) companies provide approximately 15 percent of U.S. telephone service. About 4 percent are owned by smaller independent companies that, for the most part, serve rural or sparsely settled areas. In international communications, AT&T had an exclusive franchise for switched network voice service but was excluded from offering record services until recently.

The major telegraph company in the U. S. is Western Union Telegraph Company, which provides Telex I and Telex II (TWX), mailgram, and telegram service. The traditional emphasis of this firm has been on record communications. While Western Union lost its former monopoly of U.S. telex services in 1982, it has gained the right to provide international telex services. Western Union also provides terrestrial and satellite transmission services. Satellite offerings are described later in this report under Satellite Services.

International record services were until 1982 the exclusive province of five international record carriers (IRCs): ITT World Communications, RCA Global Communications, Western Union International (known in the U. S. as MCI International; not affiliated with Western Union Telegraph Company), FTC Communications, and TRT Telecommunications. These companies provide private line services, teletypewriter exchange services (interfacing both Telex and Telex II to the international telex service), switched network data service, alternate voice/data, private message switching, and public cable services. In 1982 the IRCs gained authority to provide telex service also in the U.S. and Western Union Telegraph Company was added to the list of IRCs.

The Specialized Carriers

The concept of rate averaging existed even before the 1934 Communications Act and is basic to the financial picture of the common carriers; it is, therefore, an important element in the formula that determines class of service (i.e., availability/quality). In simple terms, rate averaging means that everyone shares the expense of providing communications service to the general public. Installation costs, including the physical plant, rights of way, etc., as well as operating expenses, are spread over a wide base and thereby allow service to be provided to those in rural or sparsely settled areas as well as those who live in high-density population centers. The bulk of traffic is naturally in the corridors connecting major cities; that fact is what spawned the specialized carriers.

In the early 60s, a firm then known as Microwave Communications Inc. (MCI) applied for permission to build a microwave radio link between Chicago and St. Louis. After years of regulatory debate, MCI was granted limited operating authority, which has since been expanding in services and locations. The traditional carriers opposed the formation and operation of the specialized carriers on the basis that they were "cream skimming" the high density routes and were not required to provide service to the general public. In a landmark decision, local telephone companies were required to interconnect their facilities to those of the specialized carriers. The result was to provide user access at each end of a connection via local telephone company facilities (either switched network or leased lines) to the routes between major cities operated by the specialized carriers. This decision was based on a belief that competition would create an environment where new services would be introduced at lower prices and with improved performance—and that's what happened.

The specialized carriers now provide interstate communications services to most large metropolitan areas. These facilities may be owned and operated by the specialized carrier, as in the case of a private microwave transmission system, or leased from a common carrier. The range of services includes voice/data capability via switched access, leased line, private switched network, satellite channel, and packet message network. The number of these specialized carriers continues to grow, as do the types of services and pricing structures offered. The idea of computer-oriented data communications sparked the concept of specialized common carriers, but voice traffic will pay for it, at least in the beginning. All of the specialized carriers offer conventional voice transmission in addition to data transmission.

With a limited number of exceptions, intrastate communications is not permitted under the tariffs that govern the specialized carriers. American Satellite Corporation provides extension service from Los Angeles to either San Francisco or San Diego as long as the total circuit extends over state boundaries. A similar extension privilege applies to a Dallas/Houston communications link. Also in Texas, an intrastate communications rate applies for some MCI offerings, if the channels are used primarily for interstate traffic.

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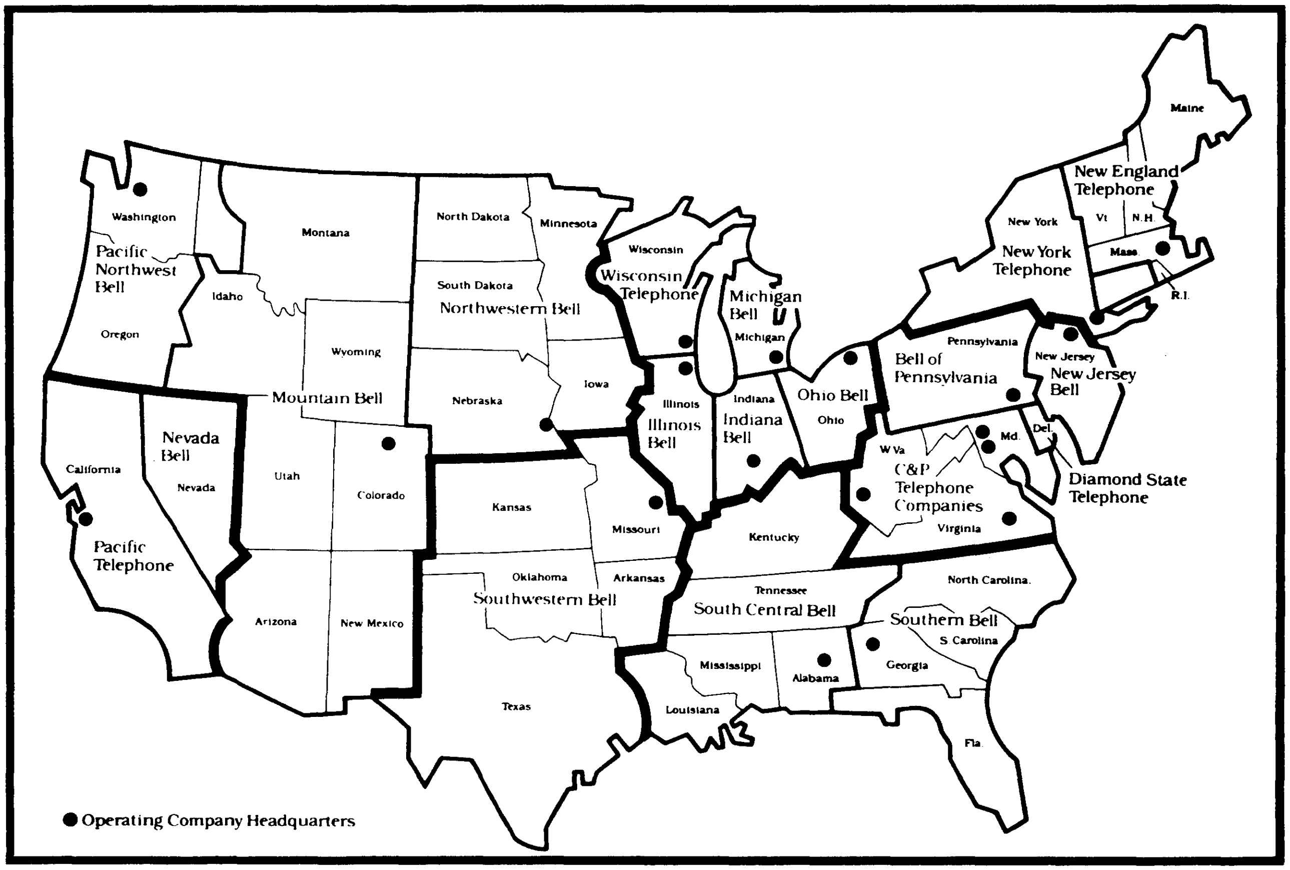

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Figure 2. The Seven Regional Operating Companies

The specialized carriers generally use traditional common carrier facilities to connect your place of business to their terminating point. These are usually cross-town circuits called "local loops." However, the FCC is encouraging the building of local distribution facilities by the specialized carriers and third-party vendors. These facilities are generally quite different from the cross-country circuits. For example, microwave radio is being tested for use in FCC-regulated Digital Termination Services. Other means of bypassing the local loop, such as using cable TV networks, are also under discussion.

The Value-Added Carriers

Value-added carriers are a specific subset of specialized carriers that piggyback their networks on top of basic communications facilities to provide additional networking services to the public. Most of the domestic value-added carriers use packet protocols to transmit data.

Companies that operate or plan to offer value-added networks (VANs) for data communications include: GTE Telenet Communications Corp., Tymnet, Graphnet, Inc., RCA Cylix Communications Network, Automatic Data Processing (ADP), United Telecommunications, CompuServe, American Bell, IBM with its Information Services, and Western Union with its recently announced Safelink.

Advantages offered by value-added networks include compatibility among dissimilar electronic devices, error control, temporary data storage, electronic mail services, and distance-independent pricing. In general, the approach seems to be for the VAN carriers to lease facilities from conventional carriers and provide the switching computers that tie the network together. The computers used in the switching operations can also be used to perform the other enhanced functions, which you would otherwise have to provide in your own computers.

Packet switching services have received strong support in Europe, Japan, and Canada. Indications are that such services will form the basis for high-speed international data communications.

The role that VAN carriers play in the communications plans of computer users depends on the costs of such services. To be fair, you cannot compare only the dollar-per-hour cost of the basic communications path but must also take into acocunt the value of the added services provided by the VAN. Widespread availability of the VAN services provides users with almost the same flexibility in some cases as provided by the public telephone network, but with greatly enhanced performance capabilities. A public value-added carrier may be able to take over some, many, or most of the overhead problems of establishing, operating, and maintaining a complex network interconnecting many terminals and computers.

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That some value-added, or enhanced, services are regulated and some are not is a controversial issue. The Computer Inquiry II differentiated between basic and enhanced services. A tentative decision was reached in 1979, and the "final" decision, made in 1980, has been modified three times. The subject is still being debated.

Essentially, Computer Inquiry II said that a basic service is the movement of information from one point to another, including message and packet switching; an enhanced service is anything beyond the movement of communications, such as protocol, speed, or code conversion, or the changing of information in some way. Enhanced services include those involving subscriber interaction, as when a user requests messages in electronic mail or voice mail services. In theory, basic services are regulated; enhanced services are not. This principle has been applied to AT&T. Its subsidiary, American Bell, which provides the enhanced AIS/Net 1000 service, is unregulated, while the Basic Packet Switching Service (BPSS) is regulated.

Some other companies' services, however, are not so clear-cut. For example, GTE Telenet and Tymnet provide speed and protocol conversion but have been regulated. Regulated companies, including Western Union, have submitted applications to the FCC to detariff their enhanced services. Enhanced services that are unregulated include those of CompuServe, RCA Cylix, and IBM.

TYPES OF FACILITIES

Communications facilities can be broadly classified according to two criteria: speed and system arrangement.

Traditionally, three *speed ranges* of facilities have been available: low-speed, up to 1200 bps, typified by teletypewriter services; medium-speed or voice-grade, generally from 2400 bps up to 9600 bps, typified by the public telephone network; and high-speed, 19.2K bps and above, typified by AT&T's Dataphone Digital Service. Complicating a categorization by speed are the requirements of the user. For example, a teletypewriter may be used on a voice channel not because this capacity is required by the transmitting unit, but because voice coordination is used to set up transmission. In addition, some high-speed facilities can be broken down and used as multiple channels of lower capacity.

System arrangements take two forms: switched network and private line. Switched networks are typified by the public telephone network and the telex low-speed networks. Private line arrangements are typified by various leased point-to-point or multipoint lines.

A switched network has fewer lines than users, since not all users will want to use the network at the same time. Several switching centers are typically present in the network; this allows alternate routing paths for a call, adding to the probability of getting a call through.

Private line systems use dedicated lines between the communicating points. In point-to-point arrangements, the line is available any time. Multiple-point systems, also called multi-drop systems, share one line among more than two stations. The line, then, is not necessarily available to all users at all times. Two basic types of access procedures, polling and contention, control the stations' use of the line. In a sense, a multipoint line constitutes a mini-network without any switching exchanges.

The traditional rule of thumb is: if you have low communications volume and many points, use a switched network; for high volume with few points, use leased lines. But this rule has some striking exceptions when detailed analyses of specific cases are made.

In addition to speed and system arrangement, two other considerations are of major impact in selecting facilities; rate structure and geographical locations served.

Four basic *rate structures* are used. One is a flat rate for full-time (full-period) usage of a communications link. This is typified by leased line charges. Differences among the various companies offering leased facilities depend on how the monthly charges are applied for multipoint operation, geographical areas served, and conditioning. Some companies also offer partial-period service, say 12 hours per day, at a discount over full-period service.

The second basic rate structure is to charge for the time used during a call only; usually, mileage and time of day are also taken into account. The public telephone network (DDD) uses this rate structure.

The third basic rate structure offers fixed monthly rates for specified areas of service based on a stepped schedule that relates decreased costs per time segment (minute or hour) to increased usage. AT&T WATS, MCI WATS, and SPCC Direct Sprint prices per time segment decrease for usage over 15 hours, decrease again for usage over 40 hours, and again for over 80 hours.

The fourth basic rate structure is to charge for the volume of data sent, independent of distance. This rate structure was introduced by Telenet, the country's first value-added data carrier, in 1975 and is also employed by other packet-switched networks.

As a user, the difficulty in employing these rate structures lies in making comparisons between alternatives. Comparisons among facilities with different rate structures cannot be made without carefully taking into account the characteristics—time and distance—of the specific communications load to be handled.

The importance of considering the specific *geographical locations served* is obvious. But the dynamic nature of the list of points served by a particular carrier creates the need for constant review of the available facilities. In general, AT&T's long-haul lines (interstate links) can be interconnected with other carriers to piece out a communications path. Telephone company facilities are used to provide the local access channels between the customer's locations and another carrier's service points. Interconnect agreements

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are possible among the independents and AT&T and between various independents.

DATA PROCESSING AND COMMUNICATIONS

The coupling of data processing and communications dates from about 1954 when IBM introduced its punched card transceivers, which were designed for use over low-speed private line channels. The subsequent developments of the late 50s initiated the concept of data communications in a computing or data processing sense; it materialized commercially in the 60s. In that turbulent first decade of computers, a typical use was in message switching systems. The most commonly available terminal hardware, technology, and data networks were those of the teletypewriter. Hence, message systems and transmission of information via teletypewriter were considered intrinsic to data communications.

Data transmission is not limited to human language information transfer. Although much of data traffic is apparently decipherable (when decoded), it is characterized by not being a complete information transfer. For example, a telegram typically carries all of the information pertaining to the message (excluding industrial codes). A data record does not. While you can recognize the numbers involved in a transfer of payroll information, you cannot understand their significance (and hence there is no information transfer) unless you know the format for each field or group of numbers transferred. That format definition is stored in the receiving computer. Assuming that the sending party and receiving party are in agreement about the definition of each information field, the definitions themselves do not have to be transmitted; however, the data transmitted must be totally accurate. Data transmission, then, is the transfer of information according to a predefined format. However, because of the similarities of message and data transmission, they are sometimes lumped together under the name record transmission.

Since the 60s, a wide array of sophisticated terminals and transmission systems has become available. A comparable growth in applications reaches well beyond simply handling message traffic. In light of these developments, it seems inappropriate to include message systems and teletypewriter exchange services with data communications. The emphasis in data communications is on information to be processed and/or stored by a computer or on information prepared/retrieved by a computer for a person or another computer.

Basic Services

Regardless of the transmission technique, the hardware utilized, or the network architectures/line protocols implemented, the carrier is only obliged to provide service to a user as described by the technical and pricing parameters set forth in the applicable tariff. How the transmission is physically routed and what techniques are invoked to get the message to its destination are up to the carrier. No particular guarantee of the routing of the data is to be assumed; therefore, if a leased circuit that has rendered satisfactory service for some period of time suddenly degrades (but remains within the tariffed specifications), the user has no legal recourse since the lease (contract) has not been violated—point-to-point communications, however impaired, still exist, and that is what the contract agreed to provide.

The public is generally aware that a switched network connection can be formed in any number of ways. The objective is to establish communications; if the line-of-sight (i.e., shortest mileage route) is operating at capacity, then another route will be used. Frequently, particularly during an originating station's busy hour, a call that would be a line-of-sight transmission of 250 or so miles ends up being transmitted over 1,000 channel miles. Voice transmission was the only consideration at the time the network was established. Since it was considered better to be able to communicate with the desired party end-to-end, even if speech repetition was necessary, than to suffer the delays of postal service or telegrams, rerouting, alternate routing, and back-up routing were established to maintain reliable voice communications. However, the ear and thought process associated with the transmission of a voice conversation is much more forgiving than a business machine process, which simply deciphers "1s" and "0s" as accurately as it can—right or wrong. Because the same plant facilities (switching, patching, supervision, radio, etc.) are used for data that are used for voice, no guarantee exists that the physical connection, plant equipment, or quality of service will remain the same from day to day. This is true of leased lines as well as the public switched network.

Line Conditioning

Users do have some control over the quality of the transmission links for which they pay, and this control is called *conditioning*. Without going into unnecessary technical detail, conditioning is the electronic process that makes all signals as close to equal as is feasible. Two types of distortion are inherently introduced by the telephone network: amplitude and delay. The characteristics of a normal voice channel cause some frequencies within the bandwidth to be attenuated (decreased in amplitude) more than others; the transit time of frequencies within the bandwidth may also be distorted, so that some arrive before others. Conditioning is the process of compensating for these distortions so that the specified frequencies can be maintained.

The carriers tariff conditioning on leased voice-grade and wideband analog circuits, and it is specified with regard to bandwidth and amplitude/delay distortion. A separate charge is levied for this guarantee of frequency level; that is all that is guaranteed—not that the physical connection or plant equipment will remain the same from day to day. Conditioning levels are generally only guaranteed on two-point circuits.

Consequently, a multipoint polled circuit will usually require more extensive conditioning, particularly at higher speeds. These networks are usually operated synchronously, and fast timing acquisition and recovery are necessary to hold the overhead down. In this case, the overhead in-

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cludes the time a channel is idle, the execution of a polling sequence without information transfer, and the portion of the bit stream that is required to ensure synchronization between the communicating ends. Microprocessor-based hardware has permitted some dramatic reductions in this overhead. Automatic and adaptive equalization is standard on many modems to compensate for changing line conditions. A benefit of overhead reduction is that the same amount of information transfer can be accomplished in less time; alternatively, if the same amount of time is utilized, the channel can be operated at a lower bit rate, and that usually translates into a lower error rate and improved performance.

The various classes of conditioning are intended to improve the quality of the data transfer on the channel. Each type of conditioning provides progressively tighter tolerances for the circuit performance. In some cases, the conditioning constitutes nothing more than the removal of elements that were installed to improve the voice performance of the channel; this is true for loading coils and amplifiers. Some modems, particularly high-speed models, require end-to-end metallic continuity without loading coils; others require a guaranteed bandwidth such as a 3002 equivalent voice-grade channel with C4 level conditioning.

The different conditioning levels are priced differently and usually involve a one-time installation charge at each location and a monthly payment thereafter. In some remote areas, the required conditioning level may not be available or may come only at a high installation cost. In any event, the recurring monthly cost must be considered when making hardware selections and determining line routings.

The Bell System currently provides three types of conditioning: B conditioning, C conditioning, and D conditioning. B conditioning is used on type 3002 channels up to 5 miles in length and only when limited distance modems are used. It is available in two types: B1 is for channels operating at 2400 or 4800 bps; B2 is for channels operating at 9600 bps.

Type C conditioning establishes amplitude and delay distortion limits by placing equalizers on the line. Types C1, C2, and C4 are the most common C conditioning. Although Type C improves the line quality, it places limitations on the bandwidth. Type D conditioning, which does not restrict the bandwidth, is sometimes necessary. Type D conditioning establishes limits on the noise-to-signal ratio and harmonic distortion of the line. Harmonic distortion is the tendency of certain telephone equipment to create multiples, or harmonics, of the transmitted frequencies. Type D conditioning is accomplished primarily by facility selection rather than by adding equalizers, and is designed for use with high-speed modems. These devices automatically equalize the circuits they use, thus duplicating the function of C conditioning.

Modern technology has advanced to the point where conditioning is unnecessary for most modems operating at speeds below 9600 bps. Although American Bell recommends Type D conditioning for its Dataphone II 9600 bps modems, many modem models offered by independent vendors operate at 9600 bps without conditioning. Conditioning is recommended by nearly all vendors for their products that operate at speeds higher than 9600 bps.

If conditioning is deemed necessary, it is a good idea to order a level of conditioning that is one level below the manufacturer's recommendation. In over 90 percent of all situations, this provides an adequate level of service. Also, it may be worthwhile to try to transmit without any conditioning at all; this is adequate for about half of all situations. Of course, the only way to determine whether the line quality is adequate is to check the error rate.

ANALOG FACILITIES

Because of the in-place availability and the capability to access virtually any point in the country, telephone company facilities have been the major carrier of data. However, these facilities were engineered to enhance voice communications, and some special apparatus and techniques must be used to transmit computer data. The most basic of these is the familiar modem, which converts the binary format of current or voltage data into audible tones suitable for transmission through these facilities. The difficulties involved in the accurate recovery of the data at the receiving end are directly proportional to the speed of the data stream and the quality of the facilities.

The Public Telephone Network

Figure 3 illustrates some of the elements in Bell's Direct Distance Dialing (DDD) network. Subscriber stations (telephones) are connected via a station loop to their serving central office. The latter is referred to as an end office or local control office, meaning the end or last office in the switching hierarchy. If, as shown in the figure, Station A wants to talk to Station B, the entire call is handled within the same end office. For A to talk with C, which is connected to a different but nearby end office, an inter-office trunk is used. When different cities are involved, such as with Stations A and D, the call from A is passed from A's end office via a toll-connecting trunk to the toll office serving A. From there the call is routed to the toll office serving D via an intertoll trunk, which may be a terrestrial or satellite link. Then the call is forwarded to D via that end office.

The intertoll trunking forms an elaborate and extensive nationwide switching hierarchy, shown schematically in Figure 4. At the bottom we see the loops, end offices, and toll-connecting trunks of Figure 3. The toll offices and intertoll trunk, however, have been replaced by four levels of switching and many intertoll trunks. The call from A to B will proceed up the hierarchy until it can find a path towards B's toll center. Notice that there are shunts called HUTs or high usage trunks. They are established where large inter-office traffic flows warrant. They expedite call completion and relieve network congestion.

The many possible variations in call routing have been a limiting factor in the use of the DDD network for data

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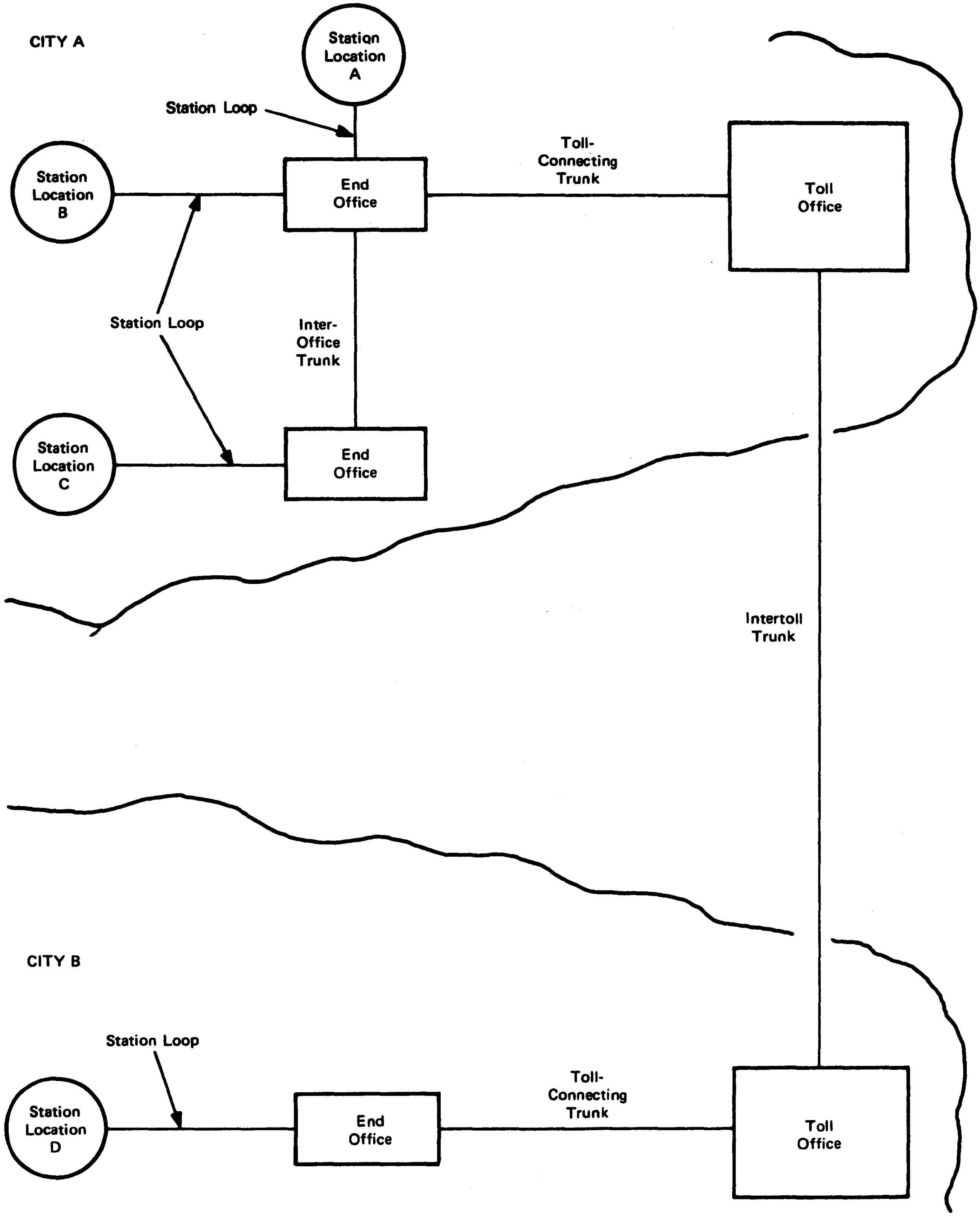
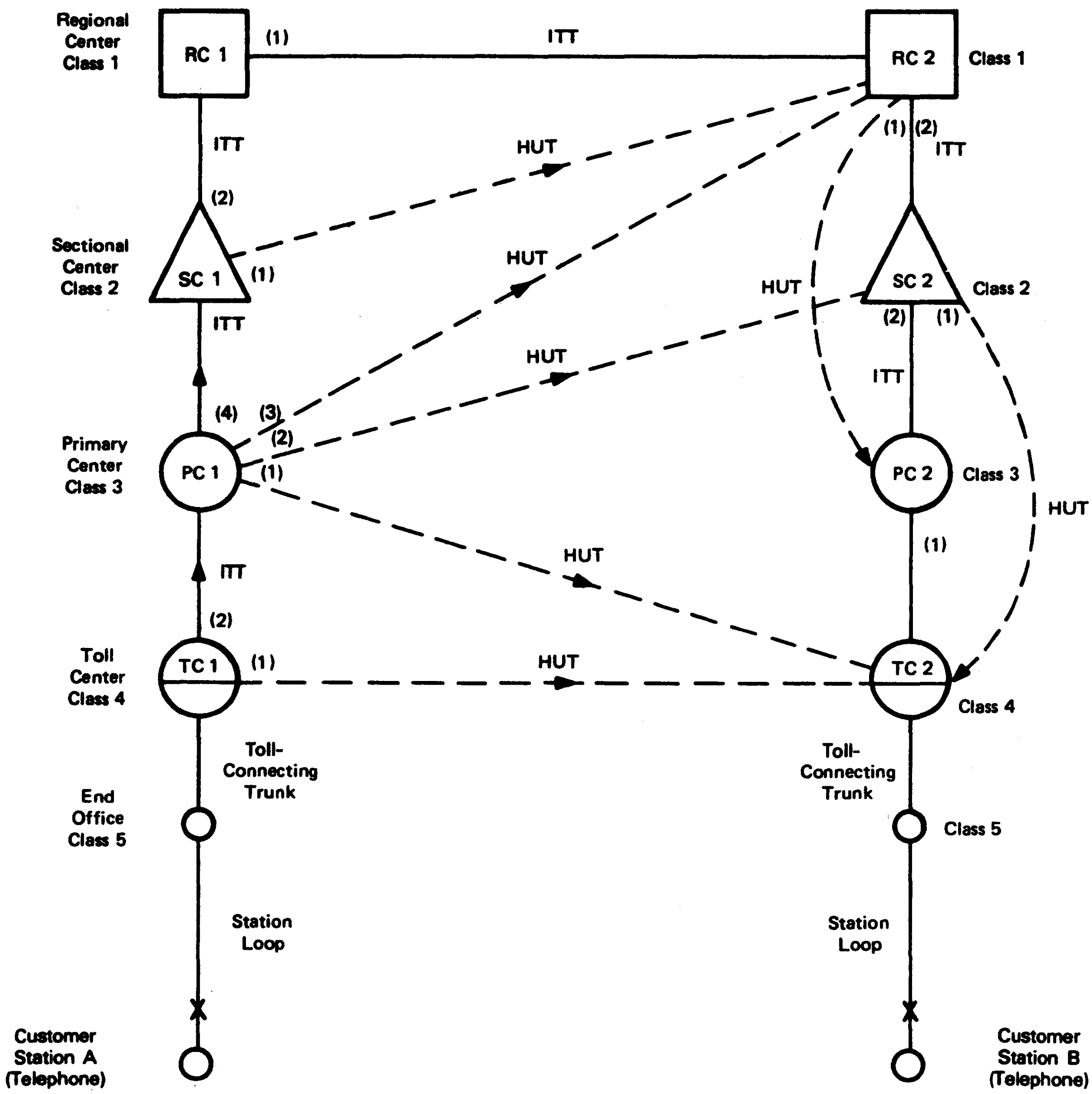


Figure 3. Typical routing for connections on the telephone network

transmission. Where a private line channel has been established between two points, the path quality can be predicted, and the transmission characteristics are essentially the same (or usually change slowly). Modems based on modern technology are equipped with circuitry that stores these characteristics. Once trained to the line, these modems can perform call set-up more quickly and the call can proceed more smoothly than could be done if the channel characteristics changed from day to day.

On the DDD network, the path changes from call to call, with corresponding variations in circuit characteristics. Different through-network delays may occur in accordance with the path established for the particular call. Delay varies especially widely if the route is changed from terrestrial to satellite facilities. Interfacing between successive trunks, varying points of amplification, and other factors also add to variations between calls.

Each connection on the path varies in terms of the level of quality of transmission service. The possibility that noise and distortion will interfere with reliable transmission is much higher than on a private line. These factors tend to lower the speed at which users transmit over the DDD



1. Numbers in ( ) indicate order of choice of route at each center for calls originating at Station A.
2. Dashed lines indicated high-usage paths.
3. ITT—Intertoll Trunk.
4. HUT—High Usage Intertoll Trunk.

Figure 4. Choice of routes on an assumed call on the telephone network

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network; although the network is capable of supporting 9600 bps operation, many users limit transmission to 4800 bps.

The DDD network supports half- or full-duplex operations at up to 2400 bps, and a wide variety of modems, such as the Bell 103 and its equivalents, are available for operation at these lower speeds. For speeds above 2400 bps, generally only half-duplex operation is supported. This is because the local loop is usually a two-wire circuit. The local loop is interfaced to a four-wire circuit via a hybrid at the central office, which could carry a full-duplex transmission; however, that capability is not extended to the local loop. (See Figure 5.) Only one modem manufacturer so far (to our knowledge) has found a way to circumvent this restraint; Anderson Jacobson's new AJ 4048 operates at 4800 bps in full-duplex mode over the DDD network.

Half-duplex transmission is inherently slower than full-duplex transmission because of the time required to reverse transmission direction back and forth between transmit mode and receive mode. A typical half-duplex procedure involves sending a block of data, awaiting the acknowledgment of the block (ACK), and sending the next block. In the DDD network, if the connection is established over a path longer than the shortest, line-of-sight route, the time to reverse transmission direction, or turnaround time, may be as much as 250 milliseconds. Since two such turnarounds occur per block, a total of 500 milliseconds of delay is incurred. One could send only 100 characters in this time using a 2400 bps modem.

Several other factors that influence the use of the DDD network for data transmission are echo supression, call establishment delay, and error control.

As stated previously, the connection between the subscriber and the serving central office is two-wire. Between central offices, the path has the properties of a four-wire circuit. The device that makes the two-wire to four-wire conversion is called a hybrid. This conversion point represents an impedance mismatch and causes the reflection of signals. Therefore, if A were speaking to B, some of A's signals would be reflected back by B's hybrid. This is particularly annoying in voice communication because you hear your own voice echo after a delay equal to the transit time through the system and back. The echo suppressor located at each conversion point on the network serves to block any reflected energy. When both parties speak at once, the echo suppressor waits an appropriate time (equal to the line turnaround time) before unblocking transmission; in doing so, it attenuates the signal in both directions. This situation is obviously a hindrance in data transmission and imposes a time overhead penalty that reduces data throughput. A device called an echo suppressor tone disabler can be placed on the circuit to relieve this problem after initial coordination; unfortunately, you don't know if such a device is present on your connection.

Another drawback for use of the DDD network for data is the call establishment delay. The first component of this is dialing. The delay between pickup and getting the dial tone ranges from 100 milliseconds to 500 milliseconds. Upon receiving dial tone, an automatic calling unit dials at the rate of 10 pulses per second plus a 600 millisecond pause between digits for a rotary dial line. For a tone-dialed line (Touch-Tone), the rate is 10 digits per second. A number such as 609-764-0100, then, would take 12.7 seconds to pulse dial or 1.0 second to tone dial plus the delay to obtain a dial tone.

When the call has been dialed, there is a delay while the switching hierarchy completes the connection. In late 1975, AT&T announced a signaling structure called CCIS for Common Channel Inter-office Signaling. With CCIS, the information needed to establish and route calls is carried on a separate data link from the call circuit. This allows faster signaling and leads to a reduction in call setup time to about two seconds, according to AT&T. CCIS is AT&T's version of the CCITT signaling system No. 6, an international specification for common-channel signaling.

The DDD network is usually thought of as being a fountainhead of data errors due to passage of the signal through switching centers and over variable routing. Studies performed by AT&T provide statistics on line performance. One such study in Bell Technical Reference PUB 41004 details the performance characteristics of conditioned and

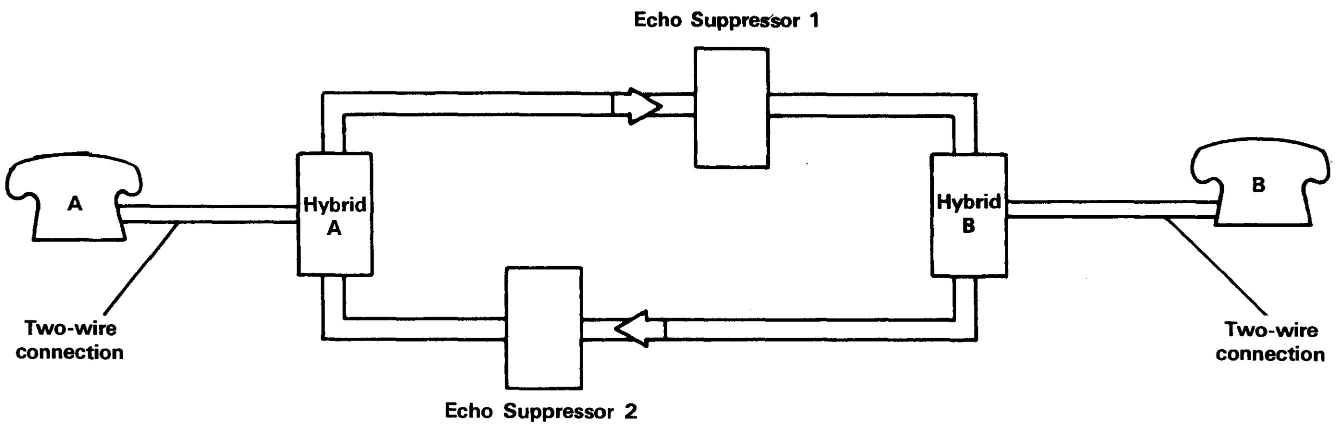

Figure 5. Schematic of telephone network connection

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unconditioned lines using Series 200 modems. The study shows that with a 208A modem operating at 4800 bps over an unconditioned voice-grade line, the minimum performance is one bit error per 100,000 bits transmitted. This reflects a dramatic increase in efficiency over the performance levels assessed a decade ago. A catalog listing this and other available Bell System Technical Publications can be obtained free of charge, by contacting AT&T, Information Release Services, P.O. Box 915, Florham Park, NJ 07932; telephone (201) 966–7111.

An error detection and retransmission scheme can substantially reduce the residual error rate. A polynomially checked code, such as a cyclical redundancy check (CRC), often raises the error-free block rate to nearly 99 percent.

Wide Area Telephone Service (WATS)

Wide Area Telephone Service (WATS) is a plan for using the public telephone network at rates different from the conventional costs. WATS offers a bulk rate for directly dialed station-to-station calls.

Interstate WATS rates are based on usage (number of hours per month), time of day, day of the week, and service areas called. The day rates are higher than evening rates, and night/weekend rates are lowest. The cost per hour decreases as interstate usage increases in the day and evening periods. Access lines for WATS service are charged separately, independent of usage.

Customers can subscribe to one or more of the six service areas. Service Area 1 generally includes nearby states; Service Area 5 provides coverage of the 48 contiguous states, Puerto Rico, and the Virgin Islands; Service Areas 2, 3, and 4 cover intermediate states; and Service Area 6 includes Alaska and Hawaii. Service to areas 2 through 6 includes service to all lower numbered areas. WATS service for only outward calls or for only incoming calls (800 Service) is available. A separate access line is required for each mode.

Expanded 800 Service is now available as an option with in-WATS 800 Service. Expanded 800 Service can increase customer control over call destinations through Single Number Service, Customized Call Routing, and Variable Call Routing.

Single Number Service enables calls to a single 800 number to automatically ring the closest of several locations. For example, if a company's sales center in Boston, Chicago, and Los Angeles have the same 800 number, calls can be automatically routed to the nearest center.

Customized Call Routing allows a business to direct its 800 Service calls to various destinations, depending on the area codes of the callers. To apply Customized Call Routing, a trucking company that serves the nation from headquarters in Virginia could direct 800 Service calls from west of the Mississippi River to the western-route agents in its office and direct calls from east of the Mississippi to its eastern-route agents.

Variable Call Routing allows a business to vary the destination of 800 Service calls at different times. A hotel chain with reservation centers in New York and San Francisco could close one center at night or for a weekend and direct all its 800 Service calls to the other center.

Intrastate as well as interstate WATS service is available. Intrastate WATS is provided by the local telephone companies, and service plans vary from state to state.

Private or Leased Line Services

Private line services (also called dedicated or leased) offer three principal transmission speeds—low-speed or narrowband; medium-speed or voice-grade; and wideband or broadband. The narrowband services—e.g., Series 1000 of AT&T and Low Speed Service of WU—are intended for the low bit rates of keyboard/printer terminals. They support operation at the older Baudot code teletypewriter rates of 45.5, 50, and 75 bps, as well as the newer ASCII keyboard/printer terminal rates of 110, 134.5, 300, 600, and 1200 bps.

Narrowband channels from AT&T and WU are offered for half-duplex service or full-duplex service (usually at a 10 percent premium). The half-duplex service is a four-wire circuit, however, permitting the quick turnaround traditionally associated with full-duplex service. The 10 percent premium is only incurred if the application involves true simultaneous data transmission both ways. Some specialized common carriers also support low-speed transmission rates, but they make no rate distinction between full- and half-duplex use. Narrowband services are used primarily for teletypewriter-based message sending.

Private line voice-grade channels are highly used in data communications. Since the carrier's main unit of capacity is the voice channel, it is generally more cost-effective than a low-speed channel. A voice-grade channel can actually cost little more than a narrowband line, and sometimes less. When one considers the cost together with the greater capacity, the voice channel is usually more cost-effective. The greater capacity also translates to faster response-time performance, an important factor in many applications. To exploit the advantage of voice channels, modern terminals, both CRTs and teleprinters, generally contain buffers that enable them to send and receive at the higher rates of the voice channels.

Companies that offer these facilities include AT&T, Western Union, MCI, SPCC, American Satellite Corporation, SBS, and RCA. AT&T's service is designated as Series 2000 and 3000 Multi-Schedule Private Line Service (MPL).

Two-point or multipoint service is available, generally at up to 9600 bps. In multipoint systems, only one remote terminal may have its modem carrier (transmitting signal) on at a time. If two or more were to be on, i.e., transmitting at the same time, the mixture would be undecipherable by the computer. Hence, the usual line control procedure is to have the computer invite or poll each remote terminal in turn to transmit. A terminal recognizes its particular poll

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(address), turns on its modem carrier signal, and if it has anything to send, begins transmission. The computer's modem then adjusts itself or "trains" to the terminal's carrier. The remote terminal waits through the Request-to-Send/Clear-to-Send (RTS/CTS) delay for the computer's modem to train before it begins to send data. For modems operating at bit rates above 4800 bps, the effect of the training time on response time is for the most part too great to allow economic multipoint operations. Some modems have a "rapid poll" capability that increases efficiency on multipoint links. Vendors offering this type of modem include Codex, General Data Comm, and Paradyne.

A variation commonly used to increase transmit capability is the use of two 9600-bps voice channels to achieve 19.2K bps. Devices are available which will split a 19.2K bps bit stream into two 9600 bps streams and feed each into a separate voice channel. At the remote end the device combines the two signals again into the original 19.2K bps stream.

Wideband channels are implemented via group, super group, or portions of line group transmission facilities. AT&T's wideband service is designated as Series 8000. This is a two-point-only service and consists of a channel bandwidth of 48 kilohertz (KHz), or the equivalent of 12 voice channels. The service is offered for operation at 19.2K, 40.8K, 50K, or 56K bps. The 19.2K bps service uses only half of the capability, and the remainder can be used either for a second 19.2K bps service, for up to six voice channels, or for PBX tie-lines.

Lease or Dial?

A leased line is a comparatively permanent facility. Changes require planning and coordination. On the other hand, the DDD system is much more flexible, allowing rapid alterations or additions to the system of communicating points. With the advent of acoustically coupled terminals, any business phone can become a communications point; simply walk up to it with a portable terminal and place the handset in the telephone coupler.

A major advantage of leased-line operation is that a constant connection is maintained between the terminals on the line and the computer. With DDD, a connection must be established each time. Use of automatic dialing units allows a computer to automatically dial remote stations according to programmed instructions; but control becomes a little more involved, the cost of the automatic dialing units must be added to the costs already mentioned, and the time required to establish connections may become important. With leased lines, operation is more predictable, since busy circuits never happen; therefore, failure to raise a terminal means there is a malfunction somewhere in the end user's equipment (which might simply mean that somebody kicked out a plug).

Leased lines are obtained from the common carriers on a monthly cost basis. The scale of costs progressively increases in terms of line speed (i.e., rate of transmission provided) and distance between points. Higher rates are generally applied between pairs of locations where at least one of the locations is designated as a low-density location. Between locations that are designated as high-density centers, considerably lower rates are usually charged.

DIGITAL FACILITIES

In recent years, digital transmission facilities such as AT&T's Dataphone Digital Service (DDS) have come into use. Digital facilities transmit data bit streams directly, that is, without first converting them to analog tones. Direct connection to a digital facility requires a digital interface, called a Data Service Unit (DSU), between the user's equipment and the service. This interface replaces a modem, which connects to analog facilities, but is much less complex than a modem. The interface may be provided by the facilities vendor or a third party or may be incorporated into the user's equipment. This interface performs certain voltage level and logical parity conversions between the user's equipment and the service, and isolates the two sides of the link from each other for protection.

The principal advantage of digital transmission is that it is less sensitive to error-inducing electrical "noise." Noise is latent in all electronic systems and can also be induced in a circuit from a multitude of sources including atmospheric events and high power levels in adjacent circuits or equipment. In analog systems, the circuit signal must be periodically amplified because it weakens with distance. The amplification unfortunately also amplifies any previously induced noise (and may add noise), making it harder for a receiver to differentiate between information and noise. Analog signals can also be distorted, which interferes with retrieval of information. Noise adds energy to a circuit; distortion rearranges the energy distribution. Digital signals are periodically reshaped or regenerated enroute by devices known as repeaters; this yields overall error rate performance superior to that of analog transmission.

The absence of modems in digital transmission suggests elimination of the RTS/CTS delay, thus improving response performance. In fact, there is a modest RTS/CTS delay, which for DDS, for example, ranges from 8 milliseconds at 2.4K bps to 0.4 milliseconds at 56K bps. But digital services introduce another delay not encountered in analog systems. As with analog transmissions, the digital services are implemented via a hierarchy of multiplexing. However, the hierarchy is one of time division multiplexing rather than frequency division. In a TDM hierarchy, bits may wait for short intervals until their assigned time slot occurs in the next level of the hierarchy. These delays occur on every transmission to and from a terminal, including those after polling. The RTS/CTS delay on analog systems applies only to the first response in any series from the polled terminal. Statistical time division multiplexers, however, minimize the delays associated with TDMs. Statistical multiplexers dynamically allocate trunk throughput to active channels. They do not reserve dedicated time slots to terminals but accept data from any connected terminal that is ready to send.

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Because digital services are not yet available in many areas, many of these digital links adjoin one or more analog segments, usually the access lines to the digital network. For example, a terminal transmitting from Macon, Georgia must be routed via analog voice channel to access the nearet DDS access point, in Atlanta. Consequently, the difficulties associated with the digital/analog conversion process, although greatly reduced when using digital services, are difficult to avoid. One possible solution to this local loop problem is Digital Termination Service, described later in this report.

Dataphone Digital Service

AT&T's Dataphone Digital Service offers a full-duplex point-to-point and multi-station private line facility, permitting synchronous data transmission at speeds of 2400, 4800, 9600, and 56K bits per second. Introduced by Bell in 1974, DDS is described in AT&T Tariff #267 and is presently available in more than 95 cities. Bell guarantees average performance exceeding 99.5 percent error free seconds, independent of transmission speed.

	Switched services			Private line services		
Carrier	**Low-speed**	**Voice-grade**	**Wideband**	**Low-speed**	**Voice-grade**	**Wideband**
ADP Autonet	VAN	VAN	—	VAN	VAN	—
American Bell*	VAN	VAN	VAN	VAN	VAN	VAN
American Satellite	—	—	—	Satellite channels	Satellite channels	Satellite channels
AT&T	—	DDD, WATS	—	Series 1000	Series 2000, Series 3000, DDS	Series 8000, DDS, TDS, HSSDS, SDC
CompuServe	VAN	VAN	—	VAN	VAN	VAN
FTC Communications	International telex	—	—	Leased channel	Leased channel	—
Graphnet	VAN	VAN	VAN	—	—	—
GTE Telenet	VAN	VAN	VAN	VAN	VAN	VAN
IBM	VAN	VAN	VAN	VAN	VAN	VAN
ITT Worldcom	International and domestic telex	—	—	Leased line	Leased line	—
MCI	—	Measured use	—	—	Leased or measured use	Leased or measured use
MCI International	International telex	—	—	Leased line	Leased line	—
RCA Americom	—	—	—	Satellite channels	Satellite channels	Satellite channels
RCA Cylix	—	VAN	—	—	—	—
RCA Globcom	International and domestic telex	International	—	—	Leased channel	—
SBS	—	Satellite channels	Satellite channels	—	Satellite channels	Satellite channels
SPCC	—	Sprint	Sprint	Leased or measured use, satellite channels	Leased or measured use, satellite channels	Leased or measured use, satellite channels
TCTS (Canada)	TWX; VAN (Datapac)	DDD, WATS, VAN	VAN	Digital data service, analog	Digital data service, analog	Digital data service, analog
Tymnet	VAN	VAN	—	VAN	VAN	—
Uninet	VAN	VAN	—	VAN	VAN	VAN
United States Transmission Service (ITT)	—	Measured use	—	—	Leased line	Leased line
Western Union Telegraph Co.	International and domestic telex	—	—	Low Speed Service	Specific Speed Data and Voice-Grade Channel Svc., satellite channels	Series 8000, satellite channels

*American Bell's VAN, AIS/NET 1000 is scheduled to be available in the third quarter of 1983.
VAN—Value Added Network or packet switching.

Figure 6. Spectrum of carrier services

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Terrestrial Digital Service (TDS)

AT&T's Terrestrial Digital Service is a full-duplex,private line service that transmits digital signals at the rate of 1.544M bps. Based on North American T-1 high-speed trunking standards, it consists entirely of terrestrial channels and utilizes no satellite channels. Terrestrial Digital Circuits described in AT&T Tariff 270 will be available September 28 if the FCC approves the AT&T proposal; however, it may take AT&T an additional six months to install the cables needed to implement the service.

Like any other private line service, TDS can be used to connect two end-user sites, or to connect an end-user site to a non-AT&T facility. In addition, TDS can be used to establish a connection between a customer's premises and an AT&T central office for access to a multiplexed T-carrier facility (e. g., T-2 or T-3), to a High Speed Switched Digital Service circuit, or to a Satellite Digital Circuit (SDC) or an SDC earth station.

T-1 service (1.544M bps) has been available internally for AT&T use in high-speed trunking and video teleconferencing. Since 1974, 1.544M bps service has been commercially available, particularly for video teleconferencing. Formerly called Picturephone Meeting Service and now called High Speed Switched Digital Service (HSSDS), this service transmits digital signals using two 1.544M bps channels arranged in parallel. In May 1983 AT&T announced a less costly version of HSSDS that uses a single T-1, enabling more customers to afford HSSDS for data communications or as emergency backup facilities for dedicated data transmission channels. HSSDS is available in 12 U.S. cities; AT&T plans to extend the service to 31 cities by the end of 1983 and to 42 cities by the end of 1984.

Digital Termination Service

Digital Termination Service (DTS) is a publicly available, short-haul digital communications service based on digital microwave radio technology. DTS can be used to directly connect two end-user sites, or an end user site and the termination point of a long-haul digital service, bypassing completely the traditional analog local loop provided by the telephone company. Vendors of DTS services in cities throughout the U. S. are in the process of being licensed by the FCC.

Satellite Services

Satellite channels are offered for two-point and multipoint service by a growing number of carriers. Satellite service is represented by the carriers as a less expensive alternative to terrestrial facilities such as AT&T's DDS or TDS.

American Satellite Company (ASC) has announced plans to launch its first satellite in 1985 and its second about a year later. ASC has been leasing satellite transponders from the Western Union Westar System, of which ASC has twenty percent ownership. Established in 1974, ASC provides voice, data, facsimile, and video conferencing communications to businesses and government agencies in the U.S. ASC has an operating agreement with the TransCanada Telephone System to provide transborder satellite communications services into Canada.

AT&T plans to launch three of its own Telstar satellites, the first in 1983 and the other two during the next two years. By operating its own satellites, AT&T will no longer rely solely upon the Comstar satellites of Comsat General, although AT&T will continue to lease them temporarily, in addition to operating its Telstar satellites. Subsequent AT&T Telstar satellites will replace the Comstar satellites when they cease operation. The AT&T satellites will furnish voice, video, and high speed data services for the U.S. mainland, Alaska, Hawaii, and Puerto Rico.

GTE Spacenet Corporation (formerly a part of Southern Pacific Communications Company) provides satellite service by leasing channels from the domestic satellite carriers, and plans to launch its own commercial spacecraft in 1984. GTE Spacenet provides a dedicated path for voice and data transmission between 12 major U.S. cities.

The RCA Communications family includes the RCA Cylix Communications Network (acquired by RCA in 1982), RCA Americom, and RCA Globcom. RCA Cylix provides a value-added, satellite-based network for data transmission in the U.S. RCA Americom provides voice, data, and video domestic transmission services to broadcast, commercial, and governmental customers via RCA's Satcom satellites. The company's fifth Satcom satellite was recently launched. RCA Globcom is an international record carrier, serving overseas locations by means of leased and switched services; it recently began offering domestic telex service.

Satellite Business Systems sent its third satellite into orbit in November 1982 and is planning to launch a fourth satellite in 1984, as well as a fifth in 1986. The company's services include Communications Network Service (CNS) for large businesses, long-distance telephone services for businesses and residences, and transponder services for broadcasting and communications. The three orbiting satellites provide service for the 48 contiguous United States. Future satellites will extend coverage to Alaska and Hawaii.

Western Union, which began offering domestic satellite service in 1974, has five satellites in orbit and plans to launch a sixth satellite in late 1983. The Western Union Westar satellites, in combination with conventional landline access facilities, provide point-to-point communication channels for voice, data, facsimile, and various wideband applications. Leased, full-period services are provided to more than 20 U.S. cities. In addition to a pricing structure based on monthly rates and fixed term rates priced according to mileage, Western Union also offers a measured usage voice/data service (Spacetel) with a monthly charge for the first 15 hours and a per-minute charge for overtime use.

Most commercial satellite systems operate in the 6/4 GHz frequency band (C band). Satellite Business Systems uses

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the relatively uncongested 14/12 GHz frequency band (Ku band). The proposed satellites of American Satellite Company will operate in both the C band and Ku band.

The FCC decided in April 1983 to reduce the spacing from 3 degrees to 2 degrees between satellites along the geostationary orbital arc above the equator for domestic satellites operating at Ku band frequencies and to begin a gradual reduction in spacing from 4 degrees to 2 degrees for satellites operating at C band frequencies. These spacing reductions will allow the number of orbiting satellites to be doubled.

Most connections over 50 miles are routed via satellite. Propagation delay is a problem in satellite data transmission when older communications line procedures such as BSC are used. To achieve a geostationary orbit (always above the same point), the satellites are positioned some 22,300 miles from earth. For a signal to propagate (travel) from an earth station to the satellite and down to another earth station requires about a quarter of a second. BSC requires two such delays per transmitted block of data (one for the block and one for its acknowledgment) or almost a half second of wasted time per block.

To properly exploit satellite channels for data communications, a different line control procedure is required. Instead of the traditional send-and-wait procedure, a "go-back-N" procedure is used. This means the transmitter continues to send data without pause. If the receiver detects a block with an error, it notifies the transmitter to "back up" and resend that block. This means the transmitter must be able to continually store the last "N" blocks it has sent, where N is dependent on the system parameters. Codex Corporation has developed equipment, which, when inserted into a send-and-wait link, makes it operate as a go-back-N link; American Satellite Corporation and SBS have also developed this type of equipment and offer it with their satellite service.

The newer high-level data link control procedures (ISO's HDLC, ANSI's ADCCP, IBM's SDLC, etc.) all use go-back-N procedures. Consequently, their appearance in systems has made satellite channels much more effective for data communications.

VALUE-ADDED NETWORKS

A value-added network, or VAN, is a special carrier service patterned after the Advanced Research Projects Agency communications network (ARPANET), which is a network sponsored by the federal government to provide shared access among 30 research facilities in the U.S. ARPANET is based on the packet-switching concept, which uses a uniform method of packaging data into segments, or packets, so they can be forwarded over any available path in the network to the desired destination. Essentially, a packet-switched network is formed by leasing lines from other carriers and by installing switching computers at the appropriate nodes. By not restricting the necessary delivery service to a single communications path, as a leased line does, packetized traffic can be balanced across the available facilities, thus increasing their utilization.

The International Consultative Committee for Telephones and Telegraphs (CCITT), part of the International Telecommunications Union (ITU), has adopted a recommended standard, X.25, to be used in packet-switching networks worldwide. This standard specifies the interface for data terminal equipment and data circuit termination equipment operating on these networks. X.25-based public packet networks are currently operating in the U.S., Canada, England, France, and Germany; several others are under development.

Some value-added networks adhere to interface specifications for packetization and depacketization (CCITT recommended standard X.21) but not to the higher level packet-switching concepts of X.25. X.21-based networks restrict the delivery of packets to a fixed path for the duration of a call, much like the traditional public telephone network. These networks are designated as X.21 circuit-switched public data networks and are currently operating in Scandinavia and Japan.

AND IN THE FUTURE?

Developments in the foreseeable future will involve the regional operating companies being divested from AT&T, detariffing of formerly tariffed enhanced services, rate changes, and new facilities.

Talk about new facilities usually includes the implementation of value-added networks, digital networks, the use of communications satellites to reduce the cost of long-distance communications, Digital Termination Services, cellular radio, and more widespread use of fiber optic facilities for short- and long-haul transmission.

SUMMARY OF CARRIER SERVICES

Evaluation and selection of the network services offered by each of the facilities vendors discussed in this report presents a formidable task. There are many alternatives that can satisfy a given business situation and choosing the best requires careful analysis. To help get you started, we've prepared a summary of the major facilities available in the U.S. and Canada (see Figure 6) and a brief overview of the carriers that offer communications facilities for data transmission, including their addresses and telephone numbers for your convenience in obtaining additional information.

For detailed specifications regarding regulated communications facilities and their costs, you can consult the FCC tariffs. These documents are available in the business offices of the regulated carriers and contain complete service specifications, the official rate structure, and current prices. Be sure the set you use is up to date. Each tariff carries a flyleaf that lists each page and its current revision. This does not tell you, however, whether the latest set of revisions (which includes a revised page list) has been received. If you use this source, expect to spend some time

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with them, as the tariffs are complex. It is much easier if you are looking for information on a specific service than if you are trying to find all the services that will handle a particular task. The tariffs, in effect, form the contract between the customer and the carrier. Unregulated services do not have FCC tariffs, but of course the unregulated carriers can provide information about their services.

ADP Autonet

Automatic Data Processing
Autonet Division
175 Jackson Plaza
Ann Arbor, MI 48106
Telephone (313) 769–6800

ADP Autonet offers a packet-switching network that links major U.S. cities and interconnects with other public networks, thus serving more than 30 countries. Autonet supports all commonly used asynchronous hard copy and CRT terminals transmitting at data rates of 110 to 1200 bps over dial-in lines. Higher speeds are supported by dedicated connections. The Autonet value-added services include error control and automatic answer dial back-up facilities.

AIS/Net 1000

American Bell Incorporated
One Speedwell Avenue
Morristown, NJ 07960
Telephone (201) 898–2000

The American Bell value-added network, AIS/Net 1000, is scheduled to be available in the third quarter of 1983 at 17 major U.S. cities. AIS/Net 1000 will provide data transmission, processing, and storage; programming capability; and network management. It will transmit data at low, medium and high speeds, using the Basic Packet-Switching Service (BPSS). Compatibility among a number of different computers and terminals will be provided by AIS/Net 1000 in point-to-point and multipoint communications on private and public transmission lines. Costs will be determined by use of processing time and storage facilities and the volume and customer-designated priority of the transmission.

ASC

American Satellite Company
1801 Research Boulevard
Rockville, MD 20850
Telephone (301) 251–8333

American Satellite Company (ASC) has established a private-line, data and voice communications network extending to major U.S. cities for commercial and government customers. More than 100 earth stations have been built or are under construction by American Satellite. The company owns 20 percent of the Westar satellite system and plans to launch its own satellites, the first in 1985. ASC's General Services network has been converted to an all-digital network, allowing data transmission at speeds up to 64M bps. The upgraded earth stations provide high-speed data, facsimile, and video teleconferencing, in addition to private line voice service.

AT&T

American Telephone and Telegraph Company
Long Lines Department
Bedminster, NJ 07921
Telephone (201) 234-4000.

AT&T provides public dial-up facilities (DDD, including WATS) for voice and data generally at transmission rates up to 9600 bps, or in certain circumstances, at rates up to 19.2K bps. AT&T private line services include the low-speed Series 1000, medium-speed Series 2000 (2001 for voice) and Series 3000 (3002 for data), wideband Series 8000 service, Dataphone Digital Service (DDS) operating at speeds from 2400 to 56K bps, Terrestrial and Satellite Digital Services at 1.544M bps, and High Speed Switched Digital Service at 1.544M and 3M bps.

CompuServe Network Services

CompuServe Incorporated
Network Services Division
5000 Arlington Centre Boulevard
Columbus, OH 43220
Telephone (614) 457–8600

CompuServe Network Services is the value-added network division of CompuServe Incorporated, which provides remote computing and information delivery services for business and home computer users. Access to CompuServe Network Services is available in about 200 U.S. and Canadian cities. CompuServe Network Services (CNS) accommodates terminal speeds from 110 to 1200 bps when dial-up connections are used, and up to 9600 bps when terminals are hardwired to the network. CNS provides protocol conversion, error correction, and security procedures.

FTC Communications Inc.

FTC Communications Inc.
90 John Street
New York, NY 10038
Telephone (212) 669–9700

FTC Communications is an international record carrier whose services include telex, cablegrams, leased channels for voice and data communications, and electronic mail. FTC Communications plans to merge with Tymshare in 1984.

Graphnet

Graphnet Inc.
329 Alfred Avenue
Teaneck, NJ 07666
Telephone (201) 837–5100

Graphnet provides data and facsimile services. The Graphnet Freedom Network is a packet-switching network for intra- and inter-company public record communications in the U.S. and abroad. The network provides speed and code conversion, enabling a variety of devices including central processor units and terminal devices to communicate. Data speeds from 50 bps to 56K bps are supported.

GTE Sprint and Spacenet

GTE Sprint Communications Corporation
GTE Spacenet Corporation
(formerly Southern Pacific Communications Company)
1 Adrian Court
Burlingame, CA 94010
Telephone (415) 692–5600

The GTE Sprint microwave system, encompassing 220 metropolitan areas in the U.S., offers leased and switched services for voice (e.g., Sprint), data, and facsimile transmission. GTE Spacenet offers satellite service. GTE completed its acquisition of SPCC in June 1983.

GTE Telenet

GTE Telenet Communications Corporation
8229 Boone Boulevard
Vienna, VA 22180
Telephone (703) 442–1000

GTE Telenet is a pioneer in packet-switched data services, having offered such services commercially since 1975, and was the first U.S. public packet network to implement the X.25 protocol. Access to the system can be through leased or dial-up connections. Transmission speeds range from 50 bps to 56K bps. Service is available in 290 U.S. cities, Canada, Mexico, and 40 other countries. GTE Telenet also provides a nationwide electronic mail service, Telemail, that can be accessed through the Telenet network.

IBM

International Business Machines
Information Network
Greenwich Office Park
51 Weaver Street
Greenwich, CT 06830
Telephone (203) 629–2000

Or
IBM Information Network
P.O. Box 30104
Tampa, FL 33630-3104

The IBM Information Network is an enhanced data communications network and remote timesharing facility, accessible from the 13 U.S. cities that are linked via IBM communications processors to the central computer complex in Tampa, Florida, as well as from the 290 U.S. cities on the GTE Telenet network. Users access the network by switched or leased line connections, using SNA/SDLC, BSC, or asynchronous terminals. Over 200 IBM software products for data management and program development are available to users.

ITT World Communications

ITT World Communications
100 Plaza Drive
Secaucus, NJ 07096
(201) 330–5000

ITT Worldcom is an international record carrier that provides telex, leased line, message switching, cablegram, and compatibility services for data, facsimile, and video communications. ITT Worldcom provides telex service in the U.S., as well as abroad.

MCI

MCI Telecommunications Corporation
1133 Nineteenth Street NW
Washington, DC 20036
Telephone (202) 872–1600

MCI services include dedicated intercity facilities for voice, data, and teleprinter communications; measured use services such as MCI WATS; switched interstate service for voice or data communications (Execunet); and a value-added network. Service is provided from most major cities in the U.S.

MCI International

MCI International
International Drive
Rye Brook, NY 10573
Telephone (914) 937–3444

MCI has purchased Western Union International, an international record carrier, which is now called MCI International in the U.S. Its Western Union name is retained in Europe. Services include telex, cablegram, leased line, facsimile, datel, and data base service.

RCA

RCA American Communications, Inc.
400 College Road East
Princeton, NJ 08540
Telephone (609) 734–4000

RCA Americom was the first U.S. company to offer satellite channels. Service began in 1973, using facilities leased from Telesat Canada. RCA now operates its own satellites. In addition to cable TV broadcasting, RCA provides leased interstate services for data and voice communications.

RCA Cylix

RCA Cylix Communications Network
800 Ridge Lake Boulevard
Memphis, TN 38119
Telephone (901) 761–1177

RCA Cylix provides dedicated service using packet-switching technology, over point-to-point and multipoint leased

All About Transmission Facilities

telephone lines and satellite data links. Transmission speeds are generally 4800 or 9600 bps. The RCA Cylix network reaches about 350 cities in the U.S.

RCA Global Communications

RCA Global Communications
60 Broad Street
New York, NY 10004
(212) 248–7738

RCA Globcom is an international record carrier whose services include telex, data, leased channel, facsimile, and voice services between the U.S. and about 250 other countries.

SBS

Satellite Business Systems
8283 Greensboro Drive
McLean, VA 22102
Telephone (703) 442–5000

SBS provides all-digital transmission of data, voice, facsimile, and video through the SBS satellites and earth stations. CNS-A service provides dedicated facilities for high-volume customers. CNS-B customers share some earth-station and other facilities.

TCTS

TransCanada Telephone System
Computer Communications Group
160 Elgin Street
Ottawa, Ontario K1G 3J4
Canada
Telephone (613) 567–3748

TCTS is the largest common carrier in Canada, comparable to AT&T in the U.S. TCTS provides switched and dedicated narrowband, voice-grade, and wideband communications facilities. Its services include a private line, digital data service (Dataroute); a nationwide, packet-switched, public data network (Datapac); a DDD network; WATS service; TWX service; and Multicom, a switched service that provides voice, data, and facsimile transmission.

Tymnet

Tymnet, Incorporated
2710 Orchard Parkway
San Jose, CA 95134
Telephone (408) 946–4900

Tymnet, Incorporated, a wholly owned subsidiary of Tymshare, Incorporated, is a value-added common carrier. It operates a packet-switched data communications network that serves more than 400 locations in the U.S. and 35 outside the U.S. mainland. Services include low-speed and medium-speed data transmission for terminal-to-terminal, terminal-to-computer, or computer-to-computer connections.

Uninet

Uninet, Inc.
United Telecom Computer Group
2525 Washington St.
Kansas City, MO 64108
Telephone (816) 221–2444

Uninet is a new packet-switching network designed to provide large-scale data communications services. The network connects computer terminals in more than 200 U.S. metropolitan areas and reaches foreign markets through the IRCs. Interactive applications at data speeds of 100 to 1200 bps are supported, as well as remote batch applications at speeds from 2000 to 56K bps. Access to the network is gained by public dial or dedicated facilities.

USTS

ITT United States Transmission Systems
100 Plaza Drive
Secaucus, NJ 07096
Telephone (201) 330–5000

USTS, an ITT subsidiary, offers leased interstate transmission services for voice and data. The network covers 22 cities in the eastern United States and also extends in a corridor from Hartford, Connecticut to Houston, Texas.

Western Union

Western Union Telegraph Co.
1 Lake Street
Upper Saddle River, NJ 07458
Telephone (201) 825–5000

Western Union terrestrial private line services include teleprinter (Telex I and Telex II), voice, and data communications over low-speed, voice-grade, and wideband channels. Facsimile transmission, one-way broadcast services, teletex service, and a long distance telephone network (Metrofone) are also provided by Western Union. The Western Union satellite system currently consists of five Westar satellites, with three more being planned. The Westar satellites accommodate full-duplex wideband data traffic, point-to-point data traffic, alternate data/voice and private line voice communications, and video transmission.

USER EXPERIENCE

Datapro is proud to present the 1983 edition of our Network Users Survey. The survey is based on results received from questionnaires mailed to a cross-section of *Data Communications* magazine subscribers.

All About Transmission Facilities

Survey Methodology

A questionnaire was designed and produced by Datapro and mailed by *Data Communications* personnel in November 1982 to approximately 10,000 addresses selected at random from a cross-section of *Data Communications'* U.S. end-user subscriber base.

The questionnaire contained 37 questions, and was divided into six basic parts. In the first part, users were asked to provide information concerning the general characteristics of their data communications networks. In each of the remaining five parts, the users were asked to specify within a given category the types of data communications equipment and services being used in their networks, and to provide usage information and equipment ratings on each type. The five categories of equipment/services included: transmission facilities, communications and network processors, modems, line multiplexers, and testing and monitoring equipment. Within the transmission facilities category, the questionnaire allowed the user to rate up to three different facility types. (Reproduction of the form was permitted so that additional types could be rated.) A summary of the facilities user ratings provided by respondents to this survey is shown in Table 1.

When Datapro received the returns, they were audited by our senior level editors. All forms were carefully examined for validity before being sent for tabulation. The *Data Communications* labels were used for initial validation and identification. Responses to specific questionnaire sections or individual questions were disqualified whenever a vendor/model identity was omitted, user ratings were not assigned, a vested interest on the part of the respondent was judged to exist, or incomprehensible or unreasonable answers were given.

By the editorial cut-off of January 14, 1983, Datapro had processed 699 valid forms, which were then shipped to Mathematica Policy Research, Inc. for key entry and tabulation by computer. Summary information was prepared in the form of totals, percentages, or weighted averages, as appropriate for each question. Weighted averages were computed in a manner similar to most college grading systems: "Excellent" is weighted as 4, "Good" as 3, "Fair" as 2, and "Poor" as 1. The tallied numbers for each value were then multiplied by the corresponding weight, and the average taken by dividing the sum of the products by the total number of responses for that category.

Datapro suggests that the reader use the information presented with discretion. The individual equipment ratings are not presented to readers as the major consideration in making an acquisition decision. Rather, the ratings and other information should be used as guides to potential strengths and weaknesses that may call for further investigation in selecting the most suitable equipment for your needs.

The Results

The first part of the Network Users Survey consisted of nine questions that solicited information on the general characteristics of the users' networks. Taken together, the results provide a brief summary of the extent and complexity of these users' network configurations.

First, the users were asked to indicate the number of sites that are linked by their networks, with the following results:

	Number of Responses	Percent of Responses
1 to 3 sites	126	18
4 to 10 sites	132	19
11 to 25 sites	119	17
26 to 50 sites	80	12
Over 50 sites	231	34
	688	100

These results present a fairly even spread of network sizes, with half the users in the 1-to-25 site range, and the other half in the 25-and-over range. Note that no distinction is made here as to the type or intelligence of the devices located at any site.

The second question asked the number of computers participating as hosts. As you can see, nearly 60 percent of these users are operating in multiple-host environments:

	Number of Responses	Percent of Responses
1 host	191	28
2 to 4 hosts	328	48
5 to 10 hosts	97	14
Over 10 hosts	71	10
	687	100

This adds some degree of clarity to the responses to Question 1, as well as developing a better picture of the level of sophistication of these users.

The users were also asked to indicate the total number of end-user workstations (CRTs, teleprinters, etc.) that are in use on their networks:

	Number of Responses	Percent of Responses
1 to 10	41	6
11 to 25	46	7
26 to 100	123	18
100 to 500	250	36
Over 500	224	33
	684	100

All About Transmission Facilities

TABLE 1. USERS' RATINGS OF COMMUNICATIONS FACILITIES

Carrier and Service	Number of Responses	Planning Assistance					Ease of Installation					Reliability of Operation					Quickness to Troubleshoot and Fix Problems				
		WA	E	G	F	P	WA	E	G	F	P	WA	E	G	F	P	WA	E	G	F	P
AT&T Bell System—																					
Leased voice-grade line	512	2.4	58	200	147	98	2.6	55	239	150	52	2.8	64	275	141	20	2.2	40	145	207	108
Leased telegraph-grade line	29	2.4	1	17	3	8	2.6	2	13	10	2	2.7	1	18	8	0	2.3	1	10	12	4
DDS Service	223	2.6	43	78	65	33	2.9	40	104	56	17	3.1	95	86	30	6	2.8	58	74	66	16
Other leased wideband line	32	2.3	0	13	10	5	2.7	4	14	8	2	2.9	5	17	5	2	2.3	4	10	8	8
DDD (telephone network)	246	2.3	25	75	85	53	2.7	34	121	66	19	2.8	31	134	67	9	2.2	16	76	98	51
Packet-switched service	7	2.6	0	5	1	1	2.6	0	4	3	0	3.0	0	7	0	0	2.7	1	3	3	0
Other	7	2.4	1	3	1	2	2.7	1	4	1	1	2.6	1	3	2	1	2.1	0	3	2	2
Subtotals	1,056	2.4	128	391	312	200	2.7	136	499	294	93	2.8	197	540	253	38	2.4	120	321	396	189
Other telephone companies—																					
Leased voice-grade line	73	2.1	3	19	33	17	2.3	5	25	29	13	2.3	4	25	33	10	1.8	2	14	26	30
Leased telegraph-grade line	5	2.2	0	2	2	1	2.2	0	3	0	2	3.0	2	1	2	0	2.2	0	2	2	1
DDD (telephone network)	17	2.2	1	7	4	5	2.9	3	11	2	1	2.7	2	9	4	2	2.4	1	8	5	3
Others and unspecified	3	2.7	0	2	1	0	2.7	1	0	2	0	3.3	1	2	0	0	2.3	1	0	1	1
Subtotals	98	2.3	4	30	40	23	2.5	9	39	33	16	2.8	9	37	39	12	2.2	4	24	34	35
GTE Telenet—																					
Leased voice-grade line	7	2.1	0	2	4	1	2.3	0	2	5	0	2.3	0	3	3	1	2.0	0	2	3	2
DDD (telephone network)	6	2.7	0	4	2	0	3.0	2	2	2	0	2.7	1	2	3	0	2.2	0	2	3	1
Packet-switched service	45	2.2	4	12	17	12	2.4	5	17	14	9	2.7	8	23	7	7	2.3	7	10	14	13
Others and unspecified	3	2.0	0	0	2	0	2.0	0	0	2	0	2.3	1	0	1	1	2.7	1	0	2	0
Subtotals	61	2.3	4	18	25	13	2.4	7	21	23	9	2.5	10	28	14	9	2.3	8	14	22	16
ITT—																					
Leased voice-grade line	4	2.5	0	2	2	0	2.3	0	2	1	1	3.0	0	4	0	0	2.5	0	2	2	0
Satellite channel	4	2.8	1	2	0	1	2.5	0	2	2	0	3.0	2	1	0	1	2.5	1	1	1	1
DDD (telephone network)	3	2.0	0	0	3	0	2.3	0	1	2	0	2.3	0	1	2	0	2.0	0	0	3	0
Subtotals	11	2.4	1	4	5	1	2.4	0	5	5	1	2.8	2	6	2	1	2.4	1	3	6	1
MCI—																					
Leased voice-grade line	9	2.6	1	4	0	2	2.7	1	4	3	0	2.8	1	5	3	0	2.6	0	6	1	1
DDD (telephone network)	8	2.5	1	2	5	0	2.7	2	2	2	1	2.6	2	2	3	1	2.3	1	1	4	1
Subtotals	17	2.5	2	6	5	2	2.7	3	6	5	1	2.7	3	7	6	1	2.5	1	7	5	2
RCA—																					
Leased voice-grade line	7	2.9	2	2	3	0	2.9	1	4	2	0	3.1	2	4	1	0	3.0	2	3	2	0
Satellite channel	16	3.0	4	9	2	1	3.1	4	9	1	1	3.3	6	8	1	0	3.3	6	8	1	0
Subtotals	23	3.0	6	11	5	1	3.0	5	13	3	1	3.3	8	12	2	0	3.2	8	11	3	0
SBS—																					
Satellite channel	3	3.3	1	2	0	0	3.0	1	1	1	0	3.3	1	2	0	0	3.3	2	0	1	0
Other	3	3.0	1	1	1	0	1.5	0	0	1	1	3.0	0	2	0	0	2.5	0	1	1	0
Subtotals	6	3.2	2	3	1	0	2.3	1	1	2	1	3.2	1	4	0	0	2.9	2	1	2	0
SPCC—																					
Leased voice-grade line	5	2.8	1	2	2	0	2.8	1	2	2	0	2.6	1	2	1	1	2.6	1	2	1	1
Tymnet—																					
Leased voice-grade line	4	3.5	2	2	0	0	3.5	2	2	0	0	3.2	2	1	1	0	3.0	2	1	0	1
DDD (telephone network)	5	2.6	0	4	0	1	3.2	1	4	0	0	2.8	0	4	1	0	2.4	0	3	1	1
Packet-switched service	28	2.8	6	12	8	2	2.7	5	12	8	2	2.8	5	15	5	3	2.7	6	10	10	2
Subtotals	37	3.0	8	18	8	3	3.1	8	18	8	2	2.9	7	20	7	3	2.7	8	14	11	4
Western Union—																					
Leased voice-grade line	11	1.8	0	2	5	4	1.7	0	1	6	4	1.7	0	1	6	4	1.5	0	2	2	7
Leased telegraph-grade line	12	1.7	0	3	2	7	1.9	0	4	2	5	2.4	0	7	3	2	1.8	0	3	4	5
Satellite channel	5	2.4	0	2	3	0	2.5	0	2	2	0	2.7	1	1	2	0	2.2	0	1	3	0
Subtotals	28	2.0	0	7	10	11	2.0	0	7	10	9	2.3	1	9	11	6	1.9	0	6	9	12
Other & unspecified facilities—																					
Leased voice-grade line	14	2.4	3	4	3	4	2.6	1	7	5	1	3.1	4	7	3	0	2.7	5	3	3	3
Satellite channel	13	3.0	4	5	2	1	3.0	3	5	3	0	3.3	5	6	1	0	3.0	4	4	4	0
DDD (telephone network)	6	2.7	1	3	1	1	3.7	4	2	0	0	3.5	3	3	0	0	3.2	3	1	2	0
Other and unspecified services	20	3.2	9	8	2	1	3.4	10	8	0	1	3.5	11	7	0	1	3.2	6	11	1	1
Subtotals	53	2.8	17	20	8	7	3.2	18	22	8	2	3.3	23	23	4	1	3.0	18	19	10	4
GRAND TOTALS	1,395	2.6	173	510	421	261	2.6	188	633	393	135	2.8	262	688	339	72	2.5	171	422	499	264

LEGEND: Weighted Average (WA) is based on 4 for Excellent, 3 for Good, 2 for Fair, and 1 for Poor.

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When examined in conjunction with Questions 1 and 2, these results characterize the typical respondent to the survey as having a network configuration consisting of approximately 25 sites, two or three hosts, and between 200 and 300 terminals (an average of 10 per site).

Although we are not in a position to draw any formal conclusions, since this year's user sample consists of different respondents from last year's, some interesting observations can be made when the two years' responses to these three questions are compared. (The size of the respondent group is approximately the same: 631 respondents in 1982 versus 699 respondents in 1983.)

For example, this year's respondents' networks appear larger in several respects:

- Number of sites—last year, only 25 percent of the respondents reported networks of 50 or more sites; this year, 34 percent indicate they are operating networks of this magnitude.
- Number of hosts—last year, only 14 percent of the respondents stated that their networks contain 5 or more hosts; this year, 24 percent reported on networks of 5 or more hosts.
- Number of terminals—last year, 55 percent of the respondents specified that their networks include over 100 terminals; this year, 69 percent indicated that their networks had at least 100 terminals. Of this group, 24 percent of last year's respondents had networks with over 500 terminals; this year's comparable figure is 33 percent.

The implication of these figures can certainly not be denied, that networks are growing in number and in size, and becoming increasingly pervasive.

Another question asked the users to identify the overall network architecture with which their networks comply, with the following results:

	Number of Responses	Percent of Total Responses
IBM BSC (non-SNA) environment	328	48
IBM SNA	274	40
Digital Equipment DNA and DECnet	48	7
Hewlett-Packard DSN	26	4
Burroughs BNA	19	3
Honeywell DSE or DSA	17	2
Prime PrimeNet	17	2
Sperry Univac DCA	16	2
Other vendor-supplied architecture	127	19
None, or user-supplied architecture	125	18

The number of responses totals 997, indicating that a large number of the respondents are using more than one of the listed architectures in their networks. As we anticipated, the largest group of users is still operating in an IBM BSC environment. However, the gap of eight percent between BSC responses and SNA responses continues to narrow (last year, the gap was 14 percent), indicating that the acceptance of that architecture is becoming more widespread. Interestingly, 18 percent of the respondents are not complying with any vendor-supported architectureal scheme, presumably either because their environments do not currently require it (but potentially may in the future) or because they have found other satisfactory alternatives.

The users were also asked to indicate the primary protocols supported by their networks:

	Number of Responses	Percent of Total Responses
Asynchronous	434	63
IBM BSC	433	63
IBM SDLC	279	40
Other bit-oriented synchronous protocol (e.g., ANSI ADCCP, ISO HDLC, Sperry Univac UDLC, or Burroughs BDLC)	81	12
X.25 packet-level	80	12
Other byte-oriented synchronous protocol (e.g., DEC DDCMP)	75	11
Other	52	8

These results correlate to the results of the preceding question, showing that a large number of users are using more than one protocol in their networks. ASCII and IBM BSC are the most widely used protocols, with IBM SDLC coming in a distant third place. The high response for multiple protocol usage suggests that many of these users are still in various stages of migration to SNA.

The users were requested to identify which vendors' systems are functioning as hosts. The following list summarizes their responses:

	Number of Responses	Percent of Total Responses
IBM	464	67
DEC	137	20
Amdahl	81	12
Burroughs	61	9
Hewlett-Packard	50	7
Sperry Univac	45	7
Honeywell	43	6
Prime	35	5
Data General	30	4
Control Data	27	4
NCR	21	3
National Advanced Systems	19	3
Other	89	13

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As expected, IBM came out well ahead of all other vendors; however, DEC placed second with a strong showing. Many of the users are using more than one vendors' systems as hosts, indicating that the multiple-host environments represented in Question 2 are frequently multiple-vendor environments as well.

We also asked these users to indicate which, if any, teleprocessing monitor software packages they are using.

	Number of Responses	Percent of Total Responses
IBM CICS and CICS/VS	294	43
Sperry Univac CMS & CMS/1100	17	2
Cullinane IDMS-DC	14	2
Cincom Environ/1	12	2
Software AG Com-plete	10	1
SDA Intercomm or Minicomm	8	1
Westinghouse Westi	6	1
ADR Datacom/DC	6	1
NCR VRX Tran-Pro	4	1
Other	113	16
None	180	27

These results indicate that, although IBM software is of course predominant, various alternatives are sought out by many users.

Another question requested that the users indicate any commercial *local* networks which they operate, have installed now, and any that they plan to implement in the coming year.

	Number of Responses	
	Installed Now	Planned for 1983
Xerox Ethernet	17	14
Datapoint ARCnet	15	7
Network Systems Corp. Hyperchannel	12	8
Prime Ringnet	11	4
Sytek LocalNet	10	12
Wang WangNet	10	23
Ungermann-Bass Net/One	8	20
Interactive Systems/3M Videodata	7	7
Other vendors' Ethernet	5	14
Amdax CableNet	4	1
Nestar Cluster One	2	6
Other	19	34
	120	150

Putting aside the possibility that a few users may have indicated more than one type of local network, approximately 17 percent of these users currently have a local area network installed. This compares to last year's comparable figure of 14 percent, representing a slight increase. Depending on how many *current* users indicated that they plan *additional* networks in 1983, (as opposed to new users installing their very first local networks), the 1983 total of LAN users could go as high as 370, or 39 percent of all respondents.

The final question in the first part of the questionnaire provided a list of ten possible sources of networking problems, and asked the respondent to indicate whether they had had any problems related to each possible source, with these results:

	Percent of Total Responses		
	Severe or Frequent Problems	Less Severe or Occasional Problems	No Problems
Local loops	14	40	32
Non-local comm. lines	12	57	17
Host software	7	54	29
Front-end software	6	43	36
Terminals	6	67	19
Terminal controllers	4	46	33
Front-end hardware	3	40	43
Host hardware	3	48	38
Modems	3	56	35
Multiplexers	2	23	46

Not unexpectedly, the area of these users' networks that causes the most headaches is their communications lines. Although few users experience severe or frequent problems with their terminals, these devices seem to be the greatest single source of minor or sporadic problems. The least frequently experienced source of problems is multiplexer equipment.

The remaining parts of the questionnaire focused on specific categories of networking services and equipment. Users were asked to list the specific vendors and types of services and equipment they are using in their networks and to provide user ratings based on their experiences with each. A summary of the results of these questions for transmission facilities is shown in Table 1.

The Datapro Research staff extends a sincere thanks to all for responding so enthusiastically to our 1983 Network Users Survey. Without your participation, it could not have been the terrific success it is, and we hope that this compendium of user experience will be of significant value to you. We look forward to hearing from you again.□