How to Analyze Your Data Communications Needs

This report explains, in down-to-earth terms, just what data communications can do and how you can put it to work in your organization. You'll find straightforward procedures for determining your communications needs and implementing an effective system to satisfy them, plus guidelines for taking full advantage of all the other helpful information in DATAPRO 70.

Data communications is a hot topic. Casual observation of the Joint Computer Conferences over the last five years or so might lead one to the conclusion that you can't really have a full-fledged EDP installation without terminals of some kind hanging out there in the boondocks anxiously awaiting the word from the computer. The trade press has been filled with the activities of various vendors competing to fill the data communications needs of data processing installations everywhere. New types of equipment—programmable communications processors, intelligent terminals, multiplexors, etc.—as well as new applications—time-sharing, management information systems, etc.—abound.

For data processing managers, the question remains, do I really need data communications, and, if so, what kind of system do I need? This report seeks to answer this question by providing an analysis of what data communications is all about and some practical guidelines for putting this new technology to work for your organization.

What can data communications do for you?

Data communications can greatly facilitate the interchange of information between a computer and its users. Time-sharing is one prime example. Accessing a remote data file to retrieve or update specific information is another.

Data communications can allow the implementation of applications not practical through other means. Examples of this include verification of a bank balance at a branch-office teller's window while the customer waits, and making airline reservations while the customer waits (and before the airplane takes off).

Through the use of data communications, a company can shave its operating costs and raise its profitability by maintaining closer control on inventory, deliveries, etc.

Decisions that affect the day-to-day business operations can be made more quickly via information transmitted to headquarters.

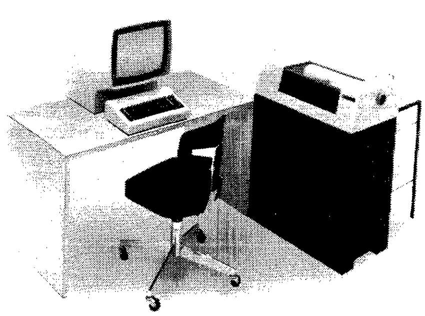
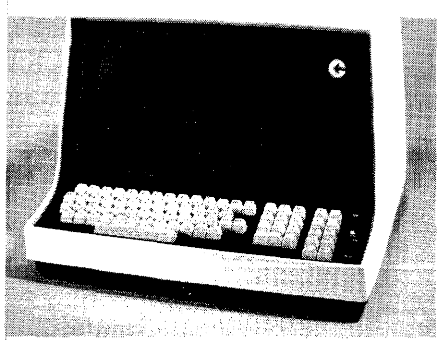
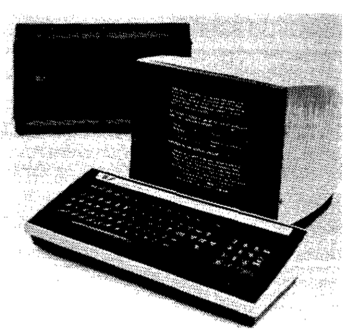
Customers can receive better service by shortcutting the time required to assemble and maintain customer information files.

The list can be extended as far as your imagination will carry you. What then, is the common link among the diverse applications for data communications?

Can all the applications for data communications be summed up in one characteristic? Yes. *Faster data flow.* The day of instant information is here (well, almost). But the day of *free* information is not, and never will be, here.

But do the benefits justify the cost?

Let us briefly divert from a straight-line discussion of data communications and delve into some of the ramifications of faster data flow. Only you can judge the benefit to be derived from speedier delivery of information from one of your locations to another. Many companies have profited—and many have not.

Three faces of CRT terminals. The IBM 3270 Information Display System, illustrated on the left, is a replacement for the prior IBM 2260 and 2265; it features high modularity and expanded capability. The Datapoint 3300, shown in the middle, can replace a Teletype Model 33 or 35 in a time-sharing network or other application; it has also been picked up by a number of manufacturers for inclusion in larger systems. The Four-Phase System IV/70 on the right includes a powerful programmable controller (background) for sophisticated applications.

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One of the primary considerations facing business executives is the acquisition of sufficient intelligence about their company's operations to make informed decisions and to acquire it in time to implement reasonable business plans. All too often in data processing, with or without data communications, information gathering is controlled by the criteria of quantity and speed. Quality (i.e., what information should be gathered) takes a subordinate position simply because it is so difficult to evaluate. And not without good reason. It is difficult to distinguish between that information which is really necessary and that which merely adds to the feeling of security or comfort.

Typically, the information managers most want cannot be obtained directly but must be derived from available information by empirical estimates based on experience—or does not exist at all. Different levels of management need different information.

The purpose of this dip into management decisions is merely to point out that data communications can assist you in expediting the flow of information. What information to gather and how it should be processed is still a management function outside the boundaries of what data communications can do for you. However, assuming that you know or can derive the kinds of information requirements you have, the question becomes: what are the cost factors associated with transferring it from one point to another?

Let's look at the cost factors

In addition to the cost of designing procedures and determining information requirements, there is the cost of the central computer, interfaces between the computer and communications lines, communications lines themselves, and terminals.

We will examine each of these areas in turn.

On-line vs. off-line

Data communications systems can be classed into two broad categories: on-line and off-line, depending on whether data is transmitted directly to a computer (on-line) or whether it is received and transcribed to some temporary storage medium such as punched cards, punched tape, or magnetic tape and then read into the computer in conventional fashion. This points up the essential characteristic of data communications—the transmitted data is in machine-readable form.

Off-line systems are relatively simple to understand and plan because the components are completely visible and control procedures are relatively straightforward. Even when multiple units share the same communications line, the nature of the system remains clear. (However, when selecting terminals for off-line systems, essentially the same criteria apply as in selecting terminals for an on-line system.)

From this, you can draw the correct conclusion that the converse is true when discussing on-line systems. The all-important control aspects of an on-line system are buried in the controlling computer within the amorphous mass referred to as software. Add to this situation the typical requirement for several different capacities among the remote stations and the many different alternatives for each aspect of an on-line data communications system, and the resulting mess seems hopeless.

But don't give up and resign yourself to the tender mercies of specialists, either the vendors' or your own. Some clear, logical thinking will enable you to effectively control the planning, procurement, implementation, and management of a data communications system. After all, data communications, like cost accounting, is only another tool to be applied to the solving of business problems.

How to set your requirements

Because the purpose of a data communications system is to speed the flow of information, let us first examine your information needs. Frequently, implementation of a data communications system is accompanied by an overhaul of a company's information collection and processing specifications. Too frequently, it is not. Like the planners of expressways in and around urban areas, planners of data communications systems sometimes find that the best way to do things is not always a permissible way to do things. A systems planner must always work within the constraints of company policy, number and level of personnel available, security restrictions, time, etc.

The two principal, non-obvious elements of the information you wish to collect are *time* and *extent.*

Be careful to evaluate the time savings associated with transmission of each set of data. If the processing cycle once data is received is much longer than the time to transmit it, little may be saved by using data communications. For example, say the processing cycle requires four days once data has been received. If the alternative to transmission over a communications line is next-day mail delivery, very little has been saved in the overall cycle. This question is sometimes complicated by multiple use of transmitted data. Sales data from a branch office can be used to generate shipping orders, invoices, inventory replenishments, sales analyses, and commission checks, each with a different time priority.

This leads to the second consideration—extent of data collected. In the example just cited, a little bit of extra information is required for each intended usage. And each little bit adds to the transmission time, the processing

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A complete batch terminal built around a minicomputer. This configuration of the DATA 100 Model 78 Programmed Terminal includes an 8K processor, line printer, card reader, card punch, CRT and keyboard, and IBM-compatible magnetic tape drives. The programming capability is used primarily to emulate various popular batch terminals such as the IBM 2780, Control Data 200 User Terminal, and UNIVAC DCT-2000.

time, etc.—all the way down the line. This is not to say that the additional uses should be eliminated and only the bare bones should be transmitted. After all, the incremental cost to handle a little bit more is usually small in comparison to the total cost of the system. But even a small incremental cost compounded many times can add up to a sizable cost after awhile. In regard to the timing and extent of information collection, then, you should be aware of the cost of each item of information transmitted, and each item should be evaluated in terms of the alternatives, including doing without.

Components of a data communications system

To refine your plans for information gathering and processing, it becomes necessary to take into account the various pieces of a data communications system by becoming familiar with their characteristics and limitations.

Basically, a data communications system can be thought of as three principal types of elements: the *computer,* the *communications links,* and the *remote stations* (or terminals). Inserted into this network of information sources (terminals), connecting links (communications lines), and control center (computer) are *interfaces* between the computer and the communications lines and between the terminals and the communications lines. Depending on who supplies the interfaces and their exact nature, the interfaces can be regarded as part of the communications link, as part of the computer or terminals, or as separate entities with sufficiently important functions to warrant separate evaluation and procurement.

System arrangements

Before getting into the nitty-gritty of equipment characteristics, let's take a look at the ways in which the pieces can be assembled.

All of the complexities involved in a data communications system stem from two factors: *a computer can control multiple communications lines, and a communications line can be shared among multiple terminals.* Now, on the surface, this doesn't seem like such a problem. Data processing installations have been working with configurations that have multiple I/O channels, each with multiple devices, since the very beginning of computers. Multiple magnetic tape subsystems are just such an example.

But there is one big difference between the multiple I/O channel situation just outlined and the multiple communications situation—that of *independence.* Local peripherals typically operate on demand as instructed in the program. A multiple-file applications program works with physically independent data streams, but the logic is present in the program. The actions of each file are responses to commands issued by the program.

Data communications is more tenuous as regards the interaction of the remote stations with the overall data processing activities of the computer. There are many approaches taken to assure a disciplined exchange of data between the computer and outlying points.

Analyzing typical applications

The two fundamental types of information flow in most applications are the transmission of data to the computer (data collection) and the transmission of data to the outlying points (data distribution). The things that change the design parameters from one application to another are the volume and number of types of data collected from each terminal, the processing that is done on the collected data, and the responses that are distributed to the various terminals, both in the sense of response time and which terminals.

To illustrate some of these points, let's take a look at the kind of information flow involved in a centralized payroll

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application. In the simplest case, just a few offices are involved. The operator in each office, on a fixed time schedule, dials the number for the single trunk connected to the computer. The operator coordinates the transmission with the operator on the computer end. The telephone/data sets are switched to the data mode and transmission proceeds. The computer operator has alerted the computer that payroll data from the particular office involved is on its way, and thus identifies the application and source of data. The computer receives the payroll data, which is added to the accumulating file of payroll information for the company, and hangs up—or disconnects if you want a more technical word. When the pay period closes, the payroll data file is input to the payroll program after sorting, if necessary. Paychecks are prepared and mailed to the branch offices.

It is doubtful that such an application would be economical if limited to the functions just described. The small advantage of having payroll information that quickly in such a small operation is probably more than offset by the equipment costs of the terminals and computer interface, along with the telephone charges and data set costs. In reality, this simple case would probably be handled by an off-line receiving unit at the computer site. The qualifiers above are necessary because there is almost always a situation with special conditions that make some particular procedure essential regardless of cost. For example, a union contract may call for immediate pay. In this case, even data communications would not permit centralized payroll generation, unless checks or deposit vouchers could also be transmitted (distributed) back to the outlying terminals.

As the number of offices that are incorporated into the centralized payroll system is expanded, complications arise. The number of calls becomes too great to be accommodated by one line or by one operator at the computer site. Okay, let the computer do it, right?

It is easy enough to arrange for the computer to answer incoming calls directly. It is even easy to arrange for multiple trunks to have the same telephone number, with incoming calls going to an available trunk. Now, coordination of the call before transmission is not possible, and the incoming data must contain information to identify the transmitting location. Along with serving expanded locations, additional applications are typically implemented, so that the incoming data must also identify the application with which it is associated. As the amount and diversity of data transmitted grows, a fixed transmission schedule becomes awkward. Let the computer do it.

Thus, the computer programs controlling the data communications application become more complex to handle multiple types of data from many locations with an unpredictable schedule of transmissions. As the data collected grows, managers in the field start lobbying for access to this data. Now the need arises for rapid interchanges between the requesting locations and the data bases that have been built. The result is again increased complexity.

Minimizing line costs

As the size and volume of the transmitted messages grow, a closer look is taken at the communications lines connecting the terminals with the computer. Because the cost of the communications lines can easily amount to one-third of the cost of the whole system, economies here can have important budgetary effects.

Several techniques are available to reduce the line costs and perhaps improve performance at the same time. A private line can be leased from the telephone company, giving exclusive use to the customer for 24 hours a day. If the volume from one location is insufficient to warrant a private line, perhaps several locations can share the same line in a party-line, or multi-drop, fashion. This requires that the terminals be equipped to recognize their own addresses, so that information directed to one terminal won't be output by all the other terminals. It also introduces the problem of multiple stations competing for use of the one line. With the dial-up telephone network, the telephone company equipment takes care of this problem for you automatically. Another capability that is achievable on a multi-drop line is broadcasting data to a selected group of terminals simultaneously.

You may also be able to improve the cost-effectiveness of your data communications system through alterations in the connecting links by examining the variety of other services available from the telephone company, other common carriers, and private companies. These range from WATS to foreign exchanges (direct lines to the telephone central office in another location) to private communications networks.

And the list is not ended yet. Economies of transmission may also be achieved through economies of scale. Multiple low-speed lines can be multiplexed onto one high-speed line. The way this usually works is to bring several low-speed lines into a central point and run the high-speed line from there to the computer, instead of running low-speed lines from each terminal to the computer.

The question of configuring a communications system is not merely selecting the one "best" technique and applying it to all locations and applications. Indeed, building a data communications system involves individual evaluations of each location and each application and their inter-relationships. Use of existing facilities, such as a private telephone network or leased voice lines between headquarters and an outlying location, must be considered as possible alternatives.

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Lightening the computer's load

Looking at some of the alternatives that exist for improving communications line costs, one wonders whether anything can be done for the computer itself. As the data communications system grows, with more lines and larger volumes of data transmitted, the control problem becomes more severe. To put this problem into perspective, let's take a closer look at it.

Multiprogramming is now more than 10 years old as a working concept. But how many simultaneously active programs constitute a large mix? Fifteen? Many installations (such as those using IBM System/360 DOS) consider three an achievement. What does a multiprogramming mix consist of? Several independent job streams. In larger communications systems there may be several dozen or even several hundred independent job streams; i.e., the stream of messages from each active terminal. Not only that, but the arrival rate of the characters within each message is so slow that the computer would be hopelessly bound up if it had to wait for the completion of each message before proceeding to another activity.

Some relief is provided within modern computers by the capability for paralleling I/O activities so that multiple data streams can be handled simultaneously without seriously impeding the main processor. This eliminates, or at least greatly reduces, the problem of handling characters within a message; but the problem of many active messages at one time still remains, because the main processor must initiate and terminate the input or output operation for each message. It's t e that a similar situation exists in conventional file proces ng, but the key difference is our need for *independence* o the messages or data elements. The problem is somewhat akin to opening and closing a file for each record transferred in a file processing application. The housekeeping becomes enormous. The reason for this stems from the economic necessity to find some other way to arrange a system than one dedicated line for each terminal.

An obvious step is to build a specialized controller to do some of the housekeeping chores, in much the same sense that multiple magnetic tape drives are connected through a single controller. This approach allows the use of the computer's capabilities for handling multiple data streams simultaneously, but the housekeeping chores required to handle the many different situations turn out to be quite complex and diverse, and the cost of hard-wiring all the necessary functions may be prohibitively high.

Back to the computer. That's what stored programming is all about. So, why don't we build a small stored-program processor just to handle the communications control functions? And that, indeed, is one of the principal trends in the data communications field today. Devices built around minicomputers and called programmable communications processors or communications front-ends are finding a place for themselves just to take care of communications housekeeping chores. More sophisticated programming in some of the units so marketed can provide additional assistance for the beleaguered main processor.

Selecting communications equipment

If, by now, you're saying to yourself that there's more to this data communications than bits per second, data sets, and CRT terminals, you're absolutely right. Information flow—that's the only thing that really counts, right? This time you're wrong. The reason is that there is not a continuous spectrum of communications lines and terminals currently in existence to serve your needs. Some range of capability are provided in abundance, making selection difficult; others don't exist, making procurement impossible. Thus, the requirements for desired information flow must be balanced against available equipment and facilities.

On to the nitty-gritty.

The types of equipment involved in a data communications system have been identified as:

- Central computer.
- Communications lines.
- Interfaces between the computer and communications lines.
- Terminals.
- Interfaces between terminals and communications lines.

Computers

Virtually all computers marketed today include some provision for data communications. Generally, this takes the form of controllers for multiple communications lines. The purpose of these controllers is to multiplex many slow data streams from terminals onto one relatively high-capacity input/output channel.

The two extremes in controller design are represented by the traditional approaches of IBM and UNIVAC. IBM has traditionally incorporated specialized circuitry into the controllers which is specifically adapted for certain terminals, mostly IBM's own. UNIVAC, on the other hand, traditionally builds general-purpose controllers with a high degree of transparency to the special control characters employed by terminals to effect line discipline.

Two new approaches are represented by the same two main-frame companies. IBM, in its System/370 Model

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135, has incorporated communications line control functions into the microprogrammed storage, thus significantly reducing costs in comparison with the 2700 series controllers used with the System/360 and larger models of the System/370. UNIVAC, with the 1110 computer system, introduced a programmable processor dedicated to the control of communications lines.

But hardware is not enough. As expressed earlier, the logical relationships involved in a data communications system can become complex due to the multiple independent data streams, varied line-control procedures, varied terminals, varied applications, non-synchronous timing considerations, and assurance checking. To manage these various factors, software of appreciable size and sophistication must be available. Until quite recently, the development of control software for communications has been the province of the main-frame vendors, consultants, and a few software houses. Primarily because IBM's development of software for the System/360 was oriented towards being all things for all people, the door was left open for more specialized entries. Today there are a number of proprietary monitors on the market, primarily aimed at the IBM System/360/370 market.

The goal of the telecommunications control software is to make programming for data exchanges between the computer and the remote terminals as simple and straightforward as programming for a local peripheral data transfer. Typically, network configuration and terminal specification are handled through parameters entered to the monitor, and exchanges with the terminals are more or less independent of timing considerations.

The facilities provided for data communications, both hardware and software, with specific computer systems are discussed within the individual DATAPRO 70 reports on these systems and can be found behind the Computers tab in Binder 1. (A quick listing of all the computers covered in these reports can be found in the Current Contents on page 70A-050-01, behind the Index tab.)

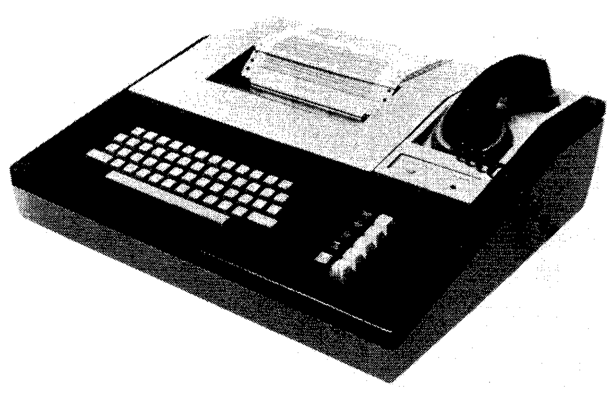
Communications lines

The number of survey and discussion articles appearing in the trade press over the last six years about communications facilities available from the common carriers (companies granted certain teritorial privileges in return for submitting to control by federal, state, and sometimes city commissions) seems far out of proportion to the actual facilities available. From Sears and Roebuck you can get a catalog that completely defines everything you can buy from them. The common-carrier tariffs, which form a sort of catalog, don't have the color pictures and sales messages traditionally associated with catalogs. They are written in exquisitely precise terms that are difficult to read and understand even if you can manage to get hold of an up-to-date copy. (The tariffs are supposed to be on file at the common-carrier business offices and the public.)

The abstruse language of the tariffs is partly due to the fact that they, in effect, form a contract and thus must be legally definitive. Another reason is that many options must be covered. Some of these are to make accommodations because the telephone network wasn't designed for data transmission in the first place, and some are due to the many different connection arrangements. Many of the complexities of selecting, implementing, and using communications lines are due to the fact that the lines were originally designed for voice communications. Implementation of the network was based more on getting calls through and on details of connection arrangements (extensions, switchboards, etc.) than on the fidelity of signal transmission. The human ear is a remarkable instrument and is relatively insensitive to many forms of distortion that drive digital transmission designers up the wall.

Further complicating the selection and procurement picture are the many different companies from which the services are procured. In any one area there is only one telephone company. But when you cross a state line you must deal with the originating company, the A.T.&T. Long Lines Division, and possibly another company at the terminating end. If you don't want to deal with the telephone company, Western Union can provide leased lines almost anywhere and switched service in some areas. (Picture, if you will, the situation of a time-sharing company operating out of New York City. The common carriers such a company must deal with include New York City, New York State, interstate to get across the state line into New Jersey, and New Jersey State. And you thought you had it rough!)

Dealing with multiple companies wouldn't be so bad if they all charged the same rates for the same service. But



Portable terminals can add a great deal of flexibility to your data communications planning. The Tracor Data Systems TDS-1601 includes a built in acoustic coupler that can convert any ordinary telephone into a data communications station.

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they don't, although the rates are usually within 10 percent of those established by the Bell System interstate tariffs. In addition, not all telephone companies support all services.

There have been several recent events that herald a new, more flexible, easier-to-live-with day coming in the communications lines for data communications.

By now nearly everybody has heard about the Carter-Phone decision and the Direct Access Arrangement for connecting non-Bell modems to the direct dial telephone network. Less well-known is the tariff submitted by the Bell System to require a similar protective device for leased lines. Although no charge was specified, the modem manufacturers arose in their wrath, fearing that the institution of a charge sometime in the future would give Bell the same kind of price advantage for leased-line modems as it now has for modems to be used on the public telephone network. Bell recently withdrew the tariff, but the specter remains.

In a few selected areas, Bell has proposed a new tariff oriented, in effect, specifically toward computers interfacing multiple lines, which would significantly increase communications line costs. The time-sharing companies are naturally uptight about this one. Bell's arguments for this change in pricing lines (actually the terminal connections) are based on the typically longer connect times of data calls in comparison to voice calls. Because the switching facilities of the telephone network are based on an estimated number of active calls at any one time, if the length of the average call increases, the quality of service (in terms of the probability of finding an open circuit through the network) decreases. So far, in each situation where this tariff has been proposed, it has been withdrawn by Bell. Do you care to bet on the future?

In a landmark decision recently, the Federal Communications Commission (FCC) paved the way for companies other than the Bell System and Western Union to provide interstate facilities specifically for data communications and to sell these services to the public. Microwave Communications, Inc. and University Computing Company are two companies actively attempting to establish such services. MCI plans a microwave link between Chicago and St. Louis and, through franchises, between many other pairs of major cities. UCC plans a nationwide network on intercommunicating microwave links through a subsidary called DATRAN. Many other companies have also filed with the FCC to provide similar services.

Perhaps the most important new development is the forthcoming data network from the Bell System. This is due to be ready by or before 1975, depending on which press release and which of the many Bell System critics you believe.

We at Datapro will be following these developments and will keep you informed about the extent and impact of such developments through new and revised Feature Reports in the Communications section. A new report in the August 1971 supplement will survey and summarize the data communications facilities available.

Terminals of many types

If the central computer represents the brain of a data communications system, then the terminals represent the hands. From these units come the raw source information for processing, and they also serve as distribution points for any gems the computer cares to dispense.

The great majority of terminals being marketed and used today seem to fall into three natural categories: typewriter terminals (including teletypewriters), CRT terminals, and batch terminals. In addition to these, by-now-classic forms of terminals, a new category, and an important one, has been added—the programmable or "intelligent" terminals. Also available is a wide range of specialized terminals (bank teller and airline reservation terminals, for example).

Typewriter terminals

The distinguishing elements of a typewriter terminal are included in the name; i.e., a keyboard and a printing device. One group is based around the familiar IBM Selectric Typewriter. The Teletype teleprinters form a separate and equally important group. Another group consists of units with thermal, electrostatic, matrix, helical-wheel, and other unconventional printing mechanisms. Still another group, but small, is composed of units with conventional typewriter mechanisms other than the IBM Selectric.

The distinguishing characteristics of typewriter terminals are:

- Slow speed.
- Printed copy of data is available.
- Skilled operator is required for maximum efficiency.
- Usually not well adapted for transmitting large amounts of numerical information.
- Using preprinted forms requires special platen feed, if it is available at all.
- Low cost.
- Reliability can be a problem.

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Frequently, use of typewriter terminals is touted over keypunches because of the necessity to use trained operators for the keypunches. But, ask yourself, how easy it it to find really skilled typists, ones that you would trust to transcribe payroll data, for example?

The typical typewriter terminal is capable of from 10 to 15 characters per second or from 100 to 150 words per minute; this is far beyond the capability of most good typists, much less the average. The layout of the numbers on a typewriter is not conducive to rapid keying; in addition, very few typist ever acquire any skill at typing numbers because there is little demand for it in most typing tasks. A few units include a special 10-key pad arranged like an adding machine or keypunch (two different arrangements, by the way) to facilitate keying numbers. If the typewriter-style keyboard is what you end up with and numbers from a major part of your transmissions, this feature may be of considerable value.

The best application for the pure typewriter terminals seems to be in interactive tasks such as time-sharing. The complete flexibility in being able to generate any kind of data in any kind of format, including graphic data on a few terminals, is useful. The slow speed of operation is not as noticeable as in other applications because many little pieces of information are interchanged, rather than large chunks, and thinking time is usually the controlling time factor.

Still, it would be nice to be able to reduce transmission time and perhaps communications costs. For this, most typewriter terminals have an integral or optional punched tape or magnetic tape (usually a cassette) attachment. Messages composed off-line can be transmitted at the full speed of the unit. Some have an unattended operation feature that permits composing the message at will and setting up the terminal so that the message will be transmitted when the unit is polled by the computer.

The addition of punched or magnetic tape readers opens up new applications for the typewriter terminals. Such an attachment provides an effective way to capture information from forms that have to be filled out anyway, such as orders. Usually, the requirements for legible, complete, easy-to-understand forms override considerations of making the data easy to process by computer; this merely means that additional editing and data manipulation are usually required when information is captured in this manner.

CRT terminals

The chief complaints against typewriter terminals are the slow transmission speed and the fact that they generate paper documents (which, incidentally, is also one of their strong points if you happen to want paper documents, as many do). Well then, what about an electronic notepad, one that's self-erasing—at your command, of course?

Over the last few years CRT terminals have attracted more space in the trade journals and more companies to their production than any other type of EDP equipment. Their primary attractions are clear. They are quiet, attractive, and relatively easy to use in comparison to a keypunch or even a typewriter. All data is fully displayed in front of you. Page flipping can be implemented to give you access to a great deal of data with relative ease.

One of the most impressive CRT capabilities, one that is shared with no other type of terminal, is "filling in the blanks". Formats with column heads and/or stub entries can be displayed to inform the operator as to just what data is required and where it goes. This is a slow process, though, if the operator must make decisions about each and every entry of data. Hopefully, the operator would soon learn the format and speed up her pace.

The selection of the right CRT terminal for you is complicated by the great variety of capabilities offered by the many units on the market. But look at it this way: the variety of choices improves your chances of finding a unit that will effectively serve your needs without having to design it yourself. For a complete discussion of all the aspects of CRT selection and use, please refer to DATAPRO 70 Feature Report 70F-350-01.

Batch terminals

This category's name stems from its primary objective of efficiently transmitting large amounts or "batches" of data at one time.

Efficiency of transmission, in this case, is interpreted as speed. Transmission of data in large blocks is more efficient than small blocks because of the fewer times that acknowledgements must be exchanged, with the resultant delays. The situation is somewhat analogous to blocking considerations on magnetic tape due to interblock gaps. Typically, a different transmission technique is employed with batch terminals than with typewriter terminals, which results in fewer bits being required to transmit a character. This requires more logic and raises costs. Higher speeds also mean huskier motors and more precise movement mechanisms for the forms, cards, or tapes, which also increase costs and physical size.

Four data media are commonly used with batch terminals: punched tape, punched cards, magnetic tape, and paper forms (as printed output). The speed of these types of terminals usually ranges from about 100 characters per second to 600 characters per second over the telephone network or to 1200 characters per second over a leased voice-band line.

Several natural groups emerge from a consideration of batch terminals.

First, there is a group of punched card/printer terminals, typified by the IBM 2780.

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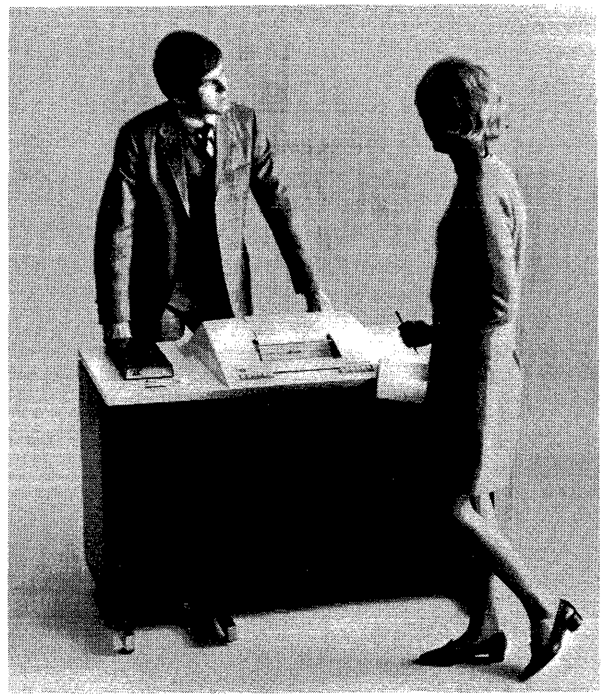
There is another group of punched tape terminals, including the Tally and Digitronics lines, as well as the Teletype Telespeed line that also shows up in the Bell System's Dataspeed service.

A third group and probably the largest in terms of number of models available and number of units installed, is the vast array of key-to-tape devices. Virtually every one of these units includes a data communications interface in its list of options. Numerous auxiliary devices, ranging from high-speed line printers to adding machine input, make these units flexible indeed.

A fourth group, really a quasi-group, is formed by the batch terminals that contain a programmable processor programmed to imitate a hard-wired terminal, most commonly the IBM 2780. These units, marketed as plug-compatible terminals, may not include support for any function other than the intended one of direct replacemnt of a hard-wired terminal, but the potential to perform various other functions is there.

The sole reason for the existence of batch terminals (with the exception of the key-to-tape units) is the transmission of large quantities of data. Because of the lack of a capability for key entry of data, they cannot be used in interactive applications. These are the terminals you go to when the quantity of data to be transmitted exceeds the capabilities of the punched tape or magnetic tape attachments on typewriter terminals. (Note that key-to-tape units, while used to prepare the tapes used for transmitting data, typically cannot enter data from the keyboard directly to the communications line.)



The old standby, Teletype, also includes some pretty fancy terminals in its product line. Some print upper- and lower-case alphabetics and can space forward or backward. The Inktronic I/O Terminal shown here prints by spraying ink on the paper. The attachment on the left is a magnetic tape cartridge unit, a slick improvement over the old paper tape reader and punch.

Compound terminals

Particularly with CRT and key-to-tape devices, it is common practice to control many units at one location via a single control unit. Data entered through the multiple key entry units comprising the subsystem is stored in a buffer for transmission (CRT) or transfer to magnetic tape (key-to-tape). The subsystem operates in the transmission speed range of batch terminals, using the total output of many operators to make up the large batches of information needed to justify the higher-speed transmission capabilities. When a remote location generates a large amount of data via a key entry device, the use of such a subsystem may be indicated.

Intelligent terminals

With the advent of the minicomputer, which brought the cost of basic computer processing power way down, application to terminals was just a matter of time. Intelligent terminals (or programmable terminals if you prefer) are not new. The UNIVAC 1004 was used as a terminal in the early 1960's. IBM 1130's and System/360 Model 20's have also been widely used as terminals for communicating with larger remote computer systems.

At first glance, this may seem like a backward step. The economies of scale—the same ideas that led to the development of the super-computers—seem to indicate that we would be better off to let the central computer do all the processing rather than distributing processing power around the network. While there may be some truth in this viewpoint about processing power—and observation of the performance of current operating systems in handling multiple independent tasks tends to raise some serious doubts—the question of communications costs raises its ugly head again.

Reducing the amount of data to be transmitted reduces connect time if you are using the public network or increases the number of terminals that can share the same line if you are using leased lines. Intelligent terminals can potentially reduce transmission volumes in two ways. Editing operations can streamline the data format. Processing power on-site makes it possible to perform simple tasks locally and thus eliminate the necessity for some

How to Analyze Your Data Communications Needs

transmissions to the computer and back. The processing load of the central computer can be further lightened by performing some of the data manipulation in the terminal prior to transmission.

Proceed carefully in your evaluation of the potential benefits of incorporating intelligent terminals into your data communications plans. It's easy to succumb to the glamor of computers talking to computers. Distributing the processing among multiple locations can add greatly to the problems of administrative control of operations.

Special terminals

Specialized needs of data processing users over the years have led to the development of a broad range of other terminals. Specialized terminals of broad applicability include optical mark readers, audio response units, protable terminals, and the ordinary telephone.

Mark readers are discussed in report 70F-320-01, *All About Optical Readers.*

Audio response, which has been around for a number of years, seems finally to have gained some momentum. Perhaps the chief reason is the growth of the minicomputer, which permitted development of relatively low-cost systems and thus opened the door for competition with IBM. Generally, the terminals used in audio response systems contain a keyboard, a loudspeaker, and precious little else.

Portable terminals became practical with the development of the acoustical coupler, which permits any conventional telephone (even a pay phone) to be used for establishing a communications link. Both typewriter and CRT portables are available.

While the telephone wasn't developed in response to data processing users' needs, the development of the Touch-Tone instrument placed a very low-cost terminal potentially in the hands of everyone (at least those in Touch-Tone dialing areas). To date, most of the use of the telephone as a terminal has been in audio response applications.

Finding the facts about terminals

Detailed information about specific terminals can be found in the individual reports within the Peripherals section of DATAPRO 70. The easiest way to find your way to a specific report is through the alphabetical Index, which begins on page 70A-100-01. You can look under the name of the vendor or the name of the terminal itself (provided it has a distinctive name rather than just a number). In addition, terminals are also listed under generic entries, so that you can easily find and compare *all* the terminals of a given type. Among the pertinent generic entries are: typewriter terminals, batch terminals, CRT terminals, magnetic tape terminals, printer terminals, punched card terminals, punched tape terminals, and key-to-tape recorders.

Interfaces

Comprehensive discussions of modems and programmable communications processors, including detailed equipment comparison charts, can be found in DATAPRO 70 reports 70G-500-01, *All About Modems,* and 70F-310-01, *All About Programmable Communications Processors.*

Summing up

Probably the most helpful way to conclude this report is by summarizing, in outline form, an effective process for determining and satisfying your data communications needs:

Critical first steps–

- Examine your present information flow with an eye toward determining who needs what information.
- Determine the bottlenecks–places where faster flow of data is imperative, or at least helpful.
- Determine the number of locations that are involved and their geographical relationships.

Making your first estimates–

- Estimate the volume of traffic from each location.
- Determine the source of data at each location; i.e., original data entry or machine-readable byproduct of another existing or planned operation.
- Examine the geographical spread of remote locations to see if it is worthwhile to try to share one line among several terminals.

Refining your estimates–

- Determine the desirable speed of transmission for each location, based on the volume of traffic and the available time. To allow for operator, line control, and error procedures, multiply this figure by ten for typewriter terminals and by five for batch and compound terminals. (This is a very rough estimate, but it will serve to get you in the ball park. Actual degradation of a terminal's peak speed varies widely.)
- Determine the type of terminal at each location, based on the source of data and application.

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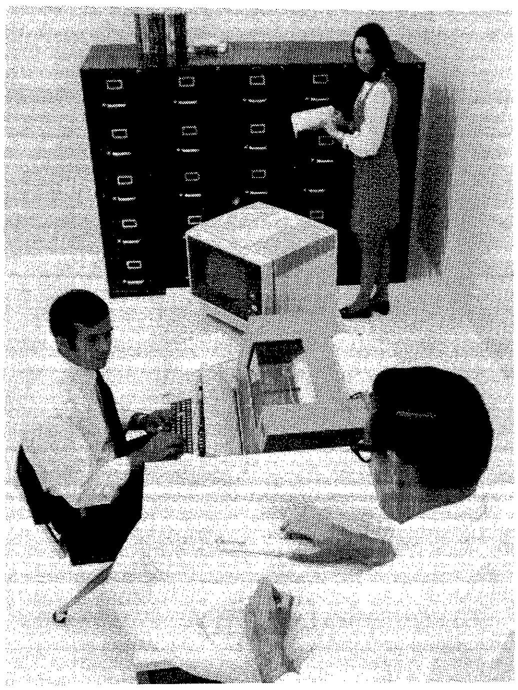
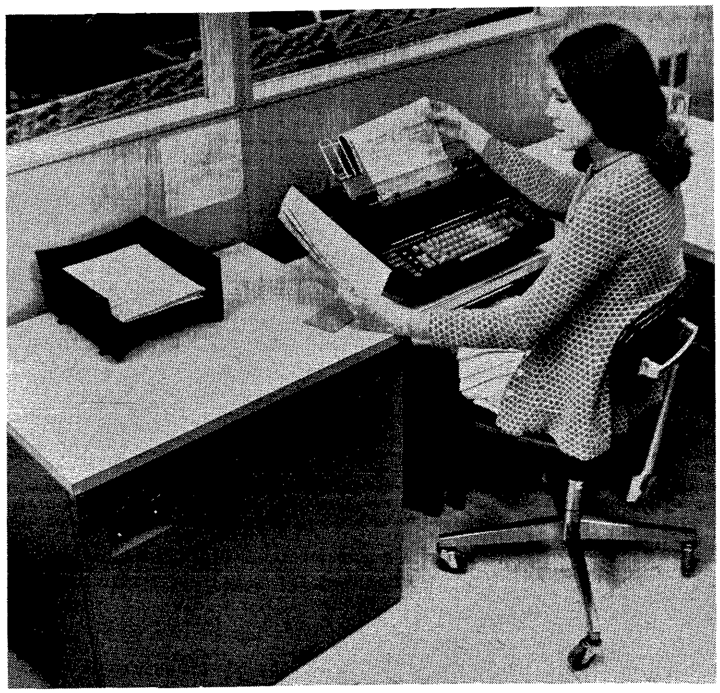
- Assign communications lines to each location, based on a cost analysis of the telephone network versus leased lines versus any other available facilities, taking into account any benefits from sharing leased lines.

From here on, many interations are usually required to evaluate the possible use of equipment from different vendors and alternate network arrangements. Probably the most uncertain factor is assurance that the lowest-cost communications facilities have been employed.

As you determine your data communications needs and evaluate various equipment components, DATAPRO 70 will form an invaluable aid in making your evaluations. Examine the contents of this service carefully to make sure that you derive the maximum benefit from it, and remember that our technical staff is always ready to help. □





Two ways to implement intelligent terminal capability by IBM. The IBM System/3 Model 6 on the left is a keyboard oriented version of the general purpose Model 10; an interface can be attached for communications with larger IBM computers. The 3735 Buffered Terminal on the right is a disk-based, record-oriented, programmable terminal primarily aimed at automating forms preparation.

All About Data Communications Facilities

The communications lines or services used to link distant points together are key elements of every data communications system. This report describes the facilities available from the various common carriers and provides guidance in selecting the best arrangements for your needs. Special emphasis is placed on the facilities offered by the emerging specialized common carriers. Numerous tables summarize the current rate structures for the public telephone network, leased lines, WATS, TWX, Telex, Telpak, and other facilities.

Communications facilities – the physical apparatus for carrying data signals from one point to another–and common carriers–the companies that build, maintain, and lease these facilities to the general public–have been doubly damned by data processing users ever since the first attempt was made to transmit data between two points not in the same room. On the one hand, users have viewed the existing communications facilities as obstacles to the development and implementation of new computer applications because of the high cost and poor quality of these facilities. On the other hand, the common carriers have been severely criticized for their seeming slowness to respond to the emerging specialized needs of computer users.

The accuracy of and justification for these complaints are for historians to contemplate. We are concerned with what is offered now and what will be offered in the foreseeable future for implementing data communications applications.

Over the years, a large and diverse array of communications facilities have been developed to meet the needs of the general public, business, the press, and broadcasters. For the "best interests" of everyone concerned, government regulation of the operations of the various facilities was instituted. Favored companies submitted to this regulation (they really had no choice) in return for an almost guaranteed rate of return on their invested capital. The guarantee is effected by granting rate increases when the rate of return declines.

Many different government agencies participate in this regulation–federal, state, and in some cases, city. Regulation takes the form of being able to postscribe services offered by the companies and rates charged for these services. Normally, the regulation is negative, i.e., defining what the companies cannot do, rather than forcing them into new areas. These regulated companies are called *common carriers.*

Much has been written and will continue to be written concerning the ethics and efficiency of the common carriers, especially giant AT&T. Criticism and praise have both been directed at the operations of this company, alternately lauding it for research developments such as the transistor and condemning it for "unfair" business practices. Contention exists between the users and the common carriers, between the equipment manufacturers and the common carriers, and among the various common carriers.

A frequently heard complaint against AT&T is the supposition that certain areas of its business are far more profitable than others, and that profits from these lucrative activities are being used to subsidize other areas. The problem, according to the complainers, is that the profitable areas are non-competitive (e.g., the public telephone network) and the subsidized areas are ones that have competitors, resulting in "unfair" competition. One such question between Western Union and AT&T, regarding their respective Telex and TWX networks, was neatly resolved when Western Union acquired TWX. Such questions are argued by batteries of lawyers and accountants.

In short, the situation is not an unusual one for a high-technology, fast-growing segment of the business world. However, it is much more visible than usual because it affects everyone so closely. Many businesses could not operate profitably–and some could not operate at all–without the vast array of communications services available today. But the demand for these services and applications seems to grow faster than the common carriers' capabilities to supply them.

This article is a survey of the facilities available today, along with helpful guidelines to aid you in selecting the best arrangement for your needs. It is not an exposé of the common carriers, but a straightforward description of the facilities and services they offer and the associated rates. From time to time, pending developments will be mentioned as they affect particular services.

Who are the common carriers?

The best-known common carriers are the telephone companies. Although there are a total of about 2000 telephone companies in the U.S., the various Bell System operating companies (almost all of which are principally owned by AT&T) and those of General Telephone and Electronics (GT&E) include the great majority of telephones within their geographical boundaries. (The Bell System alone has about 80 percent of all U.S. telephones.) Each telephone company furnishes services within an area no larger than a state. If you go outside the state over the telephone network, the only player is the Long Lines Division of AT&T. Fortunately, though, you don't have to

All About Data Communications Facilities

make separate arrangements with them—it's all included in the same call.

The other well-known common carrier is Western Union, which provides some of the same services as the telephone companies and a few unique ones, such as TWX/Telex.

The fight for viable alternatives to the offerings of the telephone companies and Western Union began about 10 years ago when MCI Communications Corporation asked for the privilege of building facilities competitive with the existing common carriers between Chicago and St. Louis. This privilege was granted in 1969. In 1971, the FCC threw open the doors for wide-scale competition. Since then, some 30 companies have announced their intentions of entering the business. Of these, six have gone far enough with their plans to merit active consideration. A separate section of this report, Specialized Common Carriers, describes the services offered and the geographical areas served by each of the six.

Throughout the remainder of this report, if a specific common carrier is not mentioned, both AT&T and Western Union supply the service mentioned. The services from AT&T are obtainable through your local telephone office, although not all offices offer the full range of services.

What kinds of facilities are available?

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, typified by teletypewriters; medium-speed or voice-grade, typified by the public telephone network; and high-speed, typified by the relatively high-priced Telpak services. 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, such as Telpak, can be broken down and used as multiple channels of lower capacity.

System arrangements take two forms: switched network and point-to-point. Switched networks are typified by the public telephone network and the TWX/Telex low-speed networks. Point-to-point arrangements are typified by various leased lines.

In a *switched network,* there are fewer lines than users. The expectation is that not all users will want to use the network at the same time. Typically, several exchanges are present in the network; this allows alternate routing paths for a call, adding to the probability of getting a call through. The telephone companies have been making strenuous noises lately about the impact of data processing users on the degree of service afforded by the public telephone network. It seems that the typical data processing call (e.g., by a time-sharing user) lasts longer than the typical voice call, resulting in a decrease in the probability of getting calls through. The telephone companies maintain that data processing users should therefore pay additional charges to support the added equipment required to restore the previous level of service. So far, no such plan has stuck.

Point-to-point systems use a dedicated line between communicating points. 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, and there is contention among the stations for use of the line. In a sense, a multi-point line constitutes a mini-network without any switching exchanges.

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

Traditional common carriers

The three most commonly thought-of communications facilities today are (1) the public telephone network, (2) WATS, and (3) leased voice-band lines. The first order of business is to explore these facilities and present some helpful comparative information to assist you in selecting the best compromise for your needs.

The public telephone network

The ubiquitous telephone lines are usually the first choice of those who need to intercommunicate among business locations, mainly because they are there. Essentially no network planning is required—only identification of the communicating points. Direct distance dialing (DDD) and numerous exchanges, which allow automatic seeking of alternate paths, make placing calls a simple, speedy task. New locations can be added to your own set of intercommunicating points at will, without a great deal of preplanning of communications facilities.

Table 1 summarizes the current rates for interstate calls. Note that the cost of a call depends on distance, length of call, and time of day when the call is placed. The bottom portion of Table 1 shows the times of day when the four rate classes are applicable on each day of the week. There are 21 different rate groups, depending on distance. Over half of these groups (11) apply to distances of less than 150 miles. For calls within your own state (intrastate), it is best to contact your local telephone office, as these rates are highly variable from state to state.

All About Data Communications Facilities

Table 1
Illustrative Long-Distance Telephone Rates

Day: First 3 min.	Day: Add'l min.	Evening: First 3 min.	Evening: Add'l. min.	Night: First min.	Night: Add'l. min.	Weekends: First 3 min.	Weekends: Add'l min.
0.17	0.05	0.13	0.04	0.10*	0.03	0.10	0.03
0.23	0.07	0.17	0.05	0.10**	0.04	0.14	0.04
0.30	0.08	0.24	0.05	0.10	0.05	0.20	0.05
0.35	0.10	0.28	0.08	0.10	0.05	0.20	0.05
0.40	0.12	0.32	0.09	0.12	0.07	0.26	0.07
0.50	0.14	0.36	0.10	0.14	0.08	0.30	0.08
0.55	0.16	0.40	0.10	0.15	0.09	0.33	0.09
0.60	0.17	0.40	0.10	0.15	0.10	0.35	0.10
0.65	0.19	0.40	0.10	0.15	0.10	0.35	0.10
0.70	0.20	0.45	0.14	0.15	0.10	0.35	0.10
0.75	0.22	0.50	0.15	0.20	0.13	0.46	0.13
0.80	0.23	0.55	0.15	0.20	0.14	0.48	0.14
0.80	0.24	0.55	0.15	0.20	0.14	0.48	0.14
0.85	0.25	0.55	0.15	0.20	0.15	0.50	0.15
0.90	0.27	0.55	0.15	0.20	0.15	0.50	0.15
0.95	0.29	0.60	0.20	0.20	0.15	0.50	0.15
1.05	0.32	0.60	0.20	0.20	0.15	0.50	0.15
1.15	0.35	0.65	0.20	0.20	0.15	0.50	0.15
1.25	0.39	0.70	0.20	0.25	0.20	0.65	0.20
1.35	0.42	0.75	0.25	0.25	0.20	0.65	0.20
1.45	0.46	0.85	0.25	0.35	0.20	0.70	0.20
8 AM-5 PM		5 PM-11 PM		11 PM-8 AM		–	
–		–		11 PM-8 AM		8 AM-11 PM	
–		5 PM-11 PM		11 PM-8 AM		8 AM- 5PM	

Miles (Interstate)	Day	Eve.	Night/ Wknds.
0–10	$3.00/hr.	$2.40/hr.	$1.80/hr.
10–16	$4.20/hr.	$3.00/hr.	$2.40/hr.
16–22	$4.80/hr.		
22–30	$6.00/hr.	$4.80/hr.	
30–40	$7.20/hr.	$5.40/hr.	$4.20/hr.
40–55	$8.40/hr.		$4.80/hr.
55–70	$9.60/hr.	$6.00/hr.	$5.40/hr.
70–85	$10.20/hr.		
85–100	$11.40/hr.		
100–124	$12.00/hr.	$8.40/hr.	
124–148	$13.20/hr.		$7.80/hr.
148–196	$13.80/hr.		$8.40/hr.
196–244	$14.40/hr.		
244–292	$15.00/hr.	$9.00/hr.	
292–354	$16.20/hr.		
354–430	$17.40/hr.		
430–675	$19.20/hr.		
675–925	$21.00/hr.		
925–1360	$23.40/hr.	$12.00/hr.	
1360–1910	$25.20/hr.	$15.00/hr.	
1910–3000	$27.60/hr.		
Mon.-Fri.	8 AM-5 PM	5 PM-11PM	11PM-8 AM
Sat.	–	–	All day
Sun	–	5 PM-11PM	11PM-5 PM

* First three minutes.
** First two minutes.

Above rates are based on station-to-station calls.

At the right side of Table 1 is a "quick approximator" that will allow you to make quick cost estimates with a reasonable degree of accuracy. This chart is derived by ignoring the premium attached to the first three (or two or one) minutes. Because most data calls are substantially longer than three minutes, the error incurred in doing this is usually small.

While a road atlas will not give exact interexchange distances, which are the basis for the rates, it will yield sufficiently accurate distances for a close approximation during the study phase of planning your communications facilities.

The chief considerations in using the public telephone network for your communications needs are cost and quality. As a further aid, comparative costing information will be presented later.

Worries about quality stem from the many diverse facilities used in the network and the non-predictability of the path to be used. The network has grown in piecemeal fashion over a period of years, leading to the use of a great diversity of equipment to implement it. The nature of the network, which automatically seeks alternate routings when the prime paths are tied up, means that you can never be sure exactly what path the signals are traveling. (There are cases on record where alternate routing caused diversions of several thousand miles; amplification equipment prevents a loss in signal strengh, but usually introduces additional distortions.)

These uncertainties dictate the use of a lower speed over the telephone network than over a similar, but dedicated communications facility. The reason lies in predictibility. The more that is known about the content of a message and the facilities over which it travels, the fewer information bits have to be transmitted to convey the intended information. A common example of this is the use of formatted data; identification of each field need not be included because the intent of each data item is known due to its position in the record. Interpretation of electrical signals presents a parallel. The more that is known about the transmission path, the smaller the proportion of the signal that must be used for non-data information.

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Table 2
Selected WATS Rates: Intrastate and Interstate Zones 1, 2, and 3

State or Segment Area Codes Principal City	Intrastate Rates, $/mo.	Interstate Rates, $/month		
		Zone 1	Zone 2	Zone 3
California-N 209 408 415 707 916 San Francisco	Statewide: 125 hr. - 900 Add'l. hr. - 6 15 hr. - 330 Add'l. hr. - 19 N or S: 125 hr. - 650 Add'l. hr. - 4.50 15 hr. - 260 Add'l. hr. - 14	ID NV OR UT WA 1070/F 215/M 16.10/A	AZ CO MT WY 1375/F 245/M 18.50/A	IA KS NE NM ND OK SD TX 1685/F 295/M 22.00/A
California-S 213 714 805 Los Angeles		AZ NE NM OR UT 1175/F 225/M 16.80/A	CO ID TX-W WA WY 1480/F 255/M 19.20/A	IA KS MT NE ND OK SD TX-E TX-S 1685/F 295/M 22.00/A
Georgia 404 912 Atlanta	Full - 550 15 hr. - 250 Add'l. hr. - 15	AL FL KY MS NC SC TN 765/F 185/M 13.80/A	AR IL-S IN LA OH-S VA WV 1070/F 215/M 16.10/A	DE DC IL-N MD MI MO NJ OH-N PA 1275/F 235/M 17.60/A
Illinois-N 309 312 815 Chicago	Full - 625 15 hr. - 212.50 10 hr. - 155 Add'l. hr. - 11.50	IN IA MI-S WI 665/F 175/M 13.10/A	KY MI-N MN MO OH TN 865/F 195/M 14.50/A	AL AR GA KS MS NE NC OK PA VA WV 1175/F 225/M 16.80/A
New York-SE 212 516 914 New York City	Full - 863.92 15 hr. - 318.99 Add'l. hr. - 17.94	CT DE MA NH NJ PA-E RI VT 510/F 135/M 10.20/A	DC ME MD OH PA-W VA WV 970/F 205/M 15.30/A	GA IL IN KY MI NC SC TN WI 1275/F 235/M 17.60/A
Texas-S 512 Houston	Full - 815 15 hr. - 320 10 hr. - 220 Add'l. hr. - 20	AR KS LA MS NM OK 1175/F 225/M 16.80/A	AL AR CO MO 1375/F 245/M 18.50/A	GA IL IN IA KY NE SD TN UT WY 1480/F 255/M 19.20/A

See Table 4 for state abbreviations.

Information in each box shows:
States and/or segments of states in the zone.
Rate for full-time service, $/month (indicated by /F).
Rate for Measured Time service, $/month for first 10 hours (indicated by /M).
Rate for each additional hour of Measured Time service (indicated by /A).

The traditional limit of the telephone network has been 2000 data bits per second, whereas the limit for a similar leased line has been 2400 bits per second. Recently, these limits have been pushed up to 4800 bits per second on the public telephone network and 9600 bits per second on leased lines. This latter speed approaches the theoretical limit of the channel—according to current theory, anyway.

WATS

Wide Area Telephone Service (WATS) is a plan for using the public telephone network under a different rate structure than in conventional usage. Basically, you rent one access line and are permitted to make as many calls as you wish within a designated area for just one monthly charge. You can obtain Outward WATS (unlimited outgoing calls) or Inward WATS (unlimited incoming calls), but not both on the same trunk.

Interstate WATS breaks the country up into six geographical areas centered around the location of the WATS user's access line. Each area contains about the same number of telephones; the state containing the WATS access line is not included. Ascending monthly charges are applied to the zones; selecting a zone automatically includes all of the closer (lower-numbered) zones.

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Table 3

Selected WATS Rates: Interstate Zones 4, 5, and 6

State or Segment	Interstate Rates, $/month		
	Zone 4	Zone 5	Zone 6
California-N	AR IL IN LA MI MN MS MO WI 1785/F 305/M 22.80/A	AL FL GA KY NC OH SC TN VA WV 1885/F 315/M 23.70/A	CT DE DC ME MD MA NH NJ NY PA RI VT 1940/F 320/M 24.10/A
California-S	AR IL IN LA MI MN MS MO WI 1785/F 305/M 22.80/A	AL FL GA KY NC OH SC TN VA WV 1885/F 315/M 23.70/A	CT DE DC ME MD MA NH NJ NY PA RI VT 1940/F 320/M 24.10/A
Georgia	CT IA MA NY OK RI TX WI 1480/F 255/M 19.20/A	CO KS ME MN NE NH NM ND SD UT VT WY 1630/F 285/M 21.30/A	AR CA ID MT NV OR WA 1885/F 315/M 23.70/A
Illinois-N	DE DC LA MD NJ NY ND SC SD 1375/F 245/M 18.50/A	CO CT RL ME MA MT NH NM RI TX VT WY 1480/F 255/M 19.20/A	AZ CA ID NV OR UT WA 1735/F 300/M 22.40/A
New York-SE	AL AR FL IA KS LA MN MS MO NE SD 1580/F 275/M 22.60/A	CO MT NM ND OK TX WY 1735/F 300/M 22.40/A	AZ CA ID NV OR UT WA 1940/F 320/M 24.10/A
Texas-S	FL MI MN NV NC ND OH SC WV WI 1580/F 275/M 20.60/A	CA DC ID MT PA VA 1685/F 295/M 22.00/A	CT DE ME MD MA NH NJ NY OR RI VT WA 1735/F 300/M 22.40/A

See Table 4 for state abbreviations.

Information in each box shows:
- States and/or segments of states in the zone.
- Rate for full-time service, $/month (indicated by /F).
- Rate for Measured Time service, $/month for first 10 hours (indicated by /M).
- Rate for each additional hour of Measured Time service (indicated by /A).

For organizations that can get by with a lesser degree of "unlimited" usage, Measured Time WATS is available. This works just like full-service WATS, except that the basic monthly charge allows only a total of 10 hours of call time. Overtime is charged on an hourly basis.

The majority of WATS applications are not for data. Prime examples include land developers' sales calls (Outward WATS) and free reservation calls (Inward WATS).

Tables 2 and 3 present the geographical WATS zones for a selected number of states, along with complete rate information for both interstate and intrastate arrangements. These tables use the new two-letter post office state abbreviations, as listed in Table 5.

Probably the most striking aspect of the WATS rate structures is their lack of regular patterns (or symmetry). For example, New York is in Zone 4 from Illinois, but Illinois is in Zone 3 from New York. Some states are divided into several areas according to area codes. (These divisions are also included in Table 5.) Occasionally the different parts of a state fall into different zones; sometimes there can be a two-zone difference between the parts of a state, depending on the location of the access line. Also, the charges per zone vary from state to state with no readily apparent pattern. There are a total of 58 separate geographical entities in the continental U.S., including the divided state areas and the District of Columbia. For intrastate WATS each state is an entity except California, where users can differentiate between the north and south segments.

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Table 4
WATS Rates: Ranges

Zone	Full-Time, $/mo.	Measured-Time, $/mo.	
		First 10 hours	Additional hour
1	510 – 1175	135 – 225	10.20 – 16.80
2	665 – 1480	175 – 255	13.10 – 19.20
3	1070 – 1685	215 – 295	16.10 – 22.00
4	1275 – 1785	235 – 305	17.60 – 22.80
5	1480 – 1885	255 – 315	19.20 – 23.70
6	1685 – 1990	295 – 325	22.00 – 24.50

Actually, there is a pattern. It follows the cost/distance relationship of the regular telephone charges, taking into account the approximately even distribution of the number of telephones in each WATS zone. Table 4 shows the range of monthly charges over the entire U.S. for each zone. A state centrally located in a populous area would have low Zone 1 and low Zone 6 charges; Northern Illinois (Chicago) is such an example ($665 per month and $1,735 per month, respectively). A centrally located state, such as southern Texas, in a sparsely populated area would have high Zone 1 and low Zone 6 charges ($1,175 and $1,735). On the other hand, a coastal state within a populous area, such as southeastern New York, would have low Zone 1 and high Zone 6 charges ($510 and $1,940). The least fortunate is the coastal state in a sparsely populated area, such as Washington; this state has high Zone 1 and high Zone 6 charges ($1,175 and $1,940).

Leased voice lines

There are many different types of voice lines that can be leased. The one intended for data is Type 3002, available from both AT&T and Western Union.

The charges for this type of line, as shown in Table 6, include the basic monthly line charges, termination charges (Service Terminals), and conditioning charges. The Service Terminal charge applies to each exchange which you enter with a terminal. For example, a two-point line connecting a pair of communications terminals in different exchanges would incur two Service Terminal charges. An additional exchange Service Terminal charge would be incurred for each communications terminal you added along the way that operated into a different exchange. If you had two or more terminals sharing a line and operating out of the same exchange, a reduced charge would apply to each additional terminal.

Conditioning refers to adjusting the electrical characteristics of the transmission path to control certain types and levels of distortion. Different charges are applied to different terminal arrangements. In Table 6, "arranged for switching" means that multiple terminals at one location can be alternately connected to the line. Some terminals can recognize their own addresses from characters in the data stream and do not require a switched arrangement. A multi-point line in Table 5 refers to connecting the terminals to more than two exchanges over the path of the line. What conditioning you will require is determined principally by the modems you select. *All About Modems,* DATAPRO 70 Report 70G-500-01, includes a survey of Bell System and independent modems along with their conditioning requirements, if any.

AT&T has been investigating the possibilities of a rate restructuring for leased voice-grade lines to make it more competitive with the new specialized common carrier offerings. Permission for such a plan was given in the original FCC decision in 1971 that opened the doors for these carriers. However, rates must be based on actual costs, and other services cannot be used to subsidize services in those areas where AT&T faces competition. Many plans have been advanced, including a bulk rate offering that gave substantial discounts to users of more than 250,000 total route-miles of lines.

The latest plan announced by AT&T identifies high- and low-density areas. Costs for high-density areas would be substantially less than for low-density areas, with a constant rate per mile in place of today's progressive rate structure. (Not surprisingly, it is the high-density routes that are seeing the majority of action by the specialized carriers.) This plan includes a charge of $0.85 per mile per month between high-density areas and $2.50 per mile per month between low-density areas. Short-haul distances (25 miles or less) would cost the same as the present rate ($3 per mile per month). There would be two termination charges in place of the present one. For high-density areas, these would be $35 for the channel terminal and $25 for the station terminal. Corresponding low-density charges would be $15 and $25. Short-haul charges would be $3 and $15. Line charges for a connection between a high- and low-density area would be at the low-density rate.

As of this writing, this plan has not been officially filed as a tariff, and it is not known when or if it will be, or whether still another plan might be proffered.

Western Union has, on the other hand, filed and gained approval for reduced rates along the path from St. Louis to Chicago that match MCI's rates along the same route. (MCI's offerings and rates are discussed under Specialized Common Carrier Facilities.)

The prognosis is that there will be continued rate activity by AT&T and Western Union as time progresses and the physical plants of the specialized common carriers are expanded.

Leased lines vs. DDD vs. WATS

Differences in rate structures—flat monthly charges for leased lines and full-service WATS as compared with measured time charges for DDD and Measured Time WATS service—make decisions about which communica-

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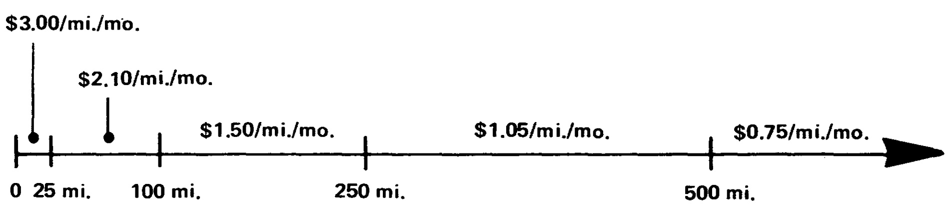
Table 5
State Abbreviations and Segmented State Area Codes (WATS)

AL	Alabama	MD	Maryland	OH-S	Ohio (513 614)
AR	Arkansas	ME	Maine	OK	Oklahoma
AZ	Arizona	MI-N	Michigan (906)	OR	Oregon
CA-N	California (209 408 415 707 916)	MI-S	Michigan (313 517 616)	PA-E	Pennsylvania (215 717)
CA-S	California (213 714 805)	MN	Minnesota	PA-W	Pennsylvania (412 814)
CO	Colorado	MO	Missouri	RI	Rhode Island
CT	Connecticut	MS	Mississippi	SC	South Carolina
DC	District of Columbia	MT	Montana	SD	South Dakota
DE	Delaware	NC	North Carolina	TN	Tennessee
FL	Florida	ND	North Dakota	TX-E	Texas (214 713 817)
GA	Georgia	NE	Nebraska	TX-S	Texas (512)
IA	Iowa	NH	New Hampshire	TX-W	Texas (806 915)
ID	Idaho	NJ	New Jersey	UT	Utah
IL-N	Illinois (309 312 815)	NM	New Mexico	VA	Virginia
IL-S	Illinois (217 618)	NV	Nevada	VT	Vermont
IN	Indiana	NY-NE	New York (315 518 607)	WA	Washington
KS	Kansas	NY-SE	New York (212 516 914)	WI	Wisconsin
KY	Kentucky	NY-W	New York (716)	WV	West Virginia
LA	Louisiana	OH-N	Ohio (216 419)	WY	Wyoming
MA	Massachusetts				

Table 6
Illustrative Rates for a Leased Voice-Grade Line



Additive Factors—
- Service Terminals—
  - First station: $15/month
  - Additional station, same exchange: $10/month
  - Installation, each station: $50
- C1 Conditioning—
  - 2 point, no switching: $5/mo./exchange
  - 2 point, arranged for switching: $10/mo./exchange
  - Multipoint: $10/mo./exchange
- C2 Conditioning—
  - 2 point, no switching: $19/mo./exchange
  - 2 point, arranged for switching: $28/mo./exchange
  - Multipoint: $28/mo./exchange
- C4 Conditioning—
  - 2 point channel, first station each exchange: $30/month
  - 3 point channel, first station each exchange: $36/month
  - Additional station in same exchange: $9.75/month
- Full Duplex: 10 per cent additional for line charges and Service Terminals; no additional charge for conditioning.

Typical Line Charges

Miles	$/month
50	127.50
100	232.50
250	457.70
500	720
1000	1095
1500	1470
2000	1845
2500	2220
3000	2595

Note: New rates may be imminent; see text.

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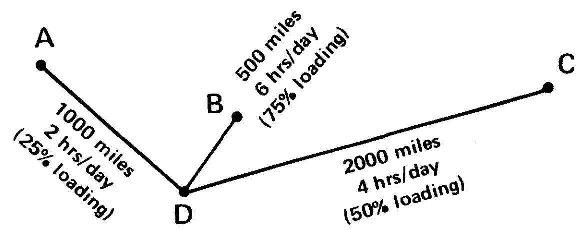
tions facility to use cumbersome and difficult. But such calculations may well save you a great deal of money. Table 7 presents comparative information on these services for a selected set of conditions. In keeping with sound analytical practices, unit costs are presented. In this case, dollars per hour of transmission was chosen as the display parameter.

The entries under "Leased Line" show the cost for a two-point line including Service Terminal charges, but no conditioning charges. The percentage figures refer to the degree of loading during a one-shift, five-day-a-week operation.

The entries under DDD reflect the effect of Evening and Night rates under second and third shift costs.

To work out a complete comparative analysis of a projected communications system, Table 7 makes a useful base to draw information from.

Consider, for example, the problem of connecting points A, B, and C to a common center, D, via suitable communications facilities, as shown below.



Drawing on Table 7, the cost comparison shown in Table 8 can be constructed. It shows clearly the impossibility of picking one class of facility as being the best for all situations. As distances and loadings vary, the most economical solution can vary. Even then, the lowest cost solution may not be the best.

Table 7
Illustrative Comparison Among Leased Line/DDD/WATS

Miles, Interstate	Leased Line 3002 (1) 1 Shift			DDD (2) $/hr.			Full-Service WATS (3) 1 Shift			Measured Time WATS (3) 1 Shift		
	$/hr, 75%	$/hr, 50%	$/hr, 25%	1st Shift	2nd Shift	3rd Shift	$/hr, 75%	$/hr, 50%	$/hr, 25%	$/hr, 75%	$/hr, 50%	$/hr, 25%
50	1.17	1.76	3.52	8.40	5.70	5.25	3.91	5.86	11.72	10.45	10.58	10.96
100	1.97	2.96	5.92	11.40	6.00	6.68	3.91	5.86	11.72	10.45	10.58	10.96
250	3.69	5.54	11.08	15.00	9.00	9.75	5.86	8.79	17.59	14.16	14.34	14.88
500	6.37	9.56	19.12	19.20	11.25	10.28	9.00	13.51	27.00	17.24	17.46	18.11
1000	8.59	12.88	25.76	23.40	12.00	13.43	11.34	17.01	34.02	19.68	19.92	20.65
1500	11.47	17.20	34.40	25.20	14.25	13.65	12.91	19.37	38.74	22.57	22.86	23.72
2000	14.33	21.50	43.00	27.60	14.25	13.95	14.44	21.67	43.33	24.30	24.60	25.49
2500	17.08	25.62	51.24	27.60	14.25	13.95	14.44	21.67	43.33	24.30	24.60	25.49
3000	20.25	30.38	60.76	27.60	14.25	13.95	14.44	21.67	43.33	24.30	24.60	25.49

(1) Based on 2-point line; figures include two Service Terminals and no conditioning. The loading figures (75, 50, 25%) refer to the actual transmission time during one eight-hour shift; 75% utilization represents 130.5 hrs./month of transmission; 50%, 87 hrs./mo.; 25%, 43.5 hrs./mo.; a full shift is 174 hours per month. To calculate the appropriate unit cost for another loading, simply divide by the ratio of hours. For example, to calculate cost at 100% loading for one shift, divide the 50% figure by 2. To calculate cost for two-shift operation, with 50% loading over the entire two-shift operation, divide the 50%, one-shift figure by 2.

(2) First shift is assumed as 9AM to 5PM; second shift, as 5PM to 1AM; third shift, as 1AM to 9AM. Allowance is made for Day, Evening, and Night rates for transmission evenly distributed over the whole shift.

(3) Based on rates with Philadelphia, Pennsylvania as the center. City-to-city points used were:

Philadelphia to:	Zone	Distance, miles	Full time	Measured time First 10 hrs.	Each add. hr.
Baltimore, Maryland	1	90	$ 510/mo.	$135/mo.	$10.20
Providence, Rhode Island	2	235	765	185	13.80
Dayton, Ohio	3	480	1175	225	16.80
Minneapolis, Minnesota	4	985	1480	255	19.20
San Antonio, Texas	5	1503	1685	295	22.00
Phoenix, Arizona	6	2076	1885	315	23.70
San Francisco, California	6	2515	1885	315	23.70

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Table 8
Cost Comparison For Selected Points*

Communicating points	Distance, miles	Loading factor	Cost, $/hr.						Least Expensive Choices			Highest Cost Service	Ratio, highest to lowest cost
			Leased line	DDD			WATS		First	Second	Third		
				Shift 1	Shift 2	Shift 3	Full	Meas.					
D-A	1000	25%	25.76	23.40	12.00	13.43	34.02	20.65	DDD/2	DDD/3	WATS-M	WATS-F	2.8
D-B	500	75%	6.37	19.20	11.25	10.28	9.00	17.24	Leased	WATS-F	DDD/3	DDD/1	3.0
D-C	2000	50%	21.50	27.60	14.25	13.95	21.67	24.60	DDD/3	DDD/2	Leased	DDD/1	2.0

*See text for description of problem.

Two other considerations are flexibility and availability. 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 by simply walking up to it with a portable terminal and placing the handset in the telephone coupler.

The foregoing seems to indicate that DDD is an ideal solution to communications problems. In a sense, it corresponds to renting business equipment rather than purchasing it. Renting normally means higher costs, but the added dimension of flexibility often justifies this. For the communications system where all calls are initiated by outlying points, this may indeed state the whole case. But in the case where the computer initiates a significant portion of the calls, flexibility takes on a different meaning.

A major characteristic 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 the Bell System 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 (which might just mean that somebody kicked out a plug).

Alternatives

The three facilities already discussed—leased voice lines, DDD, and WATS—are the most widely used for computer-oriented data communications. The great majority of the available terminal devices operate over these facilities, and almost all of the available independent modems are oriented toward these facilities. However, many other facilities are available. These will be discussed by capacity; i.e., low-speed, medium-speed (or voice-grade), and high-speed. It's worth noting that some of the high-speed facilities can be channelized into multiple low-speed channels.

Low-Speed Facilities

This group includes all those facilities with insufficient capacity to carry a human voice intelligibly. They are chiefly used to provide communications via teletypewriters. As in the case of voice-grade transmission, both leased lines and switched networks are available.

The leased lines are the series 1000 lines available from both Western Union and AT&T. Table 9 summarizes the current rates for low-speed leased lines.

The TWX and Telex services are independent networks, both now operated by Western Union. Basically, they operate much like the public telephone network, with connections being established through dialing, but intercommunication is through teletypewriters rather than voice. Western Union currently provides a service that permits Telex subscribers to have messages relayed to TWX subscribers, but not the other way. The reason why the two networks coexist is that TWX was originally developed and operated by AT&T.

Telex and TWX are used primarily for transmitting business communications other than data and are commonly used by many business concerns. For the data processing user, a computer or other business machine can be connected to the Telex or TWX network in place of teletypewriters rented from the carrier.

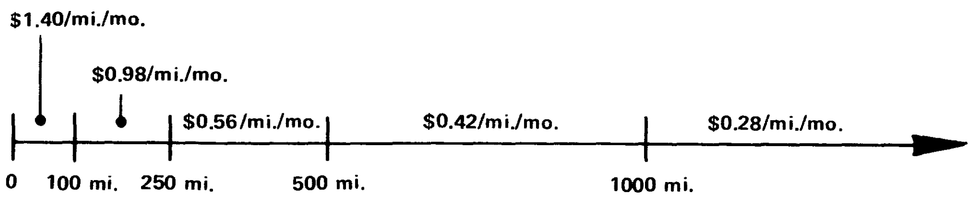
TWX provides two classes of service: 60 speed and 100 speed. These refer to traditional teletypewriter speeds of 60 words per minute (6 characters per second or 45 bits per second) and 100 words per minute (10 characters per second or about 100 bits per second). Some intercommunication can be arranged between the two classes through speed and code conversion equipment located in some exchanges.

The charges for TWX include a monthly charge for each station plus charges for each message transmitted. Station charges range from $30 per month (when the customer supplies his own equipment) to $120 per month for a Teletype Model 35 ASR-equipped station (100 speed). One of the most popular terminals, the Model 33 ASR, goes for $65 per month. Message transmission charges are based on distance and connect time; they range from a

All About Data Communications Facilities

Table 9
Illustrative Rates for Low-Speed Leased Lines

Type 1002
55 bits/sec



Type 1005: 75 bits/sec — Type 1002 rates plus 10%.

Type 1006: 150 bits/sec — Type 1002 rates plus 25%.

Additive Factors—
- Service Terminals—
  - First station, each exchange:
    - Type 1002: $25/month
    - Type 1005: $27.50/month
    - Type 1006: $31.25/month
    - Installation: $50 per station
  - Additional stations, same exchange:
    - Type 1002: $7.50/month
    - Type 1005: $8.25/month
    - Type 1006: $9.38/month
    - Installation, each station: $50
- Station Arrangement, each exchange—
  - Type 1006 only: $13.75/mo.; no additional charges for multiple station stations in one exchange.
- Full Duplex—
  - 10 per cent additional applied to line charges and Service Terminals; applies to Types 1002, 1005, and 1006.

Typical Line Charges, $/month

Miles	1002	1005	1006
50	70.00	77.00	87.50
100	140.00	154.00	175.00
250	287.00	315.00	358.75
500	427.00	469.70	533.75
1000	637.00	700.00	796.25
1500	777.00	854.70	971.25
2000	917.00	1008.70	1156.25
2500	1057.00	1162.70	1321.25
3000	1197.00	1316.70	1496.25

low of $0.20 per minute ($12 per hour) to $0.70 per minute ($42 per hour), depending on distance. Typically, charges are much higher than for DDD, which may explain why data processing users are not beating down the doors for connection to the TWX network.

Telex charges also include a monthly station charge and message charges. A station costs $50 per month and includes a Model 32 KSR. A station with a 32 ASR costs $65 per month. The country is divided into 12 geographical rate areas roughly equivalent to the classical division into New England, South East, South Central, etc. Charges run from $0.175 per minute ($10.45 per hour) to $0.60 per minute ($36 per hour)—again substantially higher than DDD.

A number of rather sophisticated services are available with TWX to ease your message transmission operations. For example, you can type in a list of subscribers (up to 100), and your message will be automatically transmitted to each one without your having to dial each number. Collect calls can be made. Automatic redialing can be provided if the station you are trying to reach is busy the first time. Telegrams and low-cost Mailgrams can be entered from your terminal, bypassing the local Western Union office. A switch can be installed to allow use of your Western Union teleprinter alternately on the TWX network and the public telephone network.

On a straight cost basis, it is difficult to justify the use of TWX or Telex for computer-oriented data communications. However, either system does provide a convenient capability for relaying business messages within or between companies when personal contact is not required. For this type of communications, the additional cost over DDD is often justified because expensive personnel time is not tied up trying to establish calls and transfer information. The written record, a natural output of the system, is also more reassuring than notes made during telephone calls.

All About Data Communications Facilities

Both AT&T and Western Union offer facilities for multiplexing multiple low-speed lines over a customer-provided (leased) voice-grade line. AT&T's service goes under the name Datrex, and Western Union calls its service Datacom.

Datrex is available as a multiplexor or concentrator/multiplexor system. As a straight multiplexor system, up to seventeen 75-bps lines can be combined onto a single 3002 voice-grade line through frequency-division multiplexing. Alternatively, a pair of 75-bps connections can be replaced by one 150-bps connection; the maximum capacity in this configuration is eight 150-bps lines and one 75-bps line. In addition to the low-speed and voice-grade line costs, charges include the multiplexor and Service Terminals. Multiplexor charges are $180 per month for the first three channels and $30 per month for each additional channel, irrespective of speed. Installation charges are $200 for the first three channels and $100 for each additional channel. Service Terminal charges are $3.75 per month for each station on the same premises as the multiplexor or $17 per month for each station in the same exchange area as the multiplexor; additional charges apply if the stations are outside the multiplexor exchange area.

The Datrex concentrator/multiplexor provides for terminating up to 128 150-bps lines at up to 32 input trunks. Open trunks are automatically sought for multiplexing up to 32 through connections at the rate of 8 low-speed lines per 3002 voice-grade line. In addition to low-speed and voice-grade line charges, charges are applied for the concentrator, the multiplexor, and Service Terminals. Low-speed line groups can be 32, 64, 96, or 128 lines. Terminating trunks can be 8, 16, or 32, corresponding to 1, 2, or 4 voice-grade lines. Concentrator costs are $79 per month for 32 lines terminating in 8 trunks; an additional $24 per month is charged for each additional group of 32 low-speed lines. For 32 lines terminating in 16 trunks, the charge is $94 per month, with each group of 32 additional low-speed lines costing $34 per month. For 32 lines terminating in 16 trunks, the charge is $125 per month for the concentrator and an additional $63 per month for each group of 32 lines. Installation charges range from $100 to $625. The multiplexor charges are $144 per month for the first three channels and $30 per month for each additional channel; derived channels can be up to the number of trunks available. Service Terminal charges are $1.00 per month for each input line and $1.75 per month for each trunk; charges for the multiplexor stations are the same as for the multiplexor-only service. Both versions of the Datrex service operate over two-point voice lines.

Datacom is a flexible method of multiplexing low-speed lines operating at 75 to 1200 bps over customer-provided 3002 voice-grade lines. Charges are highly complex and depend on the maximum speed employed, number of lines, two- or three-point service, number of stations per exchange, number of stations per premise, and half- or full-duplex operation. For example, up to twelve 150-bps lines can be multiplexed over a voice-grade line. For this service, the charges are a base equipment charge of $400 per month (two-point) or $600 per month (three-point); $33 (two-point) or $50 (three-point) per month for each of the first 6 lines and $10.50 (two-point) or $16 (three-point) per month for each of the next 6 lines; and $45 (half-duplex) or $48.10 (full-duplex) for the station termination. In addition, there are small charges for additional stations and channel drops, installation charges, and line costs. There are transmission code restrictions for each allowable speed; speeds and codes include 75 bps (Baudot); 110 bps (ASCII); 135 bps (BCD); 150 bps (ASCII); and 300, 600, and 1200 bps (ASCII, BCD, or Baudot).

Alternate voice-grade facilities

Western Union's Broadband Exchange Service has never lived up to its original intent of providing a wide range of transmission speeds which are priced according to speed and available to the user simply by dialing a code for the speed desired. So far, only 2KC (600 bits per second) and 4KC (2400 bits per second) facilities are available. One of the notable things about the Broadband Exchange Service, however, is the high quality of the lines. Exchanges are located in about 45 or the major U.S. cities, and links to Canada and some other foreign countries are available through the Datel service.

Charges for the Broadband Exchange Service include a monthly charge for the speed of service used and message charges. The basic service costs $15 per month for the 2KC service and $30 per month for the 4KC service, plus a $25 installation charge in both cases. Alternate voice/data communication is permitted. Message charges for the 2KC service begin at $0.15 per minute ($9 per hour) for distances up to 100 miles. Incremental increases of $0.05 per minute apply at mileage breakpoints of 100, 200, 300, and 600 miles; the incremental increase at 1000, 1600, and 2300 miles is $0.10. The maximum 2KC message charge is $0.65 per minute ($39 per hour). Message charges for 4KC service begin at $0.20 per minute ($12 per hour) for distances of up to 100 miles. Incremental increases of $0.05 per minute apply at mileage breakpoints of 100, 200, 300, and 600 miles; a $0.15 per minute increment applies at over 1000 miles; increments of $0.10 apply at mileage breakpoints of 1600 and 2300 miles. The maximum message charge for 4KC service is $0.75 per minute ($45 per hour). Time is charged in multiples of 0.1 minute.

Western Union also provides 600 and 1200 bit-per-second derived facilities in its Datacom service, which is discussed under Low-Speed Facilities.

Other voice-band facilities are available as channels derived from high-speed facilities.

All About Data Communications Facilities

High-speed facilities

For high-speed transmission (about 20,000 bits per second and up) or groups of voice/low-speed lines between the same points, a number of services are offered. Series 5000 leased lines, also known as Telpak C and D, and Series 8000 leased lines, also known as Wideband Data Channels, are available from both AT&T and Western Union. A limited switched network, AT&T's Dataphone 50 service, is also available on a severely restricted geographical basis.

Two services are available in the 5000 Series channels. Type 5700 has a nominal bandwidth of 240 KC; it can be subdivided into 60 voice channels or 120 low-speed channels (2 per voice channel) suitable for teletypewriters. Type 5800 has a nominal bandwidth of one megacycle and can be subdivided into 240 voice channels or 2880 low-speed channels. Other derived channels include 40,800 bits per second (requires the equivalent of 12 voice channels), 50,000 bits per second (12 voice channels), and 19,200 bits per second (6 voice channels). Private equipment can be added for additional derived lines.

The charges for Series 5000 channels consist of line charges and Service Terminal charges. The line charges are $30 per mile per month for Type 5700 and $85 per mile per month for Type 5800. The full capacity must be taken, but need not be entirely allocated to data channels. Service Terminal charges run $425 per month for each high-speed channel and $40 per month for each voice or low-speed channel. Reduced monthly charges apply to additional stations operating over the same channel. In addition, installation charges of $200 (high-speed) or $50 (voice and low-speed) apply to each channel.

Wideband Data Service—the Series 8000 channels—effectively replaces Telpak A service, which was discontinued as an interstate offering several years ago. The nominal bandwidth of the Series 8000 channels is 48KC. Several different services are available for deriving up to 12 voice/data channels, a 40,800-bps channel, a 50,000-bps channel, or two 19,200-bps channels. An arrangement with six voice channels and one 19,200-bps channel is also possible. Alternately, either half or the full channel can be used for facsimile transmission.

The charges for this service include line charges, Service Terminal charges, and a channelizing charge when individual voice channels are derived. Line charges are $15.00 per mile per month for the first 250 miles, $10.50 per mile per month for the next 250 miles, and $7.50 per mile per month for additional mileage. Service Terminal charges are $425 per month (for a 40,800 or 50,000-bps channel or two 19,200-bps channels) and $12.50 (each voice/data channel). The charge for channelizing into voice channels is $250 per month, independent of the number of voice channels used. Reduced charges apply to stations sharing the same channel. Installation fees for each derived channel are also charged.

Wideband Service also includes the 11000 series channels. Evolved theoretically as a response to users' demands for high-capacity transmission, 11000 channels are offered for communication among selected cities in seven states: Illinois, Indiana, Michigan, New Jersey, New York, Ohio, and Pennsylvania. The service is essentially a 240KC bandwidth facility equivalent to 60 voice channels. Line charges are a modest $18 per mile per month. Service Terminal charges are highly complex. Users apparently are not taking advantage of this service to the degree expected, and its continued existence is doubtful. For the high-volume user, it offers some definite economic advantages compared with other offerings of the traditional and specialized common carriers.

Exchanges for AT&T's Dataphone 50 service are currently located in Chicago, Los Angeles, San Francisco, New York City, and Washington, D.C. Chicago serves as the central exchange. The Los Angeles and San Francisco exchanges also serve several suburban areas. Users located outside these exchange areas can tie into the network via a Series 5000 or 8000 channel.

The service provides a nominal bandwidth of 48KC, equivalent to 12 voice channels. Data can be transmitted synchronously at 50,000 bits per second, with connections being established on a dial-up basis. A voice channel is provided for coordination. Lower-speed services cannot be derived from the basic channel. Charges for this service are outlined in Table 10.

The ultimate reference

The master guide to communications costs and available facilities is the tariffs themselves. These documents are available in the business offices of the various carriers. Be sure the set you look at is up to date. If you use this source, expect to spend some time 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 do a particular task. Table 11 presents a guide to the tariffs for all services discussed in this section.

Specialized common carriers

Depending on your geographical location, you may not be limited in your choices of communications facilities to those offered by the telephone companies or Western Union or to those you build yourself. By April 1974, six new microwave common carriers will have portions of their proposed networks in operation; these six have announced intentions of eventually building networks that cover an extensive portion of the U.S. along present routes that exhibit high communications traffic. Two of

All About Data Communications Facilities

Table 10
Illustrative Rates for AT&T Dataphone 50 Service

$ per minute	Miles, Interstate	$ per Hour
0.50	0 – 50	30
0.80	50 – 150	48
1.25	150 – 300	75
1.75	300 – 600	105
2.25	600 – 1200	135
2.75	1200 – 2000	165
3.25	2000 – 3000	195

Additive Factors—
- Station Terminals, per terminal—
  - Facsimile or Synchronous: $275/month.
  - Alternate Facsimile/Synchronous: $300/month.
  - Installation: $125 per terminal.
- Service Terminal—
  - To terminate Series 5000 or 8000 channel extension (required at both ends): $150/month plus $100 installation.

these companies, MCI Communications, Inc. and Western Telecommunications, Inc., have some portion of their proposed networks in operation now.

All of these companies claim that they will be offering services at costs below those of the traditional common carriers. All claim special provisions for transmission of data for computers. All claim improved performance. All claim adequate financing and knowhow to build and operate their networks. If all these claims are true, computer users will be able to implement communications applications beyond their present levels for the same dollars or reduce their communications costs for existing applications. And, if all these claims are true, why would anybody continue to deal with the traditional common carriers?

Present common carrier rates are based on national cost averaging. Thus, economies resulting from heavily trafficked routes offset higher costs for less densely populated routes. The specialized common carriers intend to build only along the routes with heavy traffic and have no high-cost areas to raise their overall operating costs. However, the traditional common carriers now have the privilege of selectively reducing their rates in high-density areas to remain competitive. Western Union has already done this along MCI's St. Louis-Chicago route. AT&T is getting ready to file for reduced rates in some areas. This topic is discussed under Leased Voice Lines. Most of the specialized common carriers are still claiming that they will be able to undercut the new AT&T and Western Union rates. And this brings up a touchy subject—regulation. Apparently the new carriers will not be regulated as to charges and rate of return. The FCC figures that natural competition will provide all the regulation required.

However, permits must be granted to build and then to operate the microwave facilities that form the basis for the new carriers' networks. To get these permits, companies must demonstrate their financial responsibility and technical competence. That provides some measure of assurance, but does not dispell all doubts about the ultimate success of the companies. The sheer number of duplicated route offerings raises the question of survival. Similar requirements were established for television stations, and in the early days many stations, particularly UHF stations competing with existing, well-established VHF stations, didn't make it.

A microwave carrier's success will be largely based on its ability to complete portions of its proposed network and get them into revenue-producing operation quickly to provide the cash flow for the remaining portions. It's important to note that the granting of a permit does not mean that a company is required to build the corresponding communications links. The Datapro technical staff is not necessarily pessimistic about the ability of the new companies to build their proposed facilities and compete successfully with the traditional common carriers. But we do feel that the present maps of proposed networks should not be taken literally until the links are built and operating. Taking a wait-and-see attitude may make you miss being the first in your neighborhood to transmit over a specialized common carrier's facilities, but it may also preclude the need for an expensive change in your plans.

Improved performance is a nebulous concept. Taken literally, it means that more bits can be transmitted before an error occurs. It follows that if completely new equipment is used, with state-of-the-art technology, it ought to perform better, on the average, than the facilities of the traditional common carriers which have been built up over a long period of time. However, all companies except Datran have indicated that they will use the traditional common carrier facilities to get from your place of business to their terminating point. These are usually cross-town circuits called "local loops." Even Datran will be using these local loops initially. The FCC encourages the building of local distribution facilities by the specialized carriers, but these facilities are quite a

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Table 11
Communications Facilities Tariffs

Service	Source	Tariff Number
Public Telephone Network (Dataphone)	AT&T	263
WATS	AT&T	259
Leased Voice-Grade Lines	AT&T	260
	Western Union	254
Leased Low-Speed Lines	AT&T	260
	Western Union	254
TWX	Western Union	240
Telex	Western Union	258
Datacom	Western Union	257
Broadband Switching Exchange	Western Union	246
Series 5000 Channels (Telpak)	AT&T	260
	Western Union	254
Series 8000 Wideband Data Channels	AT&T	260
	Western Union	254
Dataphone 50	AT&T	263

different animal than the cross-country circuits. Microwave becomes economic only when high capacity is required, as in the bundling of a hundred or so voice channels from one city to another. The picture is different for the connection of a few lines from your building to their termination point. Land lines are almost out of the question because of the cost and difficulty for obtaining rights of way to lay the lines. However, the situation is not hopeless, and the carriers express confidence that either the existing local loop facilities will prove adequate or they will be able to build their own successfully.

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 except Datran offer conventional voice transmission in addition to data transmission.

When all is said and done, what we will end up with are many attractive alternatives to the traditional common carrier facilities—if you are located in a major metropolitan area. If you are in an outlying area, you will probably have to figure out how you can interconnect effectively with one of the specialized carriers using facilities offered by the traditional carriers. Communications network configuring in the data communications environment of a couple of years from now will be far more complex than it is now—and it is none too easy now, as you will see if you refer to the discussion under Leased lines vs. DDD vs. WATS.

The following paragraphs summarize the plans and progress of the six major microwave companies that are implementing facilities over a significant portion of the country. (There are many others planning limited networks covering just a couple of states.) These six major companies are listed alphabetically and include:

- Datran
- MCI Communications Corporation
- NCCC
- Southern Pacific Communications Company
- United Video Inc.
- Western Tele-Communications, Inc.

At the beginning of each discussion, the company's address and telephone number are listed to make it easy to get more information.

Datran

Data Transmission Company
8130 Boone Boulevard
Vienna, Virginia 22180
Telephone (703) 893-2450

The Datran network is the most ambitious of all the specialized carriers. It is the only one employing digital

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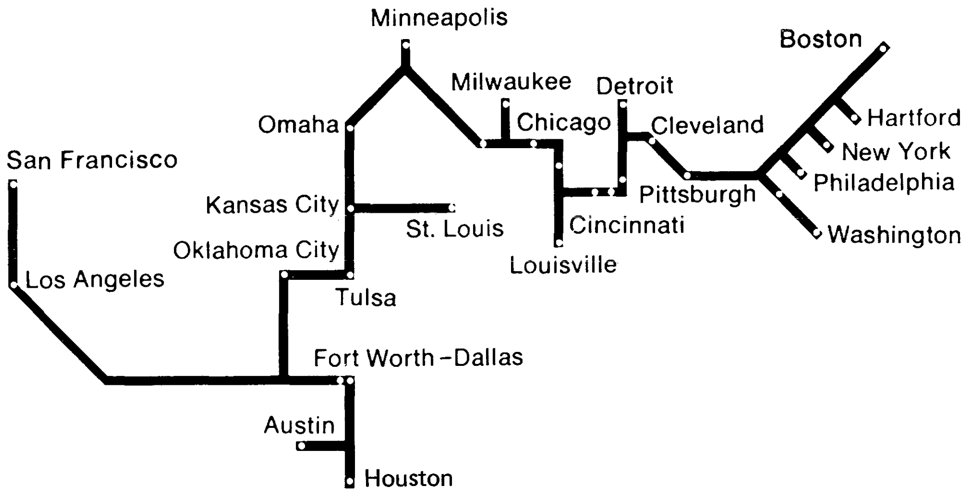

Figure 1. This is a stylized representation of the proposed Datran digital network. In addition to the cities named on the map, the network will serve Columbus, Dayton, and Madison.

communications techniques and is a switched network. The network, when completed in 1975, will interconnect 27 major cities as shown in the map in Figure 1. Initial operations are scheduled to begin in early 1974 with dedicated services (leased lines) available among seven cities in the Southwest and Midwest. Initial offerings will include channels with data rates of 2400, 4800, and 9600 bits per second. The network is planned to grow eastward from the Midwest, with the East Coast points becoming operational in June 1975; the West Coast points will be added in December 1975. Additional capabilities will be added as the network grows, including dedicated lines at up to 1.344 million bits per second and switched connections at up to 48,000 bits per second. Many sophisticated features for diagnosing faults, handling switched network calls, and planning communications systems are being advertised.

Detailed cost estimates for Datran services are not available. Sample estimates show the cost of a switched connection (analogous to DDD) operating at 4800 bits per second to be a flat rate of about $0.20 per minute ($12 per hour) for distances over a few miles. Similarly, a 150-bps connection is thought to cost about $0.08 per minute ($4.80 per hour).

The advantages of a switched network are discussed under the heading "What kinds of facilities are available?" The same reasoning applies to Datran, except that the Datran network will not be as extensive as the public telephone network.

Datran is a subsidiary of University Computing Company of Dallas, Texas. UCC has acquired extensive experience in operating remote computing services. The first plans for Datran included 35 cities and a much shorter construction schedule. Financial difficulties in the parent company caused the reduction in size and stretched out the schedules.

MCI

MCI Communications Corporation
1150 17th Street N.W.
Washington, D.C. 20036
Telephone (202) 872-1600

Because of its organization, MCI has been called "the Bell System of the independents." MCI is the parent company for a total of 17 operating companies; it has a controlling interest in all but one of the companies, and plans are under way to acquire a controlling interest in that one. The 17 operating companies are building facilities in assigned geographical areas; the whole network will be tied together to provide nationwide service for dedicated lines (leased lines) as shown in the map in Figure 2. Financing is being obtained by each operating company through another MCI subsidiary, MCI Leasing, Inc. MCI Leasing will own the communications facilities and will lease them to the individual MCI carriers for a term of nine years; then the carrier will either purchase the facilities or release them for another two years.

The one affiliate not presently majority-owned by MCI is Microwave Communications, Inc., which has already built and is operating the link between St. Louis and Chicago. This is the link for which permission was granted in 1969 after the original request in 1963. It is the facility that most people think of when they hear "MCI." All of the other subsidiaries but one also carry MCI as the first part of the company name, leading to some confusion.

The St. Louis-Chicago link began operations in January 1972. Construction permits have been granted for service to a total of 34 cities, which span the nation from Los Angeles to the major cities of the East Coast. MCI expects to have the links connecting New York with Boston, Washington, D.C., and Chicago operational by December 1973. The coast-to-coast link up is expected by the Spring of 1974.

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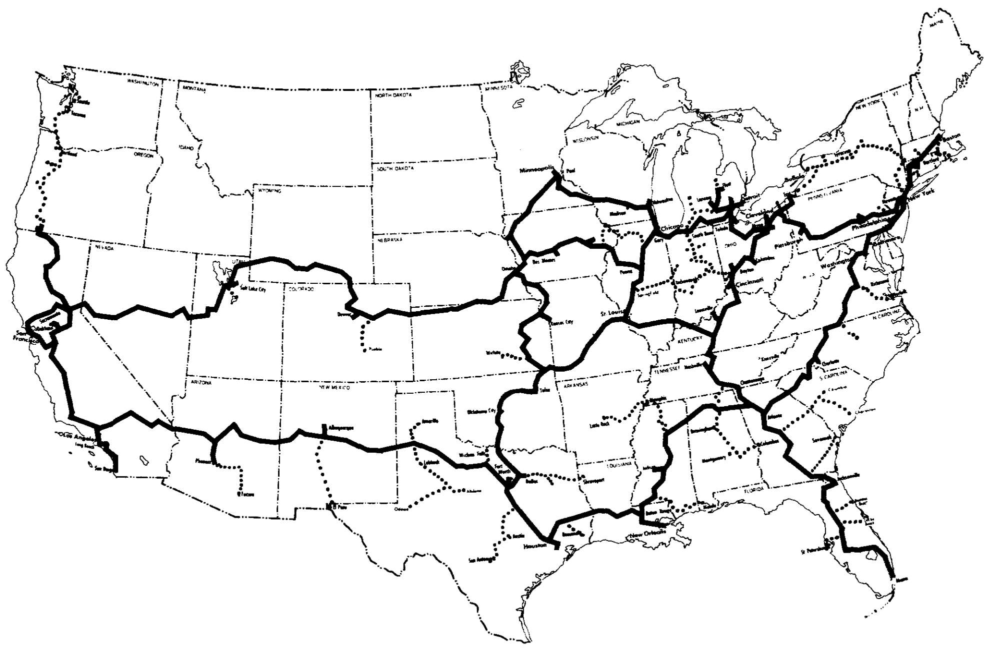

Figure 2. As shown here, the 17 operating companies of the MCI system plan one of the most extensive networks. The link between St. Louis and Chicago has been in operation since January 1972.

Table 12
MCI Proposed Rates: 4Kplus Service

From New York to	Distance, miles	Monthly charges, $						
		Transmission speed, bps*						Teleprinter**
		300	1200	2400	4800	7200	9600	
Boston	189	254	331	425	610	735	880	504
Chicago	712	430	595	755	1050	1175	1320	680
Dallas	1369	614	871	1100	1510	1635	1780	864
Phoenix	2137	822	1183	1490	2030	2155	2300	1072

* Full- or half-duplex, end-to-end service.
** Full- or half-duplex; includes 10 char/sec ASR teleprinters.

On the present St. Louis-Chicago link, a broad range of services is offered. A total of 21 different digital channels are available with capacities of 55 to 1,000,000 bits per second. Analog channels are offered with bandwidths ranging from 2 KHz to 960 KHz in 44 different increments. (A normal voice channel is nominally 4 KHz.) Charges are applied on a flat dollars per mile per month basis and vary with channel speed (or bandwidth) and channel arrangement. Additional monthly charges are made for channel termination and intracity access (local loop). Full-time or part-time service is available, as well as simplex or full-duplex transmission.

A new MCI pricing and service offering was announced in January 1973. Called 4Kplus, the new offering provides end-to-end service. In the case of transmitting data, this means that the termination point in your office can be connected directly to a computer or terminal through a conventional RS-232 interface. In the case of voice lines, hand sets are provided. There are no restrictions on customer-attached equipment. Rates are not official as yet, but Table 12 gives some selected proposed rates. Conventional channels without end-to-end service are also available in a variety of bandwidths. The St. Louis-Chicago link is expected to convert to the new pricing and service offering.

NCCC

Nebraska Consolidated Communications Corporation
3420 South 10th Street
Lincoln, Nebraska 68502
Telephone (402) 435-4371

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NCCC (or N-Triple-C) presently operates a 295-mile microwave communications system serving the State of Nebraska and its agencies in 24 counties. It was formed by seven independent telephone companies in 1966 to bid on the above system. The present system provides voice, data, teletype, and other services.

NCCC plans a network that will serve the central U.S., with connecting links to Los Angeles, Houston, and Washington, D.C. Construction began on the first 500-mile segment (Chicago to Omaha) in November 1972; completion is anticipated in April 1973. Additional 500-mile segments will become operational at about one-month intervals. The complete network is expected to be operational in April 1974. A total of 5500 route miles are planned, and construction permits are already in hand for about half the network. Dedicated channels (leased lines) will be offered for voice, data, or other signals.

SPCC

Southern Pacific Communications Company
105 Market Street, Room 304
San Francisco, California 94105
Telephone (415) 362-1212

Southern Pacific Company is engaged in many diversified aspects of the transportation industry in addition to its well-known railroading interests. A subsidiary, Southern Pacific Transportation Company, currently operates the nation's largest private microwave radio relay system to support its transportation activities. The proposed public network by SPCC will to a large extent share the same physical structures, but will be entirely independent of the private system. The proposed network covers about 4800 route miles in 11 states in the South Central, Southwest, and West Coast regions.

SPCC will offer voice channels (single or groups), analog channels, and data channels (narrow-band to wide-band). Rates are not official yet, but sample proposed rates include:

Channel	Monthly charge, $/mile
55 bps	0.10
110 bps	0.25
134.5 bps	0.30
600 bps	0.70
4 KHz voice	0.95

The above rates are for full-duplex service but do not include channel termination charges.

The SPCC proposed system begins in Seattle and swings down the Pacific Coast to San Diego, over to Houston, and then up to St. Louis, with terminations in most major cities along the way. Construction of the San Francisco-Los Angeles segment has already begun, and it will be operational in June 1973. Construction of the Los Angeles-Houston segment has been approved and is targeted for completion by June 1974.

United Video

United Video, Inc.
LVO Enterprise Building
522 South Boston
Tulsa, Oklahoma 74101
Telephone (918) 587-1171

United Video currently owns and operates microwave systems to provide service to CATV (cable TV) operators and network television. It is a subsidiary of LVO Cable, Inc., a CATV operator. It is currently building a system for transmission of voice, data, or other signals over dedicated facilities. The company's network covers the Midwestern and Southern U.S., connecting Minneapolis, Chicago, and Atlanta with Miami and Washington, D.C. A circular path also connects Atlanta with New Orleans, Houston, Dallas, Oklahoma City, Tulsa, Kansas City, and St. Louis, and then reconnects with the Chicago-Atlanta link. Completion of the initial segment connecting St. Louis, Kansas City, Tulsa, Oklahoma City, and Dallas is scheduled for September 1973. The next segment, from Miami to Washington, D.C., is due to be completed by late 1974.

Western Tele-Communications

Western Tele-Communications, Inc.
54 Denver Technological Center
Denver, Colorado 80210
Telephone (303) 771-8200

Western Tele-Communications (WTCI) presently operates over 13,000 route miles of microwave facilities serving CATV operators, network television, and radio broadcasting. Its parent company, Tele-Communications, Inc., is principally an operator of CATV systems. WTCI plans a comprehensive array of services on its proposed nationwide network, illustrated in the map in Figure 3. In addition to voice, data, and facsimile transmission, services such as store-and-forward message switching and equipment such as standard and custom terminals, modems with forward-acting error correction, and data scramblers will be offered.

The segment from San Diego to El Paso is completed and operational. Currently it is providing 100,000 and 50,000 bps data service.

WTCI's planned network is extensive, as the map shows. Totaled, it includes about 9,300 route miles. About half of the network can share physical structures with WTCI's existing network for radio and television transmission. Actual communications facilities cannot be shared.

All About Data Communications Facilities

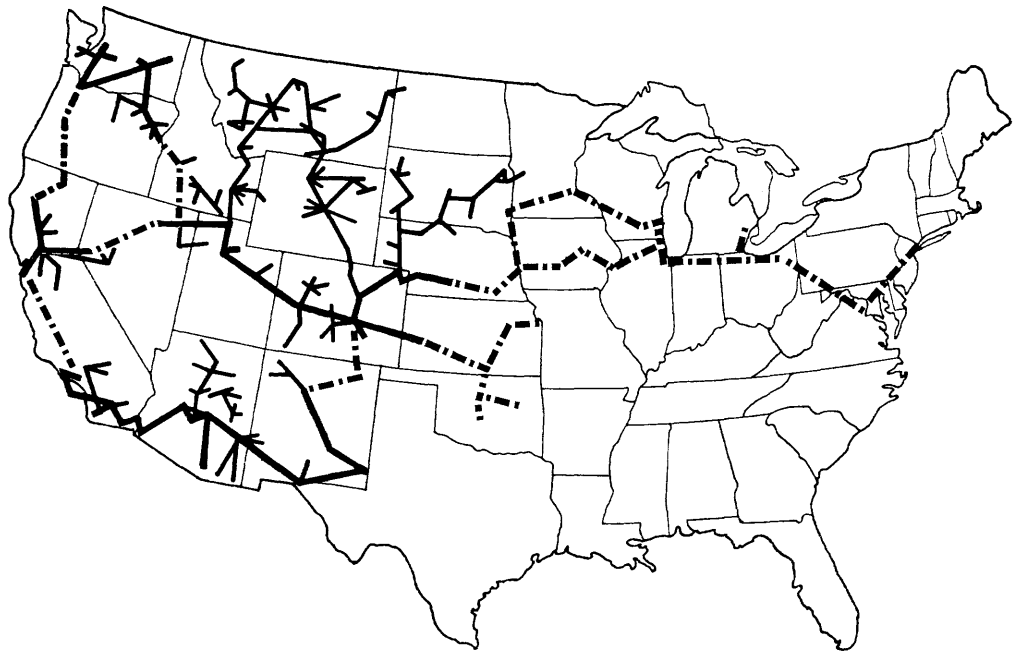


Figure 3. Western Tele-Communications plans a network rivaling MCI's in size, but distributed differently. Western has one link already operating between San Diego and El Paso.

Only WTCI and MCI have actually filed tariffs officially setting prices. Some of the services for which WTCI has set prices are as follows:

Monthly Service Cost, $

Distance	Voice line	75 bps	100 bps	150 bps	300 bps
50 miles	89.50	10.00	11.00	12.50	25.00
100 miles	163.00	20.00	22.00	25.00	50.00
500 miles	320.50	80.00	90.00	105.00	205.00

The next segment planned for completion is the San Francisco to Seattle route in late 1973; authorization has already been received. The remainder of the network is scheduled for completion by 1976.

And in the future?

Developments in the foreseeable future will usually involve rate changes and/or new facilities. Recent rate changes and possible future ones have been incorporated into the foregoing discussion of individual facilities. In summary, the emergence of the specialized common carriers will keep the subject of rates by the traditional common carriers, especially for private line services, a constant question. This will become more evident as the new networks are completed and the specialized carriers begin implementing some of the more sophisticated features. Datapro will keep you posted on important developments.

Talk about new facilities usually focuses upon the implementation of digital networks by the traditional common carriers and the use of communications satellites to reduce the cost of long-distance communications. In years to come, features beyond just bare-bones transmission capabilities will become a hotly contested topic, but, for the present, "hardware" is making all the ripples.

Digital communications networks

Both AT&T and Western Union have talked about "digital" transmission for a long time. Actually, such transmission exists today and is in common usage. For example, AT&T employs about 15 million channel miles of facilities using digital techniques in its everyday operations. While there is some benefit from these facilities, the data communications user does not realize the full potential of "digital" transmission.

Before relating the present plans of AT&T and Western Union, let's explore the meaning and effects of digital transmission techniques. As a matter of hard, cold reality, digital transmission exists only in the abstract. Physical properties of materials and the physics of energy propagation mean that there is a time factor associated with any change in a signal. Modern computer technology has reduced drastically the effect of this phenomenon by building very tiny components that are physically spaced very close together (i.e., integrated circuits). The nature of data communications precludes such a diminution of distance. Thus, all transmission techniques are technically of the analog type.

While some may feel this distinction is hair-splitting, it is necessary so that the true difference between analog transmission and "digital" transmission can be highlighted. This difference lies in the repeaters (or amplifiers or regenerators) that are necessary to compensate for the

All About Data Communications Facilities

inevitable energy losses along a line. With an analog signal, there is no additional information beyond the signal itself; the best that can be done is to amplify the signal to replenish its strength with as little distortion as possible. With voice transmission, this distortion takes the form of noises, pitch changes, and other pecularities that sometimes make understanding difficult but rarely prevent it altogether. For data transmission, pre-knowledge of the signal (the fact that only a finite number of signal elements can be present) is used to decipher the information stream. Distortion tends to confuse the interpretation process. Digital transmission uses the same pre-knowledge to regenerate the signal; the old signal is not simply amplified along with any distortion, but a brand new, "clean" signal is created. Transmitting long distances is exactly the same as transmitting from your site to the first regeneration location. In effect, communications engineers *have* found a way to reduce distances. Digital logic also simplifies multiplexing or packing multiple data channels within one physical communications facility, which is required to achieve economical long-distance transmission.

AT&T plans a graduated implementation of a digital system specifically for data transmission over the next few years. Five cities–New York, Boston, Chicago, Philadelphia, and Washington, D.C.–are to be interconnected sometime in 1974. West Coast facilities and a link between the West and East Coasts are planned to follow shortly thereafter. By the end of 1976, a total of 96 cities are scheduled to be included. The physical building of the system is centered around using portions of the bandwidth on existing microwave facilities that are presently unused. Services to be offered would include private (leased) lines operating at 2400, 4800, 9600, and 56,000 bits per second; operation would be full-duplex. Rates are not official as yet, but indications are that savings of from 20 to 50 percent over present line costs could be achieved; the lower the speed of the line, the higher the savings would be.

Western Union is planning a new service called Multipoint Data Service (MDS) to provide private line service at 2400 and 4800 bps. It will be offered initially in about 50 cities. The time frame seems to be the end of 1973 or shortly thereafter.

Digital services from the traditional common carriers share one problem with services offered by the specialized common carriers: local loops. Microwave and digital techniques are great when you need to pack a lot of channels in a single communications facility, but are not so economic for the many separate and diverging channels required to connect local business offices with the transmission centers. Thus, digital transmission may eliminate the modem, but another "black box" will need to be substituted, at least during the early days of digital transmission. There is hope, however, that full digital interfaces can be brought right into your office sometime in the future.

Satellite communications

There are two ways of viewing satellite communications. One is to observe that it is just a hardware development, no matter how glamorous. If it provides better and/or cheaper service, as preliminary indications attest, fine, but the actual details are really unimportant to everyday operations. The other point of view is that the low cost and high capacity thought possible will mean that many new services can be implemented that were economically infeasible without satellite communications.

Both points of view have validity and importance to the average user of data communications–particularly to those who need or desire to transmit over long distances, such as from New York to the West Coast or Hawaii.

Seven or more companies representing various combinations of common carriers (including some specialized carriers, satellite building firms, international carriers, and electronics firms) have applied for permission to launch satellite programs. Western Union has received the first go-ahead and plans to have its system operational by mid-1974. Western Union has named its system WESTAR (not particularly original, but catchy). Canada has already launched its satellites, and operations are due to begin almost immediately. Satellite communications systems are definitely coming.

Canadian facilities

This may seem a strange topic to introduce in connection with the future of data communications, but the fact is that our neighbors to the north have gone ahead and done some of the things we in the United States are now talking about doing: digital networks and satellite communications systems, to be precise.

The organization of Canadian communications is somewhat like that of the U.S. Telephone service is provided by a consortium of seven telephone companies which, taken together, are called the Trans-Canada Telephone System. A private company, CP-CN Telecommunications (for the Canadian Pacific and Canadian National Railroads), offers a wide range of services such as private lines, public and private teleprinter networks, facsimile transmission, etc., much as Western Union does within the U.S. Trans-Canada also offers data-oriented communications facilities.

In general, communications costs are much higher in Canada than in the U.S. For example, an unconditioned voice line is about 35 percent higher at 50 miles, 110 percent higher at 1000 miles, and back to only 19 percent higher at 3000 miles. Other services are correspondingly more expensive than similar services in the U.S.

All About Data Communications Facilities

Trans-Canada's digital service, Dataroute, bids to change this situation. Dataroute has been operating for over a year in a trial network including the cities of Ottawa, Toronto, and Calgary. A coast-to-coast system will be opened for commercial service in April 1974. Services offered include private lines operating at 110 to 50,000 bits per second, dial-in access from the telephone network into Dataroute, conventional leased-line access, multi-point and/or multi-drop configurations, and channel groupings that effectively give heavy users volume discounts. Service is provided on a full-time, part-time day, or part-time night basis.

The most dramatic example of the cost savings available with Dataroute occurs at the 30 characters per second transmission speed, a popular facility for time-sharing users. Conventional channels cost about $3,500 per month from Toronto to Vancouver, a distance of approximately 2500 miles. (By contrast, an unconditioned voice channel in the U.S. costs about $2,245 per month.) With Dataroute, the 30 cps channel costs only about $350 per month, a 90 percent drop. However, it should be noted that the conventional 30 cps channel is unusually expensive for what you get; an unconditioned voice line is actually cheaper. Savings with Dataroute are modest for medium speeds, but are more substantial for higher speeds. A 50,000 bps Dataroute channel will cost about 45 percent as much as a conventional one.

Telesat Canada launched its first Anik communications satellite (built by Hughes Aircraft Company) on November 9, 1972. A second satellite is in orbit and operations are due to begin about now. A network of 37 earth stations will provide for two-way telephone service and reception of radio and television broadcasting. The capacity of the system is 12 channels of color television or up to 5000 voice channels. The satellite system enables Canada to bring telephone and broadcasting services into remote areas that would be difficult or impossible to reach with surface facilities.

Interconnect

Now isn't that a magic word? The same FCC Carterphone decision that permitted independent modems to be attached to the public telephone network also permitted other independent equipment to be attached. The principal outgrowth of this is a market for independent PBX (private branch exchange) and PABX (private automatic branch exchange) units, with the emphasis on the latter. Many sophisticated features are being implemented with the PABX equipment for handling business phone networks. The advantage of the independents over the Bell System equipment is lower cost. The disadvantage, according to Bell and some users, is poorer service and reliability. Other users are delighted.

The same attachment problem faces the independent PABX vendors as faces independent modem manufacturers—the DAA required by Bell to "protect" the network. The situation is not resolved as yet. Bell is not even favoring a qualification program. It is easy to understand the Bell System's concern; if a portion of the network goes out, Bell gets blamed no matter whose fault it is. The independents, on the other hand, some of whom manufacture equipment used by Bell, claim that this gives Bell an unnecessary competitive advantage, since Bell's equipment does not require DAA's. No doubt the hassle will go on for some time.

There does not seem to be any immediate effect on data communications users, but rumblings of things to come are beginning to be heard. IBM and ITT have marketed equipment in Europe that is oriented toward providing flexible data channels between a company's operating points and its computer (i.e., data collection). Applications involving telephones, such as voice response, would be naturals for such equipment.

Is it possible that many of the "front-end" data communications control functions will eventually be moved from the computer room to the switchboard? It is not clear that such a move would be advantageous. The functions do have to be performed somewhere, but it appears that the data communications front-end task would far overshadow the needs for flexibility in handling other switchboard work, so it would not be a simple add-on. Perhaps the PABX functions will instead be removed from the switchboard and moved into the computer room.

What does it all mean?

The log jam so long decried by advanced users is beginning to break up. New services and cheaper services seem to be just over the horizon. It is appropriate for the first time to say that the day of computer communications is at hand. Not only are improved communications services contributing to the new age, but advances have already been made in computers and terminals that can take advantage of new services when they come out. In addition, we are finally learning how, after many painful years, to program communications applications effectively. After many years of thought and pioneer efforts, we are also learning how remote stations can be effectively used to implement business procedures.

But the fact that the necessary tools are, or soon will be, at hand does not mean that your job is any easier. Careful evaluation of the new facilities and comparison with traditional facilities is required to make sure you get your money's worth. And you must be aware of the full range of traditional services. Just as computer selection is a two-fold problem of knowing what IBM's competitors offer *and* knowing *all* of what IBM itself offers, an analogous situation is now presented by the traditional and specialized carriers in regard to communications facilities. □

All About Communications Processors

Data communications controllers that are actually programmable computers are being used with increasing frequency in today's data processing systems. A specific trend toward "front-end processors" is also gathering momentum. This report analyzes the pros and cons of the programmable processor concept in general, describes the front-end phenomenon in depth, and summarizes the capabilities of 79 communications processors in detailed comparison charts.

To casually comment that the use of computers is yet another case where the cobbler's children are the ones with holes in their shoes is to overlook much of the development process behind the modern computer and its applications. Such a comment arises because, in the opinion of some, the information handling capabilities of the computer have not been efficiently applied to controlling multiple, independent data streams – a vital requirement in every data communications network.

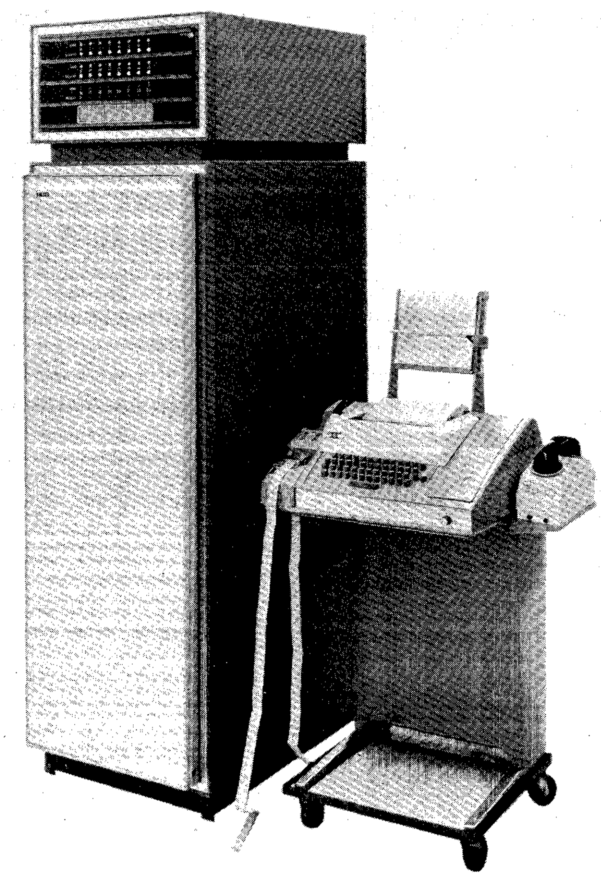
Prior to the second wave of IBM System/360 models in 1965, small "satellite" computers were widely used to handle card-to-tape and tape-to-printer data transcription operations for larger computers. The first large System/360 models were announced without provisions for attaching low-speed peripherals such as card readers and printers, the devices that form the interface between the world of the human and the province of the computer. Multiprogramming, with its promise of more efficient centralized operation, changed this direction and replaced the satellite I/O processors with on-line readers and printers.

Curiously, it is multiprogramming, which provides the means for executing multiple, independent tasks on a single computer, that makes data communications such a potentially valuable tool for the computer user. Without it, each application task must be run sequentially, or multiple processors must be installed. Either way greatly complicates the procedures for utilizing data communications effectively, because the data transferred over the network frequently impacts more than one application program. However, the flexibility inherent in stored-program computers was severely restricted by using hard-wired (fixed-function) devices to interface with communications lines. In addition, handling a large number of independent input/output operations places a severe strain on the resources of a computer in terms of main memory (for control code and buffer space) and processing time. The advent of small, inexpensive computers, the so-called minicomputers, permits a return to the concept of satellite processors. A more modern term for this chaining of hierarchies of processors is "distributed processing."

Preview, Not Review

Thus, the cobbler's children had holes in their shoes because developments in computer technology got a little bit out of synchronization. Adequate software was not available to take maximum advantage of existing hardware; when the software was developed, centralization of processor functions became an obsession that precluded taking proper advantage of the software techniques.

Well, we finally got it all together. The communications processor "came of age" when IBM blessed the concept in March 1972 with the introduction of the 3705 Communications Controller. Some people will no doubt be offended by this statement, pointing to some 40 companies that were actively promoting communications



Action Computer Systems builds its Telecontroller around a Data General Nova 1200 processor and Diablo disk unit. These components are behind the door; the display panel on top shows the status of individual lines. Action has installed several store-and-forward message switching systems incorporating the Telecontroller.

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processors prior to IBM's announcement. Indeed, IBM itself had implemented such systems through standard and special products on many occasions (though these were expensive and possessed only a small fraction of the flexibility of the 3705).

The importance of the 3705 lies in the attitudes of typical EDP users, most of whom are IBM users. Not only does IBM derive enormous revenues from this huge user base, but to a large degree it controls the acceptance of new concepts. This control depends largely on the resources IBM is willing to expend on educating the computer public. Since IBM is a product-oriented company, such educational efforts are obviously directed toward its own products. Yet the other manufacturers of communications processors, as well as users of competitive computer systems, are certain to benefit from IBM's new promotional emphasis.

The use of communications processors is still in its infancy. An estimated 25 to 33 percent of all computers in the U.S. now employ data communications, each communicating, on the average, with 25 to 60 terminals.

But only a small fraction utilize communications processors. The immediate market for the IBM 3705 is as an economic replacement for the IBM 270X series of hard-wired controllers (though there are some situations in which the 3705 turns out to be more expensive; Report 70D-491-31 explores the 3705 in detail). Replacement of the 270X controllers has already become a favored market for the many independent producers of communications processors. It will be a while before the true power provided by the programmable controllers will be fully utilized to expand the scope of applications for computer. The first step for many users will start in 1973, when IBM is scheduled to deliver the Network Control Program for the 3705, allowing the control functions to be largely moved from the System/370 mainframe to the 3705.

Definition and Applications

A communications processor, in this context, is simply a digital computer that has been specifically programmed to perform one or more control and/or processing functions in a data communications network. As a self-contained system, it may or may not include the following components, depending on its specific application: communications line multiplexor, line adapters, central computer system interface, and on-line peripheral devices. It always includes a specific set of user-modifiable software.

Communications processors do not represent a new system design concept. During the industry's second generation, in the early 1960's, such processors were offered by several of the major main-frame suppliers, including Control Data's 8090/8050, General Electric's DATANET-30, and IBM's 7740. Also, as early as March 1963, Collins Radio Company delivered its first Collins Data Central programmable communications system. In almost all such early uses, the systems were used primarily in message switching applications, acting simply, as a message router and dispatcher in a data communications network.

The principal differences today lie in the diversity of application areas, the relatively low cost of such units, and, by consequence, the trend toward widespread usage. Listed below are some of the principal uses of programmable communications processors in current data processing systems. It is important to note that many such units can be used in a variety of application areas, with specific sets of software and interface units for each application. The currently popular types of applications include:

- *Message switching.* The message switching processor receives messages from remote terminals, analyzes them to determine their proper destination, performs any code conversions that may be necessary, and transmits them to other remote terminals. The sending and/or receiving remote terminals may themselves be computer systems. Most message switching systems are of the store-and-forward type, in which the programmable processor stores the messages it receives on on-line auxiliary storage units, such as disks, drums, or magnetic tape. The length of time the messages are stored prior to transmission to other terminals or computers can range from a few seconds to an entire day or more, depending on the specific application needs and traffic volumes. The programmable processor performs little, if any, processing on the messages. it acts principally as a traffic director. Message switching was the first major application area in which programmable communications processors were used and is still a widely used application.

- *Front-end processing.* The programmable communications processor replaces a hard-wired communications controller as the interface between the central data processing system and the data communications network. The front-end processor not only receives and transmits all data passing through the network but also, and significantly, can be programmed to pre- and post-process this data in a variety of ways in order to relieve the system's central processing unit from time-consuming overhead activities related to message formatting and control. Front-end processors can perform their functions in support of a wide variety of data processing applications in the "back-end" system. For example, time-sharing systems often use a front-end processor to effectively improve user response times by

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assuming most network control functions and permitting the time-sharing central processor to dedicate itself to the efficient handling of user problems.

- *Line concentration.* Programmable communications processors sometimes fill the relatively simple role of communications line concentrators. Here the processor generally terminates a number of low-speed transmission lines and interfaces them to one or two higher-speed lines for more efficient and economical data transmission. Little, if any, processing of the transmitted data is performed. The programmable aspect of the processors is probably less used in this application than in any of the other currently popular uses. Hard-wired concentrators are generally equally effective, suffering by comparison only in their lack of flexibility.

- *Dedicated processing.* Some of the programmable communications processors have enough storage capacity and processing power to enable them to serve as the sole or principal computers in dedicated systems of various types. In inquiry/response systems, for example, the processor receives inquiry messages from remote terminals, processes them to determine the specific information required, retrieves the information from on-line random-access storage units, and sends it back to the inquiring terminal. In systems of this type, application-oriented processing is of equal importance with message receipt and transmission.

- *Remote batch terminals.* Programmable communications processors have begun appearing with increasing regularity in "intelligent" remote batch terminals. Here, the processor is the control component that regulates the operations of the on-line peripheral devices, performs small-scale data processing operations locally, and also transmits and receives data via a communications link with a remotely located central processing system. As an integral part of remote batch terminals, these processors are discussed in the Peripherals section of DATAPRO 70 in the coverage of specific terminals such as the Data 100 family.

Advantages of Programmable Processors

Programmable communications processors are enjoying increased popularity in various parts of data communications systems because they are demonstrating themselves to be more effective on a price/performance basis than their predecessor hard-wired controllers. General advantages that contribute to this price/performance edge include the following:

1. *Price.* Through the economics afforded by integrated circuitry, today's general-purpose minicomputers can often be purchased for less money than specialized hard-wired controllers. Even when the cost of specific software routines are added to the cost of the minicomputer to adapt it for specific data communications functions, the net price of the mini-based controller will often be substantially less than the hard-wired equivalent.

2. *Flexibility.* Since the programmable processors can be modified at any time and at comparatively low cost by user or vendor, they are eminently well suited to handling key roles in data communication systems, which are typically characterized by bewildering variety and constant change. Advances in communication line facilities are being made by the common carriers, and also by the independent companies, making available new, faster, and lower-cost transmission services. Remote terminals have long since surpassed the simple typewriter-style devices and now abound in a variety of shapes, styles, formats, functions, and transmission characteristics. Other dynamics at work include the tendency of most data communication networks to expand as workloads grow and applications increase. Programmable communications processors can readily serve such a continually changing environment, facilitating efficient systems growth and guarding against obsolescence.

3. *Distribution of labor.* Since these processors can be programmed to perform varying amounts of productive processing, often in conjunction with their own on-line peripheral devices, they can share portions of the overall processing load with other processors in the system—including the central processor. Peak loads can be more effectively handled and critical bottlenecks more likely avoided.

4. *Fail-soft capability.* In data communications systems that include at least one other computer, programmable communications processors can provide some form of continued system operation when one or more of the other computers become inoperative. The degree and effectiveness of this fail-soft capability depend not only on the capabilities of the programmable processor, but also, the perhaps more importantly, on the skill displayed by the system architect in his provisions for redundant components and fall-back procedures.

5. *Independent processing.* When programmable communications processors are not involved in their principal data communications tasks, they can often be used as stand-alone data processing systems—provided, of course, that their configuration includes some peripheral input/output devices.

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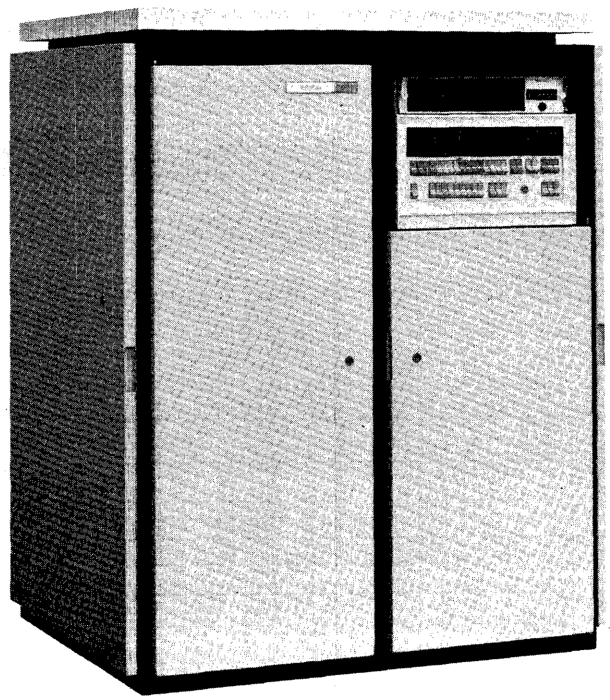

The Telefile Computer Products TCP-64 can serve as a plug-compatible replacement for IBM's 270X series of hard-wired controllers as well as in other applications. Up to 320 million bytes of disk pack storage can be connected to the processor.

Simple media conversion tasks, such as card-to-tape and tape-to-print, can be valuable by-products from these otherwise communications-oriented processors.

A Variety of Suppliers

One of the most interesting aspects of the story on programmable communications processors is that computer users can now obtain them from literally dozens of vendors, with differing product implications depending on the source selected.

Designers of data communications system will probably first contact the supplier of their present or planned main-frame computer to investigate his offerings in the area of data communications. If communications processors are strongly promoted as the best (sometimes only) way in which to construct efficient, fully supported systems, the designers will usually go along with the recommendations of the main-frame supplier. The designer is comforted by the belief that his data communications subsystem will be fully supported and will interface efficiently with the central processing system.

But not all main-frame suppliers are equally advanced in their data communications product line, and not all offer a selection of programmable communications processors supported with product-line software. The recent flurry of computer system announcements did, however, bring forth a number of such new products from the major manufacturers, as they both follow and "legitimize" the trend toward use of these processors. Modular systems such as the IBM 3705 give the same effect as a selection of models. It seems clear that by 1975, or by the advent of the fourth-generation computers, all major main-frame suppliers will offer an interesting array of programmable communications products.

The user not fully satisfied with the offerings of his selected main-frame supplier can investigate the wares of other promising suppliers, most of whom offer assurances that their communications processors can be "plug-compatible" with either the hard-wired or programmable communications controllers of the main-frame supplier, or at least with his data communications hardware and software interfaces.

The minicomputer manufacturers are one prominent group of suppliers who are actively pursuing the communications processor market with products that can either stand alone or interface smoothly with main-frame equipment of another supplier. Almost any currently marketed minicomputer is capable of serving as the fundamental building block of a programmable communications processor product—yet comparatively few of the minicomputers have been integrated with communication line multiplexors, line interface units, computer channel adapters, and specialized software packages to permit them to serve effectively as complete communications processing products.

Some manufacturers of minicomputers are making concerted efforts to produce integrated communications products. The buyer should be advised, however, that among even these suppliers, the completeness of individual offerings tends to vary substantially. Still other manufacturers of minicomputers have decided to sell their products on an OEM basis to other suppliers who will complete the communications product and sell it to end users.

DATAPRO 70 Report 70F-400-01, "All About Minicomputers," discusses these products at length and presents detailed comparison charts on 107 minicomputers from 48 different manufacturers.

A major source of integrated communications processing products are the independent systems houses, especially those that specialize in data communications systems, such as Collins, Computer Communications, Comten, Raytheon, Sanders, and University Computing Company. Companies such as these will generally provide complete hardware/software packages, including communications and central computer interfaces. In many cases they will

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accept full responsibility for the design and implementation of the entire data communications system. Such independent companies are generally well qualified in producing effective data communications systems, but the prospective buyer still has to concern himself with two important items: dividing his total system responsibility between at least two principal suppliers (communications and central system) and assuring himself that the products and systems of the several involved suppliers will indeed interface properly and function harmoniously.

Still another (and somewhat unlikely) source of integrated communications processing systems is the independent software houses. Programming Methods, Inc. has possibly begun a movement in this direction with its marketing of the FCF line of programmable front-end processors. These are supplied as complete systems ready for connection to central computer systems of the major main-frame suppliers. PMI obviously feels that the key to making such programmable processors function effectively is the system software that drives the processors. So PMI procured the required processors and other hardware from OEM suppliers, added its own previously developed Intercomm communications software, and began marketing these products, accepting full system installation and integration responsibility. If the concept proves in any way successful, other major software houses can be expected to follow suit during the next few years as programmable communications processors continue to grow in popularity and more and more highly specialized software is required. (Intercomm is closely scrutinized in DATAPRO 70 report 70E-694-01.)

Another software house getting into the communications processor field is PHI Computer Services, Inc. Based on the company's experience in operating several different communications networks as part of the line of data processing services it offers, PHI has put together a generalized package for implementing data communications processing using a programmable communications processor. Actually, a part of the complete package, which is called TPS (Telecommunications Programming System), is used by Tempo Computers in its 270T emulator products. The full package includes an access method and front-end communications processing capabilities. It is presently operational on the Tempo minicomputer, and PHI is naturally willing to entertain conversion possibilities. An interesting capability of the package is the possibility for operating a communications processor in a 270X emulation mode and as a full front-end processor simultaneously, permitting conversion to the "non-compatible" front-end processing mode gradually instead of through a direct all-or-nothing cut-over.

Regardless of which type of supplier he selects, the buyer should show partiality to those vendors who will guarantee turnkey installation of their equipment. If the user is faced with the formidable task of interfacing and integrating a variety of impressive but highly dissimilar communications and processing equipment, the proposed system may never get off the ground.

Front-End Processors

Potentially the most important use of programmable communications processors today is front-end processing, in which the processor replaces a central computer system's hard-wired communications line controller, handles all message control activities, and performs enough preprocessing of the transmitted data to relieve the central processing unit of the communications housekeeping activities that otherwise threaten to choke its productivity. Front-end processors can be rated as most important because their usage is potentially the most widespread and because their benefits to the overall system are most valuable.

The concept of front-end porcessing essentially involves removing the data communications control function from the central processing unit and setting it up as an external, largely self-contained system. This decentralized approach permits both the communications and central processors to perform their primary functions in parallel and with little interference. Data is

Texas Instruments continues to develop its thrust into systems to complement its large components business. The Electronic Message Switching System II (EMS II) is intended for free-standing store-and-forward applications. The inset in the lower right corner shows TI's latest version of its Silent 700 terminal; this one includes a pair of cassette tape units to provide ASR capability.

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passed between the processors only when necessary and with a high degree of efficiency.

A typical front-end processor might control one hundred or more communications lines of varying speeds and types attached to a large number of diverse remote terminals. The front-end processor would ideally assume all terminal, line, and message control functions, permitting the central processing unit and the user application programs to treat the communications network as just another high-speed, on-line peripheral device.

The concept of front-end processing is not new. General Electric and IBM offered users of their second-generation computer systems the availability of programmable front-end processors (the GEDATANET-30 and the IBM 7740 Communication Control System). But the concept has begun receiving widespread attention only in recent years, as processor costs have dropped and data communications software know-how has advanced. Today's enthusiastic promotion of front-end processing by the minicomputer manufacturers and independent systems houses, coupled with some obvious cost and product longevity advantages, has drawn the major main-frame suppliers into the market. This formidable marketing assemblage ensures that the typical data processing installation using or contemplating a data communications subsystem will be strongly urged, perhaps for the first time, to consider installation of a front-end processor.

Front-End Components

The essential components of every front-end processing system are the following:

1. *Processor.* The processor element is a stored-program digital computer of almost any size. It must have its own main memory, but it may or may not use on-line peripheral devices. The processor should have good interrupt handling and bit manipulation capabilities.

2. *Central processor interface.* The front-end processor component must include the proper hardware interface to permit it to connect directly to a standard input/output channel of the central processing unit (or host computer). Such an interface should permit the host computer to communicate with the front-end processor as if it were a standard peripheral device control unit.

3. *Communications multiplexor.* This component is a hard-wired device that provides a logically independent data channel into the front-end processor's main memory for every transmission line being served. The multiplexor serves as the front-end processor's functional interface with the data transmission lines. Control of incoming and outgoing data is coordinated between the multiplexor and the processor via interrupts.

4. *Line interface units.* These components are hard-wired devices that link the multiplexor with the modems that terminate each communications line. Like the modems, the line interface units are specifically tailored to serve the speed and transmission characteristics of the lines they terminate. The lines are, in turn, generally selected according to the transmission requirements of the remote terminal devices.

5. *Software.* The front-end processing hardware components become an integrated, functioning system only through the inclusion of software—some generalized, and some highly specialized. The software programs should include terminal control, line control, message control, and central system interface procedures. Depending on the supplier, the user may be asked to write some portion of this software.

Principal Front-End Functions

Because a front-end processor is essentially a programmable computer, it can be programmed to perform an almost limitless variety of functions. But in its role as external controller of a data communications network, the specific functions generally programmed are those that relate to data and message control. The following functions are the more important ones offered with the more comprehensive front-end processing systems. Some systems will not provide all these functions, but all may not be required in specific installations.

1. *Line control.* This involves the periodic polling of terminals to determine readiness to transmit and receive data. Automatic call answering, acknowledgement, and dial-up can also be handled.

2. *Character and message assembly.* Bits are assembled (and disassembled) into parallel characters, and control characters are recognized to permit the assembly and disassembly of entire messages. The host computer should receive only complete messages for processing. Data can be handled at varying line speeds and in synchronous or asynchronous formats, with start-stop bits and synchronizing characters handled automatically.

3. *Data conversion.* The data transmission codes (such as Baudot, ASCII, etc.) are converted into a common structure that is equivalent to the native data code (such as EBCDIC) of the host computer to facilitate efficient processing.

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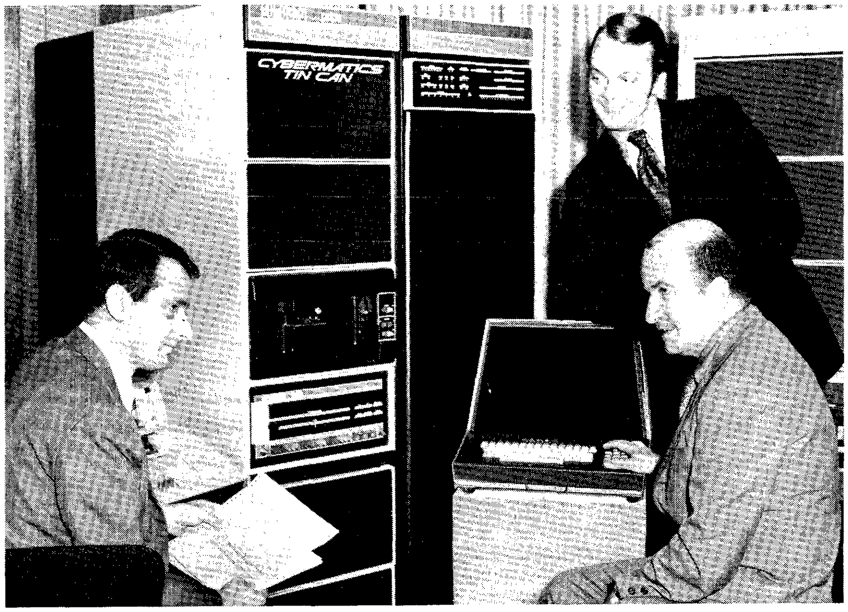

Cybermatics produces complete communications processor systems built around the Digital Equipment PDP-11 minicomputer and its own software. You buy these systems off the shelf just as you would a can of soup—everything in one package, hence the trade name "Tin Can." The company offers prepackaged systems for message switching, line concentration, front-ending, etc.

4. *Data and message editing.* This is general function that can include application-oriented reformatting, removal of spaces and zeroes (and other kinds of data compression), and other data restructuring to permit more efficient data transmission on the one hand and more efficient processing by the host computer on the other.

5. *Error control.* Using both hardware and software techniques, the front-end processor can detect and correct data transmission errors before they reach the host computer. As a result, the host computer can rightly assume that all messages it receives contain pre-validated data ready for processing.

6. *Message buffering and queuing.* The front-end processor can buffer several messages in its main memory before passing them to the host computer, with the intention of interrupting that computer as infrequently as possible. Also, if the host computer cannot process incoming messages as fast as they arrive into the system, the front-end processor can queue these messages in its own auxiliary storage units, such as disks, drums, or magnetic tape units, and can transfer these messages to the host computer when processing time becomes available. Queue management can be arranged in several different ways, including a system of priorities.

7. *Message switching.* When the front-end processor serves more than one host computer, it will analyze message headers and addresses and send each incoming message to the proper central computer. This situation can occur when several central computers share a data communications network while each remains dedicated to specific applications.

8. *Message answering.* Certain messages, such as simple inquiries, can be completely processed by the front-end processor without any contact with the central data processing system. Since many front-end processors permit attachment of on-line auxiliary storage units, these processors can store and have access to their own private data banks. Some systems also permit the front-end processors to directly access the auxiliary storage subsystems and data files of the host computer.

9. *Message recording.* Critically important incoming messages can be passed on to the host computer while being simultaneously recorded on the front-end processor's auxiliary storage units. Such message recording can assist in system restart operatons in case the central system should malfunction and lose either its messages or the results of processing the messages. Also, it may be advisable in some systems to store a journal record of every message received during each processing period.

10. *Statistics recording.* The front-end processor can keep a running record of all data communications traffic, including such statistics as total number of messages processed, number of messages delivered to each destination, number of line errors, average length of time in queue, number of busy signals, etc. These statistics can be dumped in the form of reports at the end of each processing cycle.

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Other application-oriented functions can be programmed by the front-end supplier, by the user, or by some combination of the two. It must be remembered, however, that the front-end processor, like the host computer, has only a finite amount of processing power. The more functions that are added to it in order to relieve the host computer, the more likely will it run out of power, especially in active communications networks. A front-end processor pushed beyond its capacity will result in lost messages and, ultimately, system failure.

Advantages of Front-End Processing

The possible front-end processing functions noted above can be translated into specific advantages over the more conventional hard-wired communications controllers. These advantages are not unlike the general advantages of programmable communications processors stated earlier in this report. The advantages include:

- Flexibility—handling many line speeds and transmission characteristics.
- Adaptability—supporting a wide variety of remote terminals from the main-frame and independent suppliers, regardless of their transmission speeds, line control conventions, synchronization techniques, and data codes.
- Expandability—permitting relatively easy growth of the data communications network, principally by adding line interface units and modifying the control programs.
- Performance—handling more and higher-speed data communications lines than hard-wired counterparts.
- CPU relief—controlling the entire data communications subsystem will relieve the system's central processing unit on two counts: processing time and main memory space. Central control of data communications networks can consume 40 to 50 percent of the available processing time in typical situations. And the resident software control routines can easily consume 10K to 20K bytes of main memory space, depending on the functions performed. Efficient utilization of front-end processors can provide almost full relief in both processing time and memory space overheads.
- Economy—resulting from its flexibility, adaptability, and expandability, a specific front-end processor system can deliver many years of service. Important economies will also derive from freeing the host computer to turn out 40 to 50 percent more productive work during each processing period. As a corollary, the host centrl processing unit will itself tend to have a much longer useful life span before requiring an upgrade to a larger, more expensive model. Also, one front-end processor can often serve as many lines as two or more hard-wired controllers, and one such processor can also serve multiple host computers.
- Fail-soft—adding a front-end processor to a central data processing system can, if so designed, enable portions of the communications network to keep on operating—although in degraded mode—when the central processing unit malfunctions.
- Reliability—utilizing a monitor unit, a system operator can interrogate a front-end processor at any time for information on the operational status of the data communications network. With these diagnostics, component failures can be readily identified and corrected.
- High-level user interface—permitting the user programs to address the data communications network as a standard peripheral device. The complexities of the network can remain transparent to the user.
- Independent processing—permitting the front-end processor to answer inquiries from its own data banks in on-line mode, and also to perform simple, independent tasks in off-line mode, such as card-to-tape, tape-to-print, etc. In off-line mode, the processor can also be adapted to serve specialized I/O devices, such as plotters and OCR devices, that the central system may not be able to handle.

Potential Problems

Front-end processors certainly deserve further investigation because of their many apparent advantages over hard-wired communications controllers. Such investigations should include as many probing questions as possible, because most of the full-service front-end processors have not yet been in use long enough to establish convincing track records.

One potential problem is the question of overloading the front-end processor, with the resultant loss of data. Sophisticated data and message control programs will consume large quantities of the front-end processor's computing and memory facilities, just as they do in a centrally-based communications system. Since many front-end processors are based on small-scale minicomputers, the possibility of overloading is all the more real. The tendency toward overloading can easily negate any apparent advantages of expandability and growth potential.

Another serious question is that of software. The body of software required for terminal control, line control,

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and message control activities, not to mention application-oriented pre-processing, is unquestionably complex. It is also vital to the operation of these systems. The prospective user must determine whether or not the supplier is capable of supplying this software, at what level of completeness, with what assurance of bug-free stability, with what chances of interfacing smoothly with the central system software, and with how much installation assistance.

Obviously, if the software doesn't work properly, the system is of little value. From another point of view, a system whose software works but performs very few and very basic functions may still offer little more than a typical hard-wired controller.

Another consideration is that the hardware/software combination that makes up a front-end processor may require far more time and effort to install and make operational than a hard-wired controller, especially when the supplier of the front-end equipment is different from that of the host computer system. Apart from the traditional problems (real or imagined) of divided vendor responsibility, there exists the very real problem of integrating two completely different sets of hardware and software.

A currently operational data communications installation which is considering replacing its hard-wired communications controller(s) with a front-end processor must carefully evaluate the problems of conversion. Beyond the usual problems of data integrity and the logistics of arranging the conversion process, the user may also be faced with the prospect of modifying either his central system control software or his body of application programs that use the communications network.

Evaluating a front-end processing system on a cost/value basis is extremely complex and can be almost meaningless when performed in the abstract. Costs will vary with the size and diversity of the network being controlled, with the size and processing power of the front-end processor, with the number of control and pre-processing functions incorporated (software is expensive, whether hidden in a "bundled" systems price or not), and with the number of on-line peripheral devices. Keeping costs to an absolute minimum will probably result in a system that is capable of little more than the hard-wired controller it is replacing. In this case, the cost differential is easily measured, but it will not likely be significant in either direction.

Adding functions that will permit use of "foreign" terminals, relieve the central processor of intolerable overheads, and allow independent and back-up processing will increase the costs as it increases the value. In order to evaluate the reasonableness of the cost of the front-end processor and the potential cost savings throughout the system, an effort must be made to ascribe dollar figures to the values expected to be derived from re-orienting a centrally controlled data communications system to an externally controlled one. In summary, it is clear that costs and values of front-end processing can be assessed only in terms of specific situations and specific systems.

Buying Guidance

The front-end processing products have not matured to the point where their descriptive terminology is in any way standardized or consistent. As a result, the prospective buyer must make every effort to determine exactly what he will be getting and what he will not. The sales brochures and technical manuals are often not sufficiently informative (and sometimes downright misleading).

First of all, there are at present two distinctly different kinds of front-end processors. The first and more basic variety is designed to simply replace the functions and services of the central system's hard-wired controller. It is meant to be a plug-compatible replacement, requiring few, if any, changes to the central system's communications control software or the user's application programs. It does not necessarily relieve the central system of any software control overheads, but simply provides a more flexible interface to the communications network for accommodation of additional and varied lines and terminals in the future.

The most prevalent examples of this type of front-end processor are the many available units designed to replace or "emulate" the IBM 2701 Data Adapter Unit and the IBM 2702 and 2703 Transmission Control Units. These front-end processors function with the IBM System/360 or System/370 computer systems through the standard IBM BTAM, QTAM, and TCAM communications control software.

The second and more powerful variety of front-end processor is designed to replace not only the functions and services of the hard-wired controller, but also most or all of the data communications control functions normally performed by the central system's processing unit and resident software. This variety of front-end processor provides valuable advantages not only in data communications flexibility, but also in systems throughput by freeing the central processing unit for productive work.

It is possible that a user may want to install the basic kind of front-end processor initially and then gradually add functions to it to relieve the central processing unit's communications overheads. However, the user must make sure that his selected front-end processor has enough processing and memory capacity to permit the

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gradual build-up of substantial message control routines.

Another buyer's tip is to look for the word "turnkey." Turnkey installation of front-end processors usually means that the supplier takes on full responsibility for hardware, software, and interfaces required to essentially "plug in" his product. From a user's point of view, this approach is highly desirable, since it can save him money, time, and aggravation. But the user must still determine what product with what promised functions is being offered on the turnkey basis. It may still be a somewhat limited front-end product.

A low list price can be totally misleading, since it may include only a minicomputer and an associated communications multiplexor. The cost and effort of establishing the proper interfaces and writing the all-important software can be dropped squarely on the buyer, who may have been trapped by an attractive low-price bid.

Since software development is such a critical question, the buyer should determine early in the proceedings exactly what software is provided with the basic front-end system and at the basic price. If certain software is lacking, such as specific remote terminal handlers or message queuing routines, then implementation and integration responsibilities should be clearly fixed, and with firm price quotations.

The buyer will also ask the competing bidders for clear statements of service and support after installation of the front-end processor. Since data communications subsystems can be complex and demanding in any environment, it must be considered an extremely valuable system feature if the prospective supplier of the front-end processor offers to assume full operating and service responsibility for the externally controlled communications network that is directed by his product.

When considering a front-end processor from a source other than the supplier of the central computer equipment, the buyer should insist on receiving concrete performance data, drawn from installed systems, to substantiate the supplier's claims. The buyer should beware if the supplier refuses to back up his claims with actual case studies. As further evidence of proven performance, the buyer should personally contact as many previous users as possible, probing not only for their degree of satisfaction, but also for the extent to which the installed systems reflect his own intended system design and functional objectives. However, even in highly specialized reference accounts, meaningful information can be derived regarding the supplier's competence and willingness to help, and the basic reliability of the hardware/software package.

When the proposed supplier is a major main-frame manufacturer, the buyer will also want evidence of proven performance. This evidence should apply to the overall performance of the total, integrated data processing system, and not just the front-end subsystem. However, when the main-frame supplier offers a choice of a front-end processor or a hard-wired controller (as several now do), then the buyer will again want specific, tangible performance data to justify his moving to the newer, less proven concept of front-end processing. Of course, the main-frame supplier can forcibly persuade adoption of the front-end concept even without offering convincing performance data, by simply indicating that the newer product will receive all future support and that the former one will be essentially dropped from the product line.

And What Do Users Say?

In conjunction with the revision of this report, DATAPRO 70 included a questionnaire on communications processors in the October 1972 supplement. As usual, our subscribers came through with some very useful information. There were not enough returns on individual products to warrant reporting on user's experience with specific models; but taken as a whole, the replies were revealing. Altogether, 51 users responded. Of these, 29 represented users of communications processors and 13 were users of intelligent terminals. The remaining 9 indicated that they were in the process of planning, evaluating, or implementing a communications processor.

The 29 communications processor users represented 22 different models and a total of 42 machines. Most were relatively new to the game – about one-third installed their equipment in 1971 and about one-third in 1972. The other third included users beginning as far back as 1967. Overall, user experience averaged 21 months. In general, users were well satisfied with their particular choices. They were asked to rate overall performance, reliability, and maintenance service as excellent, good, fair, or unsatisfactory. Averaged out, performance and reliability were rated about half-way between "excellent" and "good", with maintenance service shaded more toward "good." Only one user reported replacing a unit because it was unsatisfactory: the reason stated was lack of flexibility.

Users were also asked to report particular strengths and weaknesses of their equipment. Though an insufficient number of replies was received to report on particular units, three points showed up again and again in the users' replies. These points that the users were most concerned about were the ease of programming, flexibility in adapting to particular terminals, and reliability of hardware. The software was the one item most frequently mentioned, whether in praise or in condemna-

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tion. The distribution of the replies prevents an overall assessment of the quality of software being provided, but it is clear that prospective buyers of communications processors should investigate the supporting software as carefully as the equipment itself.

The 13 users of intelligent terminals represented 13 different models and a total of 64 devices. Again, insufficient replies were received about individual models to be statistically relevant. (Datapro considers the number of users replying as well as the number of devices represented.) In general, users were quite happy with the equipment. The only adverse comment mentioned frequently enough to warrant recording is the well-known lament about the slowness of the IBM 3735; both of the responding users (representing a total of 9 devices) mentioned it.

Future Prospects

As all industry estimates agree, data communications systems will continue to increase in numbers during the decade of the seventies. Only the rate of growth differs in these estimates, but an annual increase of 50 percent in the volume of equipment installed during the next few years seems entirely reasonable. It is our strong feeling that communications processors in general and front-end processors in particular will constitute a steadily increasing portion of this volume.

When all the major main-frame suppliers get really serious about installing front-end processors, life could get increasingly difficult for the independent suppliers—at least in terms of end-user sales. Sales of equipment on an OEM basis to main-frame suppliers could remain at a favorable level. The main-frame suppliers will have a strong inside position by reason of their ability to neatly integrate the front-end processor into the total data processing system. The burden of proof will remain squarely on the shoulders of the independents to give evidence that they, too, can and will install their equipment on a fully integrated turnkey basis. In any event, front-end processors create a brand new software market, and software houses with superior skills in data communications packages may find themselves with a steady, lucrative business in this area for many years to come.

The Comparison Charts

The prospective buyer of a communications processor can learn a good deal about the various suppliers of this equipment and the specifications and prices of their wares by scanning the following pages of comparison charts. These charts present the principal characteristics of 79 commercially available communications processors from 40 different manufacturers. All information was

Tempo's 270T Terminal Control Processor is designed as a turnkey replacement for IBM's 270X line of hard-wired communications controllers.

supplied and/or verified by the vendors during the months of November and December 1972. Their cooperation is acknowledged and greatly appreciated.

Subject matter for the charts includes processors with such uses as front-end processing, message switching, data collection, line concentration, etc. Those processors used strictly as controllers in remote batch terminals are not included, because these products are covered in the individual reports in the Peripherals section of DATAPRO 70. Minicomputers and their suppliers are not included unless the manufacturer offers an integrated communications product, rather than a bare minicomputer, for sale to end users. (Full treatment of minicomputers and their suppliers can be found in "All About Minicomputers." DATAPRO 70 Feature Report 70F-400-01.)

With two exceptions, hard-wired communications controllers are not covered in these charts on programmable communications processors; however, they are covered in the Computers section of DATAPRO 70 in the reports on the specific computer systems with which they function. The two exceptions are the IBM 270X hard-wired controllers and their Memorex equivalents. It seems only fitting that these products be included for comparative purposes, since they triggered much of the current interest in communications processors by the average EDP user.

The chart entries and their significance to prospective users of programmable communications processors are explained in the following paragraphs.

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Computer system interface. Those programmable communications processors that provide specific hardware interfaces to central main-frame computer systems are generally used primarily as front-end processors. This entry lists the interfaces available, if any. If none is available, the processor is probably used as the heart of a message switching or data collection system, as will be specified later on in the entry called Principal Applications. The computer system interface generally enables the front-end processor to connect directly to an I/O channel of the central computer system, appearing as a standard I/O device controller to the channel.

Number of lines. This entry summarizes the communications line handling capacity of each processor. The entry lists the total number of full-duplex lines that can be directly connected. (For those applications that normally require half-duplex lines, the reader can double all entries relating to number of lines.) The entry also lists the total number of lines that can be simultaneously active, i.e., transmitting data. This number may be less than the maximum number of lines that can be connected. The entry also shows the maximum aggregate rate at which the processor can control the incoming and outgoing transmission of data. This rate is expressed in bits per second.

In separate entries are listed the maximum number of narrow-band, voice-band, and broad-band lines that can be connected. These figures are at best meant to serve as general guidelines, since a specifically tailored processor system may be able to handle considerably less than the listed maximums (depending, for example, on the relative activities of the three types of lines and also on the amount of processor time dedicated to pre- or post-processing of the data being transmitted).

Processor and memory. This entry includes the basic performance specifications of the programmable processor and its main memory unit. The length of the processor's basic unit of data (i.e., its word size) is expressed in number of bits. Generally, the larger the word size, the more efficient the transfer of data between the processor and the central computer system. Main memory cycle times, plus binary add times, are presented to give some indications of the raw data handling speeds of these processors. Main memory capacity, expressed in range of sizes, can directly affect overall performance; the larger the main memory, the more and larger data buffers can be allocated, and the more software processing routines can be resident and instantly accessible in main memory.

The number of instructions in the processor's instruction repertoire is presented in order to give some idea of the programming flexibility of each processor. Generally speaking, the larger the number of instructions, the easier to program and more efficiently operating are the resulting software programs. The number of priority interrupt levels is listed to indicate how the hardware can assist in line control operations. Ideally, if each controlled com-receipt of a line-generated interrupt the processor would automatically know the source of that interrupt. Since the ideal situation rarely prevails, the processor must engage in some software testing in order to identify the sources of specific interrupts.

The entry also lists the various types of on-line peripheral devices, if any, that can be directly connected to the programmable communications processor. By far the most important of such devices are the auxiliary storage units, i.e., the on-line drums, disks, and magnetic tape units. The drum and disk units can be especially valuable in message buffering, batching, and queuing operations. They can also store less frequently used processing routines. Magnetic tape units can be useful in logging messages on a journal basis or in recording statistics.

The other on-line peripheral devices, such as punched card units, paper tape units, and line printers, generally play a less direct role in the communications-oriented functions of these processors. However, they are of direct value in enabling the processor to perform as an independent data processing system when it is off-line from its primary data communications control activities. These devices can also be valuable in testing and debugging the processor's software control programs.

The charts also list whether or not the processors include console performance monitors. These devices may be CRT display units, simple Teletype teleprinters, or highly specialized units, such as Comcet's SAM (System Activity Monitor) unit. But in any case, depending on the comprehensiveness of the software programs that support them, they can provide the system operator with immediate access to the status of all lines and can permit him to change this status, for example, from non-available to available, as necessary. Some devices can also provide statistics on the performance of the network, indicating the amount of time lines are idle, the amount of time spent processing interrupts, etc. In any event, these devices can be especially useful in helping to diagnose system failures, since the operator can quickly determine the operational status of all connected lines.

Software. This entry shows what levels of software are provided with the processor, and also whether or not the price of the software is included in the price of the hardware ("standard") or is priced separately ("optional"). If the processor is equipped with a software operating system to control all its operations, the charts so indicate. Likewise, if the software provided includes message control programs to automatically format, route, and queue messages, the charts so indicate. If message control routines are not provided, then the

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buyer must realize that he must provide for such routines either through use of his in-house programmers or through an independent software supplier. The vendor of the programmable processor may also offer to write such software, but obviously for an additional price.

The software entries also list the specific terminal handling routines, or handlers, that are offered as part of the standard processor package. Other handlers can often be easily provided, but on a special-order basis. The user may choose to write his own terminal handlers if none exists for his specific terminals, or he may commission the supplier of his "foreign" terminal to prepare appropriate handlers as part of the terminal system support package. (These entries refer to the popular Teletype terminals by the abbreviation "TTY.")

The entries also list whether or not the processor comes equipped with an assembler so that the user can write and modify control and processing routines as required during the installation lifetime of the processor. In some cases, the vendor provides two versions of the assembler: one that functions on the communications processor itself, and another that functions on the host or central computer for greater speed in assembling the program.

Principal applications. This entry lists the key application areas for which each programmable processor has been designed. If a given processor is listed as serving one particular application area, such as message switching, it is likely that it can be adapted to other uses with the addition of some hardware interface units and specific software packages. Specific entries have been included to pinpoint the devices capable of directly replacing IBM 270X controllers or 3705 processors.

Error Control. This entry lists the error detection and correction techniques provided as standard hardware/software features of each processor. In almost every case, additional error control techniques can be added by software on a special-order basis. The specific error control procedures selected by each user will in large measure be dependent on the data transmission characteristics of his remote terminals and the associated communications lines. The more procedures that are provided, the more likely will the user's error control needs be satisfied without special-order programming.

Pricing and availability. The entries list the purchase and monthly rental prices for each processor, except where the suppliers declined to provide such information. In many cases, price ranges are listed, indicating that actual prices in specific situations will be determined by such items as number and type of lines controlled, amount of main memory selected (based on size and number of message buffers desired), number and type of on-line peripheral devices selected, and number and extent of software functions desired. As mentioned earlier, it can be extremely dangerous to casually compare the prices of two apparently similar programmable processors without knowing precisely what is included in each package price. Therefore, the prices listed on the charts can at best serve as rough guidelines on the relative pricing of these processors.

The suppliers of these processors were asked to provide two other significant items of information: data of first delivery (actual or expected) and number of processors installed to date. (In most cases, they provided this information; those that declined are clearly indicated.) This information can be valuable in differentiating those products that have been installed for a substantial period of time and in a number of installations from those that are essentially untried to date. In those cases where the systems have been installed and running for some period of time, the buyer should check with the supplier as to whether or not the installed systems are functioning in the same application areas as those he has planned. If they are performing radically different functions, the "proven performance" assertion loses some significance.

Comments. At the bottom of the charts are listed any unusual features or characteristics of the programmable communications processors which are not reflected in the standard entries.

Suppliers of Communications Processors

Listed below for your convenience in obtaining additional information are the full names and addresses of the 40 suppliers whose products are summarized in the following comparison charts.

Action Communications Systems, Inc., 10300 N. Central Expressway, Dallas, Texas 75231. Telephone (214) 691-1201.

American Data Systems, 8851 Mason Avenue, Canoga Park, California 91306. Telephone (213) 882-0020.

Burroughs Corporation, Second Avenue at Burroughs, Detroit, Michigan 48232. Telephone (313) 972-7000.

Collins Radio Company, Dallas, Texas 75207. Telephone (214) 235-9511.

Computer Automation Inc., 895 West Sixteenth Street, Newport Beach, California 92660. Telephone (714) 833-8830.

Computer Communications, Inc., 5933 W. Slauson Avenue, Culver City, California 90230. Telephone (213) 390-7777.

Computer Control Systems, Inc. (see Teleswitcher Corp.)

COMTEC Data Systems, 12701 South Van Ness Avenue, Hawthorne, California 90250. Telephone (213) 757-9211.

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▷ *COMTEN,* 1950 W. County Road B-2, St. Paul, Minnesota 55113. Telephone (612) 633-8130.

Control Data Corporation, Box O, Minneapolis, Minnesota 55440.

Cybermatics, Inc., 2460 Lemoine Avenue, Fort Lee, N.J., 07024. Telephone (201) 871-1300.

Data General Corporation, Southboro, Massachusetts 01772. Telephone (617) 485-9100.

Data Pathing Inc., 370 San Aleso Avenue, Sunnyvale, California 94086. Telephone (408) 734-0100.

Dataserv, 770 Airport Boulevard, Burlingame, California 94010. Telephone (415) 342-0877.

Digital Computer Controls Inc., 12 Industrial Road, Fairfield, New Jersey 07006. Telephone (201) 227-4861.

Digital Equipment Corporation, 146 Main Street, Maynard Massachusetts 01754. Telephone (617) 897-5111.

General Electric Company, Communications Systems Division, Mountainview Road, Lynchburg, Virginia 24502. Telephone 703-846-7300.

General Instrument Corporation, Electronic Systems Division, Andrews Road, Hicksville, New York 11802. Telephone (516) 733-3000.

GTE Information Systems, Inc. (Tempo), 4005 West Artesia Avenue, Fullerton, California 92633. Telephone (714) 523-9440.

Honeywell Information Systems, Inc., Old Connecticut Path, Framingham, Massachusetts 01701. Telephone (617) 237-4100.

IBM Corporation, Data Processing Division, 1133 Westchester Avenue, White Plains, New York 10604. Telephone (914) 696-1900.

Intercomputer Corporation, 2201 East University Drive, Phoenix, Arizona 85034. Telephone (602) 254-6349.

Interdata, Inc., 2 Crescent Place, Oceanport, New Jersey 07757. Telephone (201) 229-4040.

Mark Computer Systems Inc., One Patterson Place, Garden City, New York 11530. Telephone (516) 543-6660.

Memorex Corporation, San Tomas at Central Expressway, Santa Clara, California 95052. Telephone (408) 987-2200.

Microdata Corporation, 17481 Red Hill Avenue, Irvine, California 92705. Telephone (714) 540-6730.

Modular Computer Systems, 2709 North Dixie Highway, Fort Lauderdale, Florida 33309. Telephone (305) 974-1380.

OMNUS Computer Corporation, 1538 E. Chestnut Street, Suite E, Santa Ana, California 92701. Telephone (714) 547-8444.

Prentice Electronics Corporation, 795 San Antonia Road, Palo Alto, California 94303. Telephone (415) 327-0490.

Programming Methods (GTE Information Systems, Inc.), 1301 Avenue of the Americas, New York, New York 10019. Telephone (212) 489-7200.

Raytheon Data Systems Company, 145 Boston-Providence Turnpike, Norwood, Massachusetts 02062. Telephone (617) 762-6700.

Sanders Data Systems, Inc., Daniel Webster Highway, South, ashua, New Hampshire 03060. Telephone (603) 885-4743.

Telefile Computer Products, Inc., 17785 Sky Park Circle, Box ao, Irvine, California 92664. Telephone (714) 557-6660.

Teleprocessing Industries, Inc. (subsidiary of Western Union Corporation), 82 McKee Drive, Mahwah, New Jersey 07430. Telephone (201) 529-4600.

Teleswitcher Corporation (formerly Computer Control Systems, a division of Union Service Industries), 13740 Gamma Road, Dallas, Texas 75240. Telephone (214) 233-2971.

Tempo Computers, Inc. (see GTE Information Systems)

Texas Instruments Inc., P.O. Box 1444, Houston, Texas 77001. Telephone (713) 494-5115.

UNIVAC (division of Sperry Rand Corporation), P.O. Box 500, Blue Bell, Pennsylvania 19422. Telephone (215) 542-4011.

UCC Communications Systems Inc., 7200 Stemmons Freeway, Dallas, Texas 75247. Telephone (214) 637-5010.

Varian Data Machines, 2722 Michelson Drive, Irvine, California 92806. Telephone (714) 833-2400.

Wells TP Sciences, Inc., 149 Route 46, Clifton, New Jersey 07011. Telephone (201) 546-3700.

Xerox Corporation, 701 South Aviation Boulevard, El Segundo, California 90245. Telephone (213) 772-4511. □

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MANUFACTURER AND MODEL	Action Communications Systems Telecontroller	American Data Systems ADS 950	Burroughs DCP	Collins Radio Company C-System	Computer Automation Alpha-8
COMPUTER SYSTEM INTERFACE	IBM/360, IBM/370; others custom	IBM/360, IBM/370	Burroughs computer systems	IBM/360, IBM/370, UNIVAC 1100 series, custom	Custom
NUMBER OF LINES					
Maximum number of full-duplex lines	64	512	64	1024	32
Narrow-band (up to 300 bps)	64	512	64	1024	32
Voice-band (up to 9600 bps)	64	128	17	256	4
Broad-band (greater than 9600 bps)	3	33	—	128	1
Total simultaneously active lines	64	512	64	1024	32
Maximum aggregate data rate, bps	Varies	2,880,000	50,000	1,228,800	400,000
PROCESSOR AND MEMORY					
Word length, bits	16	16	8	32	8
Memory cycle time, usec	1.2	1.19	1.5	2	1.6
Memory capacity (in words)	64K max.	128K max.	4K to 32K	65K	4K to 32K
Instruction set	200	94	67	92	73
Binary add time (full-word, usec.)	1.35	Not available	9	2.9	4.8
Priority interrupt levels	16	6	12	?	3 to 256
On-line peripheral devices	Disk, mag. tape, printer, card reader, others	Disk, TTY, CRT, cassette tape	Card reader	Disks, drums, mag. tape, printers, card units, others	Mag. tape, cassette tape, TTY, CRT, printer, card reader, punched tape units
Console performance monitor	Yes	Yes	Yes	Yes	No
SOFTWARE					
Operating system	Yes	Yes	Yes	Yes	No
Message control programs	Yes	Yes	Yes	Yes	No
Assembler	Yes	Yes	Yes	Yes	Yes
Terminal handlers	About 25, including Teletype, IBM, Wiltek, Memorex, CRTs, etc.	All IBM, Teletype	TTY, all Burroughs terminals	TTY, private teletypewrite networks including foreign, IBM BSC, many others	Custom
Software pricing	Standard	Standard	Optional	Standard	Optional
PRINCIPAL APPLICATIONS					
Plug-compatible with—					
IBM 2701/2/3	No	Yes	No	Yes	No
IBM 3705	Yes (NCP)	Yes	No	Yes	No
General	Message switching, inquiry response, front-end processing	Front-end processing, message switching, concentrator	Data collection, message switching, front-end processing	Front-end processing, message switching	Message switching, concentrator, front-end processing
ERROR CONTROL					
Error detection	As programmed for specific terminals	VRC, LRC, CRC	Software defined	Character and message parity	Parity standard, others as programmed
Error correction	As programmed	Retransmission	Software defined	Retransmission	As programmed
PRICING AND AVAILABILITY					
Purchase price	$60,000 to $400,000	$100,000 to $500,000	$75,000 to $150,000	Contact vendor	Contact vendor
Monthly rental, including maintenance (1-year lease)	Varies	Varies	$1,250 to $3,000	Contact vendor	Not available
Date of first delivery	January 1971	1969	August 1970	June 1967	1972
Number installed to date	20	9	Over 50	60	?
COMMENTS	Minimal changes required to IBM software when replacing 3705; turn-key support standard	Turn-key software support standard		Flexible system with impressive stand-alone capabilities; turn-key support available	Turn-key support optional

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MANUFACTURER AND MODEL	Computer Automation Alpha-16	Computer Communications Inc. CC-70	Computer Communications Inc. CC-7000	COMTEC Data Systems CT/90	COMTEN, Inc. COMTEN 20
COMPUTER SYSTEM INTERFACE	Custom	IBM/360, IBM/370, IBM 1130, CDC 3000, CDC 6000, Xerox Sigma series	IBM/360, IBM/370, IBM 1130, CDC 3000, CDC 6000, Xerox Sigma series	IBM/360, IBM/370, UNIVAC 1100 Series, Burroughs B 3500, B 4700	Custom
NUMBER OF LINES					
Maximum number of full-duplex lines	64	120	120	240	128
Narrow-band (up to 300 bps)	64	240	240	240	128
Voice-band (up to 9600 bps)	4	120	120	240	128
Broad-band (greater than 9600 bps)	1	120	120	240	128
Total simultaneously active lines	32	240	240	240	128
Maximum aggregate data rate, bps	800,000	4,000,000	4,000,000	160,000	1,777,000
PROCESSOR AND MEMORY					
Word length, bits	16	16	16	16	16
Memory cycle time, usec.	1.6	1.0	1.0	1.0	0.9
Memory capacity (in words)	2K to 32K	4K to 32K	4K to 32K	32K	8K to 32K
Instruction set	152	512	512	113	52
Binary add time (full-word, usec.)	3.2	0.72	0.72	1.0	2.7
Priority interrupt levels	3 to 256	32	32	256	134
On-line peripheral devices	Disk, mag. tape, cassette tape, TTY, CRT, printer, card reader, punched tape units	Fixed/moving-head disks, mag. tape, printer, card reader, CRT	Fixed/moving-head disks, mag. tape, printer, card reader, CRT	Disk, mag. tape, card units, cassette tape, printer	Fixed/moving head disks, mag. tape, paper tape and card units, line printer
Console performance monitor	No	Yes	Yes	Yes	No
SOFTWARE					
Operating system	Yes	Yes	Yes	Yes	No
Message control programs	No	Yes	Yes	Yes	No
Assembler	Yes	Yes	Yes	Yes	Yes
Terminal handlers	Custom	All CCI, all IBM, TTY 33/35; others custom	All CCI, all IBM, TTY 33/35; others custom	All IBM, TTY, UNIVAC Uniscopes, others, custom	None
Software pricing	Std./optional	Standard	Standard	Standard	Standard
PRINCIPAL APPLICATIONS					
Plug-compatible with—					
IBM 2701/2/3	No	Yes	No	Yes	No
IBM 3705	No	Yes	No	Yes (2701/2/3)	No
General	Message switching, concentrator, front-end processing	Front-end processing	Message switching, front-end processing	Front-end processing, Message switching	Concentrator
ERROR CONTROL					
Error detection	Parity standard, others as programmed	Char. parity, block check, CRC, LRC	Char. parity, block check, CRC, LRC	Character and message parity, CRC	Character and message switching, CRC
Error correction	As programmed	Retransmission	Retransmission	Retransmission	Retransmission
PRICING AND AVAILABILITY					
Purchase price	Contact vendor	$30,000 (basic)	$350,000 to $600,000	$50,000	$60,000 to $120,000
Monthly rental, including maintenance (1-year lease)	Not available	3-yr. and 5-yr.	3-yr. and 5-yr.	$2,000	Not available
Date of first delivery	1972	December 1970	October 1970	January 1972	March 1971
Number installed to date		26	3	7	28
COMMENTS	Turn-key support optional	Turn-key support standard. CC-71 system is a remote concentrator based on same hardware; 24 have been installed	Features multiple processors, turn-key support; CCI provides non-IBM access method	Turn-key support standard; company is part of American Micro Systems	System can be expanded through multiplexors by and combining components

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MANUFACTURER AND MODEL	Comten, Inc. Comten 45	Comten, Inc. Comten 65	Comten, Inc. Comten 3670	Control Data Corp. Cyber 1000	Cybermatics Inc. Tin Can 1
COMPUTER SYSTEM INTERFACE	IBM/360, IBM/ 370, custom	IBM/360, IBM/ 370, custom	IBM/360, IBM/ 370, custom	IBM/360; IBM/ 370; other custom	UNIVAC 418, 1108; IBM/ 360, IBM/370
NUMBER OF LINES					
Maximum number of full-duplex lines	256	256	384	32 to 512	64
Narrow-band (up to 300 bps)	256 (1800 bps)	256 (1800 bps)	384 (1800 bps)	32 to 512	64
Voice-band (up to 9600 bps)	160	160	160	32 to 512	18
Broad-band (greater than 9600 bps)	160	160	160	Custom	2
Total simultaneously active lines	256	256	384	32 to 512	64
Maximum aggregate data rate, bps	2,222,000	3,555,000	2,133,000	NA	20,000
PROCESSOR AND MEMORY					
Word length, bits	32	32	16	24	16
Memory cycle time, usec.	1.2	0.75	0.65	0.900	0.9
Memory capacity (in words)	8K to 128K	8K to 128K	8K to 256K	8K to 256K	12K to 128K
Instruction set	58	58	61	NA	320
Binary add time (full-word, usec.)	2.4	1.5	2.25	NA	2.3
Priority interrupt levels	249	249	138	NA	8
On-line peripheral devices	Fixed/moving head disks, mag. tape, paper tape and card units, line printer	Fixed/moving head disks, mag. tape, paper tape and card units, line printer	Mag. tape cassettes	Disk, mag. tape, printers, card units	Disk, mag. tape, line printers, card units, paper tape, CRTs, others
Console performance monitor	Yes	Yes	Custom	Yes	Yes
SOFTWARE					
Operating system	Yes	Yes	Yes	Yes	Yes
Message control programs	Yes	Yes	Firmware	Yes	Yes
Assembler	Yes	Yes	Yes	Yes	Yes
Terminal handlers	TTY 28/33/35, all IBM, Sanders 720, Burroughs TC 500, private teletypewriter networks	TTY 28/33/35, all IBM, Sanders 720, Burroughs TC 500, private teletypewriter networks	TTY 28/33/35, all IBM, many others	Most Teletype and IBM	CRTs, TWX, Telex, TTY networks, international terminals
Software pricing	Standard	Standard	Standard	Optional	Standard
PRINCIPAL APPLICATIONS					
Plug-compatible with—					
IBM 2701/2/3	No	No	Yes	No	No
IBM 3705	No	No	Yes (2701/2/3)	No	No
General	Message switching, front-end processing	Message switching, front-end processing	Message switching, front-end processing	Message switching, front-end processing	Message switching, front-end, inq./response, data collection/ distribution
ERROR CONTROL					
Error detection	Character and message parity, CRC	Character and message parity, CRC	Character and message parity, CRC	Parity and cyclic checks appropriate to terminals	Character and message parity
Error correction	Retransmission	Retransmission	Retransmission	Retransmission	Retransmission, intercept
PRICING AND AVAILABILITY					
Purchase Price	$100,000 to $500,000	$150,000 to $800,000	$70,000 to $200,000	$228,000 to $1,127,000 (basic)	$50,000 to $200,000
Monthly rental, including maintenance (1-year lease)	Not available	Not available	Not available	$5,790 to $31,000 (Basic)	Not available
Date of first delivery	August 1969	June 1969	March 1972	First quarter 1973	July 1972
Number installed to date	11	10	18	—	?
COMMENTS	System can be expanded through multiplexors and by combining components	System can be expanded through multiplexors and by combining components	System can be expanded through multiplexors and by combining components	System includes 1 to 4 processors; figures above span the range; software can cost from $260 to $1,400 per month	System based on Digital Equipment PDP-11 hardware

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MANUFACTURER AND MODEL	Cybermatics Inc. Tin Can 2	Data General 800 Series	Data General 1200 Series	Data Pathing Inc. Model 2102A	Data Pathing Inc. Model 2104
COMPUTER SYSTEM INTERFACE	UNIVAC 418, 1108; IBM/360, IBM/370	IBM/360, IBM/370, custom	IBM/360, IBM/370, custom	IBM/360, IBM/370, UNIVAC 1108, Burroughs B 2500, others	IBM/360, IBM/370 UNIVAC 1108, Burroughs B 2500, others
NUMBER OF LINES					
Maximum number of full-duplex lines	300	64 per mux.	64 per mux.	4	10
Narrow-band (up to 300 bps)	300	64 per mux.	64 per mux.	—	—
Voice-band (up to 9600 bps)	32	64 per mux.	64 per mux.	4	10
Broad-band (greater than 9600 bps)	4	—	—	—	—
Total simultaneously active lines	300	64 per mux.	64 per mux.	4	10
Maximum aggregate date rate, bps	32,000	13,328,000	20,000,000	9,600	24,000
PROCESSOR AND MEMORY					
Word length, bits	16	16	16	18	18
Memory cycle time, usec.	0.375	1.2	0.8	8.0	1.0
Memory capacity (in words)	12K to 128K	1K to 32K	1K to 32K	6K	8K to 16K
Instruction set	320	200	200	87	112
Binary add time (full-word, usec.)	1.4	1.35	0.8	16.0	2.0
Priority interrupt levels	8	16	16	2	2
On-line peripheral devices	Disk, mag. tape, line printer, card units, paper tape, CRTs, others	Fixed/moving-head disk, mag. tape, line printers, cassette tape, card reader, paper tape units, others		Mag. tape, line printer, DPI terminals	Disk, drum, mag. tape, line printer, CRTs, others
Console performance monitor	Yes	Yes	Yes	Yes	Yes
SOFTWARE					
Operating system	Yes	Yes	Yes	Yes	Yes
Message control programs	Yes	Yes	Yes	Yes	Yes
Assembler	Yes	Yes	Yes	Yes	Yes
Terminal handlers	CRTs, TWX, Telex, TTY networks, international terminals	TTY 33, 35, 37, CRTs	TTY 33, 35, 37 CRTs	DPI data collection, TTY, others	DPI data collection, TTY, others
Software pricing	Standard	Standard	Standard	Standard	Standard
PRINCIPAL APPLICATIONS					
Plug-compatible with—					
IBM 2701/2/3	No	No	No	No	No
IBM 3705	No	No	No	No	No
General	Message switching, front-end, inq./response, data collection distribution	Front-end processing, message switching, inquiry/response		Data collection, front-end processing	Data collection, front-end processing
ERROR CONTROL					
Error detection	Character and message parity, journal log	Character and message parity	Character and message parity	Parity, edit checks, others	Parity, edit checks, others
Error correction	Retransmission, intercept	Retransmission	Retransmission	Retransmission	Retransmission
PRICING AND AVAILABILITY					
Purchase price	$70,000 to $500,000	$6,450 to $75,000	$4,350 to $50,000	Contact vendor	Contact vendor
Monthly rental, including maintenance (1-year lease)	Not available	Third party	Third party	Contact vendor	Contact vendor
Date of first delivery	July 1972	April 1971	February 1971	October 1967	May 1970
Number installed to date	?	See Comments	See Comments	80	120
COMMENTS	Memory parity optional; system based on Digital Equipment PDP-11 hardware	Each 4-line group of the same type occupies 1 subassembly slot; 800 Series models provide from 4 to 25 slots; 1200 Series models provide from 2 to 22 slots; memory and peripherals also require slots. About 5000 Novas of all types have been delivered		Turn-key support for data collection/management standard	Turn-key support for data collection/management standard

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MANUFACTURER AND MODEL	Dataserv System 770	Digital Computer Controls Inc. D-116	Digital Equipment Corp. PDP-11/10	Digital Equipment Corp. PDP-11/40	Digital Equipment Corp. PDP-11/50
COMPUTER SYSTEM INTERFACE	IBM/360, IBM/370	IBM/360, IBM/370, UNIVAC 1108, Custom	IBM/360, IBM/370	IBM/360, IBM/370	IBM/360, IBM/370
NUMBER OF LINES					
Maximum number of full-duplex lines	128	64 per mux.	256	256	256
Narrow-band (up to 300 bps)	128	64 per mux.	256	256	256
Voice-band (up to 9600 bps)	64	64 per mux.	16	16	48
Broad-band (greater than 9600 bps)	16	64 per mux.	16	16	48
Total simultaneously active lines	128	All	256	256	256
Maximum aggregate data rate, bps	20,000,000	13,328,000	1,400,000	1,400,000	1,400,000
PROCESSOR AND MEMORY					
Word length, bits	16	16	16	16	16
Memory cycle time, usec.	0.8	1.2	0.4	0.9	0.3
Memory capacity (in words)	4K to 32K	4K to 32K	1K to 28K	1K to 124K	1K to 124K
Instruction set	200	200	400	400	400
Binary add time (full-word, usec.)	0.8	1.35	2.5	2.3	0.3
Priority interrupt levels	16	16	1 to 64	4 to 256	4 to 256
On-line peripheral devices	Disk, mag. tape, card reader, line printer, paper tape punch	Disk, card reader, line printer, paper tape units, others	Disk, mag. tape, printer, card reader, paper tape units		
Console performance monitor	Yes	Yes	No	No	No
SOFTWARE					
Operating system	Yes	Yes	Yes	Yes	Yes
Message control programs	Yes	Yes	Yes	Yes	Yes
Assembler	Yes	Yes	Yes	Yes	Yes
Terminal handlers	IBM 2740, 2780, 1050; various CRTs	TTY, CRTs	TTY 33, 35, 37, IBM 2741	TTY 33, 35, 37, IBM 2741	TTY 33, 35, 37, IBM 2741
Software pricing	Standard	Standard	Optional	Optional	Optional
PRINCIPAL APPLICATIONS					
Plug-compatible with—					
IBM 2701/2/3	Yes	No	No	No	No
IBM 3705	Yes (2701/2/3)	No	No	No	No
General	Message switching, front-end processing, inquiry/response, data collection	Data collection, front-end processing, message switching,	Line concentration, message switching, front-end processing		
ERROR CONTROL					
Error detection	Character and message parity	Character and message parity	Character and message parity, CRC		
Error correction	Retransmission	Retransmission	Retransmission (program-specified)		
PRICING AND AVAILABILITY					
Purchase price	$60,000	Contact vendor	$6,900 to $80,000	$12,995 $120,000	$18,000 to $300,000
Monthly rental, including maintenance (1-year lease)	$1,500	Not available	Not available	Not available	Not available
Date of first delivery	January 1972	January 1972	April 1972	March 1970	April 1972
Number installed to date	—	Over 500	?	?	?
COMMENTS	Based on Date General Nova 800; turn-key support standard	Compatible with Data General Nova 1200; turn-key support available	Turn-key support is not provided as a general rule		

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MANUFACTURER AND MODEL	General Electric DigiNet-1600	General Instrument System 75	GTEIS (Tempo) 270T	GTEIS (Tempo) Communication Controller	Honeywell System 700
COMPUTER SYSTEM INTERFACE	Custom	IBM/360, IBM/370; others custom	IBM/360, IBM/370	IBM/360, IBM/370, CDC 3000/6000 Series, Xerox Sigma Series, Honeywell 437	Honeywell Series 200, 2000, 6000, IBM/360
NUMBER OF LINES					
Maximum number of full-duplex lines	256	16/mux.	256	720	128
Narrow-band (up to 300 bps)	256	—	256	720	128
Voice-band (up to 9600 bps)	16	—	128	360	16
Broad-band (greater than 9600 bps)	16	—	128	360	4
Total simultaneously active lines	256	16/mux.	256	720	128
Maximum aggregate data rate, bps	Over 50,000	20,000,000	2,000,000	2,000,000	38,000
PROCESSOR AND MEMORY					
Word length, bits	16	16	16	16	16
Memory cycle time, usec.	1.2	0.8	0.75	0.75	0.775
Memory capacity (in words)	4K to 32K	4K to 32K	4K to 65K	4K to 65K	32K
Instruction set	61	200	112	112	78
Binary add time (full-word, usec.)	3.75	0.8	1.5	1.5	1.55
Priority interrupt levels	4 to 12	16	16	16	64
On-line peripheral devices	Card reader, paper tape units, line printer, GE TermiNet-300, TTY 33/35	Disk, mag. tape, card reader, line printer, paper tape punch, others	Disk, drum, mag. tape, card units, line printers, CRTs (all custom order)	Disk, drum, mag. tape, card units, line printers, paper tape units, CRTs	Disk, TTY 33, 35
Console performance monitor	Yes	Yes	Yes	Yes	Yes
SOFTWARE					
Operating system	Yes	Yes	Yes	Yes	Yes
Message control programs	Yes	Yes	Yes	Custom	Yes
Assembler	Yes	Yes	Yes	Yes	Yes
Terminal handlers	TTY/33/35, GE TermiNet-300, IBM 2741	TTY, CRTs, voice response, point-of-sale terminals	TTY 28, 33, 35, 37, all IBM, CRTs; others custom	TTY 28, 33, 35, 37, all IBM, Novar, Ultronic; others custom	TTY, Honeywell VIP CRTs
Software pricing	—	—	Standard	Optional	Standard
PRINCIPAL APPLICATIONS					
Plug-compatible with—					
IBM 2701/2/3	No	No	Yes	Yes	No
IBM 3705	No	No	Yes (2701/2/3)	Yes (2701/2/3)	No
General	Line concentration, front-end processing, message switching	Front-end processing message switching, inquiry/response	Front-end processing concentrator	Message switching, front-end processing, concentrator	Remote concentrator
ERROR CONTROL					
Error detection	Character parity, CRC	Character and message parity	Char. and message parity, CRC; others programmed	Char. and message parity, CRC; others programmed	Character parity, LRC, CRC
Error correction	Retransmission	Retransmission	Retransmission	Retransmission program specified	Retransmission
PRICING AND AVAILABILITY					
Purchase price	Contact vendor	Contact vendor	$50,000 to $150,000	$50,000 to $1,000,000	$32,900 to $37,900 (basic)
Monthly rental, including maintenance (1-year lease)	Contact vendor	Lease available	$1,700 to $6,000	$1,900 to $40,000	$990 to $1,140 (basic)
Date of first delivery	March 1971	June 1971	June 1971	June 1970	July 1972
Number installed to date	?	?	18	17	?
COMMENTS		System based on Data General Nova 800; turn-key support standard; information gathered in December 1971	Turn-key support standard	Turn-key support standard	Several models available, including one paired with a 316 processor for IBM PARS network

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MANUFACTURER AND MODEL	Honeywell Datanet-30	Honeywell Datanet-355	Honeywell Datanet-2000	IBM 3705	IBM 2701
COMPUTER SYSTEM INTERFACE	Honeywell Series 200, 400, 600	Honeywell Series 600, 6000	Honeywell Series 200, 2000	IBM/360, IBM/370	IBM/360, IBM/370
NUMBER OF LINES					
Maximum number of full-duplex lines	128	200	120	264	2
Narrow-band (up to 300 bps)	128	200	120	352	4
Voice-band (up to 9600 bps)	10	32	120	352	4
Broad-band (greater than 9600 bps)	7	16	120	8	4
Total simultaneously active lines	128	200	120	352	4
Maximum aggregate date rate, bps	?	489,600	664,000	1,834,400	460,800
PROCESSOR AND MEMORY					
Word length, bits	18	18	16	?	—
Memory cycle time, usec.	6.94	1.0	0.775	1.2	—
Memory capacity (in words)	16K	32K	32K	16K to 240K bytes	None
Instruction set	72	98	78	?	None
Binary add time (full-word, usec.)	13.88	2.0	1.55	?	—
Priority interrupt levels	1	256	64	4	—
On-line peripheral devices	Disk, mag. tape, card units, printer	Card reader, printer	Disk, TTY	None	—
Console performance monitor	Yes	Yes	Yes	No	—
SOFTWARE					
Operating system	Yes	Yes	Yes	Yes	—
Message control programs	Yes	Yes	Yes	Yes	—
Assembler	Yes	Yes	Yes	Yes	—
Terminal handlers	TTY, Honeywell 100 computers, 760 CRT, GE TermiNet 300, IBM 2741	TTY, Honeywell 100 computers, 760 CRT, GE TermiNet 300, IBM 2741	TTY 33, 35, most Honeywell terminals, IBM BSC, others	All IBM, TTY	All IBM including BSC and 2260, TTY
Software pricing	Standard	Standard	Standard	Standard	Standard
PRINCIPAL APPLICATIONS					
Plug-compatible with—					
IBM 2701/2/3	No	No	No	Yes	Yes
IBM 3705	No	No	No	Yes	No
General	Message switching, front-end processing, remote concentrator	Front-end processing, message switching	Front-end processing	Front-end processing	Line control
ERROR CONTROL					
Error detection	As programmed	Parity, timing check	Character and message parity CRC	Char. and block parity, CRC	Char. and block parity, CRC
Error correction	Retransmission	Retransmission	Retransmission	Retransmission	Retransmission
PRICING AND AVAILABILITY					
Purchase price	Contact vendor	Contact vendor	$44,500 to $168,260	$57,000 to $725,000	$12,400 to $80,500
Monthly rental, including maintenance (1-year lease)	Contact vendor	Contact vendor	$1,161 to $4,407	$1,185 to $17,700	$275 to $1,800
Date of first delivery	August 1963	November 1970	December 1972	July 1972	?
Number installed to date	?	?	—	?	?
COMMENTS				See Report 70D-491-31 for details	Hard-wired controller; see Report 70D-491-32 for details

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MANUFACTURER AND MODEL	IBM 2702	IBM 2703	Intercomputer i 50	Interdata Model 50	Interdata Model 55
COMPUTER SYSTEM INTERFACE	IBM/360, IBM/370	IBM/360, IBM/370	IBM/360, IBM/370, custom	IBM/360, IBM/370, Burroughs B5500, UNIVAC 1108	IBM/360,IBM/370, Burroughs B 5500, UNIVAC 1108
NUMBER OF LINES					
Maximum number of full-duplex lines	15	88	80	125	250
Narrow-band (up to 300 bps)	31 (200 bps)	176 (165 bps)	80	125	250
Voice-band (up to 9600 bps)	15 (600 bps)	24	8	60	90
Broad-band (greater than 9600 bps)	—	—	Custom	10	20
Total simultaneously active lines	31	176	80	125	250
Maximum aggregate date rate, bps	9,000	115,200	68,800	400,000	560,000
PROCESSOR AND MEMORY					
Word length, bits	—	—	16	16	16
Memory cycle time, usec.	—	—	1	1	1
Memory capacity (in words)	None	None	64K	32K max.	64K max.
Instruction set	None	None	63	118	231
Binary add time (full-word, usec.)	—	—	NA	1	1
Priority interrupt levels	—	—	31	255	255
On-line peripheral devices	—	—	Disk, mag. tape, printer, card reader, paper tape units	Disk, mag. tape, card reader, TTY, paper tape units	Disk, mag. tape, card reader, TTY, paper tape units
Console performance monitor	—	—	Yes	No	No
SOFTWARE					
Operating system	—	—	Yes	Yes	Yes
Message control programs	—	—	Yes	No	No
Assembler	—	—	Yes	Yes	Yes
Terminal handlers	All IBM operating at or below 600 bps; TTY	All IBM except 2260; TTY	Any terminal	IBM BSC, TTY, CRTs	IBM BSC, TTY, CRTs
Software pricing	Standard	Standard	Std. and optional	Optional	Optional
PRINCIPAL APPLICATIONS					
Plug-compatible with—					
IBM 2701/2/3	Yes	Yes	Yes	No	No
IBM 3705	No	No	Yes	Yes	No
General	Line control	Line control	Message switching, front-end processing	Terminal controller concentrator, message switching	Front-end processing, concentrators, message switching
ERROR CONTROL					
Error detection	Char. and block parity	Char. and block parity, CRC	CRC, others	VRC, LRC, CRC	VRC, LRC, CRC
Error correction	Retransmission	Retransmission	Retransmission, intercept	Retransmission	Retransmission
PRICING AND AVAILABILITY					
Purchase price	$40,000 to $77,600	$74,500 to $290,000	$15,000 to $115,000 Negotiable	$6,800	$15,900
Monthly rental, including maintenance (1-year lease)	$885 to $1,700	$1,650 to $3,050		—	—
Date of first delivery	?	?	July 1971	July 1972	August 1972
Number installed to date	?	?	12	18	5
COMMENTS	Hard-wired controller; see Report 70D-491-32 for details	Hard-wired controller, see Report 70D-491-32 for details	Turn-key support available; processor include 4K read-only memory	Software cost is $1,000; turn-key support optional	Software cost is $3,000; system includes two processors; turn-key support optional

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MANUFACTURER AND MODEL	Interdata Model 270X	Mark Computer Systems System Seventy	Memorex 1270 Model I	Memorex 1270 Model II	Microdata 1600/60
COMPUTER SYSTEM INTERFACE	IBM/360, IBM/370	IBM/360, IBM/370, custom	IBM/360, IBM 370	IBM/360, IBM/370	IBM/360, IBM/370, custom
NUMBER OF LINES					
Maximum number of full-duplex lines	125	256	96	8	256
Narrow-band (up to 300 bps)	125	256	96 (1200 bps)	8	256
Voice-band (up to 9600 bps)	12	128	24	8	256
Broad-band (greater than 9600 bps)	4	128	6	6	256
Total simultaneously active lines	125	256	96	8	256
Maximum aggregate data rate, bps	96,000	500,000	300,000	300,000	833,000
PROCESSOR AND MEMORY					
Word length, bits	16	16	–	–	Variable
Memory cycle time, usec.	1	0.8	–	–	1.0
Memory capacity (in words)	48K max.	4K to 32K	None	None	65K bytes
Instruction set	231	200	None	None	107
Binary add time (full-word, usec.)	1	0.8	–	–	5.2
Priority interrupt levels	255	16	–	–	64
On-line peripheral devices	Cassette tape, paper tape units, TTY	Disk, line printer, card reader, paper tape punch	–	–	Disk, mag. tape, line printer, card reader
Console performance monitor	Yes	Yes	–	–	Custom
SOFTWARE					
Operating system	Yes	Yes	–	–	Yes
Message control programs	No	Yes	–	–	Yes
Assembler	Yes	Yes	–	–	Yes
Terminal handlers	Most terminals supported by IBM 2703	TTY, CRT's touchtone telephone	IBM 1030, 1050, 1060, 1070, 2740, 2741, 2260, BSC; Memorex 1240, 1241, 1242, TTY	IBM 1030, 1050 1060, 1070, 2260, 2710, 2741, BSC, Memorex 1240, 1241, 1242, TTY	TTY, CRTS
Software pricing	Standard	Standard	–	–	Standard
PRINCIPAL APPLICATIONS					
Plug-compatible with—					
IBM 2701/2/3	2703	Yes	Yes	Yes	Yes
IBM 3705	No	Yes (2701/2/3)	No	No	No
General	2703 emulation	Front-end processing, message switching, inquiry/response	Line control	Line control	Front-end processing, line concentration, message switching
ERROR CONTROL					
Error detection	VRC, LRC, CRC	Character and message parity, CRC, LRC	Character and block parity	Character and block parity	Character parity, CRC, LRC
Error correction	Retransmission	Retransmission	Retransmission	Retransmission	Retransmission
PRICING AND AVAILABILITY					
Purchase price	$49,900	$25,000 to $250,000	$44,500 to $80,250	$13,500 to $61,000	$10,000 to $50,000
Monthly rental, including maintenance (1-year lease)	–	Third party	$975 to $1,860	$300 to $1,300	Third party
Date of first delivery	1970	June 1971	July 1970	June 1971	December 1972
Number installed to date	11	2	?	700	–
COMMENTS	Based on Model 55 hardware; turn-key system	Turn-key support available, line configuration limits depend on line discipline	Hard-wired replacement for IBM 2702 and 2703	Hard-wired replacement for IBM 2701; Model II can be field-upgraded to Model I	Turn-key support available; system includes two processors; processors are fully microprogrammable

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MANUFACTURER AND MODEL	Modular Computer Systems MODCOMP I	Modular Computer Systems MODCOMP II	Modular Computer Systems MODCOMP III CP	Omnus Computer Corp. OMNUS 1/C	Prentice Electronics Corp. P-3000
COMPUTER SYSTEM INTERFACE	Control Data 6000, IBM/360, IBM/370, custom	Control Data 6000, IBM/360, IBM/370, custom	Control Data 6000, IBM/360, IBM/370, custom	IBM/360, UNIVAC 1108; others custom	IBM/360, IBM/370, custom
NUMBER OF LINES					
Maximum number of full-duplex lines	67	135	256	240	352
Narrow-band (up to 300 bps)	64	128	256	240	352
Voice-band (up to 9600 bps)	2	128	128	240	60
Broad-band (greater than 9600 bps)	1	7	64	5	2
Total simultaneously active lines	67	135	256	240	Varies
Maximum aggregate data rate, bps	200,000	600,000	1,600,000	160,000	400,000
PROCESSOR AND MEMORY					
Word length, bits	16	16	16	16	8
Memory cycle time, usec.	0.8	0.8	0.8	1.2	1.0
Memory capacity (in words)	32K	64K	64K	32K	16K to 256K
Instruction set	67	153	150	500+	107+
Binary add time (full-word, usec.)	0.8	0.8	0.8	2.2	0.4
Priority interrupt levels	4	16	32	32	12
On-line peripheral devices	Disk, mag. tape, line printer, card units, paper tape units	Disk, mag. tape, line printer, card units, paper tape units	Disk, mag. tape, line printer, card units, paper tape units	Disk, drum, cassette tape	Disk, mag. tape, printer, card reader, paper tape units
Console performance monitor	Yes	Yes	Yes	No	Yes
SOFTWARE					
Operating system	Yes	Yes	Yes	Yes	Yes
Message control programs	No	No	No	Yes	Yes
Assembler	Yes	Yes	Yes	Yes	Yes
Terminal handlers	TTY, CRTs	TTY, CRTs	TTY, CRTs	TTY 33, 35, 37; IBM 2740, 2741, 2770, 2780; CRTs	TTY, IBM terminals, others
Software pricing	Standard	Standard	Standard	Standard	Standard
PRINCIPAL APPLICATIONS					
Plug-compatible with—					
IBM 2701/2/3	No	No	No	Yes	Yes
IBM 3705	No	No	No	Avail. Sept. 1973	Yes
General	Concentrator	Message switching, concentrator	Front-end processing, message switching	Message switching, front-end processing	Front-end processing
ERROR CONTROL					
Error detection	VRC, LRC, CRC	VRC, LRC, CRC	VRC, LRC, CRC	NA	VRC, LRC, CRC
Error correction	Retransmission	Retransmission	Retransmission	NA	Retransmission
PRICING AND AVAILABILITY					
Purchase price	$2,000 to $50,000	$4,000 to $77,000	$9,450 to $300,000	Contact vendor	$46,000 to $170,000
Monthly rental, including maintenance (1-year lease)	$300 to $2,100	$465 to $3,100	$580 to $12,000	—	$979 to $4,908
Date of first delivery	September 1971	July 1972	December 1969	?	March 1973
Number installed to date	180	30	110	1	—
COMMENTS	Turn-key support available	Turn-key support available	Turn-key support available	Turn-key support standard	Turn-key support available, system includes two processors with up to 8K bytes of 200-nanosecond read-only memory

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MANUFACTURER AND MODEL	Programming Methods FCF-H	Programming Methods FCF-TI	Programming Methods FCF-TII	Raytheon 450-M3	Raytheon 450-M4
COMPUTER SYSTEM INTERFACE	IBM/360, IBM/370, UNIVAC 1100, CDC 3000/6000	IBM/360, IBM/370, UNIVAC 492/494, 1100	IBM/360, IBM/370, UNIVAC 492/494, 1100	UNIVAC 1108	UNIVAC 494, 1108
NUMBER OF LINES					
Maximum number of full-duplex lines	180	256	720	26	3
Narrow-band (up to 300 bps)	180	256	720	—	—
Voice-band (up to 9600 bps)	64	64	220	26	3
Broad-band (greater than 9600 bps)	1	1	220	—	—
Total simultaneously active lines	180	256	720	5	3
Maximum aggregate data rate, bps	80,000	144,000	640,000	4,800	40,000
PROCESSOR AND MEMORY					
Word length, bits	16	16	16	16	16
Memory cycle time, usec.	0.96	0.9	0.75	0.96	1.0
Memory capacity (in words)	8K to 64K	4K to 64K	4K to 256K	12K to 16K	8K
Instruction set	100	96	94	30	30
Binary add time (full-word, usec.)	1.92	0.9	0.75	1.92	1.9
Priority interrupt levels	16	16	8	1	48
On-line peripheral devices	Disk, drum, mag. tape, others	Disk, drum, mag. tape, line printer, card reader	Disk, drum, mag. tape, line printer, card reader	TTY 33, others	TTY 33, Raytheon DIDS-400
Console performance monitor	Yes	Yes	Yes	Yes	Yes
SOFTWARE					
Operating system	Yes	Yes	Yes	Yes	Yes
Message control programs	Yes	Yes	Yes	Yes	Yes
Assembler	Yes	Yes	Yes	Yes	Yes
Terminal handlers	TTY 28 through 37, IBM 1050, 2260, 2740, 2780, others	TTY, all Ultronic, all Novar, IBM 1050, 2740, 2260, 2780, BSC, Sanders, UNIVAC, others	TTY, all Ultronic, all Novar, IBM 1050, 2740, 2260, 2780, BSC, Sanders UNIVAC, others	Local and remote CRTs	Raytheon DIDS-400 CRTs
Software pricing	Standard	Standard	Standard	Optional	Optional
PRINCIPAL APPLICATIONS					
Plug-compatible with—					
IBM 2701/2/3	Yes	Yes	Yes	No	No
IBM 3705	Yes	Yes	Yes	No	No
General	Front-end processing, message switching, data collection	Front-end processing, message switching, data collection	Front-end processing, message switching, data collection	Concentrator, front-end processing	Store and forward, front-end processing
ERROR CONTROL					
Error detection	Character parity, validity check	Character and line discipline checks	Character and line discipline checks	Char. and message parity	Char. and message parity
Error correction	Retransmission	Block or message retransmission	Block or message retransmission	Retransmission	Retransmission
PRICING AND AVAILABILITY					
Purchase price	$180,000	$220,000 to $500,000	$250,000 to $850,000	Contact vendor	Contact vendor
Monthly rental, including maintenance (1-year lease)	—	$8,500 up	$9,500 up	Contact vendor	Contact vendor
Date of first delivery	December 1970	March 1971	October 1972	June 1969	March 1970
Number installed to date	6	10	3	35	41
COMMENTS	Based on Honeywell DDP-516; turn-key support available	Based on Tempo I; replaces all IBM teleprocessing software; turn-key support available	Based on Tempo II; replaces all IBM teleprocessing software; turn-key support available	Custom systems; M3 is used primarily in CRT display networks; M4 includes Teletype controller for local I/O units; turn-key support available for M3	

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MANUFACTURER AND MODEL	Raytheon 450-M70	Raytheon PTS-100 Series	Sanders Sandac 200	Telefile Computer Products T-64	Teleprocessing Industries, Inc. C2000 Series
COMPUTER SYSTEM INTERFACE	IBM 360/65 via IBM 2703	IBM/360, IBM/370, Raytheon 704, custom	Custom	IBM/360, IBM/370	UNIVAC 1106, 1108, 1110, 418, 494
NUMBER OF LINES					
Maximum number of full-duplex lines	3	256	128	256	256
Narrow-band (up to 300 bps)	—	512	128	256	256 (2400 bps)
Voice-band (up to 9600 bps)	3	16	128	16	64
Broad-band (greater than 9600 bps)	—	8	128	8	—
Total simultaneously active lines	3	512	128	256	256
Maximum aggregate data rate, bps	40,000	4,000,000	5,000,000	240,000	500,000
PROCESSOR AND MEMORY					
Word length, bits	16	16	16	16	18
Memory cycle time, usec.	1.8	0.96	3.2	1.0	0.9
Memory capacity (in words)	16K	6K to 32K	8K to 64K	4K to 64K	8K
Instruction set	NA	29	65	72	NA
Binary add time (full-word, usec.)	3.5	2.08	4.0	2.0	NA
Priority interrupt levels	16	8	3	4 to 64	NA
On-line peripheral devices	TTY 33, Raytheon DIDS-401, paper tape reader	Disk, cassette tape, char. and line printers, card readers others	Disk, drum, mag. tape, paper tape units	Disk, drum, mag. tape, printer, card and paper tape units, TTY, CRT, others	None
Console performance monitor	Yes	Yes	Yes	Yes	Yes
SOFTWARE					
Operating system	Yes	Yes	Yes	Yes	Yes
Message control programs	Yes	Yes	Yes	Yes	Firmware
Assembler	Yes	Yes	Yes	Yes	Yes
Terminal handlers	Raytheon DIDS-400 CRTs	Raytheon displays, PARS terminals	Sanders CRT displays, TTY, IBM BSC terminals	TTY 28, 35; IBM 2740, 2741, 2260 and BSC	Any BCD, ASCII, or Baudot terminal
Software pricing	Optional	Standard	Standard	Standard	Optional
PRINCIPAL APPLICATIONS					
Plug-compatible with—					
IBM 2701/2/3	No	No	No	Yes	No
IBM 3705	No	No	No	Yes	No
General	Store and forward, front-end processing	Front-end processing, concentrator, display control, data collection	Reservation system concentrator, front-end processing	Message switching, front-end processing, data concentration	Front-end processing, message switching, multiplexing
ERROR CONTROL					
Error detection	Char. and message parity	Char. and message parity, line checks	VRC, LRC, CRC	Character and message parity, CRC, validity check	Character parity, block parity
Error correction	Retransmission	Retransmission	Retransmission	Retransmission	Retransmission
PRICING AND AVAILABILITY					
Purchase price	Contact vendor	$5,500 to $25,000	$60,000	$40,000 to $150,000	$84,000 to $180,000
Monthly rental, including maintenance (1-year lease)	Contact vendor	$200 to $825	—	$2,000 up	NA
Date of first delivery	September 1969	October 1972	January 1969	June 1969	July 1971
Number installed to date	22	20	?	12	22
COMMENTS	Custom system; turn-key support available	Prices reflect configurations for front-end processing custom software and turn-key support available	Assembler can run on IBM/360, 370, or Sandac 200 turn-key support available	Turn-key support available	Includes provisions for handling time-division multiplexing

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MANUFACTURER AND MODEL	·Teleswitcher Corp. DCS-5000	Teleswitcher Corp. BCS-1000	Teleswitcher Corp. 510	Teleswitcher Corp. 310	Texas Instruments EMS II
COMPUTER SYSTEM INTERFACE	IBM/360, IBM/370; other custom	IBM/360, IBM/370; others custom	Free-standing	Free-standing	IBM/360, IBM/370; TI 960A, TI 980A
NUMBER OF LINES					
Maximum number of full-duplex lines	128	16	16	8	127
Narrow-band (up to 300 bps)	256	32	32	16	256
Voice-band (up to 9600 bps)	32	16	8	—	20
Broad-band (greater than 9600 bps)	4	—	—	—	8
Total simultaneously active lines	256	32	32	16	256
Maximum aggregate data rate, bps	40,000	20,000	9,600	4,800	250,000
PROCESSOR AND MEMORY					
Word length, bits	16	16	12	12	16
Memory cycle time, usec.	1.0	0.175	1.2	1.2	0.75
Memory capacity (in words)	4K to 65K	65K	4K to 32K	4K to 32K	4K to 65K
Instruction set	72	60 (firmware)	52	52	123
Binary add time (full-word, usec.)	2.0	0.36	2.6	2.6	0.75
Priority interrupt levels	16 to 64	8	1	1	4
On-line peripheral devices	Fixed/moving-head disk, mag. tape, paper tape reader, printers, CRTs, others	Fixed/moving-head disk, mag. tape, cassette tape, printers, CRTs, others	Disk, mag. tape, printers, paper tape reader, CRTs, others	Disk, printers, paper tape reader, others	Disk, mag. tape, line printer, card and paper tape units, CRT, others
Console performance monitor	Yes	Yes	Yes	Yes	Yes
SOFTWARE					
Operating system	Yes	Yes	Yes	Yes	Yes
Message control programs	Yes	Yes	Yes	Yes	Yes
Assembler	No	No	No	No	Yes
Terminal handlers	TTY, Wiltek, IBM 2780, TWX, Telex, Teletype 4210	Bankwire, Fed-wire, TWX, Telex, TTY	TTY, Wiltek, IBM 2780, Teletype 4210, others	Multidrop TTY	TTY, TI 700 ASR, others
Software pricing	Standard	Standard	Standard	Standard	Standard
PRINCIPAL APPLICATIONS					
Plug-compatible with—					
IBM 2701/2/3	No	No	No	No	No
IBM 3705	No	No	No	No	No
General	Message switching, data collection/distribution, inquiry/response, front-end processing	Message switching (includes editing)	Message switching, data collection/distribution	Message switching, data collection/distribution	Message switching, data collection, store and forward
ERROR CONTROL					
Error detection	Char. and message parity, CRC, format checks	Char. and message parity, CRC	Character parity, CRC, format checks	Character parity, format checks	Char. parity, CRC, format checks
Error correction	Retransmission, intercept, rerouting	Retransmission, intercept, rerouting, on-line operator	Retransmission, intercept, rerouting	Retransmission, intercept	Retransmission
PRICING AND AVAILABILITY					
Purchase price	\$100,000 to \$500,000	\$120,000 to \$700,000	\$70,000 to \$250,000	\$50,000 to \$100,000	\$50,000 to \$500,000
Monthly rental, including maintenance (1-year lease)	Available	Available	Available	Available	\$3,500 to \$50,000
Date of first delivery	January 1971	December 1972	December 1970	June 1969	?
Number installed to date	?	1	19	5	?
COMMENTS	Turn-key support standard. System includes multiple processors (central unit is described above)	Turn-key support standard. System designed for commercial bank money transfer operations	Turn-key support standard	Turn-key support standard	Turn-key support standard; designed for free-standing message switching

All About Programmable Communications Processors

MANUFACTURER AND MODEL	UNIVAC C/SP	UNIVAC 70/1600	UNIVAC 3760	UCC Communications Systems, Inc. COPE Controllers	UCC Communications Systems, Inc. CSI 4705
COMPUTER SYSTEM INTERFACE	UNIVAC 1106, 1108, 1110	UNIVAC 70 Series, 1600; others custom	IBM/360, IBM/370	IBM/360, IBM/370, UNIVAC 1100, CDC 6000	IBM/360, IBM/370
NUMBER OF LINES					
Maximum number of full-duplex lines	64	64	192	15/62	255
Narrow-band (up to 300 bps)	64	64	384	–/32	255
Voice-band (up to 9600 bps)	64	4	384	10/30	6
Broad-band (greater than 9600 bps)	8	1	6	5/5	–
Total simultaneously active lines	64	64	384	15/62	255
Maximum aggregate data rate, bps	800,000	230,400	300,000	300,000	56,800
PROCESSOR AND MEMORY					
Word length, bits	16	18	16	12	16
Memory cycle time, usec.	0.63	1.6	0.75	1.5	1.0
Memory capacity (in words)	16K to 65K	8K to 65K	8K to 65K	32K/65K	64K
Instruction set	52	29	200	35	51
Binary add time (full-word, usec.)	1.26 (two-word)	2.5	0.75	3.0	NA
Priority interrupt levels	5	2	4	2	14
On-line peripheral devices	Card and paper tape units, printer, others	Disk, mag. tape, printer, card and paper tape units	Cassette tape	Printers, card units, TTY	Console
Console performance monitor	No	Optional	Yes	Yes	Yes
SOFTWARE					
Operating system	Yes	Yes	Yes	Yes	Yes
Message control programs	Yes	Yes	Yes	Yes	Yes
Assembler	Yes	Yes	Yes	Yes	Yes
Terminal handlers	All UNIVAC terminals, all Teletype, IBM BSC	RCA terminals, Teletype line, IBM 1030, 1050, 2780	IBM 1050, 2741, 2260, 2780, 3270, 3780; UNIVAC Uniscope 100, DCT 500, DCT 1000, TTY	UCC COPE, IBM 2780, 360/20/25; UNIVAC 1004, 2000; CDC 200	Same as IBM 3705
Software pricing	Standard	Standard	Standard	Standard	–
PRINCIPAL APPLICATIONS					
Plug-compatible with—					
IBM 2701/2/3	No	No	Yes	No	Yes
IBM 3705	No	No	Yes	No	Yes (2701/2/3)
General	Front-end processing	Front-end processing, concentrator	Front-end processing	Front-end processing	Front-end processing
ERROR CONTROL					
Error detection	CRC, VRC, LRC	Character parity, validity check	Character and block parity, CRC	Character parity, CRC, check-sum	Character and message parity, CRC
Error correction	Retransmission	Retransmission	Retransmission	Retransmission	Retransmission
PRICING AND AVAILABILITY					
Purchase price	$80,000 to $175,000	$35,000 to $72,000	$67,400 to $360,000	$55,000 to $250,000	Contact vendor
Monthly rental, including maintenance (1-year lease)	$2,000 to $4,000	$1,000 to $5,000	$1,510 up	$1,500 to $8,000	$1,014 plus adapters (2-year lease)
Date of first delivery	March 1972	June 1968	January 1973	1968	January 1973
Number installed to date	6	96	–	55	–
COMMENTS	Turn-key support available; most 9000 Series peripherals can be added via an optional multiplexer channel	Turn-key support not available		Turn-key support available	Turn-key support standard

All About Programmable Communications Processors

MANUFACTURER AND MODEL	Varian V73-DC	Varian V620f-DC	Varian V620L-DC	Wells TP Sciences T-578/1	Wells TP Sciences T-578/2
COMPUTER SYSTEM INTERFACE	IBM/360, IBM/370, Honeywell 600, 6000, CDC 3000, 6000	IBM/360, IBM/370 Honeywell 600, 6000, CDC 3000, 6000	IBM/360, IBM/370, Honeywell 600, 6000, CDC 3000, 6000	IBM/360, IBM/370	IBM/360, IBM/370
NUMBER OF LINES					
Maximum number of full-duplex lines	256	128	64	64	128
Narrow-band (up to 300 bps)	256	128	64	64	128
Voice-band (up to 9600 bps)	128	32	20	64	128
Broad-band (greater than 9600 bps)	64	16	10	1	1
Total simultaneously active lines	256	128	64	64	128
Maximum aggregate data rate, bps	1,120,000	480,000	320,000	625,000	1,250,000
PROCESSOR AND MEMORY					
Word length, bits	16	16	16	16	16
Memory cycle time, usec.	0.33	0.75	0.95	2.2, 3.6	2.2, 3.6
Memory capacity (in words)	262K max.	32K max.	32K max.	16 to 65K	16 to 65K
Instruction set	145	145	133	64	64
Binary add time (full-word, usec.)	0.66	1.5	3.6	4.4, 7.2	4.4, 7.2
Priority interrupt levels	1 to 64	1 to 64	1 to 64	1 to 12	1 to 12
On-line peripheral devices	Disk, drum, mag. tape, paper tape units, process control I/O	Disk, drum, mag. tape, paper tape units, process control I/O	Disk, drum, mag. tape, paper tape units process control I/O	Disk, mag. tape, printer, card reader, paper tape units	Disk, mag. tape, printer, card reader, paper tape units
Console performance monitor	Yes	Yes	Yes	Yes	Yes
SOFTWARE					
Operating system	Yes	Yes	Yes	Yes	Yes
Message control programs	Yes	Yes	No	Yes	Yes
Assembler	Yes	Yes	Yes	Yes	Yes
Terminal handlers	TTY 28, 33, 35; most IBM, including CRTs and HASP	TTY 33, 35	TTY 33, 35	Over 50 implemented to date	Over 50 implemented to date
Software pricing	Optional	Optional	Standard	Std. and optional	Std. and optional
PRINCIPAL APPLICATIONS					
Plug-compatible with—					
IBM 2701/2/3	No	No	No	Yes	Yes
IBM 3705	Yes (NCP)	No	No	Yes	Yes
General	Generalized communications processing	Generalized communications processing	Remote concentrator	Message switching, concentrator, data collection, front-end processing	Message switching, concentrator, data collection, front-end processing
ERROR CONTROL					
Error detection	Character parity, block check, CRC	Character parity, block check, CRC	Character parity, block check, CRC	Char. and message parity, CRC, format checks	Char. and message parity, CRC, format checks
Error correction	Retransmission	Retransmission	Retransmission	Retransmission	Retransmission
PRICING AND AVAILABILITY					
Purchase price	$25,000 to $200,000	$20,500 to $110,000	$10,000 to $60,000	$100,000 to $150,000	$125,000 to $200,000
Monthly rental, including maintenance (1-year lease)	Available	$1,450 to $7,700	$1,100 to $3,500	$4,000 to $6,000	$5,000 to $8,000
Date of first delivery	October 1972	January 1971	May 1971	January 1970	March 1970
Number installed to date	?	Over 150	Over 250	5	6
COMMENTS	Dual processors sharing memory can extend line capacity to 512; turn-key support available			Systems are based on IBM 1130 processor with Wells multiplexer; turn-key support is standard	

All About Programmable Communications Processors

MANUFACTURER AND MODEL	Wells TP Sciences T-578/3	Wells TP Sciences T-578/4	Xerox Sigma 3	Xerox Sigma 5
COMPUTER SYSTEM INTERFACE	IBM/360, IBM/370	IBM/360, IBM/370	IBM/360, IBM/370, custom	IBM/360, IBM/370, custom
NUMBER OF LINES				
Maximum number of full-duplex lines	256	16	256	512
Narrow-band (up to 300 bps)	256	16	256	512
Voice-band (up to 9600 bps)	256	16	Varies	Varies
Broad-band (greater than 9600 bps)	1	1	Varies	Varies
Total simultaneously active lines	256	16	256	512
Maximum aggregate data rate, bps	2,500,000	150,000	Varies	Varies
PROCESSOR AND MEMORY				
Word length, bits	16	16	16	32
Memory cycle time, usec.	2.2, 3.6	1.2	0.975	0.950
Memory capacity (in words)	16 to 65K	16 to 65K	8K to 64K	8K to 128K
Instruction set	64	72	37	89
Binary add time (full-word, usec.)	4.4, 7.2	2.4	1.95	2.1
Priority interrupt levels	1 to 12	16	100	224
On-line peripheral devices	Disk, mag. tape, printer, card reader, paper tape units	Wide range	Disk, mag. tape, card units, paper tape units, TTY, CRTs, others	Disk, mag. tape, card units, paper tape units, TTY, CRTs, others
Console performance monitor	Yes	Yes	Yes	Yes
SOFTWARE				
Operating system	Yes	Yes	Yes	Yes
Message control programs	Yes	Yes	Yes	Yes
Assembler	Yes	Yes	Yes	Yes
Terminal handlers	Over 50 implemented to date	Many	TTY, IBM BSC, CRTs, CDC 200 UT	TTY, IBM BSC, CRTs
Software pricing	Std. and optional	Std. and optional	Optional	Optional
PRINCIPAL APPLICATIONS				
Plug-compatible with—				
IBM 2701/2/3	Yes	Yes	Yes	Yes
IBM 3705	Yes	Yes	Yes (2701/2/3)	Yes (2701/2/3)
General	Message switching, concentrator, data collection, front-end processing	Message switching front-end processing	Generalized communication's processing	Generalized communications processing
ERROR CONTROL				
Error detection	Char. and message parity, CRC, format checks	Char. and message parity, CRC, format checks	Char. and block parity, CRC; others as programmed	Char. and block parity, CRC; others as programmed
Error correction	Retransmission	Retransmission	As programmed	As programmed
PRICING AND AVAILABILITY				
Purchase price	$175,000 to $300,000	$50,000 to $100,000	$29,700 up	$70,000 up
Monthly rental, including maintenance (1-year lease)	$6,000 to $9,000	$1,000 to $2,000	$1,000 up	$2,200 up
Date of first delivery	August 1971	March 1973	1969	?
Number installed to date	1	—	?	?
COMMENTS	System is based on IBM 1130 processor with Wells multiplexer; turn-key support is standard	Turn-key support standard	Turn-key support standard	Turn-key support standard

All About Voice Response

Voice response is the technique of using computers to generate spoken replies taken from a pre-recorded vocabulary. The concept is now gaining renewed attention after a few years of low public visibility. In text, comparison charts, and photos, this comprehensive report surveys the voice response systems and terminals currently offered by 20 suppliers.

Voice response as a concept for utilizing computer-based information processing has long languished in the hinterlands reserved for the more exotic data processing techniques. However, as the realization grows that a dirt-cheap, do-all terminal is still somewhere off in the future, and as the pressures for improved data collection and dissemination mount, a resurgence in voice response is taking place.

In this report we will survey 20 products from 10 manufacturers that represent the currently available equipment for producing computer-generated spoken messages. We will also examine some of the terminal equipment available for more extensive user input and for prospective users without access to Touch-Tone push-button telephones. Also included is a discussion of a closely related but even more exotic topic: interpretation of human speech by computer and generation of free dialog by a computer.

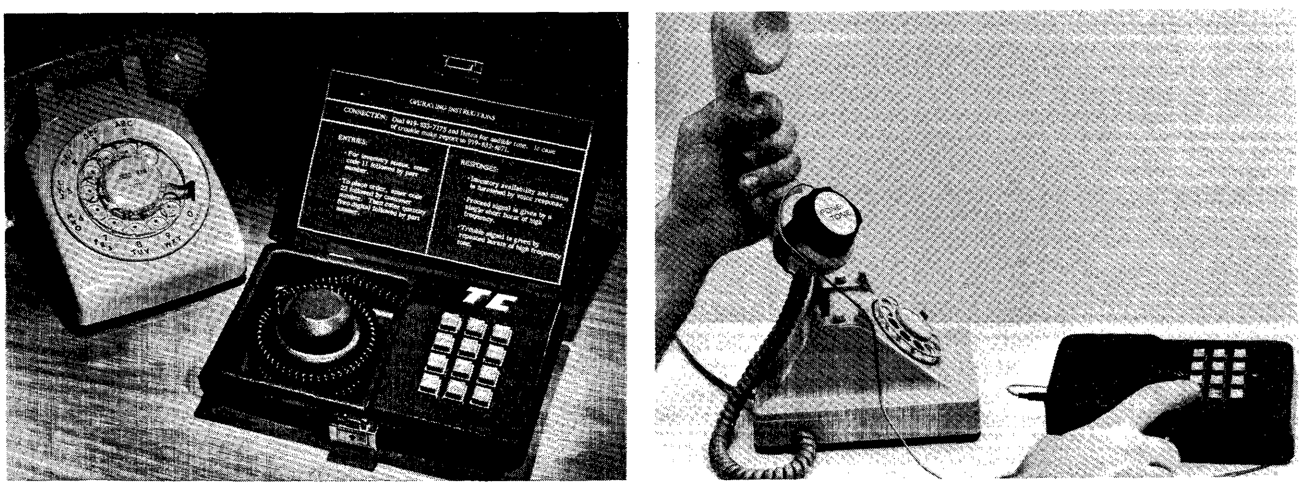
All in all, voice response adds up to a viable technique with certain limitations more closely associated with human behavior than with "logical" system design considerations.

The Impetus for Voice Response

The glamour attached to computers has created some fascinating situations. Anxious to appear modern and efficient, companies have widely publicized their new computer installations. Computer mainframe vendors, anxious for trade-name visibility in the face of IBM's dominance, have agitated for this publicity about installations. Employees become aware of the computers both through general public promotion of the "computer age" and by internal education oriented toward proper feeding of the beast. Executives, who are also employees despite public opinion, generate the same shots of adrenalin as realization of what quick collection, processing, and dissemination of information can do in terms of meeting internal performance and external competitive pressures.

Invariably, installation of a computer is associated in the lay mind with two adjectives describing information handling: more and faster. It is not appropriate in the context of this report to rehash the differences between more quantity and more quality and the situations these differences have given rise to. Rather, let's discuss the situations the "faster" qualifier has initiated.

Of the three aspects of information handling mentioned previously (collection, processing, and dissemination) only the area of processing has seen really effective solutions.



If you have a telephone, you can listen to a computer, but unless you have a Touch-Tone telephone, you can't talk back. These two "pads," however, enable you to make use of an ordinary rotary-dial telephone. The one on the left is marketed by Terminal Communications; the printing on the inside of the cover is the operating instructions for a particular application. Metroprocessing Corporation of America markets the unit on the right. Both of these units are compact and portable, so you can easily take your terminal with you if you plan to be in an area that doesn't have Touch-Tone service.

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On the more sophisticated side, this unit from Interface Industries includes provisions for reading credit cards and lever-switches for rapid entry of amounts and visual checking. This unit essentially functions as a telephone; variable information can be entered through the 12-key telephone "dial" and responses heard through the telephone handset.

(If you have doubts on this score, a good exercise is to compare the processing power of a current full-blown minicomputer with the large systems of the late 1950's—an IBM 704 for example. Now compare the costs. Even without inflation adjustments and credit for the impressive software that is now available, the result is staggering. The increase in what you can get for a dollar is virtually unparalleled in any other field.)

The problems of data collection and dissemination have not fared nearly so well. Lack of results does not in this case denote a lack of effort. Just look at the nomenclature that has risen around the efforts to solve these problems: on-line, real-time, random processing, source data collection, key entry, telecommunications, data bases, time-sharing, OCR, etc.

Invariably, the first thought is how to get the people with the information directly in touch with the computer and the computer in touch with the people who need the information. (The U.S. mail, or anybody else's mail for that matter, is hardly the answer.) The central theme of approaches to this problem is data communications—electrical connections between the central computer facility and the points where the information is created and used. At this time, we have a theoretical solution but not a practical one. These connections between the computer and outlying points (which may be on the shop floor less than a hundred yards away or across the country) involve what has been euphemistically referred to as man-machine interfaces. To most of us, they are terminals. (Often, cost considerations mean that terminals represent the termination of an investigation.)

It was no surprise then, when the common telephone, with its intrinsic connection to just about everywhere, was proposed as a terminal. No incremental cost was involved for these terminals because every office had to have one anyway. But early attempts to use the telephone as a data entry device met with difficulty. The rotary dial system of circuit interruption may be fine for making telephone exchanges work, but it is unsatisfactory for data entry both from the standpoint of user convenience and signal interpretation by data processing equipment. With the advent of the Touch-Tone system, a whole new era was born for use of the telephone as a terminal. The only catch was that the only possible output, without extra-cost equipment, was voice.

The Case for Voice Response

People react more immediately to the human voice than to any other means of communication. True, the printed word may have a more lasting and long-range effect, but for immediate reaction, you just can't beat the human voice. How else can you explain the possibility of a short, dark, brown-eyed man convincing a nation that a super race of blonde, blue-eyed giants exists and that he should lead that super race? How else can you explain the suspension of a reasonable person's civilized instincts for a time when Orson Welles delivers Mark Antony's eulogy for Caesar? Extreme examples? Then how about the traditional used car salesman? How about the last time your boss sweet-talked you into working on Saturday when you wanted to play golf? He didn't do it with a letter. Immediacy—that's the key to proper use of the human voice for information processing.

Agreed that the sounds available from existing voice response units hardly compare with Bryan's silver-tongued oratory, but the visual appeal of a CRT doesn't compare with the Mona Lisa either. The point is that people are keyed to responding quickly to the spoken word.

The primary difference between human speech and voice replies generated by existing equipment is information content. The subtle shadings of intonation used in everyday speech cannot conveniently be reproduced by machine at this time. One of the reasons is that it is virtually impossible at this time to codify intonation.

The speed of information transfer using voice deserves some mention. A typical speaking rate is 125 words per minute, or about 12.5 characters per second. Beyond about 250 words per minute, it not only becomes very difficult to form the words fast enough, but most people have difficulty in understanding what is said. By contrast, typical reading speeds range from about 400 words a minute up to several thousand for people with special training. Clearly, voice is not a rapid means for transferring information. Compounding this problem is the fact

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that no one develops a scanning capability for vocal communications. If you record a conversation, playing it back at the original speed is about the only satisfactory way to refresh your memory. Visual scanning, on the other hand, is a highly developed technique.

One of the best ways to think about voice response in terms of information handling is to regard it the same way you would regard someone reading tabular information to you. This quickly gives you a feel for the relatively small amount of information that can be transferred before loss of attention interferes.

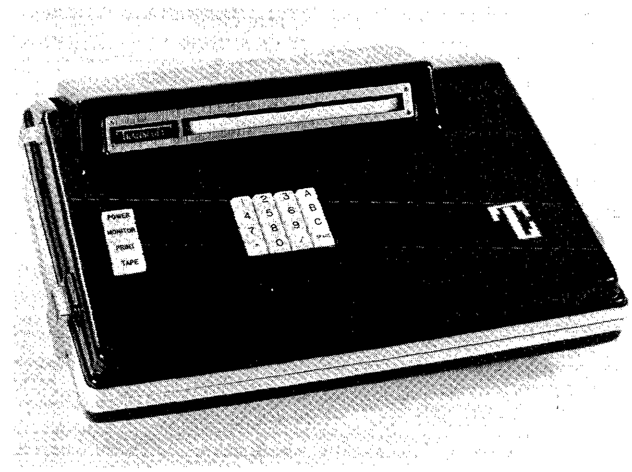
The whole case for voice response, then, rests on two points:

- It permits use of low-cost, readily available terminals—telephones.
- People are traditionally keyed to react to spoken communication.

But What is Voice Response, Really?

The heart of a voice response system is the voice or speech generation module. In many respects, a voice response system is like any other data communications system. But instead of transmitting the digitally coded characters comprising the reply message to the remote terminals for interpretation and printing, recording, or displaying, a series of characters are transferred to the voice generation module which specify what words, and in what order, will be "said" to the person listening at the other end of the line. Thus, the messages that can be generated depend entirely on the words that have been previously recorded and placed in the voice generation module. This group of words is referred to as the "vocabulary." Later, under the discussion of the entries appearing in the comparison charts, some of the more esoteric details of voice generation will be covered.

The subtleties of working with a fixed vocabulary can best be illustrated by example. The normal way of saying 1,429 is "one thousand four hundred twenty nine." This requires six different words. A couple of words can be saved by saying "one four two nine." Indeed, any number can be said by using only the ten basic numeric digits. To say numbers up in the millions in the normal way (first example), a vocabulary of some 24 words is required. But probably even more important, it is much more difficult to code a program for recognizing numbers spoken in the conventional fashion than to simply recognize a series of digits. In general, the programming difficulties involved in making use of a large vocabulary often outweigh the cost of the extra vocabulary as the deciding factor in determining the vocabulary to be used in an application.



If you simply must have a printed copy of your input and/or responses, this unit from Transcom fills the bill with its built-in strip printer. However, it does cost a bit more than a telephone or the simple pads illustrated earlier.

Where is Voice Response Used?

The three "traditional" areas of application for voice response systems are:

- Bank account balance information or, more generally, central file inquiry.
- Retail store credit checking.
- Status reporting, usually checking work in progress or inventory.

Of these areas, banking applications currently represent the vast majority of installations.

One of the most outstanding examples of voice response in the banking environment is a medium-sized bank in Chicago. For four years, this bank has been providing information to its own tellers and furnishing a similar service for nine neighboring banks. With the two voice response systems, a total of about 200,000 calls per month are handled. In addition to the principal application of answering teller inquiries about the status of customer accounts and posting memos against the balance to prevent overdrafts, the bank has implemented a calculator function to serve loan officers in calculating loan payments and interest or to assist in making bond yield calculations. Typically, a teletypewriter is used to print the final results.

Among the impressive aspects of this bank installation is the extensive training given to tellers before they face the public and the voice response system. Simulation is used, with a dummy window and real money and a training

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program in the computer. Not only standard responses, but various kinds of errors in data format or content that the system is programmed to detect, are presented to the trainee. Thus, the teller approaches the public window with confidence, which cannot help but have a salutory effect on customers. Incidentally, statistical records are maintained of the various entry errors detected, and these provide input for remedial training.

Equally impressive are the future plans the bank has for voice response. A prototype bill-paying application is being tested. Eventually, the bank plans to open the system to the public to permit checking bank balances, moving money among various accounts, and paying bills. Security details are not finalized, but will probably be along the lines currently used for manual methods, such as amount of last deposit.

One problem associated with the system and the reaction of the public to it is interesting. Customers seeing the teller pick up a telephone, push a few buttons, and hang up without ever saying a word expressed some concern, like "Are you calling the police or something?" The problem was solved by posting information about the system prominently in the lobby.

The bank referred to above is Beverly Bank of Chicago. The voice response system and services are controlled by Beverly Bancorporation, a one-bank holding company that owns almost all of Beverly Bank. Bancorporation is a progressive organization that is now providing automation systems and services and management counseling assistance to banks throughout the U.S.

Some of the newer areas receiving attention include computer-assisted education and data entry guidance.

An example of the latter involves a bank in the Southwest and a service it offers doctors for patient billing. Information is transmitted to the bank computer, which then prepares patient bills for direct mailing or delivery to the doctor. Presently, IBM 1001 units in the doctors' offices transmit the input data to a keypunch rigged for data communications.

This system is being replaced by a voice response system. The principal purpose of voice replies will be to guide the person entering data through the input process. In addition, voice will be used to provide feedback to verify entries. The system will calculate control totals based on the data entered; the operator can compare these totals with her own for checking purposes. The bank expects a typical data call to last for about 15 minutes, so the ability to check results is quite important. Once the data has been received by the bank's computer, the system will operate as before. This application permits using the telephone as an inexpensive data entry terminal while still providing control.

But How About Me?

The areas above don't include your interest? Then let's cover some general guidelines about application areas. There are two situations for which voice response seems naturally suited:

- To answer "how about" questions.
- To implement low-cost data entry from the originating source.

The "how about" question typically takes the form of "how many widgits are in stock, so I will know whether I can fill an order immediately?" Or, "what is the status of project xyz?" These are questions you typically ask someone now and get a verbal reply, frequently over the telephone. You could almost as easily make an inquiry to a computer system, using the same telephone, and get back the same kind of reply you've been getting all along. Provided, that is, that the computer system has been properly programmed and that the data base has been established and maintained. And these are not necessarily minor details. Careful attention needs to be paid in such a system to how and when data gets into the system so that correct replies can be generated.

The second area of application—low-cost data entry—is largely self-explanatory in view of the previous discussion.

Where's the Catch?

So far, voice response has sounded like a pretty good thing. You're probably thinking that there are some drawbacks somewhere. And you're right, there are. Before we get into specific limitations, let's take a look at some of the difficulties the voice response concept has experienced in the past.

Voice response became a practical reality in the early to mid 1960's and enjoyed a mild spurt of popularity. Some of the convenience of use was dimmed by the limited availability of Touch-Tone telephones. This meant that some sort of attachment was required to enter data. Though not particularly expensive, such an attachment seemed a nuisance. But much more damaging was the lack of vigorous marketing by the makers of the equipment. Other ways of handling problems suitable for voice response were supported more strongly, and a user could get more help in implementing these approaches. IBM was about the only vendor offering any kind of systems support, so it is no wonder it dominates the installations now, in spite of high equipment costs.

To computer buyers in general, voice response appeared more as a custom-designed system than a standard product. In addition, other techniques for data entry and dissemination were surfacing about this time—key-to-tape

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recorders, OCR, CRT's—and voice response nearly got lost in the shuffle mainly because applications of the concept were difficult to visualize compared to other emerging techniques. Potential users were often disappointed when confronted with the limitations of working with a small vocabulary. Making the computer talk didn't seem nearly so exciting when it was discovered that it didn't even have the vocabulary of an idiot. There was, and is, much resistance to working without a hard copy of the information received. In addition, performance of a voice response system is a difficult thing to measure objectively. You can't point to a stack of printed output and say "that's what the computer did." The resurgence of interest now is due largely to the availability of lower-cost equipment with more flexibility and better education of potential users by the interested vendors.

Generalities aside, what are the drawbacks of voice response?

For data entry assistance from originating sources, there are no major drawbacks—as long as you are entering numeric information. Sure, there are terminals for entering alphabetic information easily, but that involves extra cost. And there are techniques for entering alphabetic information from a Touch-Tone telephone, but for any sizable amount of alphabetic information, say a name and address, they're slow and error-prone. In addition, there is no hard-copy confirmation of what data was entered. Agreed, read-back can be used for operator confirmation of the data entered, but what about audit trails? Actually, this situation with voice response is no different from any other input technique except possibly OCR. As with any other technique used for data collection, the source documents are at the remote location. No better care will be taken of the source documents if the data is entered via a CRT than via the keys of a telephone. It is the same old story. Nothing happens automatically. You have to plan for it.

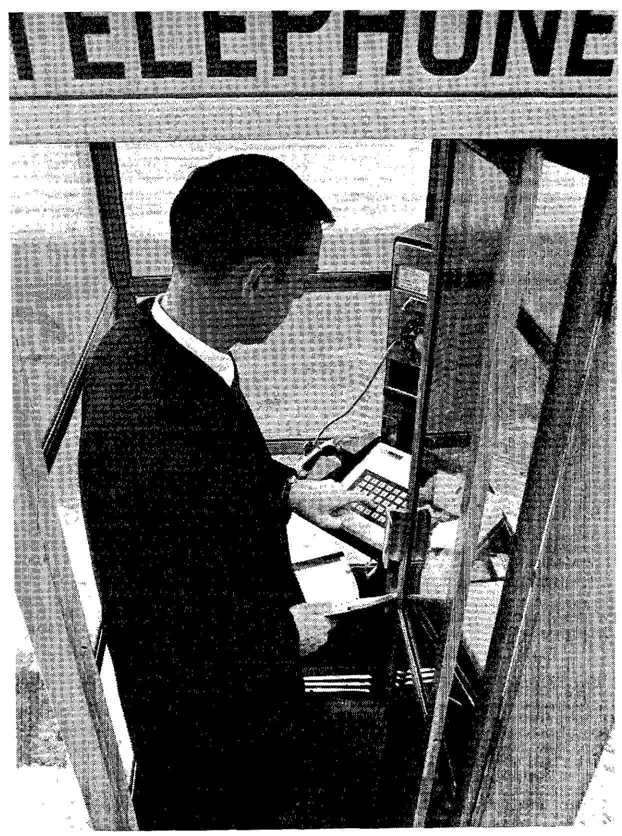
For "how about" inquiries, many of the same comments apply. The information received is limited by your memory or your ability to take notes. A programmed repeat function is often helpful to assist you in cases where your attention is diverted at the critical moment. Again, if you think of voice replies as someone reading you a tabulated report, you can get a pretty good idea of the amount of information that can be conveyed effectively in reply to an inquiry.

If the Computer Could Talk, What Would It Say?

In the beginning of this article, we promised some observations on voice input and free-form speech interpretation and generation.

Voice input is a reality, in a sense. Dimension, Inc., a subsidiary of Scope, Inc., has installed more than 12 units nationwide, and many other companies are researching the problem. The current installations are voice command systems. Words spoken by the operator are compared against previously input words and processing functions are performed accordingly. This is a pattern recognition problem, similar in many respects to OCR. Voice input is dissected and analyzed for a pattern. These patterns can be stored for future comparison with verbal pronouncements by the operator. Just as OCR does not "read" a document for content, voice command systems do not interpret the operator's speech for content—just for matches in patterns.

This capability has some fascinating applications in environments where the operator's hands are busy elsewhere, but has little application in the typical data processing environment. For the future, imagine automatic taxicabs that respond to spoken commands about your destination. Unless voice response is included, there



After entering the telephone booth in the guise of a mild-mannered salesman, this individual emerges as a "superman" by obtaining fast responses to customer inquiries about order status, availability of commodities, etc. The IBM 2721 Portable Audio Terminal offers a full alphanumeric keyboard of unusual design. It is portable and represents a powerful remote data entry/inquiry capability (although, in all fairness, it really is not faster than a speeding bullet).

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Periphonics Corporation, a relatively new company, has aggressively marketed systems rather than components with good results. The VOICEPAK 2000 shown here features variable word-length recording for more pleasing voice output by enabling a better approximation to the natural rhythm of human speech. (One does wonder just what a computer could say to make a pretty girl smile.)

will be no backtalk. More practical applications include parcel sorting in post offices, baggage sorting at airline terminals, and cockpit command systems.

The difficulties in free-form speech interpretation and generation are evidenced by the difficulty of clearly defining exactly what it is. Basically, we are referring to a capability that enables a computer to derive meaning from your normal conversation and to respond in kind. Science fiction stuff, truly. But then, so were spaceships in the 1930's. Basic research is being carried forward on reducing language usage to non-ambiguous content; this has been going on for many years without any regard for computers. One problem area will suffice to illustrate the tremendous complexities involved. It is fairly characteristic in a group of people engaged in conversation for several levels of information exchange to be going on simultaneously. Various sub-cliques within the overall group may interpret a comment differently based on "inside" references which are meaningful only to them.

But I Don't Have Touch-Tone

For those areas of the country that don't have Touch-Tone service or the equivalent, a number of companies market terminals that provide similar input capabilities. In addition, a number of terminals are available that provide more capabilities than the conventional 12-key Touch-Tone telephones. The following paragraphs discuss the relevant product lines of nine companies to give you a representative idea about what is available.

Acrodyne, Inc. offers a line of three portable terminals. The VTT-1 is a basic 16-key terminal that couples acoustically to a standard telephone handset via an attachment that fits over the mouthpiece; the reply is heard through the telephone handset receiver. The VTT-2 is similar except that it includes a cradle for holding the handset and a speaker for receiving the reply. The VTT-1 costs $150 and can be rented for $10 per month. The VTT-2 costs $220. The VTT-3 is a custom terminal with up to 63 keys; transmission can be made to look like that of the IBM 2721. This line of terminals was previously produced by Vernitron Corporation.

Chancellor Industries, Inc. produces the portable Model 102, which, in basic form, includes a 16-key pad and speaker. Optionally, an auxiliary keyboard for alphanumeric information can be plugged into the 102.

Compunetics, Inc. acquired the Media Technology line of voice response terminals. The VCT Series 400 line is broad and includes 12-key to 60-key models; one is directly compatible with the IBM 2721. All models are battery operated with an internal speaker. Prices begin at $248 (quantity discount available).

IBM gave voice response a shot in the arm two years ago with the introduction of the 2721 Portable Audio Terminal (see Report 70D-491-09). The 2721 provides full alphanumeric data entry via a 60-key layout. More recently, IBM introduced a more specialized audio terminal, the 2730 Transaction Validation Terminal. The 2730 includes provision for reading a magnetic stripe on two credit cards and a 12-key pad. The 2730 is intended for use in point-of-sale credit authorization in conjunction with voice response. The 2721 sells for $600 and leases for $20 per month; the 2730 sells for $515 and is not available for lease.

Interface Industries, Inc. is involved in point-of-sales activities. One terminal, Model CE-70, is designed for credit-oriented retail sales transactions. The terminal includes a telephone unit with provision for automatic dialing. A 12-key pad and 5-digit lever-switch arrangement are provided for data entry.

Metroprocessing Corporation of America markets the Spartan FONE-TONE line of portable terminals. A basic

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model, available for $195, provides a 12-key pad and connects to the telephone via an attachment that slips over the handset mouthpiece; the handset is held to the ear to receive the reply. Another model is available in an attache case with internal speaker. A 16-key model is planned for the spring.

Terminal Communications produces the Model 10 terminal, a 12-key pad with attachment for the mouthpiece of a telephone handset.

Transcom Inc. produces four terminals of interest for voice response. The IT 116 is a basic 16-key pad with internal speaker; it connects to the telephone network via a DAA, and sells for $270. The IT 216 adds a strip printer to the IT 116 for printing keyed data; it sells for $840. The IT 216 can also be equipped to print from tones received from a remote computer for an additional $280. The IT 416 adds a 20-column plastic card reader; it costs $1290. All of these models operate from 110-volt power. The IT 216 can be equipped with an acoustic coupler instead of the DAA arrangement. The IT 160 is a portable, battery-powered terminal similar to the IBM 2721 except that it has 65 keys.

Wavetek produces a pair of audio response terminals. The T510 is a 12-key pad, and the T500 is a 48-key unit. Both can be connected to the telephone network through an acoustic coupler or directly through a DAA. Both contain an internal speaker and operate from 110-volt power.

Western Data Products sells a terminal specialized for entering pre-paid health plan claim data from a doctor's office with voice response replies. It includes an alphanumeric keyboard and special data entry facilities. It connects to the telephone network through either an acoustic coupler or DAA.

Voice Response Systems and Components

The characteristics of 20 products from 10 vendors are shown in the accompanying comparison charts. All information in the charts was supplied by the vendors during January and February of 1972. Their cooperation with the Datapro Research staff in the preparation of these charts is greatly appreciated.

The chart entries and their significance to potential users of voice response are explained in the following paragraphs.

The first order of business, however, is to resolve the terminology of voice versus audio response. Audio response is perhaps the most widely used term, because that's what IBM uses. However, audio encompasses the tones generated by the Touch-Tone telephone as well as voice. Those few who really care about the difference insist on including tone responses within the category of voice response because they can be used to drive printers or other recording devices. As a matter of fact, if you exclude the very high-speed broad-band data communications, all data communications falls within the audible range of frequencies; and, if you wanted to stretch a point, conventional data communications could be included under the heading of audio response. In this report, voice response is used only in order to highlight the specific subject area, not because of nit-picking about precision of definitions.

Manufacturer and model identifies the equipment and its supplier.

Mode of use pinpoints the exact use of the equipment and therefore identifies the components you would expect to see. The entries for this parameter fall into four categories: complete peripheral subsystem, module for a computer communications subsystem, free-standing system, and voice generation module.

A complete peripheral subsystem includes facilities for interfacing and controlling communications lines and the voice response module. A module for a particular computer communications subsystem implies that the regular communications facilities of the computer can be adapted

This system from Datatrol Inc. is representative of one of the most popular uses for voice response. It provides bank tellers with access to information about customers with just a telephone at their window – which they normally have anyway.

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for line interfacing and control, while the subject equipment supplies the voice generation capability. A freestanding system includes facilities for interfacing and controlling the communications lines, the voice generation module, and additional processing and peripheral device capabilities suitable for implementing applications directly without requiring a host computer. A voice generation module is just that; it includes no capabilities for line interfacing or processing.

In some cases, the manufacturer offers several configurations, each intended for a different mode of use. All supported modes are listed. A remote subsystem is a special case of the peripheral subsystem; instead of being located physically adjacent to the host computer, it transfers data to and from it via a communications line.

Communications Input

The *number of lines* refers to the number of individual trunks or ports into the equipment and normally identifies the number of simultaneous inquiries that can be handled. Where a range is stated without a group size, the increment size is one.

The *form* of communications input refers to the nature of the data signals the equipment works with. In general, three types of signals are important in voice response situations: tones, serial, and parallel. Tones are generated by the Touch-Tone telephones and the 10-, 12-, and 16-key terminals produced by independent manufacturers. Serial signals are the most common form from conventional data communications terminals. Usually there is a Bell System 100 or 200 series or equivalent modem connected to the terminal. The parallel form is rarely used by conventional terminals. Usually there is a Bell System 400 series or equivalent modem connected to the terminal (although this does not guarantee that the parallel mode is being used, because some 400 series data sets can be adapted for serial operation). Tones are actually a form of parallel transmission, but they form an important separate category because the generating telephones do not require a data set and parallel, non-telephone terminals do.

The importance of the form of input is coupled with the decoding capability of the equipment; together they determine what terminals and arrangements (data sets) are required at the central processing site. Generally, a Bell System 403D3 data set is required at the processing site to convert the tones into signals the equipment can handle. This is indicated by the notation "tones via data set." A Bell System 401J3 is usually required at the processing site to accommodate terminals transmitting in a parallel mode. If the entry says "tones" only, then a data set is not required at the processing site to interface Touch-Tone input.

Decoding refers to the capability to interpret the code used to represent numbers and letters. Three codes are important in voice response. These are the 2-of-8 (AB), 3-of-12 (ABB'), and 3-of-14 (ABC). The letters in parentheses are alternate names for the codes. The 2-of-8 code is used by Touch-Tone telephones. It yields 16 different code combinations. Some independent manufacturers of pads provide 16 keys; at present the Touch-Tone telephones have 12, but a 16-key arrangement is likely to become available at some future time. The 3-of-12 code is used by the IBM 2721; special adapters are usually required to receive this code properly. The 3-of-14 code is used by IBM 1001 terminals and other parallel transmission devices.

Remote terminals accommodated identifies specific terminals from which the equipment can receive data. Naturally, equivalent devices are also accommodated. For example, systems that can handle the 12-key Touch-Tone telephones can also handle 12- and 16-key pads from independent manufacturers.

Processing Capabilities

The *source* further identifies the capabilities included in the subject equipment and those that must be supplied by the user. Cut to the barest minimum, the following three areas of processing capabilities must be provided: line control, message control, and applications. Line control involves maintaining order among the several simultaneous data paths represented by several lines being active at once. Message control involves assembling incoming data characters into whole messages and disbursing the programmed reply words in the proper order. Applications processing is the capability for interpreting incoming data and determining what the reply message should be.

If the system is a free-standing one, then all of these processing capabilities must be included. Typically, a peripheral subsystem would include line and message control facilities, with the host computer handling the applications processing. The facilities in the voice response system can be implemented through specialized, hardwired logic or, in accordance with the current trend, via a minicomputer. If a minicomputer is included, it can sometimes be programmed to do some of the applications processing.

Entries under *software* indicate the scope of support the manufacturer provides. The more he provides, the less the user will have to do. Be careful to clarify the exact pricing arrangements for software; i.e., is it priced separately and, if so, how much?

Speech Generation

Vocabulary type identifies the basic building blocks from which reply messages can be constructed. The most

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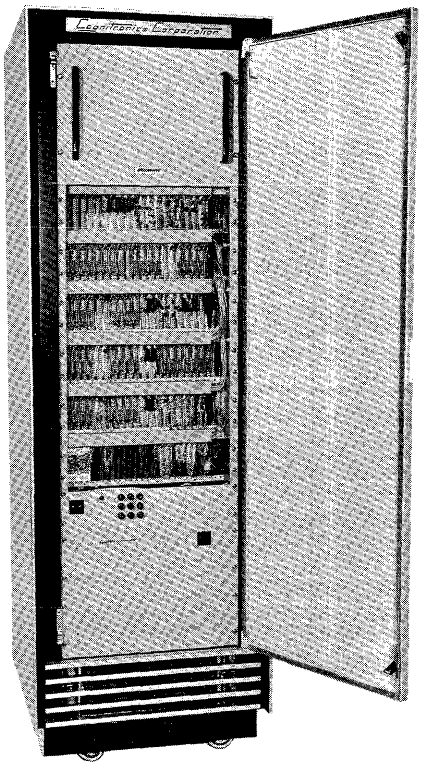

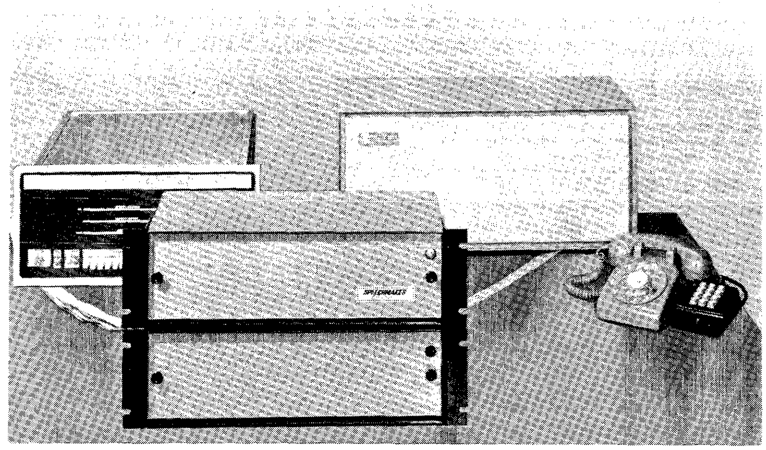

Dr. Shepard, the head of Cognitronics Corporation, has been credited with (some will say accused of) being an originator of both voice response and optical character recognition, two of the more exotic data processing concepts. Illustrated here are Cognitronics voice response systems for both large computers (at left) and minicomputers. The above photo includes essentially everything needed for a complete voice response system, including a DEC PDP-8 minicomputer. (The Bell System data set in the background is larger than either the minicomputer or the Cognitronics STAR voice response system, an interesting comment on the state of the art among various companies participating in the computer/communications revolution.) The STAR system can handle only one line, so it doesn't need a lot of the electronics shown in the multiplexed system on the left.

frequently used vocabulary units are words and phrases. A phrase consists of two or three or more words, depending on the manufacturer. A phrase differs from several independent words in that if a phrase is addressed, it all comes out. A closely allied feature provided by some manufacturers is that of programmed synthesis, discussed later, which can effectively expand the vocabulary beyond the recorded words.

Vocabulary size is the number of individual vocabulary units that can be recorded.

Typical speech rate is a more meaningful way of phrasing the usual milliseconds-per-word or milliseconds-per-track specifications quoted by the manufacturers. Normal speech rate is about 125 words per minute, corresponding to 480 milliseconds per word. Depending on the generation technique (discussed later), the speech rhythm may or may not correspond well to natural spoken words.

Vocabulary storage plays an important role in how the output will sound. There are two aspects: nature of the signal in stored form, and type of storage device. The signal can be in analog or digital form. In addition, one company, Periphonics, has developed a proprietary technique which is "somewhere in-between."

An analog signal is what you hear yourself; a tape recording is a recording of analog signals. A rotating device is required to store an analog signal. The most common approaches are magnetic sleeves mounted on drums and film sleeves mounted on drums. In the first case, the signal intensity (loudness) is related to the degree of magnetization. In the second case, the analog signal is written on the film much as sound tracks are written on movie film. In either case, the sleeves are divided into tracks. Each track corresponds to the length of a word or phrase. The difficulty with this approach is that it forces words into constant lengths, whereas natural words have different lengths. This causes interference in the rhythm of speech. Particularly long words or phrases can sometimes be spread over two tracks—with the consequent reduction in vocabulary size.

Though these techniques may require a lot of diddling to get natural-sounding speech if long phrases are required, they are well suited to the spell-it-out approach usually taken with small vocabularies. In all fairness, one of the best-sounding voice response systems heard by the DATAPRO 70 staff was such a unit, and it included a rather long phrase. (The staff could not determine exactly how it was accomplished, but the understanding is that some rather careful recording of the vocabulary, splitting up the phrase over several tracks, was involved.)

Digital signals involve determining and assigning a binary (digital) value to the amplitude of the analog waveform at fixed intervals and storing the digital values. Knowing the sampling intervals, the digital values can be retrieved and the original waveform (spoken word) can be reconsti-

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Dimension, Inc. is a subsidiary of Scope, Inc. and markets off-the-shelf components for voice-command systems. In these systems, an operator speaks the pre-set vocabulary to the equipment, which analyzes the audio input and stores a derived pattern. These words can then be used to initiate predetermined functions. New operators or changes in an operator's voice can be accommodated by "training" the unit when required; this training takes only a few seconds per word (command). Equipment is available for interpreting and storing from 24 to 128 words or short phrases.

tuted. Any conventional device for storing digital information, such as magnetic drums or disks or core storage or solid state components, can be used as the vocabulary storage device.

The above discussion is very basic in its nature. There are many problems to overcome in either analog or digital storage. Either can be effective and either can be a flop, depending entirely on the care taken in design. For example, analog recording on either a magnetic or film sleeve includes the problem of variations in output amplitude (loudness) not present in the original recording. For digital recording, the sampling rate and amplitude resolution affect the fullness of the output voice. In either method, the circuitry used affects the shape of the waveforms being output and consequently the tonal characteristics of the voice. Fortunately, there's an easy way to check for tonal quality: listen to it. However, the unit you get may vary from the demonstration unit. Be sure to make some arrangements for hearing your equipment before acceptance.

Generation technique refers to the manner of taking the recorded signals and converting them to spoken words again. For analog recording, this is simply a matter of reading the signal and amplifying it. For digital recording, some kind of tone synthesis is required. This merely means putting tones together to get the final sound (spoken word).

Programmed synthesis is handy if you want to expand your vocabulary without taking up more storage or buying more units. In essence, it is taking parts of words and putting them together to form words not in the vocabulary. An example would be to take the "fif" sound from fifteen and combine it with the "ty" sound from forty to get fifty.

Programmed intonation is the capability to vary the sound of a recorded word to give it a rising inflection, falling inflection, or changed emphasis (volume). Human speech is much more flexible than this, but these three form the basic capability. With rising and falling inflection, for example, a single vocabulary word could be used to end a statement, end a question, or appear in the middle of a sentence. The advantage of programmed intonation is to add to the understandability of the voice reply; it could be done with an expanded vocabulary if you wanted to go to the trouble. Virtually no capabilities of this type are provided in any of the units now on the market.

Vocabulary multiplexing is the simultaneous output of the same word on multiple lines. Without this, unprogrammed pauses would be inserted in a voice reply while another line was using the next word to be output on this line. Essentially, there are two answers for this entry: full and none. Single-line units naturally have no need for this capability.

Message capacity is a throughput measure. Usually, in a multi-line system, some line control logic is shared among the various lines. Therefore, calls on some lines must wait until the line control logic can get to them. This decreases the number of calls that can be handled on each line. Some very esoteric mathematics comes into play to properly discuss this subject. Queuing theory is definitely beyond the scope of this report. Basically, throughput varies also with the quality of service, as defined by the incidence of busy signals inquirers get.

More to the point, however, is a discussion of the average length of a call. The number talked about most frequently is 30 seconds. In a single-inquiry situation with little data entry, read-back verification, security checking, etc., such a call length is quite reasonable. And that is the situation most systems are in now. But as the applications for voice response expand, longer calls will be the order of the day. For this reason, throughput for 1-minute and 3-minute calls was included wherever the information was available.

Pricing and Availability

Purchase price is shown as a range when possible to properly reflect the variations in configuration and support. Where only one price is shown, it usually represents the basic system specified. The price includes only the equipment from the voice response manufacturer – not, for example, the host computer system in subsystem configurations.

The *rental price* shown includes maintenance. "NA" usually means that rental or leasing arrangements are not available as a standard option.

The date of first delivery and the number installed to date are self-explanatory.

Suppliers

Listed below for your convenience are the full names and addresses of the 20 suppliers mentioned in this report.

Acrodyne, Inc., 320 Colfax Avenue, Clifton, New Jersey 07013.

Applied Information Industries (AII), 345 New Albany Road, Moorestown, New Jersey 08057.

Beverly Bancorporation, Inc., 1357 West 103rd Street, Chicago, Illinois 60643.

Burroughs Corporation, Second Avenue at Burroughs, Detroit, Michigan 48232.

Chancellor Industries, Inc., 3005 LTV Tower, Dallas, Texas 75201.

Cognitronics Corporation, 333 Bedford Road, Mt. Kisco, New York 10549.

Compunetics, Inc., 1100 Eldo Road, Monroeville Industrial Park, Pennsylvania 15146.

Datatrol Inc., Kane Industrial Drive, Hudson, Massachusetts 01749.

Dimension, Inc. (a subsidiary of Scope, Inc.), 1860 Michael Faraday Drive, Reston, Virginia 22070.

Honeywell Information Systems, Inc., 60 Walnut Street, Wellesley Hills, Massachusetts 02181.

IBM Corporation, Data Processing Division, 1133 Westchester Avenue, White Plains, New York 10604.

Interface Industries, Inc., Box 240, Hauppauge, New York 11787.

Metrolab, Inc. (a subsidiary of Cubic Corporation), 10457 Roselle Street, San Diego, California 92109.

Metroprocessing Corporation of America, 64 Prospect Street, White Plains, New York 10606.

Periphonics Corporation, Airport International Plaza, Bohemia, New York 11716.

Phonplex Corporation (a subsidiary of Instrument Systems Corporation), 789 Park Avenue, Huntington, New York 11743.

Terminal Communications, Box 27228, Raleigh, North Carolina 27611.

Transcom (a division of HI-G Inc.), 12 Tobey Road, Bloomfield, Connecticut 06002.

Wavetek Data Communications, P.O. Box 651, San Diego, California 92112.

Western Data Products, Inc., 2321 Pontius Avenue, Los Angeles, California 90064. □

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MANUFACTURER AND MODEL	Applied Information Industries VSC-100	Burroughs Corp. BARS Audio Response Sys.	Cognitronics Corp. MARS	Cognitronics Corp. STAR
MODE OF USE	Complete subsystem for IBM 360; free-standing system; remote subsystem	Voice generation module for Burroughs computer communications subsystem	Complete subsystem for DEC PDP-8 and others	Complete subsystem for DEC PDP-8 series
COMMUNICATIONS INPUT				
Number of lines	16 to 128	Up to 128 (host computer)	2 to 64 in groups of 2	1
Form	Tones or 10/11 bit serial via data sets	Tones via data sets	Tones via data sets	Tones via data set
Decoding	2-of-8; 3-of-14; ASCII	2-of-8	2-of-8	2-of-8
Symbol set	Full alphanumeric	10 numeric; 2 specials	10 numeric; 2 specials	10 numeric; 2 specials
Remote terminals accommodated	12-key Touch-Tone; ASCII printers/ CRTs	12-key Touch-Tone	12-key Touch-Tone	12-key Touch-tone
PROCESSING CAPABILITIES				
Source	Self-contained minicomputer	Host computer	Customer-supplied minicomputer	Customer-supplied minicomputer
Software	Complete banking package; applications support; I/O routines for host computer	—	Executive program; customer supplies applications software	Executive program; customer supplies applications software
SPEECH GENERATION				
Vocabulary type	Words and phrases	Words and phrases	Words and phrases	Words
Vocabulary size	Unlimited	189 words or 63 phrases; 1 phrase replaces 3 words	31 to 189 words or 31 to 63 phrases; 1 phrase replaces 3 words	31 words
Typical speech rate, words per minute	Variable; 120 standard	120	112	96
Vocabulary storage	Digital on random access device	Analog on film	Analog on film	Analog on film
Generation technique	Tone synthesis	Amplification of recorded signal	Amplification of recorded signal	Amplification of recorded signal
Programmed synthesis	Any portions of words can be combined	None	None	None
Programmed intonation	None	None	None	None
Vocabulary multiplexing	Full	Full	Full	—
Message capacity, calls per hour 1-minute calls	40 (1 line) to 2000 (128 lines)	60 per line	84 (2 lines) to 3000 (64 lines)	53
3-minute calls	18 (1 line) to 2000 (128 lines)	20 per line	—	19
PRICING AND AVAILABILITY				
Purchase price	$40,000 to $150,000	$37,200	$24,000 up	$3,995
Monthly rental	NA	$826	NA	NA
Date of first delivery	June 1972	1969	NA	NA
Number installed to date	—	NA	NA	NA
COMMENTS	Can be used as plug-compatible replacement for IBM 7770; AII has rights to Technitrend technology; ASCII capability used for hard-copy printout.			

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MANUFACTURER AND MODEL	Cognitronics Corp. Multiplexed Mini-computer Peripheral	Cognitronics Corp. Multiplexed Main-frame Peripheral	Cognitronics Corp. 630 Series Speechmaker	Cognitronics Corp. 670 Series Speechmaker
MODE OF USE	Voice generation module for multi-line minicomputer system	Voice generation module for multi-line computer system	Voice generation component	Voice generation component
COMMUNICATIONS INPUT	Customer-supplied	Customer-supplied	Customer-supplied	Customer-supplied
Number of lines	—	—	—	—
Form	—	—	—	—
Decoding	—	—	—	—
Symbol set	—	—	—	—
Remote terminals accommodated	—	—	—	—
PROCESSING CAPABILITIES	Customer-supplied	Customer-supplied	Customer-supplied	Customer-supplied
Source	—	—	—	—
Software	—	—	—	—
SPEECH GENERATION				
Vocabulary type	Words and phrases	Words and phrases	Words	Words
Vocabulary size	31 to 381 words or 31 to 127 phrases; 1 phrase replaces 3 words	31 to 189 words or 31 to 63 phrases; 1 phrase replaces 3 words	10 or 31	31 to 189 words or 31-63 phrases
Typical speech rate, words per minute	112	112	96	112
Vocabulary storage	Analog on film	Analog on film	Analog on film	Analog on film
Generation technique	Amplification of recorded signals	Amplification of recorded signals	Amplification of recorded signal	Amplification of recorded signal
Programmed synthesis	None	None	None	None
Programmed intonation	None	None	None	None
Vocabulary multiplexing	Full	Full	None	None
Message capacity, calls per hour: 1-minute calls	—	—	—	—
3-minute calls	—	—	—	—
PRICING AND AVAILABILITY				
Purchase Price	$10,000 up	$16,000 up	$1,095 to $2,100	$5,800 to $13,900
Monthly rental	NA	NA	NA	NA
Date of first delivery	NA	NA	NA	NA
Number installed to date	NA	NA	NA	NA
COMMENTS	Cognitronics has marketed and installed voice response systems since 1963.			

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MANUFACTURER AND MODEL	Datatrol, Inc. CS-1400	Datatrol, Inc. CS-370	Honeywell 285-8	IBM 7770
MODE OF USE	Free-standing system	Complete subsystem for IBM 360/370	Voice generation module for Honeywell Series 200/2000 communications subsystem	Complete subsystem for IBM 360/370
COMMUNICATIONS INPUT				
Number of lines	4 to 64	4 to 64	6 to 60 in groups of 2	4 to 48 in groups of 4
Form	Tones via data sets	Tones via data sets	Tones via data sets	Tones or parallel signals via data sets
Decoding	2-of-8	2-of-8	2-of-8	2-of-8; 3-of-14
Symbol set	10 numeric; 2 specials	10 numeric; 2 specials	10 numeric; 2 specials	Numeric; alphanumeric
Remote terminals accommodated	12-key Touch-Tone	12-key Touch-Tone	12-key Touch-Tone	12-key Touch-Tone; IBM 1001, 1092, 2721, 2730
PROCESSING CAPABILITIES				
Source	Self-contained minicomputer	Self-contained minicomputer	Host computer	Hard-wired logic and host computer
Software	From hardware only to full turnkey system	From hardware only to full turnkey system	Line and message control; banking application package (TRUMP)	Support provided in assembly language under DOS BTAM and QTAM and OS TCAM
SPEECH GENERATION				
Vocabulary type	Words and phrases	Words and phrases	Words and phrases	Words
Vocabulary size	32 to 256 words	32 to 256 words	31 to 189 words; 1 phrase replaces 3 words	32 to 128 words
Typical speech rate, words per minute	90	90	112	120
Vocabulary storage	Analog on film	Analog on film	Analog on film	Analog on magnetic drum
Generation technique	Amplification of recorded signal	Amplification of recorded signal	Amplification of recorded signal	Amplification of recorded signal
Programmed synthesis	None	None	None	None
Programmed intonation	None	None	None	None
Vocabulary multiplexing	Full	Full	Full	Full
Message capacity, calls per hour				
1-minute calls	66 (4 lines) to 1233 (64 lines)	66 (4 lines) to 1233 (64 lines)	NA	60 (4 lines) to 2100 (48 lines)
3-minute calls	22 (4 lines) to 411 (64 lines)	22 (4 lines) to 411 (64 lines)	NA	20 (4 lines) to 700 (48 lines)
PRICING AND AVAILABILITY				
Purchase price	$30,000 to $250,000	$20,000 to $100,000	$62,000 (6 lines)	$57,000 to $200,000
Monthly rental	NA	NA	$1,500 (6 lines)	$1,300 to $4,200
Date of first delivery	September 1970	March 1972	1968	NA
Number of installed to date	8	—	NA	450 (estimated)
COMMENTS	Datatrol specializes in on-line retail credit check and bank-teller information systems.			

All About Voice Response

MANUFACTURER AND MODEL	IBM 7772	Metrolab, Inc. DIGITALK 5000 MVRS	Metrolab, Inc. DIGITALK 4000 VRS	Metrolab, Inc. 3100 and 256 VRU
MODE OF USE	Complete subsystem for IBM 360	Complete subsystem for minicomputers	Complete subsystem for computers	Voice generation module
COMMUNICATIONS INPUT				Customer-supplied
Number of lines	2 to 8 in groups of 2	2 to 96 in groups of 2	1	—
Form	Tones or parallel digital signals via data set	Tones via data set	Tones	—
Decoding	2-of-8; 3-of-14	2-of-8	2-of-8	—
Symbol set	Numeric or alphanumeric	10 numeric; 2 specials	10 numeric; 2 specials	—
Remote terminals accommodated	12-key Touch-Tone; IBM 1001, 1092, 1093	12-key Touch-Tone	12-key Touch-Tone	—
PROCESSING CAPABILITIES				Customer supplied
Source	Hard-wired logic and host computer	Hard-wired logic and host computer	Hard-wired logic and host computer	—
Software	Support provided for assembly language under DOS BTAM and QTAM	Application support; interface to host computer	NA	—
SPEECH GENERATION				
Vocabulary type	Words	Words and phrases	Words	Words and phrases
Vocabulary size	Unlimited; see comments	256 words or phrases max.	36 to 63 words	63 (3100) or 256 (256) words or phrases max.
Typical speech rate, words per minute	Variable	100 to 120	100 to 120	100 to 120
Vocabulary storage	Digital representation on disk	Analog on magnetic drum	Analog on magnetic drum	Analog on magnetic drum
Generation technique	Tone synthesis	Amplification of recorded signal	Amplification of recorded signal	Amplification of recorded signal
Programmed synthesis	None	None	None	None
Programmed intonation	None	None	None	None
Vocabulary multiplexing	Full	Full	None	None
Message capacity, calls per hour				
1-minute calls	12 (2 lines) to 180 (8 lines)	100 (4 lines) to 2100 (48 lines)	50	NA
3-minute calls	4 (2 lines) to 60 (8 lines)	—	15	NA
PRICING AND AVAILABILITY				
Purchase price	$29,000 to $64,000	NA	$5,415 to $7,350	$3,000 to $18,000
Monthly rental	$600 to $1,330	NA	$329	NA
Date of first delivery	NA	April 1972	October 1971	NA
Number installed to date	Less than 12 (est.)	—	4	150
COMMENTS	No longer in production. Storage of one word requires about 150 bytes of disk storage.			

All About Voice Response

MANUFACTURER AND MODEL	Periphonics Corp. Voicepac 2000	Phonplex Corp. Voice Response System	Wavetek A500	Wavetek ADCS1000
MODE OF USE	Complete subsystem for IBM 360/370 and other computers; free-standing system; remote subsystem	Complete subsystem for most computer systems; free-standing system	Complete subsystem for IBM computers	Free-standing system
COMMUNICATIONS INPUT				
Number of lines	1 to 93; additional lines on request	2 to 256 in groups of 4	4 to 64	4 to 64
Form	Tones via data sets	Tones via data sets	Tones or parallel signals via data sets	Tones or parallel signals via data sets
Decoding	2-of-8; 3-of-14	2-of-8; others optional	2-of-8; 3-of-14	2-of-8; 3-of-14
Symbol set	Numeric; alphanumeric	10 numeric; 2 specials; others optional	64 characters	64 characters
Remote terminals accommodated	12-key Touch-Tone; IBM 2721	12-key Touch-Tone	12-key Touch-Tone; Wavetek	12-key Touch-Tone; Wavetek
PROCESSING CAPABILITIES				
Source	Self-contained DEC PDP-11	Hard-wired logic plus self-contained minicomputer	Hard-wired logic for message and line control	Self-contained minicomputer
Software	Subsystem emulates IBM 2803 Tape Control; applications support	NA	I/O routines for host computer	Custom
SPEECH GENERATION				
Vocabulary type	Words	Phonemes or words	Words and phrases	Words and phrases
Vocabulary size	Large; see comments	50 words and 5 phrases basic; large expansion possibilities	32 to 256 words; 1 phrase replaces 3 words	32 to 256 words; 1 phrase replaces 3 words
Typical speech rate, words per minute	120	Adjustable; 120 standard	120	120
Vocabulary storage	Proprietary encoding on magnetic disk	Compressed digital in solid-state memory	Analog on magnetic drum	Analog on magnetic drum
Generation technique	Amplification of recorded signal	Tone synthesis	Amplification of recorded signals	Amplification of recorded signals
Programmed synthesis	Yes; access to any portion of any word	Yes, by combining phonemes	None	None
Programmed intonation	None	Emphasis	None	None
Vocabulary multiplexing	Full	Full	Full	Full
Message capacity, calls per hour				
1-minute calls	410 (8 lines) to 980 (16 lines)	160 (4 lines) to 1000 (256 lines)	NA	NA
3-minute calls	30-second calls per hour	70 (4 lines) to 4400 (256 lines)	NA	NA
PRICING AND AVAILABILITY				
Purchase price	$34,000 up	$19,000 (2 lines, 50 words) up	$40,000	$58,000
Monthly rental	NA	$887 up	$2,070	$2,610
Date of first delivery	First quarter 1971	NA	October 1970	May 1972
Number installed to date	6	NA	5	—
COMMENTS	System permits recording up to 1000 seconds of audio information; this corresponds to about 2000 different words; synthesis can be used for additional words.			

All About Modems

Modems (or data sets), those "black boxes" that form the interfaces between terminals or computers and communications lines, are unglamorous but critically important links in nearly every data communications network. To most users, modems are necessary evils that seem to contribute little or nothing to the functional capabilities of their communications systems. Yet no network, no matter how complex and sophisticated, can achieve a reliability level any higher than that of the modems that interface its computers and its remote terminals to the communications facilities that interconnect them.

Today, users are faced with a modem marketplace that offers a broad and bewildering array of models exhibiting a wide range of transmission speeds and a host of attractive features.

This comprehensive report is designed to aid you in understanding the basic functions and characteristics of modems, the make-up of the current modem market, and the product lines of the various modem suppliers. You'll find detailed comparison charts that summarize the current offerings of 48 manufacturers, plus users' ratings of more than 70 popular modems and modem families from 28 suppliers.

What Is It?

A modem is a device that accepts data from a computer or terminal device in the form of a digital pulse train and transforms the data into a form more suitable for transmission over a communications facility; another modem restores the data to its original form. The transformation and restoration process is called modulation and demodulation, which is contracted to modem. Other commonly used terms such as "subset" or "data set" are synonymous with modem.

During the infancy of computer-oriented communications, for all practical purposes, the only modems commercially available were those supplied by the common carriers at a cost in addition to the cost of the communications facility. The modem concept, however, was not a new one; suppliers of military communications equipment and telephone equipment had been incorporating modems as an integral component of total systems. With emphasis on terminals as a powerful extension of the computer and the increasing use of terminals such as the IBM 1050 System, a new market area—the modem market—opened.

Beginning with just a handful of suppliers and a limited number of modem models, the industry experienced rapid growth to where there are now at least 50 suppliers offering well over 200 discrete models of

Following the rising demand for computer terminals, the modem market continues to grow at a rapid rate. In addition to the offerings of the telephone companies, users can choose from a bewildering variety of modems from dozens of independent suppliers. This in-depth report summarizes the characteristics of more than 225 current modems from 48 suppliers, provides useful selection guidance, and includes a unique survey of users' experience with over 11,000 modems.

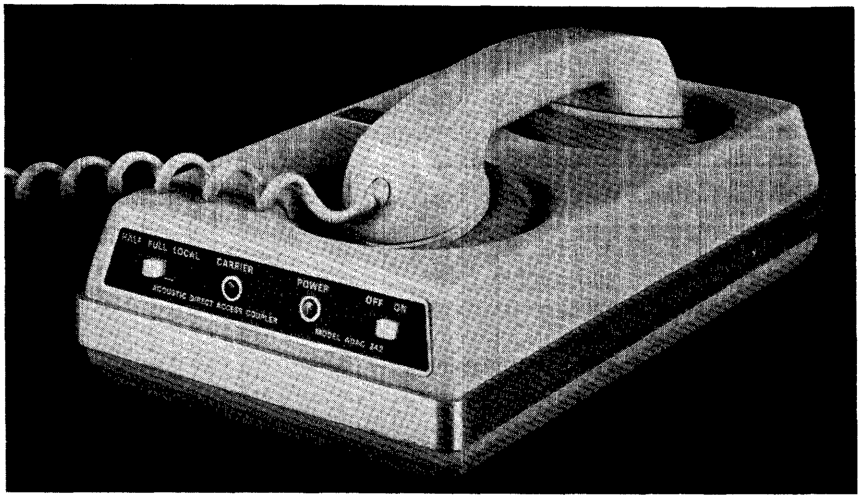
commercial modems. The impetus for such rapid growth can be accredited to the increasing number of time-sharing services, the proliferation of computer-communications installations, the revised AT&T tariffs which allow non-Bell-System modems to be attached to the public telephone network via a Bell System protective connecting device, and the slowness with which AT&T responded to users' needs.

The Modem Market

If you wonder why so many companies have entered the modem market, take a look at its size and growth rate. At present, there are just under 1 million installed mo- ▷

The familiar face of Sherry Moreau, ICC's winsome modem promoter, provides a good standard for gauging the physical size of three of the company's modems. More DATAPRO 70 subscribers reported their experience with ICC modems than with those of any other independent supplier, and they were generally well satisfied.

All About Modems



The Anderson Jacobson ADAC 242 acoustic telephone coupler makes it easy to transmit data via any ordinary telephone. Designed for speeds up to 300 bps, the modem promotes operating flexibility.

dems valued at about $125 million. The independents claim about 32 percent of the current installation base; Ma Bell continues to claim the lion's share. Projections through 1980 forecast a sharp rise in the total number of installations, from an estimated 1.5 million in 1974 to about 5 million in 1980. Ma Bell's domination over the market is expected to wane to a 50 percent share by 1980.

The current independent modem market, valued at $43 million for 1973, shows most of the action in the low-speed class (up to 600 bps), which represents 86 percent of the installed user base. Medium-speed (1200 to 4800 bps) and high-speed (over 4800 bps) modems account for 11 and 3 percent of the current user base, respectively. Projections through 1980 forecast this distribution to remain virtually the same.

The independent modem market has changed very little during the past year in respect to the number of vendors. To the amazement of those who predicted a large dropout as a result of stiff competition among the independents and pressure from AT&T, the modem market has witnessed the demise of only about a dozen vendors. Meanwhile, several new entrants are trying to gain a foothold, some by virtually giving away their products.

The big news of the past year, and the first significant merger in the independent modem market, was Sangamo's acquisition of Rixon, which in 1969 had been acquired by United Business Communications, a subsidiary of United Utilities. UBC divested itself of Rixon in 1972. Rixon is now the sole producer of Sangamo's line of modems as well as its own, and is marketing both lines under the Rixon label. A second acquisition occurred in mid-1973, when Livermore Data Systems acquired the product line of now-defunct American Data Systems, which filed for bankruptcy in March 1973.

The high-speed modem market, once the private domain of a handful of vendors credited with establishing this market as early as 1969, was invaded by Ma Bell, which announced her entry into the 4800-bps market in early 1972 as an alleged move to regain some of the ground she has lost to the independents. The introduction of the Bell System 208A, a 4800-bps modem designed for private line use and priced at a low $125 per month, jolted the modem industry and focused the spotlight on 4800 bps as a Bell-approved transmission speed. Deliveries of the 208A began in mid-1972. Bell followed the 208A with a dial-up version, the 208B, priced at $150 per month, which became available during the third quarter of 1973. Though it hasn't made as many headlines as the introduction of the 208 series, a new member of the Bell System 201 family, the 201C, was introduced this year and also became available for customer deliveries during the third quarter of 1973.

Besides a totally new and appealing change in casework design and a substantial reduction in physical size from their counterparts, the new Bell System modems, for the very first time (for Bell), include a diagnostic capability to aid in pinpointing the location of failures. The new modems also reflect a shift toward LSI technology (previously adopted by some of the industry innovators such as ICC/Milgo), which promises lower costs and reduced size. And the Bell System's tradename, Dataphone, once used to identify those modems designed for the DDD network, is now used to identify *all* Bell modems for both private line and dial-up use.

Foreign Attachments

Prior to January 1, 1969, the effective data of AT&T tariff revisions concerning foreign attachments, modems provided by non-Bell suppliers were restricted to use on leased or privately-owned lines; the connection of a

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non-Bell modem to the public telephone network was forbidden by the telephone company. A customer who disregarded the "foreign attachment" ruling risked having his service terminated.

This ruling, allegedly discriminatory and unreasonable, was challenged by the Carter Electronics Corporation, a supplier of an acoustic/inductive coupling device for interconnecting the base station of a mobile radio system to the telephone network through a conventional telephone.

Carter Electronics in 1966 brought an antitrust suit against the Bell System and GT&E, both of whom opposed use of the "Carterfone device" on the grounds that it violated both the "foreign attachment" and "interconnection" tariffs established by the telephone companies in support of their position included a discussion of telephone system integrity.

Objections to the use of the Carterfone were overruled by an FCC hearing examiner, who in August 1967 approved the Carterfone for use on the telephone network and ordered the carriers to revise their tariffs to allow its use. This decision was further upheld by the full commission in a later appeal; the commission then broadened the decision to include all "harmless" attachments. Following the FCC decision, petitions were filed by the Bell System, General Telephone System, and U.S. Independent Telephone Association for reconsideration of the FCC ruling. Again, several arguments were offered in support of the carriers' position.

The final decision not to reconsider its standing on the "foreign attachment" decision was announced by the FCC in September 1968. Following the announcement, AT&T filed tariff revisions with the FCC, which allowed the use of foreign attachments. These tariff revisions became effective on January 1, 1969.

If the above seems like ancient history, keep in mind that the battle is still being fought.

The revised tariffs permit foreign attachments, such as modems provided by non-Bell suppliers, to be connected to the public telephone network via a Bell-System-supplied protective connecting device referred to by Bell as a Data Access Arrangement.

The Data Access Arrangement, installed by Bell for a nominal charge with rental fees of $2 to $6 per month, assures network integrity by limiting the signal power from the attached modem to a level that does not exceed the power-level restrictions of the telephone network. Excess power injected into the network could result in signal interference such as crosstalk (coupling of one circuit with another).

The telephone companies maintain the exclusive right to provide all network control signaling functions.

The Manual Data Access Arrangement, contained on a single circuit board, includes a separate telephone set with a voice/data key and restricts the connection to the telephone network to a manual operation.

Computer communications, for efficient large-scale operation over the dial network, require automatic dialing and unattended answering capabilities. These are available with the Automatic Data Access Arrangement.

One effect of this arrangement is to give the Bell System modems a $2 to $6 a month leg up on competing modems from independent suppliers. The net effect, so far, is that the Bell System is not yet out of the modem market by a long shot.

The Data Access Arrangement remains a subject of bitter recriminations among the independent modem makers. Changes by AT&T in the design of the equipment, which required redesign work by the modem manufacturers, seem to have been the spark that ignited the fire. AT&T claims, with great justification, that the public telephone network must be protected. The independents state that they are quite willing to build equipment to meet any reasonable specifications, and that AT&T is using the DAA as a weapon against erosion of the company's own modem market.

A possible resolution of the connection of non-Bell modems to public and private (leased) lines is a certification program for the independent modems.

Now You See It, Now You Don't

For some time, it has appeared that the neatest solution to the whole modem problem is simply building the modems into the terminals. Technically, it is not difficult. Some savings over present, separate arrangements should be available because of elimination of some duplicated or unnecessary circuitry and cabinetry. Some terminals, notably Teletype's Model 38 teletypewriters, currently offer integral modems, and the increasing demand for single-source suppliers should convince other terminal makers to adopt the built-in modem approach. But the growth rate has been slower than expected.

Feelings among the modem makers vary as to the importance of the built-in modem concept in future years. No small part of the problem is the necessity to generate a special design for each different terminal. General-purpose, free-standing modems, by adhering to standard interface specifications, are assured of wide application. But there are no standards for logic-level interfaces, which is what the modem maker normally has to work with if he builds an integral modem. Thus, each design would have limited application. (The most widely used family of terminals, the Teletype product line, is controlled by guess who – AT&T, of course.)

The next logical question is that if it's such a good idea to build modems into terminals, then why don't the terminal manufacturers take the initiative and develop their own? After all, it can't be a terribly difficult design problem when scores of other companies have already solved it. Part of the answer may be simply that the terminal makers don't want to dilute their efforts in any way; in the economic situation of today, many are already stretched painfully thin as a result of the emphasis on leasing and nationwide marketing and service. A more fundamental reason is that built-in modems would raise the base price of the company's equipment. And price is all-important today. Look at price first and features second; this is the guiding philosophy in many markets, not just the computer field. A company's position is generally weakened in a competitive situation if it has to talk about overall considerations, such as comparing competitors' products plus the cost of an independent modem with its own integrated package. (Teletype offers the integral modem as an option on the Model 38.)

AT&T Comes Alive

Perhaps the most encouraging news of all is the increasing activity by AT&T. The giant suffers from a poor public image. Perhaps it is inevitable. The haves and the have-nots seldom get along, whether one is considering people, companies, or countries. People look at AT&T and see its protected rate of return on its telephone operations; they seldom see that the rate is based, in effect, on the value of the installed plant. This arrangement, instead of inhibiting upgrading of services, actually encourages it. The Data Access Arrangement question, along with frequent squabbles over whether AT&T was subsidizing some operations out of its telephone profits, have given the corporation a dog-in-the-manger image to many people in the computing industry.

One of the biggest gripes against AT&T a few years ago was the lack of flexibility in operating speeds. Everyone clamored for new communications facilities to accommodate operation at speeds between the normal voice-band and wide-band rates. It seems that this complaint has been virtually eliminated by the modem innovators, who are achieving progressively higher transmission speeds over the same old voice-grade facilities.

The chief thorn in AT&T's side seems to be the IDCMA (Independent Data Communications Manufacturers Association). The primary thrust of this group is to fight the "unfair" aspects of interconnection arrangements, but they get in a lick or two at price reductions as well.

Cause and effect are difficult to pinpoint, so let's just say that when everything is considered, users are certain to benefit from the continuing struggle between AT&T and the independent modem makers.

Don't Glue The Price Tags On

One inevitable result of a large number of manufacturers in a field is price competition. Modem prices have dropped significantly during the past few years, and further price erosion can be expected through both direct price-cutting and the introduction of new, lower-priced models made possible by the move toward LSI technology.

User Experience

To assess the current level of user satisfaction with specific modems, Datapro Research Corporation conducted an extensive user survey. A Modem Reader Survey Form was included in the June 1973 supplement to DATAPRO 70 and mailed to all subscribers. By August 6, usable responses had been received from 216 users with a total of 11,474 installed modems, including 2,631 Bell System modems.

The users were asked to rate the overall performance, hardware reliability, and maintenance service for each modem model in use by assigning a rating of Excellent, Good, Fair, or Poor. The ratings for more than 70 popular modems and modem families from 28 manufacturers (including the Bell System) are summarized in the accompanying tables. Prospective buyers should note that the small sample sizes for some of these models make it unwise to draw firm conclusions from the indicated ratings. A modem user's degree of satisfaction may depend heavily upon his specific application, the overall system in which the modem is incorporated, and the support and service provided by the modem supplier's local office. Also, some modem users get their technical support and/or maintenance service from sources other than the manufacturers.

The ratings assigned by all of the responding users can be combined to form the following overall pictures of user satisfaction with the current modems obtained from the Bell System and from the independents.

Combined Ratings for Bell System Modems

	Excellent	Good	Fair	Poor
Overall performance	50%	45%	5%	0%
Hardware reliability	55%	41%	4%	0%
Maintenance service	46%	32%	18%	4%

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Combined Ratings for Independent Modems

	Excellent	Good	Fair	Poor
Overall performance	63%	32%	5%	0%
Hardware reliability	56%	30%	11%	3%
Maintenance service	40%	40%	15%	5%

Thus, the survey indicates a high level of user satisfaction with both the Bell System modems and the independent modems. The combined ratings show that users rate the overall performance of the independent modems slightly higher than the Bell System modems, whereas the Bell modems are rated slightly higher in hardware reliability. Maintenance service is judged about equal for the Bell System and independent modems.

A cross-tabulation of transmission speeds against type of communications facility, as shown in the accompanying table, was made to shed some light on usage patterns of common-carrier facilities in data communications. Certain adjustments were made to the raw data to ensure that the modem population would be representative. The small group of high-speed modems (over 9600 bps) and private facilities (microwave networks and twisted-pair runs) was excluded. In addition, the response of one extremely large user of 600-1800 bps modems operating over C2-conditioned voice-grade lines was excluded to prevent distortion of the patterns. There are no large surprises in the table. The great majority of users operate at speeds of 2400 bps and lower over the dial network and unconditioned voice-grade lines. There is also clear evidence of a growing usage of modems operating at 4800 bps. The following table was based on the number of modems in use. A separate check was made utilizing the number of responding users as the base, with results very close to those presented.

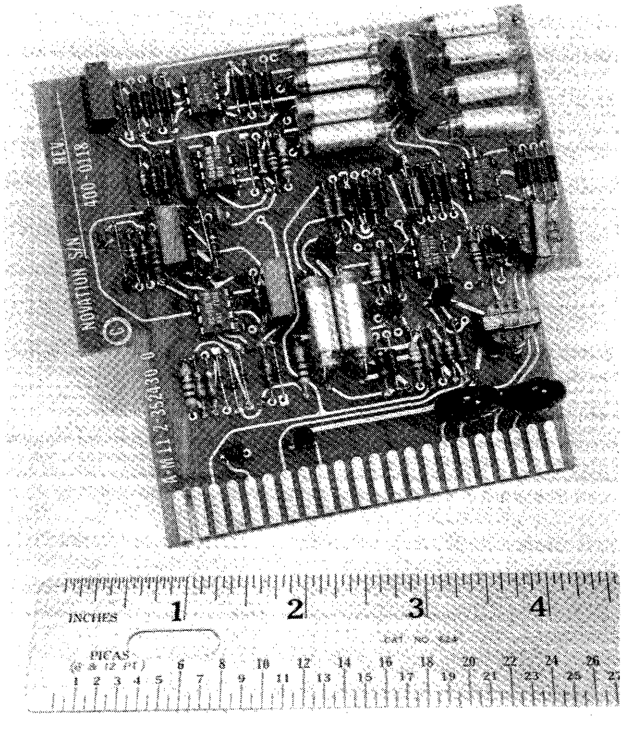
Speed and Line Utilization Patterns

Speed	DDD	Uncond.*	C1*	C2*	C4*	Totals
0-300 bps	15.0%	2.1%	0.2%	3.5%	–	20.8%
600-1800 bps	17.8	17.8	0.3	7.4	0.1	43.4
2000/2400 bps	11.2	6.4	2.2	5.4	0.2	25.4
3600 bps	0.6	0.4	0.1	–	–	1.1
4800 bps	1.2	2.6	0.8	2.3	0.1	7.0
7200 bps	–	–	0.2	0.5	–	0.7
9600 bps	–	0.3	–	1.2	0.1	1.6
Totals	45.8%	29.6%	3.8%	20.3%	0.5%	

* These four columns refer to leased voice-grate lines with no special conditioning (Uncond.) and with C1, C2, and 4 conditioning, respectively.

MODEM CHARACTERISTICS

The key functional characteristics of over 225 commercially available modems from 48 manufacturers, including the many models available from the Bell System telephone companies, are presented in the accompanying comparison charts. All information was supplied and/or verified by the manufacturers during July and August of 1973; their close operation with the Datapro Research staff in the preparation of these charts is greatly appreciated.



This Novation 300-bps, private-line modem is offered in the form of a single printed-circuit card for economy and ease of incorporation into specific terminals by OEM buyers.

Datapro sent repeated requests for information to more than 55 companies known or believed to be in the modem business. The 48 usable responses summarized in our charts provide a comprehensive picture of the modems that are currently available in the United States and Canada. *The absence of any specific company from our charts means that the company either failed to respond to our repeated information requests or was unknown to us.*

The chart entries and their significance to potential modem buyers are explained in the following paragraphs, together with some useful guidelines for selecting the most suitable modem for your situation.

Compatibility

Data communications networks are frequently implemented in stages, with multiple procurements of equipment. All equipment needs replacement sometime. The nature of data communications involves distance, both

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USERS' RATINGS OF DATA COMMUNICATIONS MODEMS

Modem Manufacturer and Model	No. of User Replies	No. of Modems in Use	Data Rate, bps	Users' Ratings: Overall Performance				Hardware Reliability				Maintenance Service			
				E	G	F	P	E	G	F	P	E	G	F	P
Anderson Jacobson ADAC 242	4	49	0-300	3	1	0	0	3	1	0	0	3	0	1	0
Anderson Jacobson (all others)	5	6	600-4800	2	3	0	0	1	4	0	0	3	2	0	0
Anderson Jacobson totals	9	55	–	5	4	0	0	4	5	0	0	6	2	1	0
Astrocom 200 Series	4	16	2000-9600	4	0	0	0	3	1	0	0	2	2	0	0
Astrocom 320	1	16	2000/2400	1	0	0	0	0	1	0	0	1	0	0	0
Astrocom totals	5	32	–	5	0	0	0	3	2	0	0	3	2	0	0
Automatic Electric	1	3,500	0-300	0	0	1	0	1	0	0	0	0	0	0	0
Bell System 101C	2	31	0-300	1	1	0	0	1	1	0	0	1	1	0	0
Bell System 101/103	1	125	0-300	1	0	0	0	1	0	0	0	1	0	0	0
Bell System 103A	31	320	0-300	16	13	0	0	14	13	0	0	8	15	4	1
Bell System 103E	2	20	0-300	1	1	0	0	1	1	0	0	1	1	0	0
Bell System 103F	8	44	0-300	3	4	1	0	3	3	2	0	3	2	3	0
Bell System 103G	2	15	0-300	1	1	0	0	1	0	0	0	1	0	0	1
Bell System 108E	1	1	0-300	0	1	0	0	0	1	0	0	0	0	1	0
Bell System 113A/113B	15	154	0-300	10	5	0	0	10	5	0	0	9	2	4	0
Bell System 100 Series totals	62	710	–	33	26	1	0	31	24	2	1	24	21	12	2
Bell System 201A	66	419	2000	28	36	2	0	29	35	1	0	27	22	13	3
Bell System 201B	25	384	2400	11	12	2	0	12	12	1	0	11	7	7	0
Bell System 202A	1	1	0-1800	0	0	1	0	0	1	0	0	0	0	0	1
Bell System 202C	36	243	0-1800	13	19	4	0	17	15	2	0	14	15	3	2
Bell System 202D	8	68	0-1800	5	3	0	0	5	2	0	0	4	2	1	0
Bell System 202R	4	249	0-1800	2	1	1	0	1	0	2	0	1	1	1	0
Bell System 203A/203B	12	78	1800-7200	8	3	1	0	9	1	1	0	7	2	2	0
Bell System 208A	21	98	2400	13	7	0	0	14	6	0	0	14	4	2	1
Bell System 200 Series totals	173	1,540	–	80	81	11	0	87	72	7	0	78	53	29	7
Bell System 300 Series	13	47	19.2K-230.4K	11	2	0	0	11	2	0	0	9	3	1	0
Bell System 400 Series	9	323	0-20 cps	2	7	0	0	3	6	0	0	1	3	5	0
Bell System 800 Series	5	11	–	5	0	0	0	5	0	0	0	4	1	0	0
Bell System grand totals	262	2,631	–	131	116	12	0	137	104	9	1	116	81	47	9
Burroughs TA 200 Series	2	127	600-1800	1	1	0	0	1	1	0	0	1	1	0	0
Burroughs TA 700 Series	6	45	600-2400	3	2	1	0	3	3	0	0	3	2	0	1
Burroughs totals	8	172	–	4	3	1	0	4	4	0	0	4	3	0	1
Carterfone 300 Series	3	27	0-300	1	0	2	0	0	1	0	2	1	0	0	2
Codex 9600 Series	7	68	9600	6	1	0	0	6	0	1	0	4	3	0	0
Codex 4800	3	6	4800	2	1	0	0	2	1	0	0	0	2	1	0
Codex totals	10	74	–	8	2	0	0	8	1	0	0	4	5	1	0
Collins 202C	1	250	0-300	1	0	0	0	1	0	0	0	1	0	0	0
ComData 300 Series	5	122	0-300	4	1	0	0	2	3	0	4	1	0	0	0
CTC Intertran 900 Series	1	2	9600	1	0	0	0	1	0	0	0	1	0	0	0
ESE, Ltd. 48/QM	1	4	4800	0	1	0	0	0	1	0	0	0	1	0	0
General Electric 100 Series	7	43	0-300	4	3	0	0	4	3	0	0	4	2	0	0
General Electric 201B	1	10	2400	0	1	0	0	0	1	0	0	0	1	0	0
General Electric TDM 330	6	26	4800-9600	5	1	0	0	4	2	0	0	2	3	0	0
General Electric 402	1	2	40.8K	1	0	0	0	1	0	0	0	0	0	0	0
General Electric 500	1	2	230.4K	1	0	0	0	1	0	0	0	0	0	0	0
General Electric totals	16	83	–	11	5	0	0	10	6	0	0	6	6	0	0

LEGEND: E – Excellent, G – Good, F – Fair, P – Poor.

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USERS' RATINGS OF DATA COMMUNICATIONS MODEMS (Continued)

Modem Manufacturer and Model	No. of User Replies	No. of Modems in Use	Data Rate, bps	Users' Ratings: Overall Performance E	G	F	P	Hardware Reliability E	G	F	P	Maintenance Service E	G	F	P
GTE Info. Systems 2000 Series*	4	66	300-1800	3	1	0	0	3	0	1	0	2	0	1	1
GTE/Lenkurt 25 Series	3	120	0-300	2	1	0	0	2	1	0	0	2	1	0	0
GTE/Lenkurt 26 Series	14	20	2000/2400	1	2	0	0	1	1	1	0	0	1	1	0
GTE/Lenkurt totals	17	140	—	3	3	0	0	3	2	1	0	2	2	1	0
IBM 2711	3	24	600-1800	3	0	0	0	3	0	0	0	2	0	0	0
IBM 3872	3	12	1200/2400	0	3	0	0	0	2	1	0	0	2	1	0
IBM 3875	1	5	3600/7200	0	1	0	0	0	1	0	0	0	1	0	0
IBM 4872	15	97	4800	4	7	4	0	6	6	3	0	5	5	3	1
IBM totals	22	138	—	7	11	4	0	9	9	4	0	7	8	4	1
ICC (Milgo) 2000 Series	29	793	2000-2400	25	4	0	0	24	3	1	0	15	9	2	1
ICC (Milgo) 3300/36	13	64	3600	10	3	0	0	10	3	0	0	5	6	1	0
ICC (Milgo) 4000 Series	38	229	4800	28	8	1	0	29	7	1	0	15	21	0	0
ICC (Milgo) 5500/96	9	20	9600	5	2	2	0	5	4	0	0	5	2	2	0
ICC (Milgo) 1100	5	26	4800/9600	4	0	1	0	2	3	0	0	1	3	1	0
ICC (Milgo) 20 LSI Series	3	24	2000/2400	3	0	0	0	3	0	0	0	2	1	0	0
ICC (Milgo) totals	97	1,156	—	75	17	4	0	73	20	2	0	43	52	6	1
Intertel 2000 Series	2	1,505	600-1800	2	0	0	0	2	0	0	0	1	0	0	0
NCR 260-400	2	4	0-300	2	0	0	0	1	1	0	0	1	1	0	0
Omnitech 700 Series	4	36	0-300	3	1	0	0	2	2	0	0	3	1	0	0
Paradyne 48 Series	9	46	4800	7	2	0	0	5	4	0	0	3	3	2	0
Penril PDC 300 Series	2	65	0-300	2	0	0	0	2	0	0	0	0	2	0	0
Penril PDC 1800	2	110	600-1800	1	1	0	0	1	1	0	0	1	1	0	0
Penril PDC 2400B	2	21	2000/2400	2	0	0	0	2	0	0	0	2	0	0	0
Penril totals	6	196	—	5	1	0	0	5	1	0	0	3	3	0	0
Prentice (all models)	6	138	0-2400	3	3	0	0	2	3	1	0	2	2	1	1
Rixon FM-300	1	10	0-300	0	1	0	0	0	0	1	0	0	0	1	0
Rixon DS 1800	3	410	600-1800	1	1	0	0	0	2	0	0	0	0	1	1
Rixon PM-24/DS 2400	3	45	2000/2400	1	2	0	0	3	0	0	0	0	1	1	1
Rixon DS 4800	5	13	4800	2	3	0	0	2	3	0	0	0	3	2	0
Rixon Sebit 72/DS 7200	3	9	7200	2	0	1	0	2	0	0	1	0	1	0	2
Rixon DS 9600	3	6	9600	3	0	0	0	3	0	0	0	0	1	0	1
Rixon totals	18	493	—	9	7	1	0	10	5	1	1	0	6	5	5
Sangamo T100 Series**	1	10	0-300	0	1	0	0	0	1	0	0	0	0	1	0
Sangamo T202 Series**	4	8	600-1800	3	1	0	0	3	1	0	0	3	0	1	0
Sangamo T201 Series**	6	47	2000/2400	2	4	0	0	2	3	0	0	1	3	2	0
Sangamo T4800**	3	5	4800	0	3	0	0	2	1	0	0	0	1	2	0
Sangamo totals	14	70	—	5	9	0	0	7	6	1	0	4	4	6	0
Sonex, Inc. 400	1	44	0-300	0	1	0	0	0	0	1	0	0	0	1	0
Sycor, Inc.	2	203	600-1800	1	1	0	0	1	1	0	0	1	0	1	0
Syntech (Tel-Tech)	2	3	600-2400	0	2	0	0	0	1	0	0	0	1	0	0
Vadic 300 Series	5	102	0-300	0	4	1	0	0	4	1	0	0	1	4	0
Vadic 1200 Series	2	75	600-1800	0	2	0	0	0	0	2	0	0	0	2	0
Vadic totals	7	177	—	0	6	1	0	0	4	3	0	0	1	6	0
Overall totals	533	11,474	—	296	197	26	0	294	186	25	9	215	181	83	21

LEGEND: E – Excellent, G – Good, F – Fair, P – Poor.
*Formerly Ultronic Systems.
**Now produced and marketed by Rixon, Inc.

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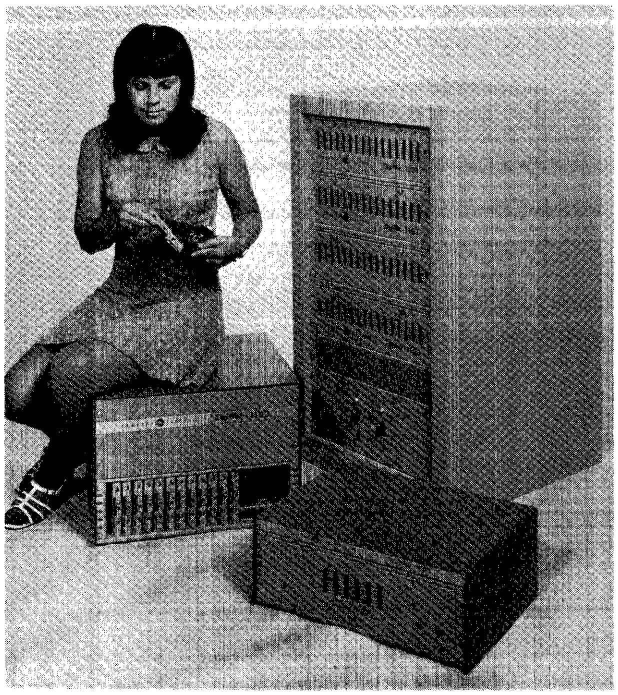

General Electric offers numerous packaging options for its DigiNet 1103 Series, a Bell System 103 Series–compatible modem line designed for the DDD network. The DigiNet 1103 features automatic call origination and is available as a plug-in module (held by the girl), a 6-channel desk-top unit (foreground), a 16-channel unit (upon which the girl is seated), and a 64-channel unit (right rear).

geographical and corporate, which not infrequently leads to division of responsibility or to different restrictions on the communications facilities. The point is that mixing modems from different suppliers on the same communications network is a problem you may have to face.

Compatibility, then, is of importance. Many factors, discussed in other parts of the comparison charts, are involved in the question of whether one data set can communicate with another accurately, reliably, or even at all. On the surface a simpler criterion seems to exist. Just as IBM sets the style for peripheral media, such as magnetic tape formats and punched card formats, the Bell System pretty much sets the standards for communications. The Bell System modems are well known and widely used. It would seem that two modems, both of which are compatible with a particular Bell System modem, are likely to be compatible with one another. In fact, modem manufacturers tend to be very reluctant to guarantee compatibility with any modems other than their own and perhaps those of the Bell System. This point requires careful discussion with the manufacturers if you find yourself in a mixed vendor situation. Get their assurance in writing.

Communications Facility

Most data communications applications are oriented toward use of the common telephone network or equivalent leased lines. But a host of other facilities are available, including radio links, direct cable connections (of several types), infra-red links, lasers, and, most importantly, other common-carrier facilities of different capacity (both higher and lower).

The telephone network and equivalent leased lines are referred to as voice-band lines. Lines of lower capacity are referred to as narrow-band lines; ones of higher capacity as broad- or wide-band lines. The term "communications line" is a convenient way of saying a path over which a particular connection is established. The exact physical nature of the connection can vary, and several different types of links may be used for one connection. The term "facility" is not just an elegant way of saying line but a way of excluding the physical nature of the communications network from a discussion. (You can't really do anything about the physical nature of the network unless you want to build your own.)

Generally speaking, a narrow-band line will accommodate up to 300 bits per second, a voice-band line up to 4800 or 9600 bits per second, and a wide-band line considerably more.

A complete discussion of communications facilities can be found in Report 70G-100-01.

Transmission Characteristics

The most basic data communications characteristic is the speed of operation or *data rate.* Depending on other transmission characteristics, modems operate either at a fixed speed or at the speed of the sending device—up to a specified limit. Some modems can be equipped to operate at several different speeds, either by changing components or wires or by simply changing a switch setting.

The *modulation* technique is a matter of largely esoteric interest, except that it is vital to the question of compatibility. Essentially, it is the way information is encoded into the signal that is transmitted. The actual digital signal from the transmitting equipment is not suitable for transmission, which is the whole reason for modems anyway. Basically, any one or any combination of three properties of a signal can be varied: frequency, phase, or amplitude. Use of a fancier modulation technique can be justified by an increase in the transmission rate that can be obtained. Offsetting this increase is an increase in the complexity of the circuitry required and hence an increase in cost. As more experience is gained with integrated circuits, added complexity may not necessitate an equivalent increase in cost if the sales volume is high enough to offset the high tooling costs.

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The terminology—indeed, the whole mathematical theory—involved in describing the nature of the physical electrical signals that are used to represent the data being transmitted is tied into the concept that a signal is composed of multiple simple signals called sine waves. The important characteristic of sine waves that make them comforting to work with is that they are periodic; i.e., a sine wave repeats itself at fixed intervals. (A second property that makes sine waves even more important is that they are the easiest periodic or aperiodic wave shape to work with mathematically.)

Only two parameters are needed to define a sine wave. For the kinds of signals we are talking about, amplitude and time are the logical candidates. Once defined, a sine wave possesses two properties convenient to mathematical manipulation: frequency and phase. Any one or any combination of the three properties (amplitude, frequency, and phase) can be used as the basis for deriving a modulation technique. For visualization purposes, you can think of amplitude as volume, frequency as tone (or pitch if you are musically inclined), and phase as rhythm.

In addition to the basic modulation method, two other factors are required to properly describe the complete modulation technique. One is the number of levels encoded. Commonly, this is selected as two, four, or eight, but others can and have been used. When more than two levels are employed, each level represents a group of bits rather than just one bit as in the more familiar two-level (binary) technique used in logic circuits. For example, the Bell System 201 Data Sets uses four-level phase encoding; each level represents a pair of bits (dibit). The four levels allow the representation of the four possible combinations of a bit pair (00, 01, 10, and 11). The second factor is whether the reference for detecting and measuring a level change will be taken from a reference source at the receiving end or whether it will be taken from the signal itself by measuring changes in the signal. (The technical term for the second method is "differentially coherent," if you'd like to work it into a conversation some time. There is also a plain "coherent" method that uses the subcarrier as a reference, if you really care.)

In summary, the three factors that describe a modulation technique are basic modulation method, number of encoding levels, and reference source.

The charts at the back of this report use a number of abbreviations and short forms to avoid cluttering up an otherwise readable format with some pretty scarey words. The most frequently used entries are FSK, AM, and PM.

FSK is short for Frequency Shift Keying. It is a two-level, frequency modulation technique. (The term "keying" is frequently used to indicate two-level operation.) Actually, either of two frequencies is transmitted depending on whether a one or a zero is the data bit being sent. This technique is used almost universally for low-speed (300 bits per second and below) operation.

AM is, of course, Amplitude Modulation. It is frequently used in multi-level techniques in combination with phase modulation (PM), which gives rise to the cryptic abbreviation, AM/PM. For higher-speed operation using amplitude modulation, a couple of specialized techniques are borrowed from radio theory: Single-Sideband (SSB) and Vestigial Sideband (VSB). Both of these techniques utilize the fact that the analog process of modulation impresses redundant information onto the carrier. Electrical and electronics engineers discuss this in terms of power distribution. In the basic method, a lot of power is wasted in parts of the signal not carrying information. SSB and VSB are techniques for concentrating the power in the information portion of the signal (suppressing or eliminating power in the non-information portions, if you prefer).

Another specialized form of amplitude modulation with a separate name is QAM, or Quadrature Amplitude Modulation; in simple terms this is four-level AM. (Try "quadrature-amplitude differentially coherent modems" on your friends.)

Modulation techniques not quite covered in the above discussion include PCM and Duobinary. PCM is Pulse Code Modulation. In this technique, the periodic nature of the signals is ignored, and the presence or duration of the signal is used to encode information. Sounds like digital logic, doesn't it? Duobinary is a technique invented by GTE Lenkurt and used only in its modems. This technique is actually a three-level scheme in which the upper and lower level represent the same thing (giving in effect a two-level result), but strict encoding rules are followed as to which level is used for a particular bit. GTE Lenkurt applies this to frequency modulation and, according to the company, achieves simplicity and accuracy.

In practical terms, modulation technique is not a basis for choosing a modem. Frequently, compatibility considerations eliminate it as a decision point. Overall performance, which includes how well a vendor implements a particular technique, is a more reasonable approach. The best advice for most users is to: (1) stick to Bell System or compatible modems, (2) install only one brand of modem, or (3) get compatibility guarantees in writing.

Pushing an electrical signal through a network is something like trying to push a many-jointed pole—it's hard to keep the thing straight. If it gets too much out of shape, it becomes useless. You can straighten out a bent

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pole only because you can see or measure what "straight" is. Impressing information on an electrical signal is a bit more dicey; if the signal gets out of shape, you have no frame of reference to straighten it up so it can be interpreted correctly. *Line conditioning* refers to adjusting the properties of the communications line to prevent the signal from getting too far out of shape. Such distortions become more critical as speeds increase. Conditioning a line involves physical attachment of electrical components, so it cannot be employed on the switched network unless the components are part of the modem itself.

For Bell System leased voice-band lines, various types of conditioning are available, called C1, C2, and C4. (These are listed in order of increasing cost.) If a line needs to be conditioned to operate with a particular modem, then your line costs go up. Some modems include equalization circuitry that effectively accomplishes the same purpose.

Synchronization refers to the time relationships among the bits that make up the characters that make up the messages. There are basically two ways for a modem to handle data: in spurts or in continuous streams.

As an example, data entered from a typewriter keyboard is entered in spurts—or, to be more precise, a character per key depression. The time interval between sequentially-keyed characters varies in duration because of the human inability to key consecutive characters at precise intervals. Data handled in spurts is referred to as asynchronous or start-stop operation.

Data entered from a storage medium such as punched cards, punched paper tape, or magnetic tape can be handled as a continuous stream of data because the transfer can be accurately controlled by electronic and/or mechanical means. Data handled in continuous streams is referred to as synchronous operation.

Asynchronous transmission is advantageous for handling irregular data input rates such as the above keyboard example; however, it is disadvantageous to transmission efficiency.

Synchronous transmission is advantageous to line efficiency, but it is disadvantageous to equipment costs, which are greater as a result of the more complex circuitry required.

Modems designed for asynchronous operation are generally capable of transmitting data at any rate up to the specified maximum rate of the modem.

Synchronous modems are designed to operate at a fixed transmission rate, which is established by an internal or external clocking source (usually a crystal oscillator).

The *data format* refers to how the data bits that comprise a character are handled for transmission. If they are sent one at a time, transmission is serial. If they are sent all at once, transmission is parallel. Most data communications devices transmit in a serial fashion, because higher performance can be attained. Parallel transmission has the attraction that it lowers the cost of the terminal because no circuitry is required to convert the normally parallel data into serial form. Parallel modems are used principally for voice response systems, but also for some lower-speed terminals. Perhaps the most significant comment on parallel modems is that with one exception (Sangamo), independent manufacturers do not produce them; the implication is that they are not particularly important.

Modems operate in one of three *transmission modes:* simplex, half-duplex, or full-duplex. The simplex mode permits unidirectional data transmission; i.e., data can either be transmitted only or received only. The half-duplex mode permits data transmission in either direction, but not simultaneously. Full-duplex operation implies that data can be simultaneously transmitted and received over a common communications facility.

Calling mode refers to a modem's capability to originate and/or answer calls. Fixed installations normally need to be able to originate and answer data communications calls from either end. For a portable unit, however, the need to be able to answer a call is less evident. The unit on the other end is similarly freed from the need to place calls. If the application permits such a limitation, a small cost saving can be achieved.

Terminal Interface

Although special interfaces are sometimes required to interconnect components supplied by different manufacturers, most commercial models provide an electrical interface in accordance with the interface standard established by the Electronic Industries Association. The EIA Standard RS-232C assures plug-for-plug compatibility between modems and all data communications devices whose manufacturers subscribe to this interface standard.

In addition to the EIA Standard, employed throughout the United States, two other interface standards are in existence: MIL-Standard 188B, an interface standard for military communications equipment, and CCITT Recommendation V.24, an international communications-interface standard established by the Consultative Committee on International Telegraphy and Telephony, Geneva, Switzerland.

Line Interface

Physical connection of the modem to the communications facility can take several forms. One is direct

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connection by wires. Another is a "soft" connection in which no direct or permanent connection to the communications facility is required; this is referred to as a telephone coupler.

Direct wired connections are usually two-wire or four-wire, which mean just what they seem to. The purpose of the four-wire connection is to provide full-duplex operation. Full-duplex can be achieved over a two-wire setup, but transmission capacity of the line is cut in half. Four-wire setups actually use two communications "lines."

As mentioned previously, the connection to the public telephone network via equipment other than that supplied by the telephone company was forbidden by the carrier tariffs prior to January 1969. Prior to the Carterfone situation, this ruling had not been actively enforced for telephone devices equipped to connect inductively or acoustically to the network. At the time, only a handful of suppliers provided modems of this nature.

After the January 1969 tariff revisions, which explicitly allow acoustic/inductive coupling of customer-supplied devices to the network, the acoustic/inductive modem market began to grow more rapidly. Currently, many different suppliers provide acoustically—or inductively—coupled modems.

The acoustic/inductive approach to data communications has two advantages: (1) it permits an expedient connection to the public telephone network via an inexpensive means from an independent supplier, and (2) it provides the user with a truly portable means of communicating.

Modems that employ acoustic and/or inductive coupling techniques can be categorized under the general heading of telephone-coupler modems. These modems are functionally similar to the hard-wired modems except for the method of line connection. Connection is established by placing a call in the conventional manner, using a standard telephone set. Then, having vocally confirmed the connection, the operator cradles the telephone handset in the acoustic and/or inductive coupling device to initiate data communications. The call is also terminated in the conventional manner by hanging up the handset at the completion of transmission.

Some modems are designed for communications over a twisted-pair or coaxial-cable connection. Typically, their use is restricted to limited-distance operation, ranging from a few hundred feet to ten miles or more. These modems are non-Bell compatible and are usually good for high-speed data transmission, although there is a correlation between operating speed and distance. The transmission speed is inversely proportional to the distances. Coaxial cable increases the modem's operating range for a given transmission rate. Several manufacturers of telephone coupler modems now also provide a wired connection as an alternate communication path.

At least one modem manufacturer uses an infrared light beam instead of a wired connection between data sets. This technique is claimed to be good for distances up to several hundred feet, though weather conditions can affect the transmission.

Features

A number of features originating with Bell System modems provide useful capabilities in a data communications environment.

Half-duplex operation of modems can be time-consuming when acknowledgment messages are transmitted back to the sending terminal to confirm whether data was received without any detected errors so transmission can proceed, or that an error was detected and retransmission is required. To speed up the acknowledgment cycle and to reduce the complexity of the circuitry required to implement retransmission capability, the *reverse channel* idea has been provided. Basically, a small slice of the communications link is used to provide a path opposite to the direction of the data flow, hence "reverse channel." Typically, a terminal monitors this path and bases its actions on whether a signal is present or absent. (This facility can also be described as a full-duplex arrangement with a large difference in the data transmission rates in the two directions.) The need for this feature depends on the characteristics of the terminal.

In some communications networks, coordination of the operations is performed by having the operators speak to one another over the same line that is used for data transmission. To do this, the modem must be cut out of the circuit to allow normal voice transmission. This capability is referred to as an *alternate voice/data* feature.

To conduct the voice coordination, a telephone is required, so it is important to know whether an *integral handset* is supplied with the modem or whether separate arrangements must be made.

For unattended operation of a terminal, *automatic answering* is required. This applies to operation on the dial network, because on a leased line full-time connection is normally maintained.

Equalization is a technique that compensates for inconsistencies of the transmission medium. It's purpose is to match line conditions to take full advantage of the data rate capability of the line. The faster the modem, the greater the need for equalization and the more complex the equalizer. Most low- and medium-speed modems contain fixed (nonadjustable) equalizers that match the average line conditions found from a statistical survey of the dial network. *Manually adjustable equalizers* are preset at time of installation to match the line and are normally used for leased or private service. *Automatic equalization* continuously compensates for line changes and is, therefore, useful for the dial network. The minimum initialization time for automatic equalizers is 50 milliseconds—during which no useful data can be transmitted.

Diagnostic Facilities

A relatively new consideration, and one of the more valuable outgrowths of modem development, is the inclusion of diagnostic capabilities within the modem which aid the user or customer engineer in determining the location of a fault, usually by isolation. Two major diagnostic techniques are self-test, a built-in psuedo-random test pattern generator which exercises the modem to simulate actual operation, and loopback, which can include both local (digital) and remote (analog) loopback to permit the integrity of the terminal, modem, line, or remote device to be determined. Indicator lamps are generally used to provide a visual indication of the diagnostic response.

Pricing and Availability

The comparison charts show whether a particular modem is available for *rental* and/or for *purchase*, and for how much. Occasionally there is also a one-time *installation* charge.

Date of first installation indicates when the first production model of each modem was delivered (or is scheduled to be delivered) to a customer.

Number installed to date shows how many modems of each type had been delivered to customers as of August 1973. All figures were supplied by the manufacturers themselves, and blanks appear in all cases where the manufacturers chose not to release this information.

Current lead time shows the amount of delay that can be anticipated between placement of an order and delivery of the modem.

MODEM MANUFACTURERS

Listed below for your convenience in obtaining additional information are the full names and addresses of the 48 manufacturers whose products are summarized in the following comparison charts.

Acrodyne Data Services, Inc., 1217 Summit Avenue, Union City, New Jersey 07087. Telephone (201) 865-3220.

Anderson Jacobson, Inc., 1065 Morse Avenue, Sunnyvale, California 94086. Telephone (408) 734-4030.

Astrocom Corporation, 293 Commercial Street, St. Paul, Minnesota 55106. Telephone (612) 933-2208.

Automatic Electric Company, 400 N. Wolf Road, Northlake, Illinois 60164. Telephone (312) 562-7100.

Badger Meter, Inc., Electronics Division, 150 East Standard Avenue, Richmond, California 94804. Telephone (415) 233-8220.

Bell System: distributed by local Bell System offices.

Burroughs Corporation, Burroughs Place, Detroit, Michigan 48232. Telephone (313) 972-7735.

Carterfone Communications Corporation, 2639 Walnut Hill Lane/Suite 223, Dallas, Texas 75229. Telephone (214) 350-7011.

Codex Corporation, 15 Riverdale Avenue, Newton, Massachusetts 02195. Telephone (617) 969-0600.

Coherent Communications Systems Corporation, 85D Hoffman Lane, Central Islip, New York 11722. Telephone (516) 582-4044.

Collins Radio Company, 19700 Jamboree Road, Newport Beach, California 92663. Telephone (714) 833-0600.

ComData Corporation, 7544 W. Oakton Street, Niles, Illinois 60648. Telephone (312) 692-6107.

Computer Transmission Corporation, 2352 Utah Avenue, El Segundo, California 90245. Telephone (213) 973-2222.

Data Access Systems, Inc., 100 Route 46, Mountain Lakes, New Jersey 07046. Telephone (201) 361-2345.

Datapoint Corporation, 9725 Datapoint Drive, San Antonio, Texas 78284. Telephone (512) 696-4520.

Data Products Corporation/Telecommunications Division, Commerce Drive, Stamford, Connecticut 06902. Telephone (203) 325-4161.

Dataserv, 770 Airport Boulevard, Burlingame, California 94010. Telephone (415) 342-0877.

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Design Elements, 1356 Norton Avenue, Columbus, Ohio 43212. Telephone (614) 294-2694.

Digital Techniques Corporation, 4248 Delemere Court, Royal Oak, Michigan 48073. Telephone (313) 549-8663.

ESE Limited, 1780 Albion Road, Rexdale, Ontario, Canada. Telephone (416) 749-2271.

General DataComm Industries, Incorporated, 131 Danbury Road, Wilton, Connecticut 06897. Telephone (203) 762-0711.

General Electric Company, Waynesboro, Virginia 22980. Telephone (703) 942-8161.

GTE Information Systems, Incorporated, 1 Stamford Forum, Stamford, Connecticut 06904. Telephone (203) 357-2000.

GTE Lenkurt, Incorporated, 1105 County Road, San Carlos, California 94070. Telephone (415) 591-8461.

Hughes Aircraft Company, Ground Systems Group, Fullerton, California 92634. Telephone (714) 871-3232.

Hycom, 6841 Armstrong Avenue, Irvine, California 92705. Telephone (714) 557-5252.

International Business Machines Corporation, Data Processing Division, 1133 Westchester Avenue, White Plains, New York 10604. Telephone (914) 696-1900.

International Communications Corporation, 7620 N.W. 36th Avenue, Miami, Florida 33147. Telephone (305) 691-1220.

I.I. Communications Corporation, 139 Terwood Road, Willow Grove, Pennsylvania 19090. Telephone (215) 657-3600.

Intertel, Incorporated, 6 Vine Brook Park, Burlington, Massachusetts 01803. Telephone (617) 273-0950.

ITT/Data Equipment & Systems, East Union Avenue, East Rutherford, New Jersey 07073. Telephone (201) 935-3900.

Livermore Data Systems, Incorporated, 2050 Research Drive, Livermore, California 94550. Telephone (415) 447-2252.

Multi-Tech Systems, Incorporated, 47 Bedford Street SE, Minneapolis, Minnesota 55414. Telephone (612) 331-5000.

Novation, 18664 Topham Street, Tarzana, California 91356. Telephone (213) 344-7191.

Omnitech Corporation, 903 North Second Street, Phoenix, Arizona 85004. Telephone (602) 258-8246.

Paradyne Corporation, 8550 Ulmerton Road, Largo, Florida 33540. Telephone (813) 536-4771.

Penril Data Communications, Incorporated, 5520 Randolph Road, Rockville, Maryland 20852. Telephone (301) 881-8151.

Prentice Electronics Corporation, 795 San Antonio Road, Palo Alto, California 94303. Telephone (415) 327-0490.

Pulse Communications, Incorporated (a division of Harvey Hubbell, Incorporated), 5714 Columbia Pike, Falls Church, Virginia 22041. Telephone (703) 820-0652.

Quindar Electronics, Incorporated, 60 Fadem Road, Springfield, New Jersey 07081. Telephone (201) 379-7400.

RFL Industries, Incorporated, Communications Division, Powerville Road, Boonton, New Jersey 07005. Telephone (201) 334-3100.

Rixon, Incorporated (a subsidiary of Sangamo Electric Company), 2120 Industrial Parkway, Silver Spring, Maryland 20904. Telephone (301) 622-2121.

Sanders Associates, Incorporated, 95 Canal Street, Nashua, New Hampshire 03060. Telephone (603) 885-5875.

Singer Tele-Signal, 250 Crossways Park Drive, Woodbury, New York 11797. Telephone (516) 921-9400.

Sonex, Incorporated (formerly I/Onex, a division of Sonex, Incorporated), Data Communication Products, 2337 Philmont Avenue, Huntingdon Valley, Pennsylvania 19006. Telephone (215) 947-6100.

Tele-Dynamics, 525 Virginia Drive, Fort Washington, Pennsylvania 19034. Telephone (215) 643-3900.

Universal Data Systems, 2611 Leeman Ferry Road, Huntsville, Alabama 35805. Telephone (205) 533-4500.

The Vadic Corporation, 505 E. Middlefield Road, Mountain View, California 94040. Telephone (415) 965-1620. □

All About Modems

MANUFACTURER AND MODEL	Acrodyne VTC-1 & VTC-2	Anderson Jacobson ADAC 242	Anderson Jacobson ADC 300	Anderson Jacobson ADAC 1200	Anderson Jacobson TMU 330K
COMPATIBLE BELL SYSTEM MODEM	103A	103A	103A	202C/202D	103A
COMMUNICATIONS FACILITY	Voice band	Voice band	Voice band	Voice band	Voice band
TRANSMISSION CHARACTERISTICS					
Data rate, bits/second	Up to 300	Up to 300	Up to 300	Up to 1200	Up to 150
Modulation	FSK	FSK	FSK	FSK	FSK
Line conditioning	None	None	None	None	None
Synchronization	Asynchronous	Asynchronous	Asynchronous	Asynchronous	Asynchronous
Data format	Serial	Serial	Serial	Serial	Serial
Transmission mode	Half/full duplex	Half/full duplex	Half/full duplex	Simplex/half duplex	Half/full duplex
Calling mode	See Comments	Originate only	Originate/answer	–	Originate/answer
TERMINAL INTERFACE	RS 232B/C or contact	RS 232B and teletype	RS 232B and Teletype	RS 232B	Teletype
LINE INTERFACE	Acoustic	Acoustic/wired	Acoustic	Acoustic/wired	Two/four wire
FEATURES					
Reverse channel	No	No	No	No	No
Alternate voice/data	No	No	No	No	No
Integral handset	No	No	No	No	No
Automatic answer	Optional	No	No	No	No
Equalization	None	None	None	None	None
DIAGNOSTIC FACILITIES	None	None	None	None	None
PRICE					
Rental, $/month	7.50 (VTC-1) 15 (VTC-2)	–	–	–	–
Purchase, $	325,625	345	475	985 (1200), 785 (1210)	565
Installation, $	20	–	–	–	–
AVAILABILITY					
Date of first installation	–	1970	1968	1969	1971
Number installed to date	1500	Over 1000	–	–	–
Current lead time on orders	3 days	Immediate	Immediate	Immediate	Immediate
COMMENTS	VTC-1 is originate-only; VTC-2 is originate/answer. Two-wire line interface available	–	–	–	Mounted in Teleprinter

MANUFACTURER AND MODEL	Anderson Jacobson DCM 151	Anderson Jacobson DCM 153	Anderson Jacobson L142 and L145	Anderson Jacobson L150/12 Series	Anderson Jacobson MU 290/12 Series
COMPATIBLE BELL SYSTEM MODEM	None	None	103F	None	103A/E
COMMUNICATIONS FACILITY	Voice band	Voice band	Voice band	Voice band	Voice band
TRANSMISSION CHARACTERISTICS					
Data rate, bits/second	Up to 150	Up to 300	Up to 300	Up to 150 or 600	Up to 450
Modulation	FSK	FSK	FSK	FSK	FSK
Line conditioning	None	None	None	None	None
Synchronization	Asynchronous	Asynchronous	Asynchronous	Asynchronous	Asynchronous
Data format	Serial	Serial	Serial	Serial	Serial
Transmission mode	Half/full duplex	Half/full duplex	Half/full duplex	Half/full duplex	Full duplex
Calling mode	Originate/answer	Originate/answer	Originate/answer	Originate/answer	Originate/answer
TERMINAL INTERFACE	IBM interface	IBM interface	RS 232C	RS 232C	RS 232C
LINE INTERFACE	Two/four wire	Two/four wire	Two/four wire	Two/four wire	DAA
FEATURES					
Reverse channel	No	No	No	No	No
Alternate voice/data	No	No	No	No	No
Integral handset	No	No	No	No	No
Automatic answer	No	No	Yes, L145	No	Std.
Equalization	None	–	–	None	None
DIAGNOSTIC FACILITIES	None	–	–	Remote and local loop back	Remote and local loop back
PRICE					
Rental, $/month	–	–	–	8	9-12
Purchase, $	300	345	325	165-195	200-210
Installation, $	–	–	–	25	20-30
AVAILABILITY					
Date of first installation	1970	1970	1970	1972	1970
Number installed to date	–	–	–	–	–
Current lead time on orders	Immediate	Immediate	Immediate	45 days	45-60 days
COMMENTS	Uses coax or twisted pair for up to 4 miles. Compatible with IBM 4634/35	Compatible with IBM 4639/47 Leased Line Adapter; for integral mount	L142 is an originate-only unit; L145 is an answer-only unit	Compatible with IBM Line Adapters; for multiple modem system	Plug-in modems for multiple modem system

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MANUFACTURER AND MODEL	Anderson Jacobson L184/12	Astrocom Series 130	Astrocom Series 120	Astrocom 320/324	Astrocom 548
COMPATIBLE BELL SYSTEM MODEM	103F	103	202	201A/201B	None
COMMUNICATIONS FACILITY	Voice band	Voice band	Voice band	Voice band	Voice band
TRANSMISSION CHARACTERISTICS					
Data rate, bits/second	Up to 450	Up to 300	Up to 1200, Up to 1800	2000 (320); 2400 (324)	4800
Modulation	FSK	FSK	FSK	PM	QAM
Line conditioning	None required	None required	C2 for 1800 bps	None required	None required
Synchronization	Asynchronous	Asynchronous	Asynchronous	Synchronous	Synchronous
Data format	Serial	Serial	Serial	Serial	Serial
Transmission mode	Half/full duplex	Full duplex	Simplex/half duplex	Simplex/half/full dup.	Simplex/half/full dup.
Calling mode	Answer only	See COMMENTS	Originate/answer	Originate/answer	Originate/answer
TERMINAL INTERFACE	RS 232C	RS 232B/C	RS 232B/C	RS 232B/C	RS 232B/C
LINE INTERFACE	Two wire	Two wire	Two/four wire	Two/four wire	Two/four wire
FEATURES					
Reverse channel	No	No	Yes	No	150 bps opt.
Alternate voice/date	No	No	No	No	No
Integral handset	No	No	No	No	No
Automatic answer	No	Yes	Yes	No	Opt.
Equalization	None	None	Fixed	Opt.	Automatic
DIAGNOSTIC FACILITIES	Remote and local loopback	Indicator lamps	Indicator lamps	Remote and local loopback and self test	Remote and local loopback; self test
PRICE					
Rental, $/month	9	12.50-18.50	12.50-22	50	–
Purchase, $	190	145-415	245-500	1,200	–
Installation, $	30	–	–	–	–
AVAILABILITY					
Date of first installation	–	February 1970	July 1970	October 1971	–
Number installed to date	–	400	350	50	–
Current lead time on orders	60-90 days	4 weeks	4 weeks	4 weeks	–
COMMENTS	Plug-in modem for multiple modem system	Calling modes available are answer only, originate only, or both	Desk or plug-in unit; up to 16 plug-in units per rack	–	For delivery in November 1973

MANUFACTURER AND MODEL	Astrocom SC200	Astrocom SC400	Automatic Electric AE 103A	Automatic Electric AE 103F	Badger Electronics DTS 2020
COMPATIBLE BELL SYSTEM MODEM	None	None	103A	103F	None
COMMUNICATIONS FACILITY	Twisted pair	Twisted pair	Voice band	Voice band	Twisted pair
TRANSMISSION CHARACTERISTICS					
Data rate, bits/second	2000 to 9600	10K to 100K	Up to 300	Up to 300	2400/4800/9600/ 19,200
Modulation	PM	PM	FSK	FSK	PM
Line conditioning	–	–	None	None	None
Synchronization	Synchronous	Synchronous	Asynchronous	Asynchronous	Synchronous
Data format	Serial	Serial	Serial	Serial	Serial
Transmission mode	Simplex/half/full dup.	Simplex/half/full dup.	Half/full duplex	Half/full duplex	Half/full duplex
Calling mode	Originate/answer	Originate/answer	Originate/answer	Originate/answer	Originate/answer
TERMINAL INTERFACE	RS 232B/C	RS 232B/C	RS 232B/C	RS 232B/C	RS 232C
LINE INTERFACE	Two/four wire	Two/four wire	Two wire	Two wire	Two/four wire
FEATURES					
Reverse channel	No	No	No	No	No
Alternate voice/data	No	No	Yes	No	No
Integral handset	No	No	No	No	No
Automatic answer	No	No	Yes	No	No
Equalization	None	None	None	None	None
DIAGNOSTIC FACILITIES	Remote loopback and self test	None	None	None	None
PRICE					
Rental, $/month	40-65	85	–		–
Purchase, $	920-1,525	1,825	580	535	875
Installation, $	–	–	–	–	–
AVAILABILITY					
Date of first installation	April 1969	May 1969	1967	1967	–
Number installed to date	550	75	1500	600	–
Current lead time on orders	4 weeks	4 weeks	7-14 days	7-14 days	–
COMMENTS	Private line use up to 3.5 to 7 miles	Private line use up to 2 to 5 miles	Available on an "as returned" basis only	Available on an "as returned" basis only	Using 22 gauge twisted pair; range is 3 miles (19,200 bps)

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MANUFACTURER AND MODEL	Bell System Data Set 103A	Bell System Data Set 103E	Bell System Data Set 103F	Bell System Data Set 113A	Bell System Data Set 113B
COMPATIBLE BELL SYSTEM MODEM	101/103/113/401H	101/103/113/401H	103F	101/103/113B	101/103/113A
COMMUNICATIONS FACILITY	Voice band	Voice band	Voice band	Voice band	Voice band
TRANSMISSION CHARACTERISTICS					
Data rate, bits/second	Up to 300	Up to 300	Up to 300	Up to 300	Up to 300
Modulation	FSK	FSK	FSK	FSK	FSK
Line conditioning	None required	None required	None required	None required	None required
Synchronization	Asynchronous	Asynchronous	Asynchronous	Asynchronous	Asynchronous
Data format	Serial	Serial	Serial	Serial	Serial
Transmission mode	Half/full duplex	Half/full duplex	Half/full duplex	Half/full duplex	Half/full duplex
Calling mode	Originate/answer	Originate/answer	Originate/answer	Originate only	Answer only
TERMINAL INTERFACE	RS 232C	RS 232C	RS 232C	RS 232C	RS 232C
LINE INTERFACE	Two wire	Two wire	Two wire	Two wire	Two wire
FEATURES					
Reverse channel	No	No	No	No	No
Alternate voice/data	With 804B	With 804J	No	Yes	Yes
Integral handset	With 804B	With 804J	No	Yes	Yes
Automatic answer	Yes	Yes	Yes	No	No
Equalization	Fixed	Fixed	Fixed	Fixed	Fixed
DIAGNOSTIC FACILITIES	None	None	None	None	None
PRICE					
Rental, $/month	25 (Dataphone) 20 (private line)	21 plus 75 (cabinet)	20 (private line)	10 (Dataphone)	10.50 (Dataphone)
Purchase, $	—	—	—	—	—
Installation, $	—	—	—	—	—
AVAILABILITY					
Date of first installation	—	—	—	—	
Number installed to date	—	—	—	—	
Current lead time on orders	—		—	—	—
COMMENTS	Models 103A1 and 103A2 are not compatible—A1 has inverted transmission; A2, upright	Mounting and control for up to 40 data sets			Cabinet for containing up to 20 data sets rents for $35 per month

MANUFACTURER AND MODEL	Bell System Data Set 201A	Bell System Data Set 201B	Bell System Data Set 201C	Bell System Data Set 202C	Bell System Data Set 202D
COMPATIBLE BELL SYSTEM MODEM	201A	201B/201C	201B/201C	202A/202C/202D/202E/202R	202A/202C/202D/202E
COMMUNICATIONS FACILITY	Voice band	Voice band	Voice band	Voice band	Voice band
TRANSMISSION CHARACTERISTICS					
Data rate bits/second	2000	2400	2400	Up to 1200 (switched., Up to 1800 (private)	Up to 1800
Modulation	PM, 4-phase	PM, 4-phase	PM, 4-phase	FSK	FSK
Line conditioning	None required	C2	None required	C1 at 1400, C2 at 1800	C1 at 1400, C2 at 1800
Synchronization	Synchronous	Synchronous	Synchronous	Asynchronous	Asynchronous
Data format	Serial	Serial	Serial	Serial	Serial
Transmission mode	Half/full duplex	Half/full duplex	Half/full duplex	Half/full duplex	Half/full duplex
Calling mode	Originate/answer	Originate/answer	Originate/answer	Originate/answer	Originate/answer
TERMINAL INTERFACE	RS 232C or contact closure	RS 232C or contact closure	RS 232C	RS 232C	RS 232C or contact closure
LINE INTERFACE	Two/four wire	Two/four wire	Two/four wire	Two/four wire	Two/four wire
FEATURES					
Reverse channel	No	No	No	Optional	Optional
Alternate voice/data	With 804	With 804	No	Yes	With 804A
Integral handset	With 804	With 804	No	Yes	With 804A
Automatic answer	Yes	Yes	Yes	Yes	Yes
Equalization	Fixed	Fixed	Fixed	Fixed	Fixed
DIAGNOSTIC FACILITIES	None	None	Remote and local loopback	None	None
PRICE					
Rental, $/month	70 (Dataphone) 55 (private line)	55 (private line)	70 (Dataphone) 55 (private line)	35 (Dataphone) 30 (private line)	40 (Dataphone) 30 (private line)
Purchase, $	—	—	—		—
Installation, $	—	—			—
AVAILABILITY					
Date of first installation	—	—			
Number installed to date	—	—			—
Current lead time on orders	—		—		
COMMENTS					

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MANUFACTURER AND MODEL	Bell System Data Set 202E	Bell System Data Set 202R	Bell System Data Set 203A-B-C	Bell System Data Set 208A	Bell System Data Set 208B
COMPATIBLE BELL SYSTEM MODEM	202A/202C/202D	202A/202C/202D/ 202E/202R	203	208A	208A
COMMUNICATIONS FACILITY	Voice band	Voice band	Voice band	Voice band	Voice band
TRANSMISSION CHARACTERISTICS					
Data rate, bits/second	Up to 1800	Up to 1800	2400/4800/7200 or 1800/3600/5400	4800	4800
Modulation	FSK	FSK	--	PM, 8-phase	PM, 8-phase
Line conditioning	C1 at 1400, C2 at 1800	C1 at 1400, C2 at 1800	C2	None required	None required
Synchronization	Asynchronous	Asynchronous	Synchronous	Synchronous	Synchronous
Data format	Serial	Serial	Serial	Serial	Serial
Transmission mode	Half duplex	Half/full duplex	Simplex/half/full duplex	Half/full duplex	Half duplex
Calling mode	Originate/answer	Originate/answer	Originate/answer	Originate/answer	Originate/answer
TERMINAL INTERFACE	RS 232C	RS 232C	RS 232C	RS 232C	RS 232C
LINE INTERFACE	Two wire	Two/four wire	Two/four wire	Four wire	Two wire
FEATURES					
Reverse channel	Yes	No	Yes	No	No
Alternate voice/data	Yes	Yes	With 804	No	No
Integral handset	Yes	No	With 804	No	No
Automatic answer	Yes	No	Yes	No	Yes
Equalization	Fixed	Fixed	Automatic	Automatic	Automatic
DIAGNOSTIC FACILITIES	None	None	None	Remote and local loopback	Remote and local loopback
PRICE					
Rental, $/month	14 (Dataphone) 14 (private)	20 (Dataphone) 18 (private)	85-210	125 (private)	150 (Dataphone)
Purchase, $	-	--	--	--	-
Installation, $		-	-	--	
AVAILABILITY					
Date of first installation			--		
Number installed to date					
Current lead time on orders					
COMMENTS			Three models provide transmit/receive (A), transmit only (B), and receive-only (C)	For use on private line	For use on DDD

MANUFACTURER AND MODEL	Bell System Data Set 303B	Bell System Data Set 303C	Bell System Data Set 303D	Bell System Data Set 401A	Bell System Data Set 401E
COMPATIBLE BELL SYSTEM MODEM	303B	303C	303D	401J/403D/403E	401J/403D/403E
COMMUNICATIONS FACILITY	Wide band	Wide band	Wide band	Voice band	Voice band
TRANSMISSION CHARACTERISTICS					
Data rate, bits/second	19,200 (6 voice-band lines)	50,000 (12 voice-band lines)	230,400 (60 voice-band lines)	Up to 20 char/sec	Up to 20 char/sec
Modulation	AM, VSB	Restored polar	Restored polar	FSK	FSK
Line conditioning		-		None required	None required
Synchronization	Synchronous	Synchronous	Synchronous	Asynchronous	Asynchronous
Data format	Serial	Serial	Serial	Parallel	Parallel
Transmission mode	Half/full duplex	Half/full duplex	Half/full duplex	Simplex, send only	Simplex, send only
Calling mode	Originate/answer	Originate/answer	Originate/answer	Originate only	Originate only
TERMINAL INTERFACE	RS 232C	RS 232C	RS 232C	Contact closure	Contact closure
LINE INTERFACE	Four wire	Four wire	Four wire	Two wire	Two wire
FEATURES					
Reverse channel	With 404B1	With 404B1	With 404B1	No	No
Alternate voice/data	With 804A	With 804A	With 804A	Yes	Yes
Integral handset	With 804A	With 804A	With 804A	Yes	Yes
Automatic answer	Yes	Yes	Yes	No	No
Equalization	Fixed	Fixed	Fixed	Fixed	Fixed
DIAGNOSTIC FACILITIES	None	None	None	None	None
PRICE					
Rental $/month	425 (private)	425 (private) 275 (Dataphone)	650 (private)	5 (Dataphone) 4.50 (private line)	7 (Dataphone) 7 (private)
Purchase, $		--		-	
Installation, $		--			
AVAILABILITY					
Date of first installation					
Number installed to date		--			
Current lead time on orders					
COMMENTS	Part of wide-band service terminal	Part of wide-band service terminal	Part of wide-band service terminal	Uses restricted 2 of 8 code to transmit 12 discrete code combinations	Uses restricted 3-of-14 code to transmit 99 discrete code combinations

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MANUFACTURER AND MODEL	Bell System Data Set 401J/L	Bell System Data Set 402C	Bell System Data Set 402D	Bell System Data Set 403D	Bell System Data Set 403E
COMPATIBLE BELL SYSTEM MODEM	401A/401E/401H/401L	402D	402C	401A/401E/401H/401L	401A/401E/401H/401L
COMMUNICATIONS FACILITY	Voice band	Voice band	Voice band	Voice band	Voice band
TRANSMISSION CHARACTERISTICS					
Data rate, bits/second	Up to 20 char/sec	Up to 75 char/sec	Up to 75 char/sec	Up to 10 char/sec	Up to 10 char/sec
Modulation	FSK	FSK	FSK	FSK	FSK
Line conditioning	None required	C1	C1	None required	None required
Synchronization	Asynchronous	Asynchronous	Asynchronous	Asynchronous	Asynchronous
Data format	Parallel	Parallel	Parallel	Parallel	--
Transmission mode	Simplex, receive-only	Simplex, send-only	Simplex, receive-only	Simplex, receive-only	Simplex, receive-only
Calling mode	Answer only	Originate only	Answer only	Answer only	Answer only
TERMINAL INTERFACE	Contact closure	Contact closure	Contact closure	RS 232C or contact closure	RS 232C or contact closure
LINE INTERFACE	Two wire	Two/four wire	Two/four wire	Two wire	Two wire
FEATURES					
Reverse channel	No	Optional	Optional	No	No
Alternate voice/data	401J only	Yes	With 804A	With 804K	Yes
Integral handset	401J only	Yes	With 804A	With 804K	Yes
Automatic answer	401J only	Optional	Optional	Yes	Yes
Equalization	Fixed	Fixed	Fixed	Fixed	Fixed
DIAGNOSTIC FACILITIES	None	None	None	None	None
PRICE					
Rental, $/month	40 (401J) 20 (401L)	20 (Dataphone) 24 (private line)	60 (Dataphone) 53 (private line)	37 plus 75 (cabinet)	53 (Dataphone)
Purchase, $	–	–	–	–	–
Installation, $	–	–	–	–	–
AVAILABILITY					
Date of first installation	–	–	–	–	–
Number installed to date	–	–	–	–	–
Current lead time on orders	–	–	–	–	–
COMMENTS	Uses restricted 3-of-14 code to receive 99 discrete code combinations	Can use any 8-level code	Can use any 8-level code	Can have any of 3 interfaces: contact, RS 232 with BCD coding, and RS 232 with ASCII coding	Can have any of 3 interfaces: contact, RS 232 with BCD coding, and RS 232 with ASCII coding

MANUFACTURER AND MODEL	Burroughs TA 734-24	Burroughs TA 714	Burroughs TA 713	Burroughs TA 783	Burroughs TA 733-48
COMPATIBLE BELL SYSTEM MODEM	201B	202C	202D	202D	None
COMMUNICATIONS FACILITY	Voice band	Voice-band	Voice band	Voice band	Voice band
TRANSMISSION CHARACTERISTICS					
Data rate, bits/second	1200/2400	Up to 1200 (DDD) or 1800 (leased)	Up to 1200	Up to 1800	4800
Modulation	PSK, 4-phase	FSK	FSK	FSK	PSK, 8-phase
Line conditioning	None required	None required	None required	None required	C1
Synchronization	Synchronous	Asynchronous	Asynchronous	Asynchronous	Synchronous
Data format	Serial	Serial	Serial	Serial	Serial
Transmission mode	Half/full duplex	Half/full duplex	Half/full duplex	Half/full duplex	Half/full duplex
Calling mode	Originate/answer	Originate/answer	Originate/answer	Originate/answer	Originate/answer
TERMINAL INTERFACE	RS 232C or CCITT	RS 232C	RS 232C	RS 232C	RS 232C or CCITT
LINE INTERFACE	Two/four wire	Two/four wire	Four wire	Four wire	Four wire
FEATURES					
Reverse channel	No	No	No	No	No
Alternate voice/data	No	No	No	No	No
Integral handset	No	Std.	No	No	No
Automatic answer	No	Fixed	No	No	No
Equalization	–	–	–	–	–
DIAGNOSTIC FACILITIES	–	Remote and local loopback	–	–	–
PRICE					
Rental, $/month	85	30	20	22	195
Purchase, $	2,990	990	447-590	890	5,990
Installation, $	30	30	30	30	30
AVAILABILITY					
Date of first installation	April 1972	1971	–	–	April 1972
Number installed to date	–	–	–	–	–
Current lead time on orders	Immediate	Immediate	Immediate	Immediate	Immediate
COMMENTS	–	Auto call optional; equivalent to TA 214 used with TC Series terminals	Equivalent models TA 211/TA 212 are used with Burroughs TC 500/TC 700 terminals	Equivalent models TA 281/TA 282 are used with Burroughs TC 500/TC 700 terminals	–

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MANUFACTURER AND MODEL	Carterfone DS 103A	Carterfone 403D	Coherent DAM-1 and TYM-1	Coherent DAM-4	Coherent DAM-5
COMPATIBLE BELL SYSTEM MODEM	103A, 103C	403D	None	None	202C
COMMUNICATIONS FACILITY	Voice band	Voice band	Voice band	Voice band	Voice band
TRANSMISSION CHARACTERISTICS					
Data rate, bits/second	Up to 440	Up to 10 char/sec.	Up to 600 (DAM-1) Up to 150 (TYM-1)	Up to 600 or 1200	Up to 1800
Modulation	FSK	FSK	FSK	FSK	FSK
Line conditioning	None required	None required	None required	None required	None required
Synchronization	Asynchronous	Asynchronous	Asynchronous	Asynchronous	Asynchronous
Data format	Serial	Parallel	Serial	Serial	Serial
Transmission mode	Full duplex	Full duplex	Simplex/half/full duplex	Half/full duplex	Simplex/half/full duplex
Calling mode	Originate/answer	Answer only	Originate/answer	Originate/answer	Originate/answer
TERMINAL INTERFACE	RS 232B/C; Teletype	2 out of 8 parallel	RS 232C, CCITT, MIL 188B, or contact	CCITT	RS 232C, CCITT, or MIL 188B
LINE INTERFACE	Two/four wire		Two/four wire	Two/four wire	Two/four wire
FEATURES					
Reverse channel	Optional	No	Yes	Opt. up to 75 bps	Yes
Alternate voice/data	Std.	No	Yes	Yes	Yes
Integral handset	Std.	No	No	No	No
Automatic answer	Std.	Std.	No	No	No
Equalization	None	None	None	None	None
DIAGNOSTIC FACILITIES	Remote loopback	Busy out	None	Local and remote loopback	None
PRICE					
Rental, $/month	–	–	–	–	–
Purchase, $	365	710; 1080 (cabinet)	525-600	500	325-375
Installation, $	35	–	–	–	–
AVAILABILITY					
Date of first installation	April 1971	February 1971	September 1970	–	June 1971
Number installed to date	1,000	33	250	–	100
Current lead time on orders	45-60 days	90-120 days	45 days	45 days	30 days
COMMENTS	Unattended operation	Plug-in modem card; up to 12 modems/cabinet	Multiplexer option provides up to 18 or 36 channels on a single two or four wire line	For use on switched telephone networks	–

MANUFACTURER AND MODEL	Codex 4800	Codex 7200	Codex 9600	Codex 4800 Dial	Codex 4800 MP
COMPATIBLE BELL SYSTEM MODEM	None	None	None	None	None
COMMUNICATIONS FACILITY	Voice band	Voice band	Voice band	Voice band	Voice band
TRANSMISSION CHARACTERISTICS					
Data rate, bits/second	4800/3200	7200/4800	9600/7200/4800	4800	4300
Modulation	QAM	QAM	QAM	QAM	QAM
Line conditioning	Not required	C2	C2	None required	C1
Synchronization	Synchronous	Synchronous	Synchronous	Synchronous	Synchronous
Data format	Serial	Serial	Serial	Serial	Serial
Transmission mode	Simplex/half/full duplex	Half/full duplex	Half/full duplex	Half duplex	Full duplex
Calling mode	Originate/answer	Originate/answer	Originate/answer	Originate/answer	Originate/answer
TERMINAL INTERFACE	RS 232C or CCITT	RS 232C, CCITT, or MIL 188C	RS 232C, CCITT, or MIL 188C	RS 232C, CCITT	RS 232C, CCITT
LINE INTERFACE	Two/four wire	Four wire	Four wire	Two wire	Four wire
FEATURES					
Reverse channel	Optional up to 150 bps	No	No	Optional	Optional
Alternate voice/data	Optional	Optional	Optional	Optional	Optional
Integral handset	No	No	No	No	No
Automatic answer	No	No	No	Standard	No
Equalization	Automatic	Automatic	Automatic	Automatic	Automatic
DIAGNOSTIC FACILITIES	Local and remote loopback	Local and remote loopback	Local and remote loopback	Local and remote loopback	Local and remote loopback
PRICE					
Rental, $/month	120	185	265	150	120
Purchase, $	4,800	7,200	9,750	5,575	4,800
Installation, $	100	100	100	100	100
AVAILABILITY					
Date of first installation	January 1971	April 1971	October 1971	November 1972	April 1972
Number installed to date	500	200	500	Over 100	Over 100
Current lead time on orders	30 days	45 days	45 days	45 days	45 days
COMMENTS	Multiplexor option provides up to four channels using any combination of 1200 and 2400 bps rates	Multiplexer option provides up to three channels that combine rates of 2400 and 4800 bps	Multiplexer option provides up to four channels that combine rates of 2400, 4800, and 7200 bps	For use on dial (DDD) network	For use on multipoint line

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MANUFACTURER AND MODEL	Collins FDM	Collins TE-1200	Collins TE-236	Collins TE-216A	ComData 150 Series
COMPATIBLE BELL SYSTEM MODEM	None	202D	201B	None	103, 113
COMMUNICATIONS FACILITY	Narrow band	Voice band	Voice band	Voice band	Voice band
TRANSMISSION CHARACTERISTICS					
Data rate, bits/second	75/110/150/300/600	Up to 1800	2400	4800/2400, 3600/ 2400, or 2400/1200	Up to 300
Modulation	FSK	FSK	PM, 4-phase	Combined PM/AM (Collins Kineplex)	FSK
Line conditioning	None required	None required	None required	See COMMENTS	None required
Synchronization	Asynchronous	Asynchronous	Synchronous	Synchronous	Asynchronous
Data format	Serial	Serial	Serial	Serial	Serial
Transmission mode	Half/full duplex	Half/full duplex	Half/full duplex	Full duplex	Full duplex
Calling mode	–	Originate/answer	Originate/answer	Originate/answer	Originate only
TERMINAL INTERFACE	RS 232C	RS 232C	RS 232C or CCITT	RS 232B/C, MIL 188B, or CCITT	RS 232C, CCITT, or MIL 188B
LINE INTERFACE	Two/four wire	Two/four wire	Two/four wire	Four wire	Acoustic and/or hardwire
FEATURES					
Reverse channel	No	Optional	No	No	No
Alternate voice/data	No	Optional	Optional	Optional	No
Integral handset	No	No	No	Optional	No
Automatic answer	No	Optional	Optional	No	No
Equalization	None	None	None	Fixed	None
DIAGNOSTIC FACILITIES	None	None	Local loopback	Remote and local loopback	None
PRICE					
Rental, $/month	–	–	–	185	–
Purchase, $	505	470	1,350	5,200	125 to 175
Installation, $	–	–	–	225	–
AVAILABILITY					
Date of first installation	May 1973	March 1973	June 1971	1968	January 1972
Number installed to date	500	300	600	700	–
Current lead time on orders	30 days	30 days	30 days	30 days	Immediate
COMMENTS	–	–	Desk unit or PC card	2400 bps (C1); 3600 bps (C2); 4800 bps (C4). Lower, switch-selected data rates optional	Complete unit, TTY 33 mount, or PC card

MANUFACTURER AND MODEL	ComData 302 Series	ComData 330 Series	ComData 201	ComData 202	ComData DTS 2020
COMPATIBLE BELL SYSTEM MODEM	103, 113	103, 113	201	–	None
COMMUNICATIONS FACILITY	Voice band	Voice band	Voice band	Voice band	Twisted pair
TRANSMISSION CHARACTERISTICS					
Data rate, bits/second	Up to 300	Up to 300	Up to 1800	2000 or 2400	2400/4800/9600/19.2K
Modulation	FSK	FSK	FSK	PM	–
Line conditioning	None required	None required	None required	C2 at 2400	–
Synchronization	Asynchronous	Asynchronous	Asynchronous	Synchronous	Synchronous
Data format	Serial	Serial	Serial	Serial	Serial
Transmission mode	Full duplex	Full duplex	Half/full duplex	Half/full duplex	Half/full duplex
Calling mode	See COMMENTS	Originate/answer	Originate/answer	Originate/answer	
TERMINAL INTERFACE	RS 232C, CCITT, MIL 188B, or contact	RS 232C, CCITT, Teletype, MIL 188B	RS 232C	RS 232C	RS 232C
LINE INTERFACE	See COMMENTS	Two wire or DAA	Two/four wire	Two/four wire	Two/four wire
FEATURES					
Reverse channel	No	No	Optional	No	No
Alternate voice/data	No	No	Optional	Optional	No
Integral handset	No	No	No	No	No
Automatic answer	On some models	Standard	Optional	Optional	No
Equalization	None	None	Manual	Manual	None
DIAGNOSTIC FACILITIES	Local loopback	Local loopback	Local loopback	Local loopback	Local loopback
PRICE					
Rental, $/month	–	5-5.50	–		–
Purchase, $	245-325	150-170	425	1000	875
Installation, $	–	–	–	–	–
AVAILABILITY					
Date of first installation	November 1968	November 1971	June 1969	June 1969	June 1971
Number installed to date	–	–	–	–	–
Current lead time on orders	Immediate	Immediate	Immediate	Immediate	Immediate
COMMENTS	Available with originate and/or answer modes and acoustic and/or 2/4 wire interface	Up to 16 plug-in modems per cabinet	–	–	Limited distance, up to 3 miles

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MANUFACTURER AND MODEL	Computer Transmission Intertran 911 and Optran 1811	Computer Transmission Intertran 915 and Optran 1815	Computer Transmission Intertran 916 and Optran 1816	Computer Transmission Optran 1817	Computer Transmission Data Set Master Model 900
COMPATIBLE BELL SYSTEM MODEM	None	None	None	None	None
COMMUNICATIONS FACILITY	Twisted pair (911) infrared light beam (1811)	Twisted pair (915) infrared light beam (1815)	Twisted pair (916) infrared light beam (1816)	Infrared light beam	Twisted pair or infrared light beam
TRANSMISSION CHARACTERISTICS					
Data rate, bits/second	2400/4800/9600 or up to 1800	Up to 20,000	20,000-250,000	Up to 250,000	See COMMENTS
Modulation	PCM	PCM	PCM	PCM	Baseband
Line conditioning	–	–	–	–	–
Synchronization	Synchronous/asynch.	Synchronous	Synchronous	Synchronous	Synchronous
Data format	Serial	Serial	Serial	Serial	Serial
Transmission mode	Half/full duplex	Half/full duplex	Half/full duplex	Half/full duplex	Half/full duplex
Calling mode	Originate/answer	Originate/answer	Originate/answer	Originate/answer	Originate/answer
TERMINAL INTERFACE	RS 232C	RS 232C	Low impedance current switching	Low-impedance current switching	Low-impedance current switching
LINE INTERFACE	Four wire	Four wire	Four wire	Four wire	Four wire
FEATURES					
Reverse channel	No	No	No	No	No
Alternate voice/data	No	No	No	No	No
Integral handset	No	No	No	No	No
Automatic answer	No	No	No	No	No
Equalization	None	None	None	None	None
DIAGNOSTIC FACILITIES	Remote and local loopback	Remote and local loopback	Remote and local loopback	Remote and local loopback	None
PRICE					
Rental, $/month	162 (1811)	162 (1815)	182 (1816)	204	72
Purchase, $	1,400 (911); 2,950 (1811)	1,400 (915); 2,950 (1815)	1,650 (916); 3,300 (1816)	3,700	1,300
Installation, $	100 (911); 150 (1811)	100 (915); 150 (1815)	150 (916); 150 (1816)	200	50
AVAILABILITY					
Date of first installation	1970	1970	1970	–	–
Number installed to date	300 (911)	100 (915)	100 (916)	–	–
Current lead time on orders	30 days	30 days	30 days	30 days	30 days
COMMENTS	Switched synch. data rates to 9600 bps; asynch. rates to 1800 bps. Max. range is 10 miles over twisted pair, one mile over light beam	Maximum range is seven miles at 20,000 bps over twisted pair, one mile over light beam	Maximum range is two miles at 250,000 bps over twisted pair, one mile over light beam	Maximum range is one mile	Accommodates any combination of up to 9 PC-card equivalents of Optran and Intertran modems—all models

MANUFACTURER AND MODEL	Computer Transmission Directran 611	Computer Transmission Directran 631	Computer Transmission Data Set Master Model 901	Data Access Systems DAS DH100	Data Serv 1340
COMPATIBLE BELL SYSTEM MODEM	None	None	None	103A	103A
COMMUNICATIONS FACILITY	Twisted pair	Twisted pair	Twisted pair	Voice band	Voice band
TRANSMISSION CHARACTERISTICS					
Data rate, bits/second	Up to 2400	Up to 2400	Up to 2400	Up to 300	Up to 300
Modulation	Baseband	Baseband	Baseband	FSK	FSK
Line conditioning	–	–	–	None required	None required
Synchronization	Asynchronous	Asynchronous	Asynchronous	Asynchronous	Asynchronous
Data format	Serial	Serial	Serial	Serial	Serial
Transmission mode	Half/full duplex	Half/full duplex	Half/full duplex	Half/full duplex	Half/full duplex
Calling mode	Originate/answer	Originate/answer	Originate/answer	Originate/answer	Originate/answer
TERMINAL INTERFACE	RS 232C	RS 232C	RS 232C	Contact closure	RS 232C
LINE INTERFACE	Four wire	Four wire	Four wire	Two/four wire	Two wire
FEATURES					
Reverse channel	No	No	No	No	No
Alternate voice/data	No	No	No	No	No
Integral handset	No	No	No	No	No
Automatic answer	No	No	No	No	Yes
Equalization	None	None	None	None	Automatic
DIAGNOSTIC FACILITIES	Remote and local loopback	Remote and local loopback	Remote and local loopback	None	Local loopback
PRICE					
Rental, $/month	16	20	38	25 (1-yr. lease)	25
Purchase, $	300	370	700	295	575
Installation, $	30	40	50	35	–
AVAILABILITY					
Date of first installation	1972	1972	1972	1969	February 1971
Number installed to date	200	200	20	Over 500	–
Current lead time on orders	30 days	30 days	30 days	3-5 weeks	10 days
COMMENTS	Max. range is 30 miles at 1200 bps over #22 pair	Max. range is 30 miles at 1200 bps over #22 pair	Accommodates up to 9 Directran 631 plug-in modems		MOS construction; desk-top unit

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MANUFACTURER AND MODEL	Datapoint 2200-401	Datapoint 2200-402	Data Products/ Telecommunications DataPak	Data Products/ Telecommunications 703AC	Design Elements Design Models 76, 88, 101, and 103
COMPATIBLE BELL SYSTEM MODEM	103A	202C	None	103A	103A/113A
COMMUNICATIONS FACILITY	Voice band	Voice band	Voice band	Voice band	Voice band
TRANSMISSION CHARACTERISTICS					
Data rate, bits/second	Up to 300	Up to 1800	75/150/300/600/1200/ 1800	Up to 300	Up to 300
Modulation	FSK	FSK	FSK	FSK	FSK
Line conditioning	None	C2 at 1800	None required	None required	None required
Synchronization	Asynchronous	Asynchronous	Asynchronous/synch.	Asynchronous	Asynchronous
Data format	Serial	Serial	Serial	Serial	Serial
Transmission mode	Full duplex	Half Duplex	Simplex/half/full duplex	Half/full duplex	Half/full duplex
Calling mode	Originate/answer	Originate/answer	Originate/answer	Originate/answer	See COMMENTS
TERMINAL INTERFACE	RS 232B	RS 232B	RS 232C, CCITT, MIL 188B, Teletype	RS 232C	RS 232B/C or Teletype
LINE INTERFACE	Two wire	Two/four wire	Two/four wire	Acoustic	See COMMENTS
FEATURES					
Reverse channel	No	Yes, 150 bps	No	No	No
Alternate voice/data	No	No	No	No	On some models
Integral handset	No	No	No	No	On some models
Automatic answer	Yes	Yes	No	No	On most models
Equalization	None	None	None	None	None
DIAGNOSTIC FACILITIES	None	None	None	None	Remote loopback on 101 and 103
PRICE					
Rental, $/month	45	45	–	–	–
Purchase, $	1500	1500	350/channel end	380	295-750
Installation, $	15	15	–	–	–
AVAILABILITY					
Date of first installation	March 1971	March 1971	August 1970	January 1970	1970
Number installed to date	125	50	Over 2000	Over 200	–
Current lead time on orders	4-6 weeks	4-6 weeks	30 days	30 days	2-3 weeks
COMMENTS	Used with Datapoint 2200 Terminal	Used with Datapoint 2200 Terminal; has auto dial feature	Can combine several low-speed channels on a leased or private line where combined speeds do not exceed 1800 bps	–	Models provide acoustic, acoustic/inductive, or two-wire interface and provide all combinations of originate and answer modes

MANUFACTURER AND MODEL	Digital Techniques Series 2000, 3000, and 4000	ESE Limited 48/QM	General Datacomm 103 Series	General Datacomm 201 Series	General Datacomm 202 Series
COMPATIBLE BELL SYSTEM MODEM	103	None	103A/103F/113A/113B	201A/201B	202C/202D/202E
COMMUNICATIONS FACILITY	Voice band	Voice band	Voice band	Voice band	Voice band
TRANSMISSION CHARACTERISTICS					
Data rate, bits/second	Up to 300	2400/4800	Up to 300	2000 (DDD); 2400 (leased)	Up to 1200 or Up to 1800
Modulation	FSK	QAM	FSK	PM	FSK
Line conditioning	None	C2 at 4800 bps	None required	C2	–
Synchronization	Asynchronous	Synchronous	Asynchronous	Synchronous	Asynchronous
Data format	Serial	Serial	Serial	Serial	Serial
Transmission mode	Half/full duplex	Simplex/half/full duplex	Half/full duplex	Half/full duplex	Half/full duplex
Calling mode	See COMMENTS	Originate/answer	See COMMENTS		See COMMENTS
TERMINAL INTERFACE	RS 232C or Teletype	RS 232C, MIL 188B, or CCITT	RS 232C, Teletype, or logic level	RS 232C	RS 232C
LINE INTERFACE	Wired or acoustic	Two/four wire	Two/four wire	Two/four wire	Two/four wire
FEATURES					
Reverse channel	No	Optional	No	No	Optional
Alternate voice/data	Model 4520A only	No	No	No	No
Integral handset	No	No	No	No	No
Automatic answer	Model 4520A only	No	On some models	Yes	No
Equalization	None	Automatic or manual	None	–	–
DIAGNOSTIC FACILITIES	None	Remote and local loopback	Remote loopback	Remote and local loopback	Remote loopback
PRICE					
Rental, $/month	–	–	–	–	–
Purchase, $	149;389	Price on request	215-440	–	365-420
Installation, $	25-60	–	–		–
AVAILABILITY					
Date of first installation	July 1968	May 1971	–	–	–
Number installed to date	6,500 (all models)	–	–	–	–
Current lead time on orders	Immediate	90 days	30 days	–	45 days
COMMENTS	Models provide originate only or originate and answer modes	The 48/QM features a family of interchange-able line equalizers	Available with different combinations of originate and answer modes	–	Available with originate-only or originate and answer modes

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MANUFACTURER AND MODEL	General Datacomm 402 Series	General Electric TDM-114	General Electric TDM-115	General Electric DigiNet 1103 Series	General Electric DigiNet 2201 Series
COMPATIBLE BELL SYSTEM MODEM	402D	103A	103A	103A, 103E, 103G, 113A, 113B	201B
COMMUNICATIONS FACILITY	Voice band	Voice band	Voice band	Voice band	Voice band
TRANSMISSION CHARACTERISTICS					
Data rate, bits/second	600 (75 char/sec)	Up to 300	Up to 300	Up to 300	2400
Modulation	FSK	FSK	FSK	FSK	PSK, 4-phase
Line conditioning	None required	None required	None required	None required	C2
Synchronization	Asynchronous	Asynchronous	Asynchronous	Asynchronous	Synchronous
Data format	Parallel	Serial	Serial	Serial	Serial
Transmission mode	Transmit only	Half/full duplex	Half/full duplex	Full duplex	Half/full duplex
Calling mode	Originate only	Originate only	Originate/answer	Originate/answer	Originate/answer
TERMINAL INTERFACE	Contact closure	RS 232C	RS 232C	RS 232C	RS 232C
LINE INTERFACE	Two/four wire	Acoustic	Acoustic	Two wire	Two/four wire
FEATURES					
Reverse channel	Optional	No	No	No	No
Alternate voice/data	No	No	No	No	No
Integral handset	No	No	No	No	No
Automatic answer	No	No	No	Yes	No
Equalization	—	—	—	—	—
DIAGNOSTIC FACILITIES	None	—	—	—	—
PRICE					
Rental, $/month	—	—	—	—	—
Purchase, $	485-540	410	510	Not established	Not established
Installation, $	—	—	—	—	—
AVAILABILITY					
Date of first installation	—	1969	1969	1971	1971
Number installed to date	—	—	—	—	—
Current lead time on orders	90 days	—	—	—	—
COMMENTS	—	—	—	Available in 6 or 16-channel configuration only	—

MANUFACTURER AND MODEL	General Electric DigiNet 160 Series	General Electric TDM-330	General Electric DigiNet 400	General Electric DigiNet 500	GTE Information Systems IS/2300
COMPATIBLE BELL SYSTEM MODEM	None	None	None	None	103/113
COMMUNICATIONS FACILITY	Voice band	Twisted pair	Twisted pair	Twisted pair	Voice band
TRANSMISSION CHARACTERISTICS					
Data rate, bits/second	Up to 110, 150, 300, or 600	2400/4800/9600	Up to 50,000	Up to 230,400	Up to 300
Modulation	FSK	PM, 2-phase	AM, VSB	AM, VSB	FSK
Line conditioning	None to C4	—	—	—	None required
Synchronization	Asynchronous	Synchronous	Asynchronous/synch.	Asynchronous/synch.	Asynchronous
Data format	Serial	Serial	Serial	Serial	Serial
Transmission mode	Full fuplex	Full duplex	Full duplex	Full duplex	Simplex half/full duplex
Calling mode	Originate/answer	Originate/answer	Originate/answer	Originate/answer	Originate/answer
TERMINAL INTERFACE	RS 232C	RS 232C	RS 232C	RS 232C	RS 232C and Teletype
LINE INTERFACE	Four wire	Four wire	Four wire	Four wire	Two/four wire/acoustic
FEATURES					
Reverse channel	No	No	No	No	No
Alternate voice/data	No	No	Optional	Optional	No
Integral handset	No	No	Optional	Optional	No
Automatic answer	No	No	No	No	No
Equalization	—	—	—	—	None
DIAGNOSTIC FACILITIES	—	—	—	—	Self test
PRICE					
Rental, $/month	—	—	—	—	Available on request
Purchase, $	Not established	925	3,100-4,850	3,100-4,850	325-350 (195/card)
Installation, $	—	—	—	—	—
AVAILABILITY					
Date of first installation	1971	1970	1968	1968	1969
Number installed to date	—	—	—	—	—
Current lead time on orders	—	—	—	—	Immediate
COMMENTS	Multiplexes up to 17 channels at different speeds onto a single leased or private line	Switch-selected data rates. Range is up to 5 miles using twisted pair	Operates in synchronous or asynchronous mode by switch selection	Operates in synchronous or asynchronous mode by switch selection	Desk unit or plug-in modems; up to 40 per cabinet

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MANUFACTURER AND MODEL	GTE Information Systems IS/2120	GTE Information Systems IS/2240	GTE Information Systems IS/2481	GTE Lenkurt 25C	GTE Lenkurt 25D
COMPATIBLE BELL SYSTEM MODEM	202C/202D	201B	None	None	None
COMMUNICATIONS FACILITY	Voice band	Voice band	Voice band	Voice band	Voice band
TRANSMISSION CHARACTERISTICS					
Data rate, bits/second	Up to 1200	2400	4800	Up to 600	Up to 200
Modulation	FSK	FSK	AM, SSB	FSK	FSK
Line conditioning	None required	None required	C2	C1, C2, or C4	C1, C2, or C4
Synchronization	Asynchronous	Synchronous	Synchronous	Asynchronous	Asynchronous
Data format	Serial	Serial	Serial	Serial	Serial
Transmission mode	Simplex/half/full duplex	Simplex/half/full duplex	Simplex/half/full duplex	Simplex/half/full duplex	Simplex/half/full duplex
Calling mode	Originate/answer	Originate/answer	Originate/answer	Originate/answer	Originate/answer
TERMINAL INTERFACE	RS 232B	RS 232B	RS 232B, MIL 188B, or CCITT	RS 232C	RS 232C
LINE INTERFACE	Two/four wire	Two/four wire	Two/four wire	Two/four wire	Two/four wire
FEATURES					
Reverse channel	No	No	No	No	No
Alternate voice/data	No	No	No	No	No
Integral handset	No	No	No	No	No
Automatic answer	No	Optional	No	No	No
Equalization	None	Fixed	Manual	None	None
DIAGNOSTIC FACILITIES	Remote and Local loopback	Remote and local loopback	Local loopback and test generator	VF and digital loopback	VF loopback
PRICE					
Rental, $/month	Available on request	Available on request	Available on request	Do not lease	Do not lease
Purchase, $	499	1,695-3,190	3,330	450/channel	550/channel
Installation, $	–	–	100	–	–
AVAILABILITY					
Date of first installation	1969	1969	1970	1971	1971
Number installed to date	–	–	Over 200	–	–
Current lead time on orders	Immediate	Immediate	Immediate	90-120 days	90-120 days
COMMENTS	–	–	–	Multi-channel operation: 25 channels at 75 bps, 18 at 110 bps, 12 at 150 bps, 7 at 200 bps, or one 600 bps channel	Multi-channel operation: 25 channels at 75 bps, 18 at 110 bps, 12 at 150 bps, or 7 at 200 bps

MANUFACTURER AND MODEL	GTE Lenkurt 26C	GTE Lenkurt 26C 40.8	GTE Lenkurt 26D	GTE Lenkurt 26U	Hughes Model HC-278
COMPATIBLE BELL SYSTEM MODEM	None	None	None	202C/202D	None
COMMUNICATIONS FACILITY	Voice band	Wide band	Voice band	Voice band	Voice band
TRANSMISSION CHARACTERISTICS					
Data rate, bits/second	Up to 1800 or 150/300/600/1200/2400	20,400/40,800	4800	Up to 1200	75/150/300/600/1200
Modulation	Duobinary FM	Duobinary FM	Modified Duobinary FM	FSK	PC-FSK
Line conditioning	None, C1, or C2	–	C2	None required	C1
Synchronization	Asynchronous/synch	Synchronous	Synchronous	Asynchronous	Synchronous
Data format	Serial	Serial	Serial	Serial	Serial
Transmission mode	Simplex/half/full duplex	Simplex/half/full duplex	Simplex/half/full duplex	Half/full duplex	Full duplex
Calling mode	Originate/answer	Originate/answer	Originiate/answer	Originate/answer	Originate/answer
TERMINAL INTERFACE	RS 232B or MIL 188B	Current switching	RS 232C, MIL 188B, or CCITT	RS 232C	MIL 188B
LINE INTERFACE	Two/four wire	Four wire	Two/four wire	Two/four wire	Four wire
FEATURES					
Reverse channel	Optional	No	Optional	No	No
Alternate voice/data	Optional	No	Optional	No	No
Integral handset	No	No	No	No	No
Automatic answer	No	No	No	No	No
Equalization	Manual	Manual	Manual	None	Fixed
DIAGNOSTIC FACILITIES	Remote and local loopback	VF loopback	VF and digital loopback	None	Line and self test
PRICE					
Rental, $/month	Do not lease	Do not lease	Do not lease	Do not lease	–
Purchase, $	1,700-2,200	1,750-2,000	2,700-3,300	499	–
Installation, $	–	–	–	–	–
AVAILABILITY					
Date of first installation	1965	1967	1969	1973	June 1969
Number installed to date	–	–	–	–	125
Current lead time on orders	90-120 days	90-120 days	90-120 days	45 days	–
COMMENTS	Two models provide asynchronous rates up to 1800 bps or synchronous switched data rates up to 2400 bps	Switched data rates	Secondary asynchronous channel at up to 150 bps or two at up to 75 bps	Produced by GTE Information Systems as Model IS/2120	–

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MANUFACTURER AND MODEL	Hughes Model HC-276	Hycom 502	Hycom 503	IBM 3872	IBM 3875
COMPATIBLE BELL SYSTEM MODEM	None	None	None	None	None
COMMUNICATIONS FACILITY	Voice band	Voice band	Voice band	Voice band	Voice band
TRANSMISSION CHARACTERISTICS					
Data rate, bits/second	1200/2400	2400/4800	2400/4800	2400/1200	7200/3600
Modulation	PM	QAM	QAM	DPSK	Combined PM/AM
Line conditioning	C1	None required	None required	C1	C2
Synchronization	Synchronous	Synchronous	Synchronous	Synchronous	Synchronous
Data format	Serial	Serial	Serial	Serial	Serial
Transmission mode	Full duplex	Half/full duplex	Half/full duplex	Half/full duplex	Half/full duplex
Calling mode	Originate/answer			Originate/answer	Originate/answer
TERMINAL INTERFACE	RS 232C, MIL 188B	RS 232C, MIL 188B, CCITT	RS 232C, MIL 188B, CCITT	RS 232C	RS 232C
LINE INTERFACE	Four wire	Two/four wire	Two/four wire	Two/four wire	Two/four wire
FEATURES					
Reverse channel	No	Optional	Optional	No	No
Alternate voice/data	Yes	Standard	Standard	No	Yes
Integral handset	No	No	No	No	Optional
Automatic answer	No	No	No	Optional	No
Equalization	Automatic	Automatic	Automatic	–	–
DIAGNOSTIC FACILITIES	Digital and line loop test	Local and remote (opt.) loopback, test pattern gen.	Local and remote (opt.) loopback, test pattern gen.	–	–
PRICE					
Rental, $/month	–	On request	On request	85	240
Purchase, $	–	–	–	2,975	8,400
Installation, $	–	–	–	–	-
AVAILABILITY					
Date of first installation	December 1969	1st qtr. 1974	1st qtr. 1974	August 1972	September 1972
Number installed to date	300	–	–	–	–
Current lead time on orders	–	6 months	6 months	–	–
COMMENTS	–	Has 2.3 second request to send delay	Has 50 msec. request to send delay	Features operation over public telephone network	Several features available

MANUFACTURER AND MODEL	IBM 4872	IBM Line Adapters	II Communications II 201A/B	II Communications II 201B	II Communications II 201R
COMPATIBLE BELL SYSTEM MODEM	203A	103F	201A/201B	201B	201R
COMMUNICATIONS FACILITY	Voice band	Voice band/cable	Voice band	Voice band	Voice band
TRANSMISSION CHARACTERISTICS					
Data rate, bits/second	4800	Up to 134.5 or Up to 600	2000/2400	2400	2400
Modulation	AM, SS	FSK	PM, 4-phase	PM, 4-phase	PM, 4-phase with FSK
Line conditioning	C2	None required	None required	None required	None required
Synchronization	Synchronous	Asynchronous	Synchronous	Synchronous	Synch./Asynch.
Data format	Serial	Serial	Serial	Serial	Serial
Transmission mode	Full duplex	Half/full duplex	Half/full duplex	Half/full duplex	Half/full duplex
Calling mode	Originate/answer	Originate/answer	Originate/answer	Originate/answer	Originate/answer
TERMINAL INTERFACE	RS 232B or MIL 188B	IBM interface	RS 232C	RS 232C	RS 232C
LINE INTERFACE	Four wire	Two/four wire	Two/four wire or DAA	Two/four wire	Two/four wire
FEATURES					
Reverse channel	No	No	No	No	Standard, 150 bps
Alternate voice/data	Optional	No	Optional	Optional	Optional
Integral handset	Optional	No	No	No	No
Automatic answer	No	No	Yes	No	No
Equalization	–	–	Manual	Manual	Manual
DIAGNOSTIC FACILITIES	-	–	Remote and local loopback	Remote and local loopback	None
PRICE					
Rental, $/month	–	10-23	-	–	–
Purchase, $	4,400	500-1,050	990	840	990
Installation, $	–	–	–	–	-
AVAILABILITY					
Date of first installation	–	–	1971	1971	1972
Number installed to date	–	–	200	1,100	200
Current lead time on orders	–	–	30 days	30 days	45 days
COMMENTS	–	Consists of two voice band models and two cable-connected models; maximum cable ranges are 4.75 and 8.25 miles	Desk or rack mount	Desk or rack mount	For use on dial (DDD) network

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MANUFACTURER AND MODEL	ICC (Milgo) 2200/20	ICC (Milgo) 2200/24	ICC (Milgo) 3300/36	ICC (Milgo) 4500/48	ICC (Milgo) 4600/48
COMPATIBLE BELL SYSTEM MODEM	201A	201B	None	None	None
COMMUNICATIONS FACILITY	Voice band	Voice band	Voice band	Voice band	Voice band
TRANSMISSION CHARACTERISTICS					
Data rate, bits/second	2000	1200/2400	3600	4800	4800
Modulation	PM, 4-phase	PM, 4-phase	Combined AM/PM	AM, VSB	DPSK/AM
Line conditioning	None required	None required	None required	C2	None
Synchronization	Synchronous	Synchronous	Synchronous	Synchronous	Synchronous
Data format	Serial	Serial	Serial	Serial	Serial
Transmission mode	Half/full duplex	Simplex/half/full duplex	Simplex/half/full duplex	Full duplex	Half/full duplex
Calling mode	Originate/answer	Originate/answer	Originate/answer	Originate/answer	Originate/answer
TERMINAL INTERFACE	RS 232B/C or CCITT	RS 232B/C or CCITT	RS 232B/C or CCITT	RS 232B/C or CCITT	RS 232B/C or CCITT
LINE INTERFACE	Two/four wire	Two/four wire	Two/four wire	Four wire	Four wire
FEATURES					
Reverse channel	No	No	Optional	No	No
Alternate voice/data	Optional	Optional	Yes	Optional	Optional
Integral handset	No	No	No	Optional	No
Automatic answer	No	Optional	Yes	No	No
Equalization	Fixed	Fixed	Manual	Automatic	Manual
DIAGNOSTIC FACILITIES	None	None	Self test	On/off line test	Remote and local loopback
PRICE					
Rental, $/month	53 (2-yr lease)	53 (2-yr lease)	95 (2-yr lease)	100	100 (2-yr lease)
Purchase, $	1,780	1,780	3,620	4,980	4,750
Installation, $	–	–	–	–	–
AVAILABILITY					
Date of first installation	1970	1969	1970	1970	1972
Number installed to date	–	–	–	–	–
Current lead time on orders	–	–	–	–	–
COMMENTS	For use on public tel. network or leased lines	Strap-selected operation at 1200 bps	Reverse channel provides asynchronous operation at up to 150 bps using FSK modulation	Combines two 2400-bps channels on one line	Provides dual equalizers to equalize a line in both directions

MANUFACTURER AND MODEL	ICC (Milgo) 4800/72	ICC (Milgo) 5500/96	ICC (Milgo) 1100	ICC (Milgo) 20 LSI	ICC (Milgo) 24 LSI
COMPATIBLE BELL SYSTEM MODEM	None	None	None	201A	201B
COMMUNICATIONS FACILITY	Voice band	Voice band	Twisted pair/coaxial	Voice band	Voice band
TRANSMISSION CHARACTERISTICS					
Data rate, bits/second	7200/4800	9600	4800 to 1,000,000	2,000	2400
Modulation	AM, VSB	AM, VSB	PM, 2-phase	PM, 4-phase	PM, 4-phase
Line conditioning	C1	C2	–	None required	None required
Synchronization	Synchronous	Synchronous	Synchronous	Synchronous	Synchronous
Data format	Serial	Serial	Serial	Serial	Serial
Transmission mode	Full duplex	Full duplex	Full duplex	Half/full duplex	Half/full duplex
Calling mode	Originate/answer	Originate/answer	Originate/answer	Originate/answer	Originate/answer
TERMINAL INTERFACE	RS 232B/C or CCITT	RS 232B/C or CCITT	RS 232B/C or current switching	RS 232C, CCITT, or MIL 188B (opt.)	RS 232C, CCITT, or MIL 188B (opt.)
LINE INTERFACE	Four wire	Four wire	Four wire	Two/four wire	Two/four wire
FEATURES					
Reverse channel	No	No	No	No	Optional
Alternate voice/data	Optional	Optional	No	Optional	Optional
Integral handset	No	Optional	No	No	No
Automatic answer	No	No	No	Optional	Optional
Equalization	Automatic	Automatic	Manual	Fixed	Fixed
DIAGNOSTIC FACILITIES	Self test	Remote and local loopback	None	Local and remote (opt.) loopback	Local and remote (opt.) loopback
PRICE					
Rental, $/month	155 (2-yr lease)	235	75-85 (2-yr. lease)	53 (2-yr lease)	53 (2-yr. lease)
Purchase, $	6,900	9,750	2,300-2,800	1,/80	1,780
Installation, $	–	–	–	–	–
AVAILABILITY					
Date of first installation	1972	1970	1969	1972	1972
Number installed to date	–	–		–	–
Current lead time on orders	–	–	–	–	–
COMMENTS	Can combine two 2400-bps channels on one line	Options provides two 4800-bps, four 2400-bps, or two 2400-bps and one 4800-bps channel	Limited-distance operation; standard speeds are 4800, 9600, 19.2K, 40.8K, 48K, 50K, and 230.4K bps	Modem uses LSI technology and features self-testing	Modem uses LSI technology and features self-testing

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MANUFACTURER AND MODEL	ICC (Milgo) 4700/48	ICC (Milgo) Com-Link II	Intertel Series IN202	Intertel MCS 1200	Intertel MCS 2000
COMPATIBLE BELL SYSTEM MODEM	None	None	202C/202D	202C/202D	201A
COMMUNICATIONS FACILITY	Voice band	Twisted pair	Voice band	Voice band	Voice band
TRANSMISSION CHARACTERISTICS					
Data rate, bist/second	4800	2400/4800/7200/ 9600/19,200	Up to 1200 or Up to 1800	Up to 1200	2000
Modulation	3-level VSB	PM, 2-phase	FSK	FSK	PM, 4-phase
Line conditioning	None required	–	See COMMENTS	None required	None required
Synchronization	Synchronous	Synchronous	Asynchronous	Synch./asynch.	Synchronous
Data format	Serial	Serial	Serial	Serial	Serial
Transmission mode	Half/full duplex	Half/full duplex	Simplex/half/full duplex	Half/full duplex	Half/full duplex
Calling mode	Originate/answer		Originate/answer	Originate/answer	Originate/answer
TERMINAL INTERFACE	RS 232C, CCITT, or MIL 188B (opt.)	RS 232C, CCITT, or current	RS 232B/C	RS 232B/C or CCITT	RS 232B/C or CCITT
LINE INTERFACE	Two/four wire	Two/four wire	Two/four wire	Two/four wire	Two/four wire
FEATURES					
Reverse channel	No	No	On some models	Optional	Optional
Alternate voice/data	Optional	No	Yes	Yes	Yes
Integral handset	No	No	No	No	No
Automatic answer	Standard	No	On some models	Optional	Optional
Equalization	Automatic	Manual	–	Statistical	Statistical
DIAGNOSTIC FACILITIES	Local loopback	Test generator	–	Remote and local loopback	Remote and local loopback
PRICE					
Rental, $/month		45 (2-yr. lease)	–	30	50
Purchase, $		1,100	535-665	925	1,750
Installation, $		–	–	–	–
AVAILABILITY					
Date of first installation	1973	1973	August 1970	April 1973	May 1973
Number installed to date	–	–	–	–	–
Current lead time on orders	–	–	30 days	30-45 days	30-45 days
COMMENTS	For use on the dial network (DDD)	For limited distances; up to 3 miles at 19.2K bps	Conditioning: C1 at 1400 bps, C2 at 1800 bps. Synchronous interface available		

MANUFACTURER AND MODEL	Intertel MCS 2400	ITT 2003R	ITT 2003V	Livermore (ADS, Livermore) 71 Series	Livermore (ADS, Livermore) Classic Series
COMPATIBLE BELL SYSTEM MODEM	201B	None	None	103, 113A	103A2
COMMUNICATIONS FACILITY	Voice band	Voice band	Voice band	Voice band	Voice band
TRANSMISSION CHARACTERISTICS					
Data rate, bits/second	2400	1200	2400	Up to 300	Lp to 300
Modulation	PM, 4-phase	FSK	AM, VSB	FSK	FSK
Line conditioning	None required	C2	C2	None required	None required
Synchronization	Synchronous	Synchronous	Synchronous	Asynchronous	Asynchronous
Data format	Serial	Serial	Serial	Serial	Serial
Transmission mode	Half/full duplex	Half/full duplex	Half/full duplex	Half/full duplex	Half/full duplex
Calling mode	Originate/answer	Originate/answer	Originate/answer	Originate/answer	Originate/answer
TERMINAL INTERFACE	RS 232B/C or CCITT	RS 232B/C or CCITT	RS 232B/C	RS 232B/C or Teletype	RS 232B/C or Teletype
LINE INTERFACE	Two/four wire	Two/four wire	Two/four wire	See COMMENTS	Acoustic
FEATURES					
Reverse channel	Optional	Optional	No	No	No
Alternate voice/data	Yes	Optional	Optional	No	No
Integral handset	No	Optional	Optional	No	No
Automatic answer	Optional	Optional	Optional	No	No
Equalization	Statistical	None	None	None	None
DIAGNOSTIC FACILITIES	Remote and local loopback	None	None	None	None
PRICE					
Rental, $/month	50	40	40	13-32	–
Purchase, $	1,750	1,430	1,430	235-325	250-360
Installation, $	–	25	25	No charge	No charge
AVAILABILITY					
Date of first installation	May 1973	June 1971	December 1971	–	–
Number installed to date	–	60	10		–
Current lead time on orders	30-45 days	2 weeks	30 days	–	–
COMMENTS	–	–	–	Available with acoustic and/or two-wire line interface	–

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MANUFACTURER AND MODEL	Livermore (ADS, Livermore) 403	Livermore (ADS, Livermore) 412	Livermore (ADS, Livermore) 424	Livermore (ADS, Livermore) 436	Livermore (ADS, Livermore) 448-III
COMPATIBLE BELL SYSTEM MODEM	103A				None
COMMUNICATIONS FACILITY	Voice band	Voice band	Voice band	Voice band	Voice band
TRANSMISSION CHARACTERISTICS					
Data rate, bits/second	Up to 300	1200	2400	3600	2400/4800
Modulation	FSK	FSK	FM	PAM	PAM
Line conditioning	None	None	None	None	None
Synchronization	Asynchronous	Asynchronous	Synchronous	Synchronous	Asynchronous/synch.
Data format	Serial	Serial	Serial	Serial	Serial
Transmission mode	Simplex/half/full duplex	Simplex/half/full duplex	Simplex/half/full duplex	Simplex/half/full duplex	Simplex/half/full duplex
Calling mode	Originate/answer	Originate/answer	Originate/answer	Originate/answer	Originate/answer
TERMINAL INTERFACE	RS 232C, CCITT, or or MIL 188B	RS 232C, CCITT or MIL 188B	RS 232C, CCITT, or MIL 188B	RS 232C, CCITT or MIL 188B	RS 232C, CCITT or MIL 188B
LINE INTERFACE	Two/four wire	Two/four wire	Two/four wire	Two/four wire	Two/four wire
FEATURES					
Reverse channel	Optional	Optional	Optional	Optional	Optional
Alternate voice/data	No	No	No	No	No
Integral handset	No	No	No	No	No
Automatic answer	Yes	No	No	No	Optional
Equalization	—	—	—	—	—
DIAGNOSTIC FACILITIES	—	—	—	—	—
PRICE					
Rental, $/month	—	—	—	—	—
Purchase, $	—	—	—	—	—
Installation, $	—	—	—	—	—
AVAILABILITY					
Date of first installation	November 1971	October 1971	October 1971	October 1971	April 1972
Number installed to date	40	—	—	—	None
Current lead time on orders	30 days	30 days	30 days	30 days	30 days
COMMENTS	—	—	—	—	—

MANUFACTURER AND MODEL	Livermore (ADS, Livermore) ADS-448	Multi-Tech FM 300 Series	Multi-Tech FM 1200 Series	Multi-Tech 220/224	Novation DC/TM 100 Series
COMPATIBLE BELL SYSTEM MODEM	None	103/113	202	201A/201B	103
COMMUNICATIONS FACILITY	Voice band	Voice band	Voice band	Voice band	Voice band
TRANSMISSION CHARACTERISTICS					
Data rate, bits/second	See comments	Up to 300	Up to 1200 or 1800	2000/2400	Up to 440
Modulation	Combined AM/PM	FSK	FSK	DPSK	FSK
Line conditioning	C2 at 2400, C4 at 4800	None required	C2 at 1800 bps	None required	None required
Synchronization	Asynchronous/synch.	Asynchronous	Asynchronous	Synchronous	Asynchronous
Data format	Serial	Serial	Serial	Serial	Serial
Transmission mode	Simplex/half/full duplex	Half/full duplex	Half duplex	Half duplex	Half/full duplex
Calling mode	Originate/answer	Originate/answer only	Originate/answer	Originate/answer	See COMMENTS
TERMINAL INTERFACE	RS 232C, MIL 188B, CCITT, or contact	RS 232B/C and Teletype 20 ma	RS 232B/C	RS 232B/C	RS 232B or Teletype
LINE INTERFACE	Two/four wire	Acoustic or two wire	Two/four wire	Two/four wire	Two wire/acoustic
FEATURES					
Reverse channel	Optional	No	Yes	No	No
Alternate voice/data	Optional	No	Yes	Yes	No
Integral handset	Optional	No	No	No	No
Automatic answer	Optional	FM 300B only	Yes	Yes	No
Equalization	—	None	None	None	None
DIAGNOSTIC FACILITIES	—	Remote loopback on FM 330B	Local loopback	None	None
PRICE					
Rental, $/month	—	—	—	—	17-22
Purchase, $	—	95-275	450	895	190-350
Installation, $	—	—	—	—	—
AVAILABILITY					
Date of first installation	1968	June 1971	September 1972	August 1973	July 1969
Number installed to date	600	—	—	—	3,000
Current lead time on orders	2 weeks	6 weeks	6-8 weeks	—	Immediate
COMMENTS	Data rates are switch-selected. Operates asychronously or synchronously at 1200, 2400, 3600, 4800, or 6400 bps	Desk unit or PC card	Desk unit, rack mount, or PC card	Available as PC card only	Several models provide wired or acoustic line connection, and originate- or answer-only mode or both

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MANUFACTURER AND MODEL	Novation EC 100 Series	Novation ATM 103D	Novation 202	Novation 201	Omnitech Series 700
COMPATIBLE BELL SYSTEM MODEM	103	101C	202C/202D/202E	201A/201B	103
COMMUNICATIONS FACILITY	Voice band	Voice band	Voice band	Voice band	Voice band
TRANSMISSION CHARACTERISTICS					
Data rate, bits/second	Up to 440	Up to 300	Up to 1200 or 1800	2000/2400	Up to 110/300/450
Modulation	FSK	FSK	FSK	PSK, 4-phase	FSK
Line conditioning	None required	None required	C2 at 1800 bps	None required	None required
Synchronization	Asynchronous	Asynchronous	Asynchronous	Synchronous	Asynchronous
Data format	Serial	Serial	Serial	Serial	Serial
Transmission mode	Full duplex	Half/full duplex	Half/full duplex	Half/ful duplex	Simplex/half/full duplex
Calling mode	–	–	Originate/answer	Originate/answer	See COMMENTS
TERMINAL INTERFACE	logic level	RS 232B or Teletype	RS 232B/C or TTL	RS 232B/C, CCITT, or TTL	RS 232B or Teletype
LINE INTERFACE	Two wire	Two wire	Two/four wire	Two/four wire	Two wire/acoustic
FEATURES					
Reverse channel	No	No	Optional	No	No
Alternate voice/data	No	Yes	Optional	No	No
Integral handset	No	Yes	No	No	No
Automatic answer	No	Yes	Optional	Standard	Yes, 703A only
Equalization	None	None	Fixed	Manual; fixed opt.	None
DIAGNOSTIC FACILITIES	Optional self-test	Remote and local loopback	Remote loopback	Remote and local loopback	Remote and local loopback
PRICE					
Rental, $/month	–	–	25-40	–	–
Purchase, $	100	350-520	366	995	275-445
Installation, $	–	–	0	0	No charge
AVAILABILITY					
Date of first installation	July 1971	January 1972	March 1971	June 1971	1963
Number installed to date	–	–	1000	1500	over 20,000
Current lead time on orders	30 days	30 days	30 days	30 days	Immediate
COMMENTS	Available with acoustic and/or wired line interface and with originate and/or answer modes; PC card only	Teletype mount	Desk unit or PC card	Desk unit or PC card	Several models provide wired or acoustic line connection, and originate- or answer-only mode or both

MANUFACTURER AND MODEL	Paradyne MARQ-48	Paradyne BISYNC-48	Paradyne M-48	Paradyne PIX	Penril PDC 300 Series
COMPATIBLE BELL SYSTEM MODEM	None	None	None	None	103/113
COMMUNICATIONS FACILITY	Voice band	Voice band	Voice band	Voice band	Voice band
TRANSMISSION CHARACTERISTICS					
Data rate, bits/second	4800	4800	4800	4800	Up to 300
Modulation	PAM, VSB	PAM, VSB	PAM, VSB	PAM, VSB	FSK
Line conditioning	None required	None required	None required	None required	None required
Synchronization	Synchronous	Synchronous	Synchronous	Synchronous	Asynchronous
Data format	Serial	Serial	Serial	Parallel	Serial
Transmission mode	Half/full duplex	Half/full duplex	Half/full duplex	Half/full duplex	Half/full duplex
Calling mode	Originate/answer	Originate/answer	Originate/answer	Originate/answer	Originate/answer
TERMINAL INTERFACE	RS 232C	RS 232C	RS 232C	Logic level (8-bit)	RS 232B/C or current switching
LINE INTERFACE	Two/four wire	Two/four wire	Two/four wire	Two/four wire	Two wire
FEATURES					
Reverse channel	Standard	Standard	Optional	Standard	Optional
Alternate voice/data	Optional	Optional	Optional	Optional	Optional
Integral handset	No	No	No	No	Optional
Automatic answer	Optional	Optional	Optional	Optional	Yes
Equalization	Automatic	Automatic	Automatic	Automatic	None
DIAGNOSTIC FACILITIES	Local loopback	Local loopback	Remote and local loopback	Local loopback	None
PRICE					
Rental, $/month	195 (2-yr. lease)	185 (2-yr. lease)	120 (2-yr. lease)	250-550 (2-yr. lease)	10-13.50
Purchase, $	4,500	6,450	3,350	10,000-22,000	200-250
Installation, $	225	225	100	250-400	50
AVAILABILITY					
Date of first installation	January 1971	January 1971	September 1971	January 1973	January 1970
Number installed to date	–	–	–	–	1000
Current lead time on orders	30 days	30 days	30 days	30 days	30 days
COMMENTS		Same as MARQ–48 but is compatible with IBM BSC mode	–	Allows use of standard IBM peripherals at remote location	Available as a desk unit, rack mount (12 modems) PC cards, or integral Teletype unit

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MANUFACTURER AND MODEL	Penril PDC 1200/5 and 1200/150	Penril PDC 1800	Penril PDC 2400B	Penril PDC 2400B1	Penril PDC 4800B
COMPATIBLE BELL SYSTEM MODEM	202C	202D	None	201B	None
COMMUNICATIONS FACILITY	Voice band	Voice band	Voice band	Voice band	Voice band
TRANSMISSION CHARACTERISTICS					
Data rate, bits/second	Up to 1200	Up to 1800	2400	1200/2400	2400/4800
Modulation	FSK	FSK	AM, VSB	PM, 4-phase	AM, VSB
Line conditioning	None required	C2 at 1800 bps	C2	None required	C2
Synchronization	Asynchronous	Asynchronous	Synchronous	Synchronous	Synchronous
Data format	Serial	Serial	Serial	Serial	Serial
Transmission mode	Half/full duplex	Half/full duplex	Half/full duplex	Half/full duplex	Half/full duplex
Calling mode	Originate/answer	Originate/answer	Originate/answer	Originate/answer	Originate/answer
TERMINAL INTERFACE	RS 232B/C	RS 232B/C	RS 232B/C	RS 232B/C	RS 232B/C
LINE INTERFACE	Two wire	Two/four wire	Two/four wire	Two/four wire	Two/four wire
FEATURES					
Reverse channel	Yes	No	No	Optional	Optional
Alternate voice/data	Optional	Optional	Optional	Optional	Optional
Integral handset	Optional	Optional	Optional	Optional	Optional
Automatic answer	Yes	Yes	Yes	Yes	Yes
Equalization	Fixed	Fixed	Manual	Fixed	Automatic
DIAGNOSTIC FACILITIES	Remote and local loopback	Remote and local loopback	Remote and local loopback	Remote and local loopback; self test	Remote and local loopback
PRICE					
Rental, $/month	15-20	12	35	66	130
Purchase, $	300-400	320	950	1,325	3,500
Installation, $	50	50	50	50	50
AVAILABILITY					
Date of first installation	November 1970	July 1970	August 1970	December 1970	December 1970
Number installed to date	350	682	556	132	44
Current lead time on orders	30 days	30 days	30 days	30 days	30 days
COMMENTS	Reverse channel for acknowledgement at up to 5 bps or up to 150 bps				Provides dual-channel operation at 2400 bps and automatic equalization. Optional 300 bps subchannel

MANUFACTURER AND MODEL	Penril PDC 4800D	Penril PDC 4800B1	Penril PDC 4800B2	Penril PDC 2000A	Prentice P-103/P-113
COMPATIBLE BELL SYSTEM MODEM	None	None	None	201A	103/113
COMMUNICATIONS FACILITY	Voice band	Voice band	Voice band	Voice band	Voice band
TRANSMISSION CHARACTERISTICS					
Data rate, bits/second	4800/2400	4800	4800	2000	Up to 300
Modulation	AM, VSB	DPSK, 8-phase	PM	PM	FSK
Line conditioning	None	C2	None required	None required	None required
Synchronization	Synchronous	Synchronous	Synchronous	Synchronous	Asynchronous
Data format	Serial/parallel	Serial	Serial	Serial	Serial
Transmission mode	Full duplex	Half/full duplex	Half/full duplex	Half/full duplex	Half/full duplex
Calling mode	Originate/answer	Originate/answer	Originate/answer	Originate/answer	See COMMENTS
TERMINAL INTERFACE	RS 232B/C, CCITT, or MIL 188B (opt.)	RS 232B/C	RS 232B/C, CCITT, or MIL 188B (opt.)	RS 232B/C, CCITT, or MIL 188B (opt.)	RS 232C or Teletype
LINE INTERFACE	Four wire	Two/four wire	Two/four wire	Two/four wire	Two wire
FEATURES					
Reverse channel	Optional	No	Optional	No	No
Alternate voice/data	Optional	Yes	Optional	Optional	No
Integral handset	Optional	Optional	Optional	Optional	No
Automatic answer	Yes	Yes	Optional	Yes	No
Equalization	Automatic	–	Automatic	Fixed	None
DIAGNOSTIC FACILITIES	Remote and local loopback	–	Remote and local loopback	Remote and local loopback	Remote and local loopback
PRICE					
Rental, $/month	157	150	131	55	8-11
Purchase, $	4,200	2,800	3,500	1,475	135-195
Installation, $	100	–	100	50	No charge
AVAILABILITY					
Date of first installation	1971	1971	–	–	September 1970
Number installed to date	–	–	–	–	5000
Current lead time on orders	30 days	30 days	30 days	30 days	2 weeks
COMMENTS	Provides dual 2400 bps channels and automatic equalization; optional 300-bps subchannel	For use in a multi point, polling environment; manually equalized	–	–	Available as originate-only, answer-only, or originate-and-answer units

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MANUFACTURER AND MODEL	Prentice P-202	Prentice P-201B	Prentice P-1200 Series	Prentice Line Adapters	Prentice Limited-Range Adapter-1
COMPATIBLE BELL SYSTEM MODEM	202C/202D/202R	201B	None	None	None
COMMUNICATIONS FACILITY	Voice band	Voice band	Voice band	Voice band	Twisted pair or co-axial cable
TRANSMISSION CHARACTERISTICS					
Data rate, bits/second	Up to 1200	2400	Up to 1200	Up to 150/600	19.6K/9600/4800/2400/1200/600
Modulation	FSK	PM	FSK	FSK	PM, 2-phase
Line conditioning	None required	None required	None required	None required	—
Synchronization	Asynchronous	Synchronous	Asynchronous	Asynchronous	Synchronous
Data format	Serial	Serial	Serial	Serial	Serial
Transmission mode	Half/full duplex	Half/full duplex	Full duplex	Half/full duplex	Full duplex
Calling mode	Originate/answer	Originate/answer	Originate/answer	Originate/answer	Originate/answer
TERMINAL INTERFACE	RS 232C, Teletype	RS 232C	RS 232C, Teletype	RS 232C, Teletype	RS 232C
LINE INTERFACE	Two/four wire	Two/four wire	Two wire	Two/four wire	Four wire
FEATURES					
Reverse channel	Standard	No	Std., 150/300 bps	No	No
Alternate voice/data	No	No	No	No	No
Integral handset	No	No	No	No	No
Automatic answer	Standard	No	Standard	No	No
Equalization	None	Automatic	Automatic	None	Automatic
DIAGNOSTIC FACILITIES	Remote and local loopback	Remote and local loopback	Remote and local loopback	Remote and local loopback	Remote and local loopback
PRICE					
Rental, $/month	15-20	55	22-25	9-15	42.50
Purchase, $	300-350	1,000	400-450	135-200	800
Installation, $	No charge	No charge	No charge	No charge	No charge
AVAILABILITY					
Date of first installation	January 1972	June 1972	June 1973	December 1970	January 1972
Number installed to date	700	150	—	1500	200
Current lead time on orders	2 weeks	2 weeks	2-9 weeks	2 weeks	2 weeks
COMMENTS	Up to 20 units plug into P-1000 cabinet	Up to 20 units plug into P-1000 cabinet	Designed to government specs. for ARPA	Up to 56 units plug into P-1000 cabinet	For limited distance operation; 2 units per P-1000 cabinet

MANUFACTURER AND MODEL	Prentice Limited Range Adapter-2	Pulsecom 4080 Series	Quindar QDM-108/113	Quindar QDM-1200	RFL 5220/5105
COMPATIBLE BELL SYSTEM MODEM	None	103/113/108	108/113	202	101/103/113
COMMUNICATIONS FACILITY	Twisted pair or co-axial cable	Voice band	Voice band	Voice band	Voice band
TRANSMISSION CHARACTERISTICS					
Data rate, bits/second	40.8K/20.4K/10.2K	Up to 300	Up to 300	Up to 1200	Up to 300
Modulation	PM, 2-phase	FSK	FSK	FSK	FSK
Line conditioning	—	None required	None required	None required	None required
Synchronization	Synchronous	Asynchronous	Asynchronous	Asynchronous	Asynchronous
Data format	Serial	Serial	Serial	Serial	Serial
Transmission mode	Full duplex	Half/full duplex	Half/full duplex	Half/full duplex	Half/full duplex
Calling mode	Originate/answer	Originate/answer	Originate/answer	Originate/answer	See COMMENTS
TERMINAL INTERFACE	RS 232C	RS 232B/C or Teletype	RS 232, CCITT, or Teletype	RS 232C or CCITT	RS 232C or Teletype
LINE INTERFACE	Four wire	Two wire	Two/four wire	Two/four wire	Two/four wire or acoustic
FEATURES					
Reverse channel	No	No	No	Optional	No
Alternate voice/data	No	Yes	No	No	No
Integral handset	No	No	No	No	No
Automatic answer	No	No	QDM-113 only	Optional	Optional
Equalization	Automatic	None	None	Manual	None
DIAGNOSTIC FACILITIES	Remote and local loopback	None	Local loopback	Local loopback	Remote and local loopback
PRICE					
Rental, $/month	65	—	—	—	—
Purchase, $	1,000	225-300	By request only	By request only	95 (5105); 180 (5220)
Installation, $	No charge	—	—	—	—
AVAILABILITY					
Date of first installation	January 1972	January 1971	1971	1971	—
Number installed to date	200	1,500	—	—	—
Current lead time on orders	2 weeks	90 days	—	—	30 days
COMMENTS	For limited distance operation; 2 units per P-1000 cabinet	Originate-only or answer-only models available; units are also available with 6 or 32 channels	—	—	Operates in originate-only or answer-only mode

All About Modems

MANUFACTURER AND MODEL	RFL 4604	RFL 3952	RFL 22DB	RFL 32DT/32DR	RFL 6385
COMPATIBLE BELL SYSTEM MODEM	201A	201B	202C	None	202C
COMMUNICATIONS FACILITY	Voice band	Voice band	Voice band	Voice band	Voice band
TRANSMISSION CHARACTERISTICS					
Data rate, bits/second	2000	2400	Up to 1200	Up to 1200	Up to 1800
Modulation	PM, 4-phase	PM-4-phase	FSK	FSK	FSK
Line conditioning	None required	C2	C1	C1	None required
Synchronization	Synchronous	Synchronous	Asynchronous	Asynchronous	Asynchronous
Data format	Serial	Serial	Serial	Serial	Serial
Transmission mode	Half/full duplex	Half/full duplex	Half/full duplex	Full duplex	Half/full duplex
Calling mode	Originate/answer	Originate/answer	Originate/answer	Originate/answer	Originate only
TERMINAL INTERFACE	RS 232C	RS 232C	RS 232C	RS 232C	RS 232C
LINE INTERFACE	Two/four wire	Two/four wire	Two/four wire	Two wire	Two/four wire
FEATURES					
Reverse channel	No	No	Optional	Optional	No
Alternate voice/data	No	No	No	No	No
Integral handset	No	No	No	No	No
Automatic answer	Optional	Optional	Optional	Optional	No
Equalization	Compromise	Compromise	Compromise	Compromise	None
DIAGNOSTIC FACILITIES	Remote loopback	Remote loopback	Remote and local loop-back	Remote loopback	None
PRICE					
Rental, $/month	90	90	60	60-70	–
Purchase, $	1600	1600	830	785-940	240
Installation, $	–	–	–	–	–
AVAILABILITY					
Date of first installation	–	–	–	–	–
Number installed to date	–	–	–	–	–
Current lead time on orders	30 days	30 days	30 days	30 days	60 days
COMMENTS	–	–	–	Two complementary modems provide a 1200 bps and a 120 bps channel	–

MANUFACTURER AND MODEL	Rixon T101CSC	Rixon T103A1/T103A2	Rixon T103F	Rixon T103GSB	Rixon T113 Series
COMPATIBLE BELL SYSTEM MODEM	101/103	103A1/103A2/113	103F	103/113	103A2, 103E, 113B
COMMUNICATIONS FACILITY	Voice band	Switched network via DAA	Voice band	Voice band	Voice band
TRANSMISSION CHARACTERISTICS					
Data rate, bits/second	Up to 200	Up to 300	Up to 300	Up to 300	Up to 300
Modulation	FSK	FSK	FSK	FSK	FSK
Line conditioning	None required	None	None	None	None
Synchronization	Asynchronous	Asynchronous	Asynchronous	Asynchronous	Asynchronous
Data format	Serial	Serial	Serial	Serial	Serial
Transmission mode	Full duplex	Full duplex	Full duplex	Full duplex	Full duplex
Calling mode	Originate/answer	Originate/answer	Originate/answer	Originate/answer	Originate/answer only
TERMINAL INTERFACE	RS 232C, Teletype, or MIL 188C	RS 232/C	RS 232B/C	RS 232C or Teletype	RS 232B or Teletype
LINE INTERFACE	Two wire	Two wire	Two wire	Two wire	Two wire
FEATURES					
Reverse channel	No	No	No	No	No
Alternate voice/data	Yes	Via Bell System 804B	Yes	Yes	Yes
Integral handset	Yes	On 804B	No	No	No
Automatic answer	Yes	Yes	No	Yes	T113BDS only
Equalization	None	None	None	None	None
DIAGNOSTIC FACILITIES	Remote test	Local loopback and re-mote test	Local loopback and re-mote test	Remote test	Remote test
PRICE					
Rental, $/month	–	23	23	23	10
Purchase, $	780	520	435-480	500	195-6,800
Installation, $					
AVAILABILTY	–	–	–		–
Date of first installation	–	–	–	–	–
Number installed to date	–	–	–	–	–
Current lead time on orders	30 days	60 days	30 days	30 days	30 days
COMMENTS	Mounts in Teletype for use on DDD via DAA	–	–	For use on DDD via DAA	T113 BDS contain 20 C113B modem cards

All About Modems

MANUFACTURER AND MODEL	Rixon T201A/B	Rixon T202C	Rixon T202D	Rixon T202E	Rixon T4800F
COMPATIBLE BELL SYSTEM MODEM	201A, 201B	202C	202D	202E	None
COMMUNICATIONS FACILITY	Voice band	Voice band	Voice band	Voice band	Voice band
TRANSMISSION CHARACTERISTICS					
Data rate, bits/second	2000 (T201A) 2400 (T201B)	Up to 1800	Up to 1800	Up to 1200	4800
Modulation	PM	FSK	FSK	FSK	PM-AM
Line conditioning	C2 (T201B only)	See COMMENTS	See COMMENTS	None required	None or C2
Synchronization	Synchronous	Asynchronous	Asynchronous	Asynchronous	Synchronous
Data format	Serial	Serial	Serial	Serial	Serial
Transmission mode	Half/full duplex	Half/full duplex	Half/full duplex	Transmit only	Half/full duplex
Calling mode	Not applicable	Not applicable	Not applicable	Not applicable	Originate/answer
TERMINAL INTERFACE	RS 232B or contact closure	RS 232B or contact closure	RS 232B or contact closure	RS 232B	RS 232C or CCITT
LINE INTERFACE	Two/four wire	Two/four wire	Two/four wire	Two wire	Two/four wire
FEATURES					
Reverse channel	No	Optional	Optional	Optional	No
Alternate voice/data	Via Bell System 804A	Via external set	Via Bell System 804A	Via external set	Standard
Integral handset	On 804A	On telephone set	On 804A	On telephone set	No
Automatic answer	Via Bell System 804A	Yes	Via Bell System 804A	Via external set	No
Equalization	Fixed	Fixed	Fixed	None	Fixed
DIAGNOSTIC FACILITIES	Remote test	Local loopback and remote test	Local loopback and remote test	Remote test	Remote and local test
PRICE					
Rental, $/month	50	27-32	27-32	–	104
Purchase, $	1,075 (A); 1,390 (B)	1,090-1,235	865-1,005	475-570	3,750-4,000
Installation, $	–	–	–	–	–
AVAILABILITY					
Date of first installation	–	–	–	–	–
Number installed to date	–	–	–	–	–
Current lead time on orders	30 days	30 days	30 days	30 days	30 days
COMMENTS	–	Conditioning required for 1400 bps (C1) and 1800 bps (C2)	Conditioning required for 1400 bps (C1) and 1800 bps (C2)	–	–

MANUFACTURER AND MODEL	Rixon T208A	Rixon DS-1800	Rixon DS-2400	Rixon DS-4801	Rixon DS-7200
COMPATIBLE BELL SYSTEM MODEM	208A	202	201B	None	None
COMMUNICATIONS FACILITY	Voice band	Voice band	Voice band	Voice band	Voice band
TRANSMISSION CHARACTERISTICS					
Data rate, bits/second	4800	Up to 1800	1200/2400	2400/4800	3600/4800/7200
Modulation	DC, 8-phase	FSK	PM, 4-phase	AM, SSB	AM, VSB
Line conditioning	None or C2	C1 at 1400, C2 at 1800	C1 at 2400	Unc., C1, or C2	C2
Synchronization	Synchronous	Asynchronous	Synchronous	Synchronous	Synchronous
Data format	Serial	Serial	Serial	Serial	Serial
Transmission mode	Full duplex	Half/full duplex	Half/full duplex	Half/full duplex	Full duplex
Calling mode	Originate/answer	Originate/answer	Originate/answer	Originate/answer	Originate/answer
TERMINAL INTERFACE	RS 232C	RS 232B/C	RS 232B/C or MIL 188B	RS 232B/C, MIL 188B, or CCITT	RS 232B/C or MIL 188B
LINE INTERFACE	Four wire	Two/four wire	Two/four wire	Two/four wire	Four wire
FEATURES					
Reverse channel	No	Optional	No	No	No
Alternate voice/data	Yes	Optional	Optional	Optional	Optional
Integral handset	No	No	No	No	No
Automatic answer	No	Optional	Optional	No	No
Equalization	Automatic	Fixed	Manual	Automatic	Automatic
DIAGNOSTIC FACILITIES	Remote and local loopback, etc.	Remote and local loopback	Remote and local loopback	Remote and local loopback	Remote and local loopback
PRICE					
Rental, $/month	104	23	50	160	225
Purchase, $	3,750	500	1,300	3,750	6,000
Installation, $	–	–	–	–	–
AVAILABILITY					
Date of first installation	–	–	–	–	–
Number installed to date	–	–	–	–	–
Current lead time on orders	30 days	Immediate	Immediate	Immediate	Immediate
COMMENTS	–	Conditioning required for 1400 bps (C1) and 1800 bps (C2)	–	–	Speeds are switch-selected

All About Modems

MANUFACTURER AND MODEL	Rixon DS-9601	Sanders Modem Packs Series 3A	Sanders Modem Packs Series 12A	Sanders Modem Packs Series 18A	Sanders Modem Packs Series 20S
COMPATIBLE BELL SYSTEM MODEM	None	103	202C	202D	201A
COMMUNICATIONS FACILITY	Voice band	Voice band	Voice band	Voice band	Voice band
TRANSMISSION CHARACTERISTICS					
Data rate, bits/second	3600/4800/7200/9600	Up to 300	Up to 1200	Up to 1800	2000
Modulation	AM, VSB	Dual FSK	FSK	FSK	PSK
Line conditioning	C2	None required	None required	C1 at 1800	None required
Synchronization	Synchronous	Asynchronous	Asynchronous	Asynchronous	Synchronous
Data format	Serial	Serial	Serial	Serial	Serial
Transmission mode	Full duplex	Half/full duplex	Half/full duplex	Half/full duplex	Half/full duplex
Calling mode	Originate/answer	See COMMENTS	Originate/answer	Originate/answer	Originate/answer
TERMINAL INTERFACE	RS 232B/C or MIL 188B	RS 232B/C	RS 232B/C	RS 232B/C	RS 232B/C
LINE INTERFACE	Four wire	Two wire	Two wire	Two/four wire	Two/four wire
FEATURES					
Reverse channel	No	No	Optional	No	No
Alternate voice/data	Optional	No	No	No	No
Integral handset	No	No	No	No	No
Automatic answer	No	No	Optional	No	Optional
Equalization	Automatic	None	Statistical	Statistical	Statistical
DIAGNOSTIC FACILITIES	Remote and local loopback	Remote and local loopback	Remote and local loopback	Remote and local loopback	Remote and local loopback
PRICE					
Rental, $/month	250	—	—	—	—
Purchase, $	9,600	366	493	486	900
Installation, $	—	—	—	—	—
AVAILABILITY					
Date of first installation	—	April 1971	December 1970	November 1969	June 1973
Number installed to date	—	—	—	—	—
Current lead time on orders	30 days	30-60 days	30-60 days	30-60 days	60 days
COMMENTS	—	Available in all combinations of originate and answer modes	—	—	For use on DDD

MANUFACTURER AND MODEL	Sanders Modem Packs Series 24S	Sanders Modem Packs Series 24D	Singer Tele-Signal 881C	Singer Tele-Signal 883A	Singer Tele-Signal 883P
COMPATIBLE BELL SYSTEM MODEM	201B	201C	101C	103	201
COMMUNICATIONS FACILITY	Voice band	Voice band	Voice band	Voice band	Voice band
TRANSMISSION CHARACTERISTICS					
Data rate, bits/second	2400	2400/1200	Up to 200	Up to 300	1000/1200/2000/2400
Modulation	PSK	PSK	FSK	FSK	Combined AM/FM
Line conditioning	C2	None required	None required	None required	None required
Synchronization	Synchronous	Synchronous	Asynchronous	Asynchronous	Synchronous
Data format	Serial	Serial	Serial	Serial	Serial
Transmission mode	Half/full duplex	Half/full duplex	Half/full duplex	Half/full duplex	Half/full duplex
Calling mode	Originate/answer	Originate/answer	Originate/answer	Originate/answer	Originate/answer
TERMINAL INTERFACE	RS 232B/C	RS-232B/C or MIL 188B	Contact closure	RS 232B/C	RS 232B/C or CCITT
LINE INTERFACE	Two/four wire	Two/four wire	Two wire	Two/four wire	Two/four wire
FEATURES					
Reverse channel	No	Optional	No	Yes	No
Alternate voice/data	No	No	No	No	No
Integral handset	No	No	No	No	No
Automatic answer	No	Optional	Yes	No	Yes
Equalization	Statistical	Statistical	None	None	Manual
DIAGNOSTIC FACILITIES	Remote and local loopback	Remote and local loopback	Remote loopback	None	Local loopback
PRICE					
Rental, $/month	—	—	—	—	—
Purchase, $	828	1,100	495	418	795
Installation, $	—	—	—	—	—
AVAILABILITY					
Date of first installation	June 1971	February 1972	—	—	—
Number installed to date	—	—	—	—	—
Current lead time on orders	30-60 days	60 days	120 days	120 days	120 days
COMMENTS	—	For use on DDD	—	300 bps reverse channel. Acoustic coupler optional	Data rates are strapped or switch-selected

All About Modems

MANUFACTURER AND MODEL	Singer Tele-Signal 898D	Singer Tele-Signal 2024	Sonex 2103F	Sonex 2113 Autoset	Sonex 2202 Autoset
COMPATIBLE BELL SYSTEM MODEM	202C	201A/201B	103	113	202C/202D/202E
COMMUNICATIONS FACILITY	Voice band	Voice band	Voice band	Voice band	Voice band
TRANSMISSION CHARACTERISTICS					
Data rate, bits/second	Up to 1800	1000/1200/2000/2400	Up to 300	Up to 300	Up to 1800
Modulation	FSK	PM	FSK	FSK	FSK
Line conditioning	C2 at 1800	Uncond. or C1	None required	None required	C2 at 1800 bps
Synchronization	Asynchronous	Synchronous	Asynchronous	Asynchronous	Asynchronous
Data format	Serial	Serial	Serial	Serial	Serial
Transmission mode	Half/full duplex	Half/full duplex	Full duplex	Half/full duplex	Half/full duplex
Calling mode	Originate/answer	Originate/answer	Originate/answer	Originate/answer	Originate/answer
TERMINAL INTERFACE	RS 232B/C or CCITT	RS 232C or CCITT	RS 232C, Teletype, or logic	RS 232C, Teletype, or logic	RS 232C
LINE INTERFACE	Two/four wire	Two/four wire	Two wire	Two wire	Two/four wire
FEATURES					
Reverse channel	Optional, 5 or 75 bps	No	No	No	Optional
Alternate voice/data	No	No	No	Optional	Optional
Integral handset	No	No	No	Optional	Optional
Automatic answer	Optional	Yes	No	Standard	Standard
Equalization	Manual	Automatic	None	None	None
DIAGNOSTIC FACILITIES	Local loopback	None	None	Remote and local loop-back	Remote and local loop-back
PRICE					
Rental, $/month	–	–	10-15	10-15	–
Purchase, $	575	–	180-280	140-180	–
Installation, $	–	–	–	–	–
AVAILABILITY					
Date of first installation	–	–	1970	1970	1972
Number installed to date	–	–	300	2,000	–
Current lead time on orders	120 days	–	30 days	30 days	45 days
COMMENTS			Desk unit, Teletype mount, or PC card	Multi-channel unit with up to 12 channels	Multi-channel unit with up to 12 channels

MANUFACTURER AND MODEL	Sonex 2401 Autotone	Sonex 2403 Autotone	Tele-Dynamics Type 7113A/B	Tele-Dynamics Type 7103F/G	Tele-Dynamics Type 7202D/E
COMPATIBLE BELL SYSTEM MODEM	401J	403D/403E	113A/113B	103/113	202D/202E
COMMUNICATIONS FACILITY	Voice band	Voice band	Voice band	Voice band	Voice band
TRANSMISSION CHARACTERISTICS					
Data rate, bits/second	Up to 20 char/sec	Up to 10 char/sec	Up to 300	Up to 300	Up to 1800
Modulation	FSK	FSK	FSK	FSK	FSK
Line conditioning	None required	None required	None required	None required	C2 at 1800
Synchronization	Asynchronous	Asynchronous	Asynchronous	Asynchronous	Asynchronous
Data format	Parallel	Parallel	Serial	Serial	Serial
Transmission mode	Half duplex	Half duplex	Full duplex	Half/full duplex	Half/full duplex
Calling mode	Answer only	Answer only	See COMMENTS	Originate/answer	Originate/answer
TERMINAL INTERFACE	Contact closure	RS 232C, contact closure, or logic	RS 232C, CCITT, Teletype, or logic	RS 232C, MIL 188B, or CCITT	RS 232C, CCITT, or logic level
LINE INTERFACE	Two wire	Two wire	Two wire	Two wire	Two/four wire
FEATURES					
Reverse channel	No	No	No	No	Optional
Alternate voice/data	No	No	No	Via Bell System 804A	No
Integral handset	No	No	No	On 804A	No
Automatic answer	Standard	Standard	No	Yes	Optional
Equalization	None	None	None	None	Fixed
DIAGNOSTIC FACILITIES	None	None	None	Remote and local loop-back	Remote and local loop-back
PRICE					
Rental, $/month	17-27	17-27	–	–	–
Purchase, $	325-530	325-530	88-98	170 to 320	123-475
Installation, $	–	–		–	–
AVAILABILITY					
Date of first installation	1972	1972	June 1972	June 1972	February 1972
Number installed to date	200	800	500	200	300
Current lead time on orders	45 days	45 days	30 days	30 days	30 days
COMMENTS	Multi-channel unit with up to 12 channels	Multi-channel unit with up to 12 channels	Available with originate-only or answer-only mode	–	–

All About Modems

MANUFACTURER AND MODEL	Tele-Dynamics Type 7201A/B	Tele-Dynamics Type 7202S	Universal Data Systems UDS-103	Universal Data Systems UDS-201B	Universal Data Systems UDS-202C
COMPATIBLE BELL SYSTEM MODEM	201A/201B	202D/202E	103A	201B	202C
COMMUNICATIONS FACILITY	Voice band	Voice band	Voice band	Voice band	Voice band
TRANSMISSION CHARACTERISTICS					
Data rate, bits/second	2000/2400	1200	Up to 300	2400	Up to 1200
Modulation	PM, 4-phase	FSK	FSK	DC, PSK	FSK
Line conditioning	C2 at 2400	None required	None required	None required	None required
Synchronization	Synchronous	Synchronous	Asynchronous	Synchronous	Asynchronous
Data format	Serial	Serial	Serial	Serial	Serial
Transmission mode	Half/full duplex	Half/full duplex	Full duplex	Half/full duplex	Half/full duplex
Calling mode	Originate/answer	Originate/answer	Originate/answer	Originate/answer	Originate/answer
TERMINAL INTERFACE	RS 232C, CCITT, or logic level	RS 232C, CCITT, or logic	RS 232B/C or Teletype	RS 232B/C	RS 232B/C
LINE INTERFACE	Two/four wire	Two/four wire	Two wire	Two/four wire	Two/four wire
FEATURES					
Reverse channel	No	No	No	No	Opt., 5 or 150 bps
Alternate voice/data	No	No	No	No	No
Integral handset	No	No	No	No	No
Automatic answer	Optional	No	Optional	No	Yes
Equalization	Fixed	Fixed	None	None	None
DIAGNOSTIC FACILITIES	Remote and local loopback	Remote and local loopback	Remote and local loopback	Remote and local loopback	Remote and local loopback
PRICE					
Rental, $/month	–	–	–	–	–
Purchase, $	610-850	224-400	245	1,185	495
Installation, $	–	–	–	–	–
AVAILABILITY					
Date of first installation	August 1972	June 1973	June 1971	1972	1972
Number installed to date	1,500	50	–	–	–
Current lead time on orders	30 days	60 days	30 days	30 days	30 days
COMMENTS	–	–	–	–	–

MANUFACTURER AND MODEL	Vadic VA 300 Series	Vadic VA 1200	Vadic VA 3400 Series
COMPATIBLE BELL SYSTEM MODEM	103	202	None
COMMUNICATIONS FACILITY	Voice band	Voice band	Voice band
TRANSMISSION CHARACTERISTICS			
Data rate, bits/second	Up to 300	Up to 1800	Up to 1200
Modulation	FSK	FSK	–
Line conditioning	None required	C2 at 1800	None required
Synchronization	Asynchronous	Asynchronous	Synchronous
Data format	Serial	Serial	Serial
Transmission mode	Simplex/half/full duplex	Simplex/half/full duplex	Full duplex
Calling mode	Originate/answer	Originate/answer	Originate/answer
TERMINAL INTERFACE	RS 232B/C or Teletype	RS 232B/C	RS 232B/C
LINE INTERFACE	Two wire	Two/four wire	Two wire
FEATURES			
Reverse channel	No	Optional	No
Alternate voice/data	No	No	No
Integral handset	Optional	No	No
Automatic answer	Yes	Yes	Yes
Equalization	None	None	Compromise
DIAGNOSTIC FACILITIES	Remote and local loopback	Remote and local loopback	Remote and local loopback
PRICE			
Rental, $/month	–	–	–
Purchase, $	175	250	600
Installation, $	–	–	–
AVAILABILITY			
Date of first installation	August 1969	September 1969	April 1973
Number installed to date	–	–	–
Current lead time on orders	4 weeks	4 weeks	4 weeks
COMMENTS	3 plug-in modules for PC card or rack mount Integral	3 plug-in modules for PC cards	Desk unit or rack mount

All About Data Communications Multiplexors

Multiplexors and their more complex cousins, concentrators, are elements that can combine the multiple paths of a data communications network into a reduced number of physical facilities. As a result, these devices can yield substantial dollar savings.

Multiplexors and concentrators, which subdivide physical communications facilities into multiple logical paths for increased transmission efficiency, should be thoroughly understood by anyone planning a data communications network. This report explains the techniques and applications of multiplexing, summarizes the characteristics of 61 current units from 30 vendors, analyzes the experience of multiplexor users, and provides useful selection guidance.

Because communication line charges constitute a major part of the total cost of every data communications network, careful network planning is essential to reduce facility requirements to a minimum. Through the use of multiplexors and concentrators, multiple data paths between remote terminals and a central computer can be combined on a single communications facility, resulting in substantial dollar savings over the cost of individual leased lines. A multiplexor or concentrator is used at each end of the line to logically combine and then separate the individual data paths. Furthermore, these devices can also be used at intermediate points (nodes) to link lines from geographically diverse locations into a common line.

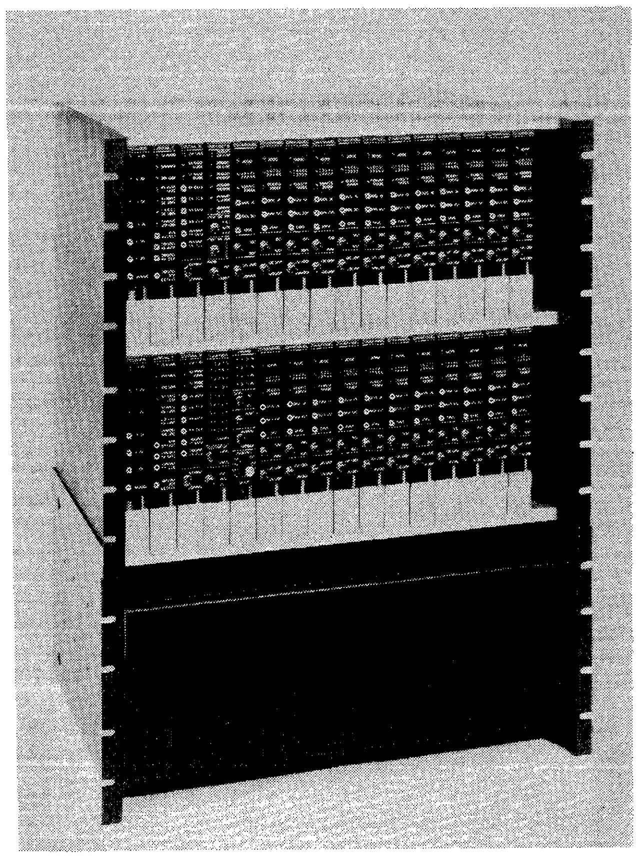
Critical evaluation of planned or existing networks may disclose inadequacies that preclude the satisfaction of current or future objectives. Skimping on the number of data paths can result in operating inefficiencies and degraded performance. The intelligent selection and implementation of multiplexors and/or concentrators in your existing or planned communications network is a cost-effective approach to increasing your current operating efficiency as well as providing the capability to satisfy future objectives and the flexibility to deal with contingencies.

To Mux or Concentrate

Multiplexors and concentrators perform the same basic task: to combine multiple data paths into one physical path consisting of logically discrete data streams, and, conversely, to logically separate (demux) the combined streams into individual data paths. However, the two types of devices perform the task differently.

Multiplexors are conceptually simpler than concentrators, and are restricted to basic multiplexing/demultiplexing operations. Multiplexors are characterized by equal input and output data rates and by their design limitation of one line per channel. Because of this design, casual usage can result in non-cost-effective results. Throughput is reflective of input loading. Less than full loading results in unused output capacity. However, as a result of their basic simplicity, multiplexors are potentially more reliable and are less expensive than their more complex counterparts.

Concentrators, in contrast to multiplexors, are characterized by their combined capabilities of multiplexing/demultiplexing and non-synchronized data handling. Concentrators are capable of storing complete messages or blocks of data and can alter the data format and/or content. Unlike multiplexors, concentrators can accommodate more terminals or lines than there are multiplexed channels, a striking advantage over multiplexors, because terminals are seldom used full-time. Because these processor-based devices are not subject to the inadequacies of multiplexors and are capable of extended capabilities such as reformatting and editing, they offer increased flexibility and are likely to be more cost-effective than multiplexors in large networks.



Infotron's Timeline 240, known as the "Cadillac of the industry," boasts redundant multiplexing logic. This low-speed, time-division multiplexor incorporates a second set of multiplexor circuits that run in step (but off-line) with the first set. Switch-over is automatic upon detecting a failure, and the distant multiplexor is alerted to the event.

All About Data Communications Multiplexors

In practice, the term "concentrator" has been applied to several types of devices during the course of teleprocessing history. At one time or another, "concentrator" has referred to simple multiplexors, to multiplexors capable of accommodating multidrop lines, to front-end devices for multiplexing multiple data streams into a single computer I/O channel, and to stored-program units for remote multiplexing and data manipulation in a communications network. The last definition is the one in current vogue, probably because of the wide interest in programmable communications processors.

In this report, we use the term *multiplexor* to refer to *devices for accommodating multiple single-terminal or multi-terminal lines.* Concentrators are stored-program units. Because of their additional complexity, remote concentrators are discussed in the DATAPRO 70 report *All About Communications Processors* (70G-400-01). Remote concentration is just one of the functions that can be accomplished by combining a programmable processor and communications line interfaces.

Modems Can Also Multiplex

Applications that require only a few terminals to be multiplexed onto a common high-speed line can be neatly handled by a multi-channel modem. During the past year, the Bell System and some of the more prominent independent modem vendors (such as Codex, ICC/Milgo, Intertel, and Paradyne) have introduced multi-channel modems that can multiplex as many as four 2400-bps inputs over a 9600-bps voice-grade line. These modems split the line into channels that are multiples of 2400 bps. The number of available input channels is determined by the combined rate of all inputs, which cannot exceed the output rate. The details on multi-channel (or multi-port) modems can be found in Report 70G-500-01, *All About Modems.*

An Old Concept

Multiplexing is not new. In fact, the tuned circuits that led to the use of radiated electromagnetic energy (radio) for communications presented one form of multiplexing in which space was the communications medium. The commonplace radio set is an instrument for selecting one station at a time from a multitude of simultaneous broadcasts. But this is not the kind of information multiplexing of interest to EDP users with communications networks. They need to receive all of the information streams at the same time. More to the point in the way of analogy would be stereo FM broadcasts in which two information streams (left and right channels) are received, decoded, and reproduced by tuning in only one channel. But this still does not do justice to EDP multiplexing because in addition to accommodating multiple data streams on one channel, each stream must be fully independent of the others.

The history of the development of communications technology has been based on the problems of predicting the result of impressing changing electrical signals on different media, whether they be space (radio), a twisted pair of wires, or a specially engineered coaxial cable, and finding ways to improve efficiency in order to reduce costs. (The changes in the electrical signals are what carries the information or data.) One of the results of such development is the great increase in the data capacity of a leased voice-grade line—from just 2400 bps only a few years ago to 9600 bps today.

However, one element of the generation and exchange of information has not kept pace with the increased efficiency of communications circuits. That element is the speed with which an operator can enter data through a keyboard. As a matter of fact, it has not changed at all. Some applications permit waiting until enough information has been gathered to make transmission at high speed practical. But this approach requires that all such information be at one place prior to transmission. Some applications do not permit the economic gathering of all information at one place, and others require immediate response to the transmitted data. Various time-sharing services, airline reservation systems, etc., all come to mind as examples of the need to intercommunicate rapidly with a central facility from multiple remote points.

The growth of multiplexors can be traced directly to the need for high-volume, low-speed communications.

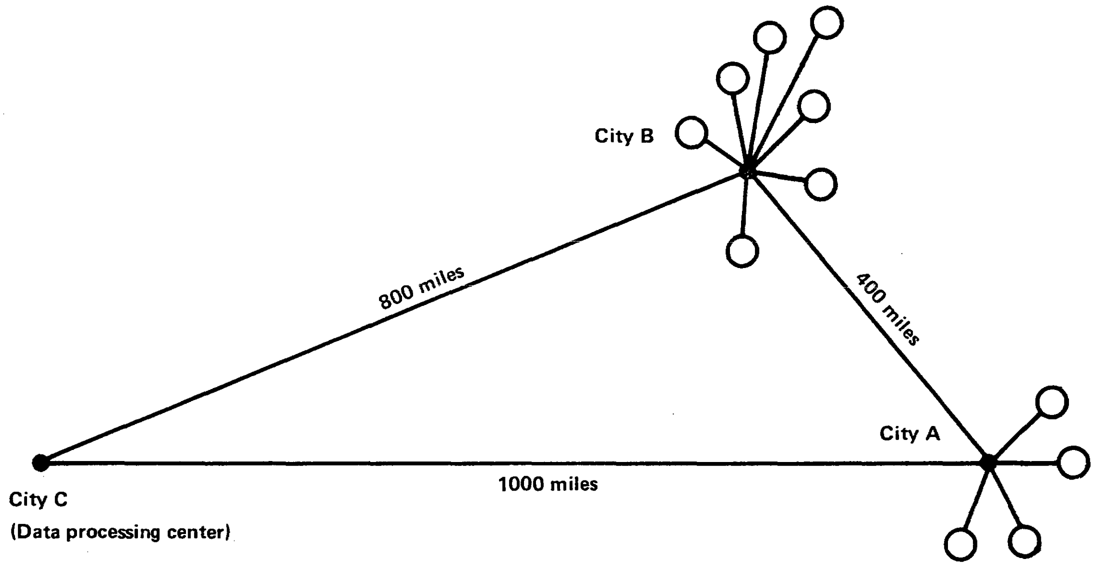
Multiplexing is an effective way to reduce your communications costs—under certain circumstances. In general, these circumstances can be reduced to two overlapping situations. Multiplexing should be considered within your communications network when:

- You need multiple, independent data paths between two points; or
- You have multiple data paths that parallel each other for a distance.

The second criterion includes the situation in which multiple points are communicating with a central point and the remote points lie along a more-or-less straight line.

The comparatively small size of the current multiplexor market (estimated at approximately $50 million worth of equipment shipped in 1974) and the small response to the Datapro user survey discussed later in this report indicates that only a small proportion of data communications users have yet begun to exploit the potential of multiplexing techniques and equipment. Large communications networks that encompass several wide-band facilities feeding a multiplicity of terminals via numerous multiplexors and concentrators are indeed impressive to contemplate—but to date the implementation of such networks has been largely limited to the very large corporations and, particularly, to the companies that offer time-sharing and other remote computing services.

All About Data Communications Multiplexors



Terminal-hours per day		Monthly Line Cost Using DDD	Difference in Line Costs Using Multiplexors	
City B	City A		Two Lines (AC & BC)	One Line (ABC)
6	4	$ 4,562	$ 2,754	$ 3,218
30	20	22,812	21,004	21,468
60	40	45,625	43,817	44,281

This example illustrates the potential for savings through the use of multiplexing techniques in place of Direct Distance Dialing. The indicated differences are for communications facility costs only and do not reflect the costs of the required multiplexing equipment, local lines between the terminals and the multiplexor, and additional modems. See the text for a complete explanation. The line costs are based on rates for Daytime telephone usage and Hi-Density to Hi-Density leased AT&T lines that were in effect March 1, 1975; rates for both DDD and private lines will probably rise in late March 1975.

Potential Dollar Savings

Implementation of a modern computer-based communications network for information processing involves selection of computers, modems, communications lines, terminals, and possibly programmable communications processors to serve as "front ends" for your computers. Why in the world would you want to complicate things with still more equipment and its associated requisites for evaluation, configuration, and system design? The answer can be expressed in two ways. One is to save money, a worthwhile objective for any business enterprise. Another way of saying essentially the same thing is to note that multiplexors can permit applications that are absolutely not economical to implement in any other way.

To get a basic feel for the subject, let's consider some practical examples. The accompanying diagram shows the requirements for a hypothetical system involving but three points. Assume that a central data processing facility is located in City C, together with multiple locations clustered around Cities B and A that need independent, rapid-turnaround communications with the processing facility in City C. Further assume that the locations clustered about Cities B and A are within local-call range of their respective cities.

Of the various possible approaches for configuring the system, we will consider three:

- Direct calls (DDD) from each location to the processing facility in City C.

- Leased voice-grade lines between Cities B and C and between Cities A and C. Each cluster of locations will be multiplexed over the respective leased line. For the sake of discussion, we will assume that line BC requires C2 conditioning and line AC requires no conditioning.

- A leased voice-grade line extending from A to B and then to C. C2 conditioning will be assumed.

The nature of the computations will be to see the differences in cost among the three arrangements for the communications facilities only. The differences will show the amount of money that can be spent on multiplexing equipment to achieve the same total costs. If multiplexing equipment can be acquired for less money, then that difference represents savings. The parameter used as a variable is terminal-hours, or the number of terminals multiplied by their average usage per day. This figure gives the cost of using DDD for communications. Use of the multiplexing equipment and leased lines is a fixed monthly cost and is independent of usage.

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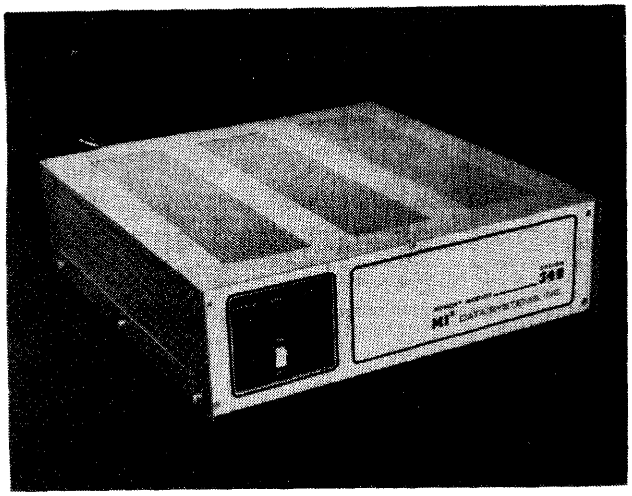

Designed around the Intel 8008 Microprocessor, the Design 349 Memory Module, produced by MI2 Data Systems, Inc., can be used as a remote concentrator. It can accommodate up to four terminals at speeds ranging up to 9600 bps.

From the chart in the illustration, you can see that the potential savings are great indeed, even for moderate terminal usage. Naturally, the calculations have been simplified to some extent, but they do include typical charges for modems for the leased lines. In this particular case, the greatest savings would probably be accomplished by routing one line from point A through B to C. In this arrangement, three "ends" would be required, one at each city. The multiplexing equipment would have to have multidrop capability, which would increase the cost of the individual stations, but probably not as much as the requirement for four "ends" for the arrangement using two leased lines into City C. The geographical locations would, of course, play an important role in determining the best configuration for a particular system. This method can be used to advantage to quickly gain perspective as to which of several arrangements offers the most potential.

One additional benefit of and reason for multiplexing is shown by this exercise. The entire cost differential between using DDD and leased lines can be saved by ignoring multiplexing and running a party line among all stations and the processing center at City C. But there are two serious drawbacks to this approach. One is that only one station at a time can communicate. This leads directly to the second limitation. At most, there are only 24 terminal hours available per day for the one line. Multiplexing, then, provides simultaneous data paths and greatly increases the capacity of a leased line in terms of the number of data exchanges that can be accommodate from low-speed terminals.

Cause and effect are difficult to establish in a communications network because of the many alternative arrangements that are possible. Each arrangement carries its own advantages and disadvantages, but in general, these boil down to tradeoffs between cost and flexibility. Two topics will serve to better illustrate the dilemma: centralized processing and use of the public telephone network (DDD).

The advantages of centralized processing are two-fold. The economies of scale can be utilized to provide more processing power for each dollar expended, and common data bases can be made available on a wider scale. On the other hand, multiple smaller computer centers provide the flexibility to tailor each center to the work it serves, which tends to reduce to some extent the economic advantage of the centralized operation. In addition, a malfunction does not knock out the whole operation. Decentralized processing facilities normally reduce communications costs as well.

With centralized operations you have the advantages of more processing power and common data bases. With decentralized operations you have an additional degree of flexibility, because each center can be run differently.

Using the public telephone network for high-volume transmission is admittedly one of the more expensive ways to do business. However, there is an additional degree of flexibility which may be the overriding concern. Using DDD, virtually any office can quickly become a communications point. Malfunctions in communications lines delay you only for the time required to redial (excepting, of course, natural disasters that knock out exchanges or portions of the lines).

The preceding, seemingly digressive, discussion merely points up the fact that multiplexors are only a tool for accomplishing a job, not an end unto themselves. They represent the lowest-cost method for implementing multiple, independent data paths between two points because they permit more efficient utilization of available communications facilities. They offer no intrinsic value other than the potential for reducing the costs of communications facilities.

Multiplexing Techniques

There are two basic techniques used to construct multiplexors: frequency division multiplexing (FDM) and time division multiplexing (TDM).

Frequency division multiplexing (FDM) is the older of the two technologies, having been used for over 30 years. To understand how FDM works, we must delve briefly into basic electronics. In general, different frequencies can be combined on one facility at one end and separated at the other. No information is carried as yet; only the presence of the frequencies has been established. To transmit information, we must modulate each of the frequencies present. At the other end, the modulated signal is first separated and then demodulated to recover the information. Modulation of one of the frequencies (sub-carriers) causes a signal to be generated of varying frequencies centered around the sub-carrier frequency. The range of frequencies generated is the bandwidth. Every communications facility has a total effective bandwidth, as a result of its physical properties, that restricts the maximum and minimum frequency that can be reproduced at the other end of the line.

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The bandwidth of a particular channel is dependent on the speed of the digital signal stream that it accommodates—the faster the bit stream, the larger the bandwidth generated. The conclusion is obvious. A particular communications facility can accommodate only so many channels of a particular speed. FDM is applied mainly to voice-grade lines. Signal streams of up to about 600 bps can be accommodate, but at that rate the maximum number of channels per line is two at most. FDM is most often used for transmission of data at conventional typewriter terminal speeds of 75 to 150 bits per second.

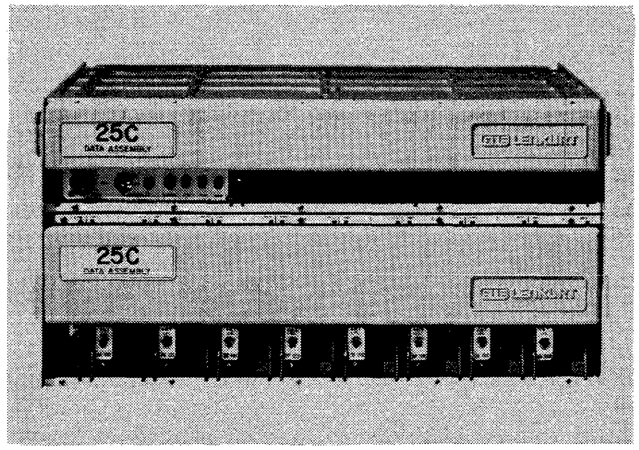
In general, the total capacity of a voice-grade line via FDM ranges from about 1800 bps (24 75-bps channels) down to about 1200 bps (two 600-bps channels). To achieve the maximum capacities, conditioning of the line is almost always required. The exact conditioning required depends on the particular line you happen to get. Under certain circumstances, such as a very long line with a very short local loop, an unconditioned line may perform almost as well as a conditioned one. If you have the time, some economy may be achieved by experimenting with conditioning.

Time division multiplexing (TDM) uses a different approach. This technique intersperses data elements from different sources into one bit stream. There are several approaches: bit or character interleaving and fixed or variable framing.

In the fixed-frame approach, a frame consists of one data element from each channel along with any timing information required. The data element can be a bit or a character. The data stream is decipherable because the data element from any one channel is always in the same location; e.g., the four bit or character. (Properly speaking, there is only one channel, which is the output data stream. Convention and convenience lead to the use of the term "channels" for the input data streams.)

In the variable-frame approach, data elements from each input source need not be present in each frame. Control information is transmitted with each frame to indicate which channels are present. The advantage of this approach is that blank spaces do not have to be transmitted when no information is coming in from an input source. This permits more channels to be handled than with a fixed-frame arrangement—provided that all channels are not active simultaneously for any length of time (several character times). This approach works well when data is being keyed in. It is not so good when data is being read in via paper tape or punched cards.

To accomplish the framing of the data elements, buffers are used to hold the incoming data streams. These are sampled at a constant rate in a cyclic manner to generate the output frames. Several bits or characters must be held to permit the synchronization of the sampling process and compensate for the vagaries of the independent data streams coming in.



GTE Lenkurt, a manufacturer of telecommunications equipment for the telephone and other industries for the past 25 years, offers low-speed frequency-division multiplexors for the data communications market. The 25C is available for channel speeds ranging from 75 to 600 bps, with the number of channels ranging from 25 to 4, respectively.

In general, bit multiplexing is less expensive to implement, while character multiplexing can be more efficient. The total capacity in bits per second that can be accommodated is generally about the same as or slightly higher than the output bit rate. The discrepancies between input bit rates and output bit rate occur because of the need to add control information and because the start/stop bits (or sometimes just the stop bits) may be stripped off the incoming asynchronous data characters.

A general comparison can be drawn between FDM and TDM. FDM devices usually cost less than TDM units. On the other hand, TDM units are usually more efficient than FDM devices, particularly on voice-grade lines if the higher-speed modems (4800 bps and above) are employed. (In this context, more efficient can be also stated as being able to accommodate more channels.)

Network Considerations

In the example given in the early part of this report, *multidrop* capability was used to further increase cost savings. The essential characteristic of this feature is that multiple geographic locations are involved, all transmitting to the central processing facility. Basically, the multidrop technique permits one leased line to carry the communications load for more than one location. As the data stream leaves each location, additional channels have been added; the appropriate channels are "stripped off" at each location for data being transmitted from the computer. This feature does not usually permit communications among the terminals using the same line (although some of the more sophisticated multiplexors can be arranged for this purpose). Frequently, intermediate legs of the leased line are operated at just the speed required to handle the portion of the load accumulated to that point; this can save you money on conditioning and data sets.

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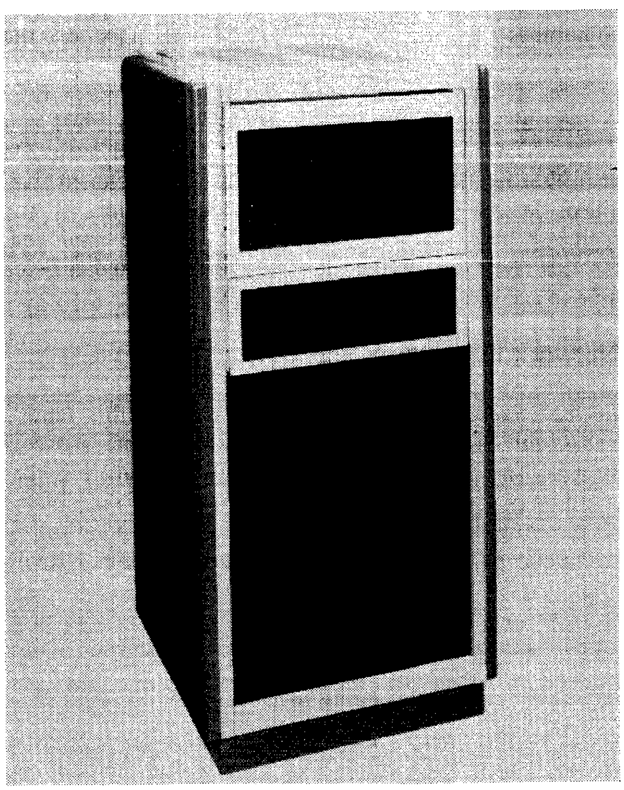
Another feature for additional cost savings is *contention.* This feature implies that more terminals are connected to the multiplexors than there are channels. If a terminal attempts to transmit while the line is being used at capacity, it will not be able to establish a connection. If the people using the terminals do not mind occasional delays, this technique is a good way to reduce communications costs by implementing less capacity than is required to handle the theoretical maximum load. This technique has long been successfully used in party-line (also called multidrop) arrangements where a number of terminals share a line, one at a time. If you investigate the contention technique, be sure to get the complete story about how a terminal is notified that it does not have a connection, and whether there is any arrangement for ensuring that a terminal can get access to the system (by using variable-period time-out devices, for example).

The overall considerations for network design are really the same with or without multiplexors. The easiest way to look at the inclusion of multiplexors within your network is to consider them as providing economical low-speed facilities between certain points. In effect, this adds to the list of communications facilities you can select from in configuring your network. The chief difference is that you have a finite number of facilities (low-speed lines) to draw on rather than the "infinite" pool of facilities from the common carriers. All of the conventional communications techniques, such as party lines, can still be employed, because the multiplexors are virtually "transparent"; i.e., your operations are essentially the same whether or not multiplexors are used.



Timeplex's T-96 belongs to a family of time-division multiplexors designed to provide flexibility in the configuration of complete networks. The T-96 can accommodate from 2 to 96 lines (typically 29 lines) at speeds up to 9600 bps. Timeplex is also a modem vendor.

Full transparency with regard to certain control signals associated with standard data sets is not always implemented. This consideration should be carefully checked with potential vendors if you include such operations as automatic disconnect and answering. Usually, transparency is of most concern in a system using contention or party-line arrangements.

Equipment Selection

The selection procedure for multiplexors is much the same as for any other piece of hardware, with a few exceptions. It is not usually possible to mix TDM equipment from different manufacturers. In some cases, FDM equipment can be mixed because of adherence to common channel frequency sets, but extreme care is recommended because the modulation techniques may be incompatible even if the frequencies are compatible.

The most confusing aspect of selecting multiplexors is the configuration rules regarding the intermixing of codes and speeds on the line. As the upper limit of the capacity of a voice-band line is approached, conditioning plays an important role. For TDM equipment, the selection of the modem to use on the high-speed side may govern the conditioning required.

Alternatives

In addition to the multi-port modems and programmable remote concentrators mentioned earlier in this report, common carriers provide multiplexing facilities under the name Datrex (AT&T) and Datacomm (Western Union). These services are discussed in *All About Data Communications Facilities,* Report 70G-100-01.

Users Speak

To assess the current usage patterns and the level of user satisfaction with data communications line multiplexors, a Reader Survey Form was included in the December 1974 supplement to DATAPRO 70. Even though one month longer than usual was allowed for reader responses, only 20 usable replies had been received by the editorial cutoff date of March 1, 1975. (This compares with 15 replies when we made a similar multiplexor survey 18 months ago.) Some users were using more than one type of multiplexor, so the replies represented a total of 26 product ratings. A total of 665 multiplexors were reported on, but 550 of these were from just 2 users. The 20 user replies represented just 7 percent of the number of replies to our modem survey two months earlier.

Several explanations for the low number of responses are possible. One may be that there are very few multiplexors in use. (Highly doubtful). A second is that Datapro doesn't reach the personnel responsible for handling multiplexors, who probably are more often located in

All About Data Communications Multiplexors

USERS' RATINGS OF DATA COMMUNICATIONS MULTIPLEXORS

Multiplexor Manufacturer and Model	Type	Number of Responses	Number of Units	Avg. Lines per Mux.	User Responses and Ratings																								
					Overall Performance					Hardware Reliability					Maintenance Service					Ease of Installation					Ease of Expansion				
					WA	E	G	F	P	WA	E	G	F	P	WA	E	G	F	P	WA	E	G	F	P	WA	E	G	F	P
Codex 800 series	TDM	3	7	6.3	3.7	2	1	0	0	3.0	1	1	1	0	3.0	0	3	0	0	3.0	0	3	0	0	3.0	0	3	0	0
Infotron	TDM	3	14	9.3	3.7	2	1	0	0	3.7	2	1	0	0	3.0	0	3	0	0	3.3	1	2	0	0	3.0	1	1	1	0
Timeplex T-16	TDM	11	48	8.5	3.4	5	5	1	0	3.5	6	4	1	0	2.1	1	2	5	3	3.0	2	7	2	0	3.3	5	4	0	1
Other FDM	FDM	5	554	17.8	3.8	4	1	0	0	3.6	3	2	0	0	3.0	1	3	1	0	3.0	1	3	1	0	3.4	2	3	0	0
Other TDM	TDM	4	9	18.0	2.3	0	2	0	1	2.3	0	2	0	1	2.0	0	1	1	1	2.7	0	2	1	0	2.3	0	1	2	0
Grand Totals	–	26	632	11.5	3.4	13	10	1	1	3.3	12	10	2	1	2.5	2	12	7	4	3.0	4	17	4	0	3.1	8	12	3	1

LEGEND: E—Excellent; G—Good; F—Fair; P—Poor; WA—Weighted Average based on a weighting of 4 for Excellent, 3 for Good, 2 for Fair, and 1 for Poor.

communications operations than in data processing operations. (Most likely.) A third possibility is that our readers didn't bother to reply. (Based on their gratifyingly high participation in our other surveys, almost certainly not the case.)

The accompanying table presents a summary of the product ratings assigned by the responding users. The entries are self-explanatory and need no exposition. It's clear that the users are generally well satisfied with the overall performance, hardware reliability, ease of installation, and ease of expansion of their multiplexors. Maintenance service was the one rating category that was downgraded by a significant number of the respondents.

Several questions were included in the Reader Survey Form to determine multiplexor usage patterns, including low-speed-side line types and speeds used, high-speed-side line types and speeds used, and multidrop usage.

All but two responses indicated the type of facility used between the terminals and the multiplexor. About one-third used DDD (the public telephone network) and about two-thirds used leased lines to establish the low-speed side connections. In response to the query about speeds used, the following tabulation, based on 26 responses, summarizes the answers:

Speed, bps (Low-Speed Side)	Number of Responses	Percent
75	1	4
110	11	42
134.5	12	46
150	1	46
300	13	50
600	2	8
950	1	4
1200	6	23
1800	1	4
2400	2	8
3000	1	4

The "percent" column totals more than 100 because 14 users reported the use of more than one speed.

For the output side, 22 responses indicated usage of a leased voice-grade line and 1 reported usage of a leased microwave facility; the other 3 responses included no indication. Only the users of TDM reported speeds for the output side; the following tabulation summarizes the 21 responses:

Speed, bps (High-Speed Side)	Number of Responses	Percent
2400	4	18
3600	1	5
4800	8	36
7200	4	18
9600	6	27

The "percent" column totals just over 100 percent because a few users with several multiplexors used them at different output speeds.

In response to the question about the use of geographically separated multiplexors feeding the same line, 20 responses indicated that all feeder lines were terminated at the same location, and 6 responses indicated that way stations were being used.

A final question probed specific causes of significant difficulties. A total of 20 of the 26 responses included check marks indicating one or more of the problems in the list below.

Problem	Number of Responses	Percent
Multiplexor hardware	6	23
Control code recognition	1	4
Diagnostic facilities	4	15
Line outages	5	19
Line quality	8	31
Modems	3	12

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The percentages reported above are based on the total sample of 26 responses, which means we assumed that if the user did not check any of the listed problems, he experienced no significant problems.

The Comparison Charts

The principal characteristics of 61 multiplexors from 30 manufacturers are presented in the accompanying comparison charts. All information in the charts was furnished by the vendors in January and February 1975; their cooperation with the Datapro Research staff in the preparation of these charts is greatly appreciated.

DATAPRO 70 sent repeated requests to a total of about 60 manufacturers thought to be in a position to manufacture multiplexing equipment. Of the 40-some replies, only the 30 companies represented in the charts actually produce equipment. Several manufacturers of programmable communications processors indicated that their equipment could be used for this purpose—which indeed it could, as could any general-purpose computer with appropriate communications interfaces. In fact, all of the equipment described in Report 70G-400-01, *All About Communications Processors,* should be considered if functions beyond just multiplexing are contemplated.

The absence of any specific company from our charts means that the company either failed to respond to our repeated information requests or was unknown to us.

The comparison chart entires and their significance to EDP users with substantial communications loads are explained in the following paragraphs, together with additional guidelines for equipment selection.

Manufacturer and Model identifies the subject device. For your convenience, a list of all manufacturers along with their addresses and telephone numbers precedes the comparison charts.

Multiplexing Technique identifies the method used for combing multiple data streams onto one communications facility. TDM refers to Time Division Multiplexing; bit or character refers to the interleaving level. FDM refers to Frequency Division Multiplexing. These techniques have been discussed earlier in the report, under the "Multiplexing Techniques" heading.

Network Features provides for identification of those devices capable of multidrop or contention operation. These concepts were also discussed earlier, under "Network Considerations." Briefly, *multidrop* refers to the capability for connecting lines to the main line at multiple points. *Contention* refers to the capability to control the situation where more terminals are connected to the line than there are channels.

Low-Speed Side refers to the terminal side where the low-speed lines are connected to the multiplexor, and/or to the computer side where the low-speed lines are fanned out into the computer I/O interfaces.

Low-speed side lines is a brief summary of the capabilities of the multiplexor to accommodate multiple lines. Complete information as to all configuration possibilities is, in most cases, beyond the scope of a comparison chart. In essence, more importance was attached to stating the range of line speeds and the maximum number of channels than to detailed configuration specifications.

The time-division multiplexors are particularly difficult to specify because of the general capability for operating over a wide range of speeds on the multiplexed side. Generally, a rough approximation of the number of lines operating at a specific speed can be obtained by dividing the multiplexed output rate by the input line rate. Typically, this number is conservative for lower input speeds and more exact for higher input speeds.

For FDM equipment, a rule of thumb for equivalent multiplexed speed is about 1800 bps (lower input speeds) to 1200 bps (higher input speeds). Full-duplex lines allow simultaneous transmission in both directions; a full-duplex line will generally accommodate half-duplex operation. Asynchronous transmission is that which uses start and stop bits; it is universally used by data communications equipment operating at up to 300 bps, and sometimes at up to 1200 bps.

The *Low-speed side interface* indicates physical connections. Common standards, which specify pin utilization for data and control signals and voltage levels for signals, include the EAI RS-232B and RS-232C (abbreviated 232B and 232C), MIL-188B and MIL-188C, and CCITT. The EAI standards are almost universally used in the U.S. for all commercial data communications terminals except some teletypewriter systems that connect directly to a communications facility through a current interface. There are a couple of the current interfaces in use, so be careful which you specify. The heritage of the multiplexor equipment is revealed in the numerous units that include a MIL-188B or C in their repertoire; this interface is a military standard. The CCITT is an international standard used mostly in Europe.

Other possible interfaces are various logic-level interfaces than enable connection directly to the logic-level outputs of a terminal or computer. There are many different types of logic-level interfaces, though they can be grouped into broad categories based on the type of solid-state devices used. If you are going this way, make sure the manufacturer knows exactly that he must interface with, and secure a specific commitment of compatibility.

In a few instances in the chrt, the range of interfaces provided is so wide that the entry "all" is appropriate; this indicates provision of all of the types discussed here.

Low-speed side code provides a reference for the data codes that can be accommodated. Precise terminology

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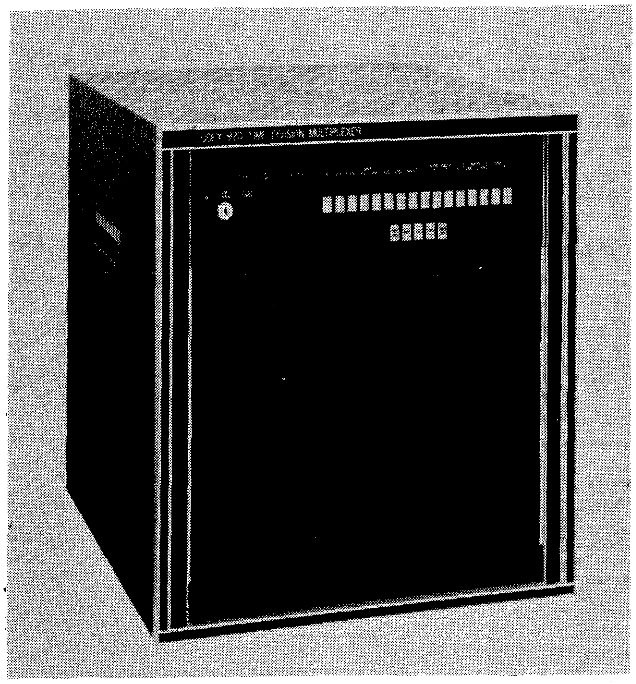


Produced by an industry leader and billed as the "Blue Mux," the Codex 920 provides for up to 64 low-speed channels (in increments of 16) with speeds ranging from 75 to 7200 bps. The unit's aggregate throughput, however, is limited to 9600 bps. The Codex 900 Series features RAM or ROM control logic that permits dynamic configuration changes initiated by the remote host computer and automatic speed detection.

would indicate that "level" refers to the data elements of a code exclusive of start and stop bits, while "unit" includes start and stop bits. The entries in the comparison charts follow the statements of the manufacturers where cross-checking with their documentation was inconclusive. Very possibly, some of the "level" entries should be "unit" entries. For the most part, this should be of importance only in special situations. There were no reported restrictions other than on the number of elements permitted.

Low-speed side speed intermix defines restrictions on the number of different input speeds that can be accommodated. Entries range from "any" to "one." TDM equipment usually requires a separate card containing clocking circuitry for each different speed. FDM equipment uses a different set of band-pass filters and subcarrier frequency set for each different speed. In many cases, intermixing speeds cuts down on the effectiveness of the multiplexor; i.e., the total allowable data rate for all input lines is decreased. In the case of FDM equipment, a parenthetical entry was added to show available channel capacities; each channel can be used at any speed from zero up to its capacity. TDM equipment is usually restricted to operation at those speeds implemented; but a wide range of speeds is normally available, with special situations accommodate on special order.

High-Speed Side refers to the side interfacing the leased line over which the multiplexed data is flowing. The high-speed side at one end of the multiplexed line faces the high-speed side at the other end. For some reason, manufacturers of FDM equipment balk at the term "high-speed side" but generally fail to replace it with one of their own. If you have difficulty talking to them, try using the term "multiplexed side."

High-speed side line identifies the type of facility used to transmit the multiplexed data stream. For the most part, the multiplexors in this survey operate over a leased voice-band line. A number of TDM devices can operate at much higher speeds using facilities with substantially higher bandwidths. A few can be configured to include more than one line on the high-speed side. Normally, this just adds to the number of low-speed lines that can be multiplexed, but it does raise some interesting network configuration possibilities. For additional information about the communications facilities available from the common carriers, see Report 70G-100-01.

High-speed side interface refers to the physical connection of the multiplexor to the communications line. Entries reading 232B or C as well as MIL-188B or C are explained above under *low-speed side interface.* Entries unique to the high-speed side include direct and Bell 300 series. All FDM equipment connects directly to the communications line. (The technical specification for this usually mentions 600-ohm balanced interface.) The Bell 300 series interface refers to the Bell System 300 series data sets used for high-speed transmission over wide-band lines. (Another name for this interface is high-speed current.)

High-speed side speed refers to the bit rate of the multiplexed data stream for TDM equipment; there is no equivalent characteristic for FDM equipment since transmission is parallel asynchronous.

Diagnostic Facilities is a nebulous area. Facilities range from lights that stay on or go off or blink, through meters with quivering needles, to switching arrangements called "loopback" that permit various portions of the system to be isolated to check proper functioning.

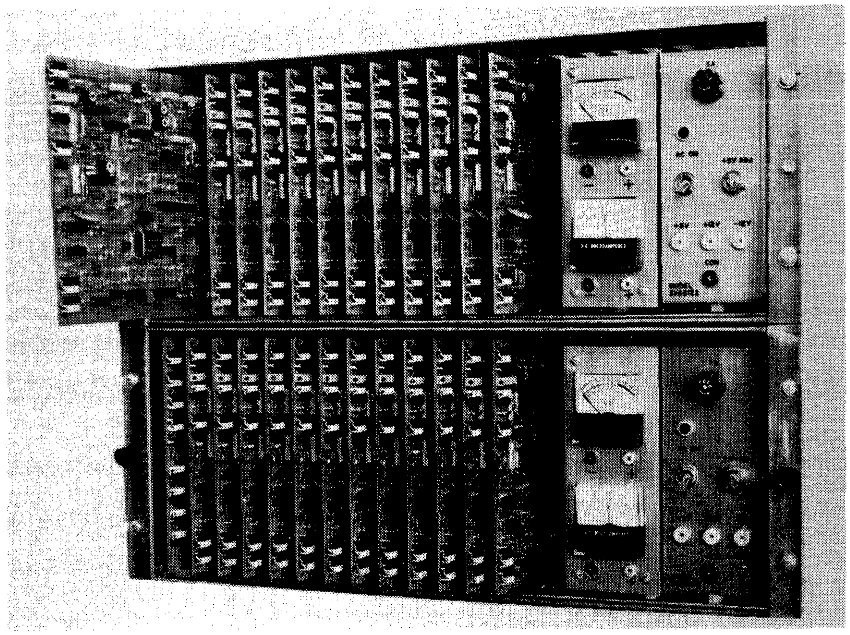
Loopback facilities are generally acknowledged as being very useful in that they eliminate the need for separate test equipment. The purpose of these facilities is to quickly determine the cause of a malfunction. A few can do this from one end, but most require cooperation between operators at each end and any way point (in a multidrop arrangement) for effective testing. This is an important point to check with current users of the equipment you are evaluating. (The appropriate question is "How long did it take to fix?")

Pricing and Availability is the bottom-line section of the charts that tells the costs of the facilities described in the upper part of the charts.

Purchase price typically shows a range for minimum to maximum configurations. In some cases, the manufacturers elected to provide specific configuration information; in others, the manufacturers declined to specify

All About Data Communications Multiplexors

This exposed view of Singer's Series 6000 Frequency Division Multiplexor illustrates the industry's typical packaging technique. Housed in a standard 19-inch chassis for rack mounting, the unit contains up to 24 circuit boards (12 per shelf), each containing a full-duplex channel capable of speeds up to 300 bps.



any pricing information at all. In general, pricing information is stated for one end only; to configure a system, two ends are required, unless you input the multiplexed data stream directly into the computer and use software to sort out the data. (This technique is not possible with FDM equipment.)

Monthly rental information was requested for a one-year lease period. Many manufacturers make two years the minimum lease period; this information is stated where applicable. Like purchase price, monthly rental is stated for one end.

Date of first delivery tells when the initial delivery of a commercial unit was made.

Availability indicates the length of time required to deliver the equipment after receipt of order (ARO). This figure could vary quite a bit due to varying production and other rates.

Number installed to date indicates the number of units that had been installed as of the writing of this report. FDM manufacturers most commonly replied in terms of the number of channels installed; with multiple channels per multiplexor, the actual number of units installed is substantially lower. (What an impressive figure it would make if computer manufacturers reported installation figures in terms of files created or programs written!)

Serviced by tells who performs equipment maintenance. A substantial number of manufacturers reported that they do their own servicing. If the name of another company appears in this entry along with the manufacturer's own name, it frequently means that the manufacturer handles certain geographical areas and the remainder are handled by the second company.

Comments is the place where you'll find those bits and pieces of information which may be of interest but which don't fit anywhere else in the charts.

Multiplexor Makers

Listed below, for your convenience in obtaining additional information, are the full names, addresses, and telephone numbers of the 30 manufacturers whose products are summarized in the comparison charts.

Anderson Jacobson, Inc., 1065 Morse Avenue, Sunnyvale, California 94086. Telephone (408) 734-4030.

Codex Corporation, 15 Riverdale Avenue, Newton, Massachusetts 02195. Telephone (617) 969-0600.

Coherent Communications Systems Corporation, 85D Hoffman Lane, South, Central Islip, Long Island, N.Y. 11722. Telephone (516) 582-4044.

Collins Radio Company, 19700 Jamboree Road, Newport Beach, California 92663. Telephone (214) 235-9511.

ComData Corporation, 7544 W. Oakton Street, Niles, Illinois 60648. Telephone (312) 692-6107.

Computer Transmission Corp. (Tran), 2352 Utah Avenue, El Segundo, California 90245. Telephone (213) 973-2222.

Comtech Laboratories, 135 Engineers Road, Smithtown, N.Y., 11787. Telephone (516) 231-5454.

Databit, 93 Marcus, Hauppauge, N.Y. 11787. Telephone (516) 231-5005.

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Dataproducts Corporation, Stelma Telecommunications, Commerce Drive, Stamford, Connecticut 06902. Telephone (203) 325-4161.

Digital Communications Associates, Inc., 2801 Clearview Place, Suite 400, Atlanta, Georgia 30340. Telephone (404) 458-6215.

General DataComm Industries, Inc., 131 Danbury Road, Wilton, Connecticut 06897. Telephone (203) 762-0711.

General Electric Company, Data Communication Products Department, Mountainview Road, Lynchburg, VA 24502. Telephone (804) 846-7311.

GTE Information Systems, Inc., One Stamford Forum, Stamford, Connecticut 06904. Telephone (203) 357-2000.

GTE Lenkurt Inc. (a subsidiary of GTE Information Systems), 1105 County Road, San Carlos, California 94070. Telephone (415) 591-8461.

Harris–RF Communication Division, P.O. Box 160, 325 West Hibiscus Blvd., Melbourne, FL 32901. Telephone (305) 727-6700.

Honeywell Information Systems, Inc., MS 093, 60 Walnut Street, Wellesley Hills, MA 02181. Telephone (617) 237-4100.

IBM Corporation, Data Processing Division, 1133 Westchester Avenue, White Plains, New York 10604. Telephone (914) 696-1900.

Infotron Systems, 7300 North Crescent Blvd., Pennsauken, NJ 08110. Telephone (609) 665-3864.

Livermore Data Systems, Inc., 2050 Research Drive, Livermore, California 94550. Telephone (415) 447-2252.

MI^2 Data Systems, Inc., 1356 Norton Avenue, Columbus, OH 43212. Telephone (614) 294-2694.

Prentice Electronics Corporation, 795 San Antonio Road, Palo Alto, CA 94303. Telephone (415) 327-0490.

Pulse Communications, Inc., a division of Harvey Hubbell, Inc., 5714 Columbia Pike, Falls Church, VA 22041. Telephone (703) 820-0652.

Pye TMC Canada, 15 Sheffield Street, Toronto, Ontario, Canada M6M 3E5. Telephone (416) 249-7044.

Quindar Electronics, Inc., 60 Fadem Road, Springfield, NJ 07081. Telephone (201) 379-7400.

RFL Industries, Inc., Powerville Road, Boonton, NJ 07005. Telephone (201) 334-3100.

Rixon Inc.(a subsidary of Sangamo), 2120 Industrial Parkway, Silver Spring, Maryland 20904. Telephone (301) 622-2121.

Singer Tele-Signal Corporation, 250 Crossways Park Drive, Woodbury, NY 11797. Telephone (516) 921-9400.

Sonex, Inc., (formerly I/Onex, a division of Sonex, Incorporated), Data Communication Products, 2337 Philmont Avenue, Huntingdon Valley, PA 19006. Telephone (215) 947-6100.

Tele-Dynamics, Division of AMBAC, 525 Virginia Drive, Fort Washington, PA 19034. Telephone (215) 643-3900.

Timeplex, Inc., 100 Commerce Way, Hackensack, NJ 070601. Telephone (201) 646-1155. □

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MANUFACTURER AND MODEL	Anderson Jacobson L154/12	Codex 910	Codex 920	Codex 930
MULTIPLEXING TECHNIQUE	FDM	TDM—char.	TDM—char.	TDM—char.
NETWORK FEATURES	Multidrop; contention	Unattended	Unattended	Multidrop; contention; unattended
LOW-SPEED SIDE				
Lines	1 to 4 @ 150 bps, half- or full-duplex, asynchronous	1 to 8 @ 75 to 7200 bps, full-duplex, 8 asynchronous or 2 sync. plus 6 async.	1 to 64 in 16-channel increments @ 75 to 7200 bps, full-duplex, up to 4 sync. per 16 channels	1 to 64 @ 75 to 7200 bps
Interface	232C	232C; CCITT; current	232C; CCITT; current	232C; CCITT; current
Code	Any	Any 5- to 8-level	Any 5- to 8-level	Any 5- to 8-level
Speed intermix	Any	Any	Any	Any
HIGH-SPEED SIDE				
Line	Voice-grade	Voice-grade	Voice-grade	Voice-grade
Interface	232C	232C; CCITT; MIL-188	232C; CCITT; MIL-188	232C; CCITT; MIL-188
Speed	—	1200, 2400, 3600, 4800, 7200, 9600	1200, 2400, 3600, 4800, 7200, 9600	1200, 2400, 3600, 4800, 7200, 9600
DIAGNOSTIC FACILITIES	—	Local and remote loop-backs; test pattern	Local and remote loop-backs; test pattern	Local and remote loop-backs; test pattern
PRICING AND AVAILABILITY				
Purchase price	Contact vendor	$1,500 to $4,000	$2,200 to $15,000	Contact vendor
Monthly rental, including maintenance (1-year lease)	$8 per channel end end	$80 to $175 (2-yr.)	$105 to $690 (2-yr.)	Contact vendor
Date of first delivery	1969	11/74	11/74	—
Availability (ARO)	60 days	60 days	60 days	—
Number installed to date	—	—	—	—
Serviced by	Anderson Jacobson	Codex	Codex	Codex
COMMENTS	Compatible with the IBM Shared Line Adapter	Features include RAM or ROM control logic, which permits dynamic configuration changes at mux. or from host CPU, automatic speed detection, automatic channel assignment, and off-line or on-line diagnostics; current loop interface is also available.		

All About Data Communications Multiplexors

MANUFACTURER AND MODEL	Codex 880	Codex 8000	Coherent Communications FDMA/FDMT	Coherent Communications SPMA-1
MULTIPLEXING TECHNIQUE	TDM—bit	TDM—bit	FDM	FDM
NETWORK FEATURES	—	—	Multidrop	Multidrop
LOW-SPEED SIDE				
Lines	1 to 8 @ 600 to 4800 bps, half- or full-duplex, synchronous; 9600 bps max.	1 to 20 @ 2400 bps, full-duplex, synchronous	from 36@ 50 bps to 1 @ 600 bps, full-duplex, asynchronous	4 @ 75 bps plus voice
Interface	232C; MIL-188C; CCITT	232C; CCITT	232C; current; DAA	232C
Code	Any	Any	Any 4- to 14-level	Any
Speed intermix	Any	Any multiple of 2400 bps	5 @ 110 bps to 1 @ 600 bps	Any
HIGH-SPEED SIDE				
Line	Voice-grade	Wideband	Voice-grade	Voice-grade
Interface	232C	Bell 303 modem; CCITT V.35	232C; CCITT; current loop	232C; CCITT; current loop
Speed	1200 to 9600 bps; automatic fall-back	48K to 64K bps	—	—
DIAGNOSTIC FACILITIES	Local and remote loopbacks; test pattern	Local and remote loopbacks; error detection	Local and remote alarms, loopback, metering	Loopback
PRICING AND AVAILABILITY				
Purchase price	$2,000 plus $350 to $900 per channel	$4,600 to $6,400 per channel end	$425 per channel end	$1,400 per channel end
Monthly rental, including maintenance (1-year lease)	$120 (2 channels, 2-year lease) per end	—	Contact vendor	Contact vendor
Date of first delivery	11/71	1/73	1969	1970
Availability (ARO)	90 days	30 days	45 days	45 days
Number installed to date	120	30	6,000 channels	2,000
Serviced by	Codex	Codex	Dow Jones	Dow Jones
COMMENTS	Multiplexors can be pyramided		Crystal controlled keyer and receiver	Signaling optional

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MANUFACTURER AND MODEL	Coherent Communications DPMA-1	Collins TE-75	Collins TE-110	Collins TE-150	Collins TE-300
MULTIPLEXING TECHNIQUE	FDM	FDM	FDM	FDM	FDM
NETWORK FEATURES	Multidrop	—	—	—	—
LOW-SPEED SIDE					
Lines	1 to 4 @ 75 to 1200 bps, full-duplex, asynchronous	1 to 24 @ 50 or 75 bps, half- or full-duplex, asynchronous	1 to 16 @ 75 or 110 bps, half- or full-duplex, asynchronous	1 to 12 @ 100 or 150 bps, half- or full-duplex, asynchronous	1 to 6 @ 200 or 300 bps, half- or full-duplex, asynchronous
Interface	232C	232C; CCITT V.24; TTL	232C; CCITT V.24; TTL	232C; CCITT V.24; TTL	232C; CCITT V.24; TTL
Code	Any	Any	Any	Any	Any
Speed intermix	2 @ 75 bps to 1 @ 1200 bps	Any	Any	Any	Any
HIGH-SPEED SIDE					
Line	Voice-grade	Voice-grade	Voice-grade	Voice-grade	Voice-grade
Interface	232C; CCITT; current loop	Direct; no modem required	Direct; no modem required	Direct; no modem required	Direct; no modem required
Speed	—	50 or 75 bps	75 or 110 bps	100 or 150 bps	200 or 300 bps
DIAGNOSTIC FACILITIES	Loopback	Local and remote loopback; test pattern gen.	Local and remote loopback; test pattern gen.	Local and remote loopback; test pattern gen.	Local and remote loopback; test pattern gen.
PRICING AND AVAILABILITY					
Purchase price	$2,300 per channel end	$505 per channel end	$505 per channel end	$505 per channel end	$545 per channel end
Monthly rental, including maintenance (1-year lease)	Contact vendor	$20 to $25 per channel end	$20 to $25 per channel end	$20 to $25 per channel end	$20 to $25 per channel end
Date of first delivery	1970	5/73	1974	1974	1974
Availability (ARO)	45 days	30 days	60 days	60 days	60 days
Number installed to date	600	500	250	750	100
Serviced by	Dow Jones	Collins	Collins	Collins	Collins
COMMENTS					

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MANUFACTURER AND MODEL	Collins TE-600	ComData Series 200	Computer Transmission (Tran) Multitran 1100	Computer Transmission (Tran) Multitran 2100	Computer Transmission (Tran) Multitran 1215
MULTIPLEXING TECHNIQUE	FDM	FDM	TDM—char.	TDM—bit	TDM—bit and char. interleaved
NETWORK FEATURES	—	Multidrop; contention	Multidrop	Multidrop	Multidrop
LOW-SPEED SIDE					
Lines	1 to 3 @ 400 or 600 bps, half- or full-duplex, asynchronous	From 18 @ 75 bps to 1 @ 1800 bps, full-duplex, asynchronous on unconditioned line; up to 1/3 more on conditioned line	1 to 127 half- or full-duplex, asynchronous @ 40 to 9600 bps	2 or more half- or full-duplex, asynchronous @ 40 to 4800 bps, synchronous @ 1200 to 250K bps, or combinations	1 to 12 half- or full-duplex, asynchronous @ 110 to 9600 bps, 1 to 4 @ any 2 asynchronous speeds to 250,000 bps, or combinations
Interface	232C; CCITT V.24; TTL	All	232C; MIL-188B; CCITT	232C; CCITT; MIL-188B	232C; MIL-188B; CCITT
Code	Any	Any	Any	Any	Any
Speed intermix	Any	Any (75, 110, 150, 300, 600, 1200, 1800 bps)	Any up to 8	Any	Any up to 10
HIGH-SPEED SIDE					
Line	Voice-grade	Voice-grade	1 to 8 voice-grade or wide-band	1 to 3 voice-grade and/or wideband	1 voice-grade or wideband
Interface	Direct; no modem required	Direct; no modem required	232C; MIL-188B; CCITT	232C; MIL-188B; CCITT	232C; MIL-188B; CCITT
Speed	400 or 600 bps	—	Up to 64,000 bps	Up to 2,000,000 bps	Up to 2,000,000 bps
DIAGNOSTIC FACILITIES	Local and remote loopback; test pattern gen.	Line and signal loopback	Built-in circuitry isolates malfunction to lines, data sets, multiplexors, or terminals	Built-in circuitry isolates malfunction to lines, data sets, multiplexors, or terminals	Built-in circuitry isolates malfunction to lines, data sets, multiplexors, or terminals
PRICING AND AVAILABILITY					
Purchase price	Contact vendor	$465 plus $325 per channel end	$4,800 up	$3,550 up	$5,800 plus $160 to $450 per channel end
Monthly rental, including maintenance (1-year lease)	Contact vendor	Full-payout leases available	$250 (2-year lease) up per end	$180 (2-year lease) up per end	$300 (2-year lease) up per end
Date of first delivery	1974	1/69	1972	1970	1973
Availability (ARO)	60 days	From stock	45 days	45 days	45 days
Number installed to date	—	—	250	500	25
Serviced by	Collins	ComData	Tran	Tran	Tran
COMMENTS	Available on special contract basis only	Can be configured to provide a voice channel and up to 6 data channels over the same line for about $500 extra each end	Automatic speed recognition on low-speed lines is standard		Automatic speed recognition on low-speed lines is standard; compatible with other family members

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MANUFACTURER AND MODEL	Computer Transmission (Tran) Multitran 3000	Comtech TDM-700	Databit 920	Databit 922	Dataproducts DATAPAK
MULTIPLEXING TECHNIQUE	TDM—char.	TDM—bit	TDM—bit	TDM—bit	FDM
NETWORK FEATURES	Multidrop; contention	Multidrop	Multidrop	Multidrop	Multidrop; contention
LOW-SPEED SIDE					
Lines	Up to 256 half- or full-duplex, asynchronous	From 204 @ 50 bps to 34 @ 300 bps, half-duplex, asynchronous	44 std.; 60 opt.; 40 to 1200 bps asynchronous; 1200/2400 bps synchronous; half- or full-duplex	46 to 138 @ 75 bps, half- or full-duplex, asynchronous	From 25 @ 75 bps to 1 @ 1800 bps, full-duplex, asynchronous or synchronous
Interface	232C; MIL-188B; CCITT	232C	232C; current	Current	All
Code	Any	Any	Any	Any	Any 5- to 8-level
Speed intermix	Any	Any	Any 6	Any	Any
HIGH-SPEED SIDE					
Line	1 to 8 voice-grade or wideband	Wideband	Voice-grade	Voice-grade	Voice-grade, unconditioned
Interface	232C	CCITT V.35 or direct	232C; internal modem	Direct; no modem required	Direct; no modem required
Speed	Up to 64,000 bps	56,000 bps	Up to 9600 bps	Up to 7200 bps	—
DIAGNOSTIC FACILITIES	—	Loopback	Extensive	Remote loopback	Local and remote loopback
PRICING AND AVAILABILITY					
Purchase price	$47,500 (basic)	$150 per channel	Contact vendor	Contact vendor	Under $500 per channel per end
Monthly rental, including maintenance (1-year lease)	$1,650 (5-year lease)	—	—	—	—
Date of first delivery	1973	—	1970	1970	6/69
Availability (ARO)	90 days	90 days	—	—	30 days
Number installed to date	5	—	40,000 channels	—	2500 channels
Serviced by	Tran	Comtech	Western Union	Western Union	Dataproducts and contract support
COMMENTS	Multiplexes output from Multitran units; can be expanded to 2048 channels in 256-channel increments and to 64 outputs in increments of 8			Designed for the Telex Network	Wide range of standard low-speed-side speed adapters; any speed on special request

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MANUFACTURER AND MODEL	Digital Communications Smart Mux	Digital Communications Minimux	Digital Communications PRC8	General DataComm Industries FDM 1150	General DataComm Industries TDM 1202
MULTIPLEXING TECHNIQUE	TDM—char.; block	TDM—char.; block	TDM—char.	FDM	TDM—char.
NETWORK FEATURES	Multidrop; contention	Multidrop; contention	Multidrop; contention	Multidrop; contention	Multidrop; contention
LOW-SPEED SIDE					
Lines	8 to 32 @ 110 to 1200 bps, full-duplex, asynchronous	1 to 7 @ 110 to 1200 bps, full-duplex, asynchronous	8 to 64 @ 50 to 2400 bps, full-duplex, asynchronous	From 37 @ 50 bps to 2 @ 600 bps, full-duplex, asynchronous	1 to 96 full-duplex, asynchronous; total of all channels approximates high-speed side line rate
Interface	232C; current; logic level	232C; current; logic level	232C; current; logic level	232C; DAA; MIL-188B	232C; MIL-188B; CCITT; current
Code	Any 5- to 8-level	Any 5- to 8-level	Any 5- to 8-level	Any	Any 5- to 8-level
Speed intermix	Any	Any	Any	Any (50, 75, 110, 134.5, 300, and 600 bps)	Any
HIGH-SPEED SIDE					
Line	Voice-grade	Voice-grade	Voice-grade	Voice-grade	Voice-grade or wideband
Interface	232C	DAA	232C	232C; DAA; MIL-188B	232C; CCITT; Bell 303
Speed	Up to 9600 bps	1200 bps	Up to 9600 bps	—	600 to 40,800 bps
DIAGNOSTIC FACILITIES	Loopback; optional remote test	Loopback; optional remote test	Loopback; optional remote test	Local and remote loopback	Local and remote loopback; in-service line validation
PRICING AND AVAILABILITY					
Purchase price	$13,000 to $35,000	$8,000	$18,000 to $50,000	Contact vendor	Contact vendor
Monthly rental, including maintenance (1-year lease)	$1,000 (average)	—	$1,200 (average)	Contact vendor; 2- and 3-year leases available	Contact vendor; 2- and 3-year leases available
Date of first delivery	1/75	4/75	2/74	1/71	5/69
Availability (ARO)	60 days	60 days	45 days	45 days	45 days
Number installed to date	—	—	12	—	—
Serviced by	Iomec	Iomec	Iomec	General DataComm	General DataComm
COMMENTS	Employs a DEC PDP-8/E or 8/M with 8K to 32K bytes of memory; software support included	Employs a DEC PDP-8/A with 2K ROM and 2K RAM; software is included	Employs a DEC PDP-8/E with 8K to 32K bytes of memory; software support is included		

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MANUFACTURER AND MODEL	General DataComm Industries TDM 1251	General Electric DigiNet 160	GTE Information Systems IS/8800	GTE Lenkurt 25C	GTE Lenkurt 25D
MULTIPLEXING TECHNIQUE	TDM—bit	FDM	FDM	FDM	FDM
NETWORK FEATURES	—	Multidrop	Multidrop;	Multidrop; contention	Multidrop; contention
LOW-SPEED SIDE					
Lines	1 to 62 @ 50 bps to 64K bps, half- or full-duplex, asynchronous or synchronous	From 12 @ 110 bps to 2 @ 600 bps, full-duplex, asynchronous over unconditioned line; conditioning adds 40 to 50 percent	From 25 @ 75 bps to 3 @ 600 bps, full-duplex, asynchronous	From 25 @ 75 bps to 1 @ 600 bps, full-duplex, asynchronous	From 25 @ 75 bps to 8 @ 200 bps, full-duplex, asynchronous
Interface	232C; CCITT; MIL-188B; Bell 303	232C; current	232C; current	232C; current; logic level	Current
Code	Any	Any	Any	Any	Any
Speed intermix	Any	Any (110, 150, 300, and 600 bps)	Any	Any (75, 110, 150, 200, 300, and 600 bps)	Any (75, 110, 150, and 200 bps)
HIGH-SPEED SIDE					
Line	Voice-grade or wideband	Voice-grade	Voice-grade	Voice-grade	Voice-grade
Interface	232C; CCITT; MIL-188B; Bell 303	Direct; no data set required	Direct; no data set required	Direct; no data set required	Direct; no data set required
Speed	2400 to 256K bps	—	—	—	—
DIAGNOSTIC FACILITIES	Local and remote loopback	Remote loopback; meter; carrier indication	Loopback	Local and remote loopback	Full-duplex/half-duplex test; remote loopback
PRICING AND AVAILABILITY					
Purchase price	Contact vendor	Contact vendor	$600 to $2,360	$450 up per end	$550 up per end
Monthly rental, including maintenance (1-year lease)	Contact vendor	Contact vendor	—	—	—
Date of first delivery	12/73	—	—	1971	1971
Availability (ARO)	45 days	—	90 days	Varies	Varies
Number installed to date	—	—	2,000 channels	—	—
Serviced by	General DataComm	GE	GTEIS	Lenkurt	Lenkurt
COMMENTS		Available for use with GE TermiNet printers only			

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MANUFACTURER AND MODEL	Harris—RF Communications Series 700 FDM	Honeywell HC-650	IBM Shared Line Adapter	Infotron Systems Timeline 240	Infotron Systems Timeline 450
MULTIPLEXING TECHNIQUE	FDM	TDM	FDM	TDM—char.	TDM—bit
NETWORK FEATURES	Multidrop; contention	—	Multidrop	Multidrop; contention	Contention
LOW-SPEED SIDE					
Lines	From 24 @ 75 bps to 3 @ 600 bps, full-duplex, asynchronous	1 to 6 @ 50 to 150 bps, full-duplex, asynchronous	1 to 4 @ 134.5 bps, half- or full-duplex, asynchronous	1 to 162; typical is 51 @ 110 bps to 17 @ 300 bps, full-duplex, asynchronous for 4800 bps output	2 to 254 @ up to 1800 bps, asynchronous; 2 to 32 @ 2400 bps, synchronous; full-duplex
Interface	232C; current; MIL-188C	232C; MIL-188C	232C	232C; current	232C; current
Code	Any	5-level Baudot	Any	Any, up to 8-level	Any
Speed Intermix	Any (75, 110, 150, 220, 300, and 600 bps)	Any	—	Any 7; any 10 optional	Any
HIGH-SPEED SIDE					
Line	Voice-grade unconditioned	Voice-grade	Voice-grade	Voice-grade	Up to 124
Interface	Direct; no data set required	MIL-188C	Direct; no data set required	232C	232C
Speed	—	100 to 2000 bps	—	Up to 9600 bps	Up to 2400 bps
DIAGNOSTIC FACILITIES	Manual loopback on each channel; automatic loopback indicators for data and carriers optional	Self-test	—	Local and remote loopback; remote status reporting and test control	Line and port status indicators
PRICING AND AVAILABILITY					
Purchase price	About $410 to $500 per channel per end	Contact vendor	$816 per channel per end	$3,160 (1 channel) to $56,355 (162 channels) per end	$6,220 (16 x 8)
Monthly rental, including maintenance (1-year lease)	—	Contact vendor	$21 per channel per end	Contact vendor	Contact vendor
Date of first delivery	6/71	—	—	7/71	1973
Availability (ARO)	30 days	—	—	30 days	30 days
Number installed to date	7,000 channels	—	—	—	—
Serviced by	Harris	Honeywell	IBM	Infotron	Infotron
COMMENTS	Simultaneous speech and data arrangement available	Supplies storage for up to 24,000 characters (12 pages)	These are actually independent modems arranged to operate at different frequencies	Purchase price includes warranty service; central logic redundancy with automatic switching in case of failure	Switches up to 254 inputs to up to 124 outputs; up to 7 partitions; auto speed recognition and/or CPU selection

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MANUFACTURER AND MODEL	Livermore Data Systems System 665	Livermore Data Systems System 670	MI^2 Data Systems 349M^2	Prentice P-SLA Shared Line Adapter	Pulsecom Series 4300
MULTIPLEXING TECHNIQUE	TDM—char.	TDM—char.	TDM—char. or message	FDM	FDM
NETWORK FEATURES	—	—	Multidrop; contention	Multidrop; contention	Multidrop; contention
LOW-SPEED SIDE					
Lines	8 to 45 @ up to 300 bps, half- or full-duplex, asynchronous	8 to 128 @ 15 to 1200 bps, half- or full-duplex, asynchronous	1 to 4 @ 75 to 9600 bps, full-duplex, asynchronous or synchronous	1 to 6 @ 134.5 bps, full-duplex, asynchronous	From 22 @ 75 bps to 6 @ 300 bps, full-duplex, asynchronous
Interface	232C; CCITT; current	232C; CCITT; current	232C; current	232C; current	232C; current
Code	Yes	Yes	Any 5- to 8-level	Any	Any
Speed intermix	Any 3	Any 7	Any	—	Any
HIGH-SPEED SIDE					
Line	Voice-grade	Voice-grade	Voice-grade	Voice-grade	Voice-grade
Interface	232C; CCITT	232C; CCITT	232C	Direct	232C; current
Speed	2000 to 9600 bps	1200 to 9600 bps	Up to 9600 bps	—	—
DIAGNOSTIC FACILITIES	Internal test	Local and remote loopback, internal test	—	Status indicators and loopback	Loopback
PRICING AND AVAILABILITY					
Purchase price	$1995 (8 chan.); $80 each add'l.	$2,800 to $20,000	$2,400 to $5,200	$200 per channel end plus enclosure	$325 per channel end
Monthly rental, including maintenance (1-year lease)	$225 (8 chan.); $7.50 each add'l.	$260 to $1,800	—	$15 per channel end	—
Date of first delivery	1966	1971	—	8/71	6/73
Availability (ARO)	30 days	60 days	90 days	30 days	30 days
Number installed to date	2,600	420	—	800	2,000
Serviced by	Livermore	Livermore	MI^2	Prentice	Pulsecom
COMMENTS			Portable data concentrator; weighs about 50 pounds; contains a 2,000-byte PROM and 14,000-byte RAM with microprocessor	Compatible with the IBM Shared Line Adapter	Ancillary data bridges, hubs, and special configurations are available

All About Data Communications Multiplexors

MANUFACTURER AND MODEL	Pye TMC ADS 670	Pye TMC Telegraph MVX	Quindar FM-124	RFL Industries Model 5150	RFL Industries Series 6850
MULTIPLEXING TECHNIQUE	TDM	FDM	FDM	FDM	FDM
NETWORK FEATURES	Multidrop; contention	Contention	Multidrop; contention	Multidrop	—
LOW-SPEED SIDE					
Lines	Up to 128 lines @ 75 to 1200 bps, half- or full-duplex asynchronous; 1 to 5 @ 1200 bps, synchronous	1 to 24 @ 50 to 300 bps, half- or full-duplex, asynchronous	From 24 @ 75 bps to 12 @ 150 bps, half- or full-duplex, asynchronous	From 24 @ 75 bps to 1 @ 600 bps, full-duplex, asynchronous	From 18 @ 85 bps to 2 @ 600 bps, full-duplex, asynchronous
Interface	232C; current; CCITT; DAA	CCITT	232C; current, CCITT	232; current; logic level	232C; current; logic level
Code	Any	Any	Any	Any	Any
Speed intermix	Any	Any	Any	Any (75, 110, 150, 200, 300, and 600 bps)	Any
HIGH-SPEED SIDE					
Line	Voice-grade or wideband	Voice-grade	Voice-grade	Voice-grade	Voice-grade
Interface	—	CCITT	Direct; no data set required	Direct; no data set required	Direct; no data set required
Speed	Up to 400,000 bps	—	—	—	—
DIAGNOSTIC FACILITIES	Seven loopback modes, including remote loopback	Status indicators and self-diagnostics	Status display; loopback	Analog and digital loopback	Carrier detect and receive data indicators
PRICING AND AVAILABILITY					
Purchase price	Contact vendor	Contact vendor	Contact vendor	$290 per channel end	$300 per channel end
Monthly rental, including maintenance (1-year lease)	Contact vendor	Contact vendor	Contact vendor	—	—
Date of first delivery	1968	—	1971	—	1/75
Availability (ARO)	3 months	—	4 to 6 weeks	—	60 days
Number installed to date	300	—	225	—	100
Serviced by	Pye	Pye	Quindar	RFL	RFL
COMMENTS			Compatible with the Bell System Data Station 1A		Voice and data can be mixed; AM and/or FSK modems included; channels can be combined for up to 8-state signaling

All About Data Communications Multiplexors

MANUFACTURER AND MODEL	Rixon TDX-4	Singer Tele-Signal 6000 Series	Singer Tele-Signal 7000 Series	Sonex 108	Sonex 116
MULTIPLEXING TECHNIQUE	TDM—bit	FDM	FDM	TDM—bit	TDM—bit
NETWORK FEATURES	—	—	—	—	—
LOW-SPEED SIDE					
Lines	From 4 @ 1200 or 2,000 bps to 2 @ 4800 bps, full-duplex, synchronous	8 to 24 @ 50 to 300 bps, full-duplex, asynchronous	8 to 24 @ 50 to 600 bps, full-duplex, asynchronous	1 to 8 @ 110, 134.5, 150, and 300 bps, full-duplex, asynchronous; max. total rate of about 1200 bps	1 to 16 @ 110, 134.5, 150, and 300 bps, full-duplex, asynchronous; max. total rate of about 2400 bps
Interface	232C	232C; current	232C; current	232C; current	232C; current
Code	Any	Any	Any	Any, up to 16-level	Any, up to 16-level
Speed intermix	Any	Any	Any	Any	Any
HIGH-SPEED SIDE					
Line	Voice-grade	Voice-grade	Voice-grade	Voice-grade, unconditioned	Voice-grade, unconditioned
Interface	232C	Direct; no data set required	Direct; no data set required	Direct; no data set required	Direct; no data set required
Speed	Up to 9600 bps	—	—	Tailored to number of channels	Tailored to number of channels
DIAGNOSTIC FACILITIES	Local loopback	Channel and aggregate loopback	Channel and aggregate loopback	Local and remote loopback; quality monitor; sync loss alarm	Local and remote loopback; quality monitor; sync loss alarm
PRICING AND AVAILABILITY					
Purchase price	$1,400	Contact vendor	Contact vendor	$2,675 per 8 channels	$7,000 per 16 channels
Monthly rental, including maintenance (1-year lease)	$75	Contact vendor	Contact vendor	Contact vendor	Contact vendor
Date of first delivery	2/72	1975	1974	1970	1971
Availability (ARO)	30 days	120 days	120 days	14 days	30 days
Number installed to date	75	—	1,000 channels	—	—
Serviced by	Rixon	Singer	Singer	Sonex	Sonex
COMMENTS					

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MANUFACTURER AND MODEL	Tele-Dynamics 7260	Timeplex MC-70	Timeplex T-4, T-16, & T-20	Timeplex T-96
MULTIPLEXING TECHNIQUE	FDM	TDM—char.	TDM—char.	TDM—char.
NETWORK FEATURES	Multidrop; contention	Multidrop; contention	Multidrop; contention	Multidrop; contention
LOW-SPEED SIDE				
Lines	12 @ 150 bps, 6 @ 300 bps, 2 @ 600 bps, full-duplex, asynchronous	25 to 71 @ 110 bps for 2400 to 9600 bps output line; other rates proportionate; std. speeds range from 45.5 to 1200 bps	2 to 112; typical is 29 @ 110 bps for 2400 bps output; std. speed range is 50 to 1200 bps	2 to 96; typical is 29 @ 110 bps for 2400 bps output
Interface	232C; MIL-188C	232C; MIL-188C; current; DAA	232C; MIL-188C; current; DAA	232C; MIL-188C; current; DAA
Code	Any	Any 5- to 8-level	Any 5- to 8-level	Any 5- to 8-level
Speed intermix	Any (75, 110, 150, 300, and 600 bps)	Any 3	Any 20	Any
HIGH-SPEED SIDE				
Line	Voice-grade, C-4	Voice-grade	Voice-grade; wideband	Voice-grade; wideband
Interface	Direct; no data set required	232C; MIL-188C	232; MIL-188	232C; MIL-188C; DAA
Speed	—	2400 to 9600 bps	600 to 22,000 bps	200 to 64,000 bps
DIAGNOSTIC FACILITIES	Carrier detect indicator	System and channel loopback; error counter	Remote loopback on each channel	Remote loopback
PRICING AND AVAILABILITY				
Purchase price	$5,400 (8 channels) each end	$5,217 (4 channels) to $8,067 (71 channels) per end	$1,175 (2 channels) to $4,485 (20 channels)	$2,760 (2 channels) to $16,480 (96 channels)
Monthly rental, including maintenance (1-year lease)	$28 per channel end	$500 (4 channels) to $760 (71 channels) per end	$108 (2 channels) to $412 (20 channels)	$254 (2 channels) to $1,520 (96 channels)
Date of first delivery	3/74	1969	1971	1973
Availability (ARO)	30 days	30-60 days	30-60 days	60 days
Number installed to date	200 channels	600	2,000	100
Serviced by	Tele-Dynamics	Timeplex	Timeplex	Timeplex
COMMENTS			Integral modem available for 1200 bps high-speed-side operation	

All About Data Communications Multiplexors

MANUFACTURER AND MODEL	Timeplex SMC-210	Timeplex B-96	Timeplex C-32 Concentrator	Timeplex CCE Contention Expander
MULTIPLEXING TECHNIQUE	TDM—bit	TDM—bit	TDM—bit	—
NETWORK FEATURES	—	Multidrop; contention	Multidrop; contention	Multidrop; contention
LOW-SPEED SIDE				
Lines	2 to 32 full-duplex, synchronous; rates can be integer or proper fraction of output line speed	2 to 96 full-duplex, asynchronous and synchronous	32 full-duplex, asynchronous or synchronous at up to 9600 bps	32 full-duplex, asynchronous or synchronous at up to 9600 bps
Interface	232; MIL-188C; coax cable; CCITT	232C; MIL-188C; current; Telex	232C; MIL-188C	232C
Code	Any	Any 5- to 8-level	Any	Any
Speed intermix	Almost any	Any	Any	Any
HIGH-SPEED SIDE				
Line	Voice-grade or wideband	Voice-grade	Up to 16	Up to 16
Interface	232C; MIL-188C; coax cable; CCITT	232C; MIL-188C	232C; MIL-188C	232C
Speed	2400 to 1,544,000 bps	200 to 9600 bps	Up to 9600 bps	Up to 9600 bps
DIAGNOSTIC FACILITIES	System and channel loopback; pattern generator	System and channel loopback	—	—
PRICING AND AVAILABILITY				
Purchase price	$5,200 (2 channels) to $10,500 (32 channels)	$2,760 (2 channels) to $16,480 (96 channels)	$3,690 (4 x 4) to $5,010 (32 x 16)	$1,165 (2:1) to $3,000 (24:1)
Monthly rental, including maintenance (1-year lease)	$480 (2 channels) to $966 (32 channels)	$254 (1 channel) to $1,520 (96 channels)	$340 (4 x 4) to $460 (32 x 16)	$110 (2:1) to $265 (24:1)
Date of first delivery	1970	1973	1973	1971
Availability (ARO)	60-90 days	90 days	60 days	60 days
Number installed to date	200	—	100	50
Serviced by	Timeplex	Timeplex	Timeplex	Timeplex
COMMENTS	Can be pyramided	Will handle WU Telex circuits	Switches up to 32 inputs to any of up to 16 outputs	Channel contention concentrator for a wide range of contention ratios

All About Remote Computing Services

Remote computing service companies owe their existence and rapid growth to the generally accepted principles that:

- Because of the inherent economics of computer production and operation, it's usually chapter to use a small piece of a large computer system than a large piece (or all) of a small one.
- Computers should be easy to use and should maximize the efficiency of the *people* who use them.
- Thousands of prospective users want and need a convenient, economical source of computer power.
- Present equipment, software, and communications technology makes it practical to divide the resources of a large computer system among many simultaneous users at remote terminals.

The currently available remote computing services can be broadly classified as either interactive time-sharing or remote batch processing services. Many companies now offer both types of services, and the distinctions between them are frequently blurred.

The economical Teletype Model 33 terminals (shown here with Teletype's cartridge-loaded Magnetic Tape Data Terminal) are still by far the most widely used terminals for time-sharing applications.

Remote computing companies are supplying a broad range of services to thousands of business firms of all sizes. This report explains interactive time-sharing and remote batch processing, describes their advantages and drawbacks, summarizes the current offerings of 97 remote computing companies, reports users' ratings of 30 of the leading companies, and provides straightforward guidelines for selecting the company that best meets your needs.

An *interactive time-sharing system* can be defined as a computer system that enables multiple users to gain simultaneous access to its facilities and to interact with the system in a conversational mode. A *remote batch processing system* can be defined as a system that enables users at remote locations to enter data, initiate the batch-mode execution of programs, and receive the resulting output data. Ideally, either type of system should give each user the impression that all the computational, storage, input/output, and software resources he needs are continuously at his disposal, while keeping him unaware of the fact that he is actually competing with many other customers for the use of these resources.

Though the remote computing concept is quite simple, its effective implementation turned out to be a difficult task for both equipment and software designers.

The first time-sharing systems were developed in the universities in the early 1960's, with M.I.T. and Dartmouth in the vanguard. The first commercial time-sharing services were established in 1965. Both the suppliers and the users of these early services had to overcome many problems, and progress was quite slow at first. But by 1968, time-sharing had become the hottest topic in the computer industry and the darling of Wall Street, and it seemed as if everybody was trying to get into the act.

Unfortunately, the economic crunch that began in 1969, coupled with the sadly misdirected technical and sales efforts of many of the young time-sharing firms, led to a severe shakeout. New customers were hard to find, and it became virtually impossible to raise capital to start a new remote computing company or nurture an existing one. Dozens of remote computing service firms merged with other companies, abandoned their remote computing efforts in favor of more promising activities, or closed their doors completely.

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THE REMOTE COMPUTING INDUSTRY TODAY

In the face of all these adverse conditions, more than 100 U.S. and Canadian remote computing companies have managed to survive. What's more, a goodly number of them are now showing profits on their remote computing operations.

Despite the problems that have been experienced by many of its suppliers, it's clear that remote computing is here to stay. It represents an effective solution to some or all of the information processing requirements of many companies, and new developments in equipment and software are steadily increasing the scope of its practical applications. Datapro's survey of remote computing users, which is summarized on page 70G-900-01h, indicated a high degree of user satisfaction with the overall effectiveness of the current commercial remote computing networks.

Total revenues for commercial remote computing services, including both interactive time-sharing and remote batch processing, rose from just $20 million in 1966 to an estimated $750 million in 1973, and the industry's revenues are currently growing at the rate of nearly 30 percent per year.

Until 1973, the leading supplier of remote computing services had long been General Electric Company, which entered the business in 1965 and has invested over $150 million in developing an international network that serves the United States, Canada, and Western Europe. A "super-center" in Cleveland contains more than 100 interconnected central processors and communications controllers. GE's new "Mark III" service combines interactive time-sharing, remote batch processing, and network data management services that provide rapid access to centralized information files.

Control Data Corporation became the largest supplier of computing services in January 1973, when it acquired IBM's Service Bureau Corporation as part of the out-of-court settlement of its antitrust suit against IBM. With SBC's revenues added to those of its own Cybernet service, Control Data grossed more than $100 million from computing services in 1973 – an estimated $30 million more than GE. It should be noted, however, that a significant portion of SBC's revenues are derived from conventional service bureau operations that do not involve communications links.

Other leading suppliers of remote computing services include Applied Logic Corporation, Computer Sciences Corporation, Com-Share, Cyphernetics Corporation, Honeywell Information Systems, International Timesharing Corporation, Leasco Response, McDonnell Douglas Automation Company, National CSS, On-Line Systems, Rapidata, Remote Computing Corporation, Tymshare, United Computing Systems, and University Computing Company. Each of these firms has made a multimillion-dollar investment in remote computing and offers a wide range of services over a broad geographical area. Not to be overlooked, however, are the dozens of smaller remote computing companies, which offer a wide choice of equipment, software, and services together with the possibility of more personalized attention to your specific needs.

WHY USE REMOTE COMPUTING?

Commercial remote computing services offer numerous attractive benefits to their users. Some of these benefits, indeed, are so compelling that many companies with large inhouse computer systems of their own are also heavy users of commercial remote computing networks. Here are some of the principal reasons for using remote computing services:

- *Flexibility.* Remote computing enables you to buy only as much computing power as you need and (except for fixed terminal costs and minimum service charges) to pay only for what you use. Thus, you can effectively "stretch" or "shrink" the size of your computer installation from day to day as your workload expands or decreases. You can use a remote computing service to handle the peak-period overloads on your in-house computer system. You can explore the possibilities of centralized data bases and management information systems at comparatively low costs and without any long-term commitments. What's more, you can deal simultaneously with two or more remote computing companies and take advantage of differences in their pricing structures, languages, and program libraries.

- *Ease of use.* In general, remote computing terminals are straightforward in operation and easy to learn and use. Programming languages such as BASIC, together with conversational-mode compilers and debugging aids, have made programming quite simple and fun to learn. The comparative simplicity of the terminals and their ease of operation has made interactive time-sharing an accepted mode of operation for numerous engineers and accountants who previously resisted all efforts to get them directly involved with computers.

- *Man/machine interaction.* Interactive time-sharing permits direct, instantaneous communication between humans and computers at affordable prices. Users can test and debug their programs as they write them, with the computer checking, guiding, and reassuring them at each step in the process. A similar dialog process between man and computer can greatly facilitate the solution of many engineering and

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scientific problems, and can provide managers with exactly the information they need for informed decision-making. What's more, time-sharing users can spend hours of "head-scratching" time at their terminals without holding up an expensive processor – although it should be noted that the terminal connect time usually costs from $5 to $15 an hour.

- *Fast turn-around.* Remote computing can greatly reduce the elapsed time between the submission of data to be processed and the delivery of the computed results. In the case of typical in-house batch computer systems, turn-around times usually range from several hours to several days. The remote computing user can simply sit down at his terminal, enter the data, initiate execution of the appropriate program, and get the results he needs, either at his terminal or on a suitable output device at the computer site, all with a minimum of delay.

- *Choice of languages.* Most remote computing suppliers offer a choice of several programming languages, making it quite feasible for each user within your organization to work with the language that best suits his problem and his background.

- *Application programs.* Most of the commercial remote computing companies are placing an ever-increasing emphasis upon the development of ready-made programs for specific applications. The availability of suitable application programs can save you thousands of dollars in programming costs and get you "on the air" much sooner.

- *Networks and data bases.* A number of companies now offer nationwide communications networks that permit users scattered around the country to access a centralized data base. These services can permit your company to enjoy most of the advantages of a widespread on-line communications network with centralized files at a fraction of the cost of setting up and operating your own. What's more, recent FCC decisions have opened the way for independent carriers to provide cheaper and more flexible data transmission facilities, which should spur further progress in this area. (It should be noted, however, that considerations of communications reliability, access control, file security, and flexibility of the available data manipulation and retrieval languages become particularly important in this type of application.)

- *Dedicated services.* Dozens of companies are now offering remote computing systems dedicated to providing a specific type of service. These systems can be divided into two basic classes: those that provide specialized computational or data processing services, and those that provide access to a single central data base. Examples of the first class include dedicated systems for hospital accounting, automobile dealer accounting, text editing, and civil engineering computations. Probably the best-known services of the data base type are the stock quotation services, automated credit bureaus, and reservation systems.

POTENTIAL DRAWBACKS

Despite its many benefits, remote computing can be a distinctly mixed blessing. Here are some of the potential drawbacks to watch out for:

- *Questionable reliability.* This is the question that should be uppermost in the minds of prospective remote computing users: Just how reliable is the service? Many of the early time-sharing networks earned a notorious reputation for being down (out of service) more often than they were up. Fortunately, a great deal of progress has been made since those days. Only 4 percent of the respondents to Datapro's 1973 survey of remote computing users rated the reliability of the services they were using as poor. Most of the system "crashes" that occur nowadays are of short duration and are followed by effective recovery procedures that minimize their impact upon users' operations.

  Unfortunately, the purveyors of time-sharing services are still being plagued by problems arising within the facilities of the telephone companies which provide the vital communications links between the computers and their users. The telephone companies are being severely criticized for their failure to provide the quality of service required for reliable data communications. Overall, the reliability of the existing remote computing services is more than adequate for most applications of the computational variety. But companies contemplating the use of remote computing for business data processing, where important files must be stored and processed with minimal errors, should pay careful attention to the reliability aspect.

- *Slow input/output.* In many of the current remote computing networks, input and output speeds are still limited to the 10 to 15 characters-per-second rates of conventional typewriter-style terminals. These low speeds are more than adequate for many applications, but in other cases they impose a severe restriction on throughput. To overcome this limitation, many remote computing companies now support 30-cps interactive terminals and/or much faster remote batch terminals.

- *Low computational efficiency.* The complex software required to coordinate and control the operations of multi-user interactive time-sharing systems usually

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requires large amounts of central processor time and memory space. As a result, the computational efficiency of many of the current systems is very low. From the user's point of view, this poor efficiency may or may not be a matter of concern, depending upon the manner in which the central processor costs are allocated.

- *Questionable data security.* When multiple users share a computer system, challenging problems are encountered in safeguarding the confidentiality and integrity of each user's programs and data files. Most of the commercial remote computing services have paid a good deal of attention to this security problem, combining special access protection with passwords and a variety of other techniques. Prospective users of any remote computing system should make sure that the available security provisions will adequately protect their interests.

- *System loading problems.* In addition to down-time resulting from the reliability problems discussed above, a remote computing system may be unavailable when you need it because the system is "saturated." Saturation occurs when a remote computing system is being accessed by the maximum number of users it is capable of serving simultaneously. As the load on a system grows heavier, response times tend to increase, turnaround times get longer, and throughput drops. Finally, when saturation is reached, no more users can be served until someone completes his job and disconnects. Unfortunately, the heavy system loading conditions that are so frustrating for users often represent high-profit situations for the suppliers. Among the remote computing users who responded to Datapro's recent survey, 5 percent judged the response time to be poor and 18 percent rated it only fair.

- *High communications costs.* Unless you choose a remote computing company that offers "free" or fixed-cost local access in your area, communications costs can easily represent the largest component of your remote computing bill. One of the problems is that it is usually necessary to use standard voice-grade telephone lines, with a practical data-carrying capacity of 4800 bits per second or more, to transmit teletypewriter data at 110 bits per second. Needless to say, the user pays for this inefficiency. Prospective remote computing users should carefully investigate the communications costs they will encounter and make every reasonable effort to minimize them.

- *High data storage costs.* The costs associated with on-line storage of large data files at the remote computer center may rule out some applications that otherwise seem made to order for remote computing. Based on a typical monthly charge of $1.00 per 1,000 characters stored, it would cost $800 per month just to keep a file of 10,000 80-character records on-line. The cost of storing the programs to manipulate the file would further increase the user's monthly bill.

- *Loss of control.* When interactive time-sharing terminals are installed in a company, their ease of use and undeniable appeal often lead to their utilization for many problems that could more economically be handled by a desk calculator, a slide rule, an in-house computer, or a conventional service bureau. As a result, the bill for remote computing services is likely to escalate beyond management's wildest dreams. Therefore, it's important to establish and enforce proper control procedures. But controlling the access to and utilization of multiple terminals can be considerably more difficult and frustrating than administering a centralized computer facility. It can help a lot if the remote computing network requires each user to identify himself with a password and a department or project charge number.

- *Man/machine communication barriers.* A mundane but nonetheless important factor that militates against the dream of giving every manager and/or every engineer direct access to a central computer utility is that fact that most of these prospective users lack the typing skill that is now required for efficient man/machine communication. It is safe to predict that this problem will eventually be solved through the use of simplified keyboard layouts and through gradual development of the necessary keying skills. In addition, more direct input techniques, such as light pens and touch-sensitive display tubes, will receive increased development emphasis and wider usage.

REMOTE COMPUTING FOR SCIENTISTS

Scientific, engineering, educational, and other predominantly computational applications are the ones for which time-sharing computer systems were originally conceived and developed, and they still comprise the bulk of the workload for many of the commercial remote computing services. Users with problems of the computational type can take full advantage of most of the previously discussed advantages of remote computing: flexibility, ease of use, direct man/machine interaction, fast turn-around times, program libraries, etc.

Time-sharing computer systems, when properly utilized, can open up new dimensions in productivity, creativity, and job satisfaction for scientists, engineers, financial analysts, applied mathematicians, and many other professionals. Examples of specific applications have been documented in dozens of articles in the trade press during the past few years.

From the viewpoint of the remote computing suppliers, the only disappointing aspect of these computational-type

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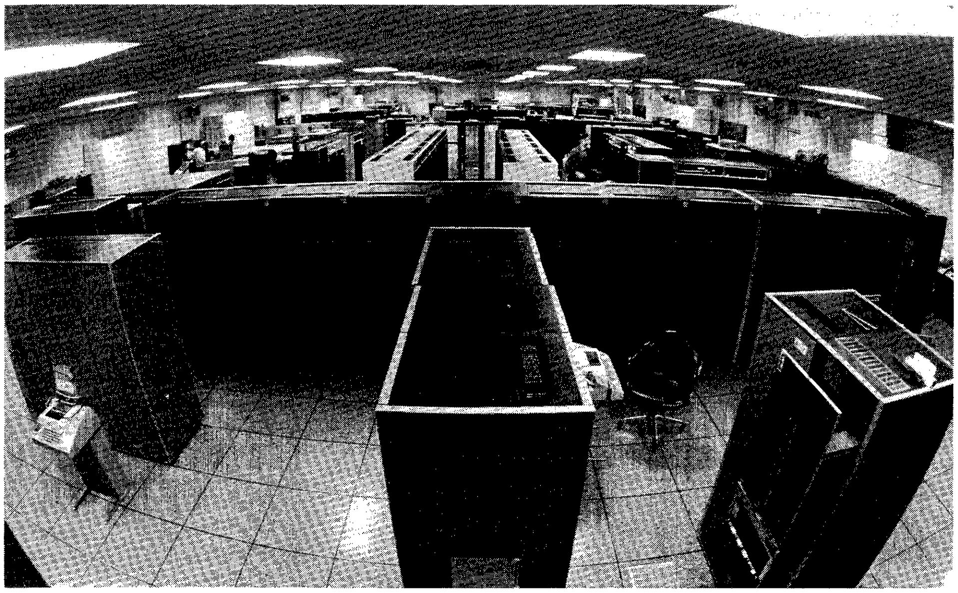

This panoramic view shows the eight DEC PDP-10 computers, configured in pairs, that provide the processing power for Applied Logic Corporation's AL/COM Time-Sharing System.

applications has been the gradual realization that the total potential market for them is far smaller than the market for business data processing services. And remote computing has really only begun to tap the latter market.

REMOTE COMPUTING FOR BUSINESSMEN

Just a few years ago, many observers of the EDP industry were predicting that the availability of remote computing services would quickly revolutionize the business world. One or more terminals in every business establishment, tied into a powerful central computer, would handle the company's bookkeeping, billing, payroll, inventory control, and many other vital functions – and do all this at an irresistibly low cost.

These predictions may yet come true, but it is now apparent that it's going to be a long, gradual process rather than a rapid revolution. The use of both interactive time-sharing and remote batch processing for business functions is growing steadily now, but the rate of acceptance has been well below the early predictions. The prognosticators apparently overlooked – or underestimated the impact of – four important factors.

First, a remote computer, like every other computer, must be *programmed* before it can solve anybody's problems. Few small business firms have employees capable of analyzing and programming their data processing requirements, and few have been willing to pay an outside firm thousands of dollars to write the programs they need. This means that suitable readymade application programs are a virtual necessity for any remote computing supplier vying for business data processing accounts – yet the suppliers have been surprisingly slow to develop and offer such programs. There has, however, been significant recent progress in this area. As shown by the chart on the last two pages of this report, many of the remote computing companies now offer programs to handle accounts payable, accounts receivable, general ledger, payroll, inventory control, and other common business functions. Moreover, most of the suppliers offer programming services to tailor their "packaged" programs to the specific needs of each user.

Second, small businessmen tend to be quite conservative and set in their ways. Very few of them are anxious to plunge into the use of a new and unperfected technology. They tend to be understandably apprehensive about storing their vital, confidential files in a computer system that is located miles away and shared by many other simultaneous users. The remote computing suppliers seem to be gradually learning how to answer the questions and dispel the doubts of these prospective customers, but their penetration of the huge business data processing market continues to be relatively slow.

Third, the previously discussed reliability problems have caused many companies to reject the use of remote computing for applications in which undetected errors and missed deadlines cannot be tolerated. Outright rejection of remote computing on these grounds alone probably represents an unduly harsh judgement. In designing a remote computing application – as in any business data processing function – the systems analysts and programmers should attempt to anticipate every possible source of error and then incorporate appropriate controls and checks to detect and overcome these errors. When this is done, present commercial remote computing systems should be able to satisfy all reasonable requirements for reliability and security in data processing applications.

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Fourth, the 10-character-per-second Teletypewriter input/output speeds of the early commercial time-sharing services made them unsuitable for any data processing function that involved large volumes of input and/or output data. In order to qualify for a broader range of business applications, many of the remote computing companies are now offering both faster typewriter-style terminals, with speeds in the 30-character-per-second range, and high-speed batch-mode terminals capable of reading cards and printing reports at 120 to 600 characters per second.

Thus, definite progress is being made toward overcoming the main obstacles against widespread use of commercial remote computing systems for business applications. Three other recent trends seem destined to help accelerate the swing toward remote computing for business data processing:

- The establishment of dedicated systems designed to satisfy the data processing requirements of specific types of businesses.
- The development of nationwide networks that enable users in many different locations to access a central data base. (The most impressive current examples are GE's international network, which is available by local telephone in over 300 cities in the U.S. and Canada and over 25 cities in Western Europe, and Tymshare's TYMNET, which uses more than 60 special communications processors and over 40,000 miles of leased Bell System lines.)
- The availability of a wide range of application programs from sources other than the remote computing companies themselves. A promising concept called "piggy-backing" involves the development of application programs by independent software firms and the marketing of these programs for operation on specific remote computing systems.

THE FUTURE OF REMOTE COMPUTING

The advantages of remote access to large computer systems are so obvious and attractive that the number of users and applications are bound to increase dramatically in the years to come.

On the basis of current trends and projections, it seems likely that the remote computing industry of the future will shape up this way:

- There will be several large, nationwide suppliers of remote computing services. These will be true "information utilities," offering a broad range of computational, information retrieval, and communications services to users throughout the country (and perhaps the world).
- The smaller remote computing companies that survive will generally do so by offering highly specialized services to specific types of business firms. Companies attempting to market plain "computing power" will find it increasingly difficult to stay alive.
- Many current users of commercial remote computing services will install their own in-house computer systems. Some companies will install small computers (such as the IBM System/3 or the proliferating minicomputers) to replace individual time-sharing or remote batch terminals, while others will install full-barreled in-house time-sharing systems of their own. To make up for these lost customers and maintain their growth, the remote computing suppliers will have to keep on attracting new customers, primarily from the huge ranks of small business firms.
- Remote computing users will have an ever-growing variety of "packaged" application programs to choose from. These will be developed by both the remote computing companies and independent software firms. "Piggy-backing" of specialized services on existing remote computing networks will continue to increase.
- Finally, both suppliers and users will begin to take advantage of the fact that the nationwide remote computing networks can be used effectively for a broad range of communications functions, as well as for computation and information retrieval. The same remote computing system that satisfies a company's computational needs and holds its data files will also be able to handle its message transmission, data collection, report distribution, and other communications requirements.

When the remote computing companies offer this broad spectrum of services, and when a large number of business firms accept and use them on a daily basis, the age of the "information utility" will have arrived at long last. At the present time, however, remote computing users have to settle for much less. The guidelines and comparison charts that follow will help prospective users to assess what's available today and how it can aid in solving their information processing problems.

USER EXPERIENCE

To access the current level of user satisfaction with specific remote computing companies and with remote computing techniques in general, Datapro Research Corporation conducted an extensive user survey. A Reader Survey Form on Computer Time-Sharing Services was included in the September 1973 supplement to DATAPRO 70 and mailed to all subscribers. By November 1, usable responses had been received from 141 users of commercial remote computing services in the United

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States and Canada. Some users reported their experiences with as many as 4 different remote computing companies, and the average number of companies mentioned was 1.75. Thus, it is apparent that many organizations are finding it advantageous to use the services of two or more suppliers concurrently.

It should be noted that the 141 DATAPRO 70 subscribers who responded to our survey do not necessarily constitute a representative sample of "typical" remote computing users. Furthermore, the small sample sizes for many of the services make it unwise to draw firm conclusions from the indicated ratings. If the reader will keep these caveats in mind, we believe the survey results that follow can be of considerable value to users and prospective users of the commercial remote computing services.

The responding users were asked to rate each remote computing service they were using by assigning a rating of Excellent, Good, Fair, or Poor to its overall effectiveness, reliability, response time, languages and compilers, application programs, technical support, and economy. The individual user ratings earned by 30 remote computing companies are summarized in the accompanying table.

A "Weighted Average of All Ratings" was calculated for each company by assigning a value of 4 to each user rating of Excellent, 3 to Good, 2 to Fair, and 1 to Poor. Among the 13 companies rated by 5 or more users, those that earned the highest average ratings were: International Timesharing Corporation (rated 3.20 by 7 users), Cyphernetics Corporation (rated 3.17 by 7 users), Computer Sciences Corporation (rated 3.15 by 7 users), Rapidata, Inc. (rated 3.12 by 6 users), On-Line Systems, Inc. (rated 3.03 by 5 users), and The Service Bureau Corporation (now a Control Data subsidiary; rated 3.01 by 28 users). Highly regarded companies mentioned by fewer than five users included Scientific Time Sharing Corporation (rated 3.50 by 2 users) and Metridata Computing, Inc. (rated 3.19 by 3 users).

The ratings assigned by all of the responding users can be combined to form the following overall picture of user satisfaction with the current remote computing services:

	Excellent	Good	Fair	Poor
Overall effectiveness	30%	57%	11%	2%
Reliability	32%	51%	13%	4%
Response time	27%	50%	18%	5%
Languages and compilers	28%	57%	13%	2%
Application programs	22%	48%	24%	6%
Technical support	23%	40%	26%	11%
Economy	16%	45%	31%	8%

These figures make it clear that users are quite pleased with the overall effectiveness of the current remote computing services, and also with their reliability and with the languages and compilers they offer. On the other hand, there is still ample room for improvement in the areas of technical support, economy, application programs, and response time.

The communications terminals used by the survey respondents were as follows:

Terminal	No. of Users	% of Total
Teletype Model 33	53	38
GE TermiNet 300	32	23
UNIVAC DCT 500	21	15
Teletype (model not specified)	15	11
IBM 2741	14	10
Texas Instruments Silent 700 Series	12	9
Hazeltine 2000	10	7
Anderson-Jacobson (all models)	9	6
CTS Execuport	6	4
Memorex 1200 Series	6	4
Teletype Model 35	6	4
Computer Devices (all models)	5	4
Novar (now GTE; all models)	5	4
ITT Asciscope	4	3
NCR 260	3	2
Teletype Model 38	3	2
Other interactive terminals	31	22
Remote batch terminals (all makes and models)	14	10

The number of different types of terminals used by individual respondents ranged from 1 to 7 and averaged 1.74.

The programming languages used by the survey respondents were as follows:

	No. of Users	% of Total
BASIC	102	72
FORTRAN	92	65
COBOL	29	21
PL/1	14	10
Assembly (all types)	7	5
APL	4	3
ALGOL	2	1
None*	4	3
All other languages	14	10

* Apparently these users relied completely on "packaged" application programs.

The number of different programming languages used by individual respondents ranged from 1 to 5 and averaged 1.90.

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USERS' RATINGS OF REMOTE COMPUTING SERVICES

Company*	No. of User Replies	Weighted Average of All Ratings**	Users' Ratings**																											
			Overall Effectiveness				Reliability				Response Time				Languages and Compilers				Application Programs				Technical Support				Economy			
			E	G	F	P	E	G	F	P	E	G	F	P	E	G	F	P	E	G	F	P	E	G	F	P	E	G	F	P
ACTS Computing Corp.	2	2.93	0	2	0	0	0	1	1	0	0	1	1	0	0	2	0	0	0	2	0	0	0	2	0	0	1	1	0	0
Allen-Babcock Computing	3	2.33	1	0	1	1	0	1	1	1	1	0	0	2	0	3	0	0	0	0	2	1	0	1	2	0	1	1	1	0
Compu-Serv	2	3.07	1	1	0	0	0	1	1	0	1	1	0	0	1	1	0	0	0	1	0	1	0	1	1	0	2	0	0	0
Computel Systems Ltd.	2	2.92	0	1	1	0	1	0	1	0	1	0	1	0	1	1	0	0	0	1	0	0	1	0	0	1	0	2	0	0
Computer Sciences Canada	3	2.48	0	2	1	0	0	2	1	0	0	1	2	0	0	0	3	0	0	2	1	0	0	2	1	0	0	1	2	0
Computer Sciences Corp.	7	3.15	3	3	1	0	2	4	1	0	4	3	0	0	5	1	1	0	1	5	0	0	1	4	1	1	0	4	3	0
Com-Share, Inc.	4	2.68	0	4	0	0	1	2	1	0	0	1	2	1	2	2	0	0	0	2	2	0	0	2	1	1	0	2	2	0
Control Data Corp.	6	2.62	2	4	0	0	0	3	1	2	1	3	2	0	0	4	1	1	2	1	2	1	0	2	2	2	1	3	2	0
Cyphernetics Corp.	7	3.17	2	5	0	0	2	5	0	0	1	5	1	0	2	5	0	0	2	4	1	0	1	4	1	0	1	5	0	0
DatalineSystems Ltd.	3	3.05	2	1	0	0	0	2	1	0	1	1	0	1	1	2	0	0	0	3	0	0	1	1	1	0	1	1	1	0
Data Resources Inc.	2	3.07	1	1	0	0	1	1	0	0	0	0	1	1	0	2	0	0	1	1	0	0	2	0	0	0	0	1	1	0
Dialcom, Inc.	2	2.50	1	0	0	1	0	1	0	1	1	0	1	0	0	1	1	0	0	1	1	0	0	0	1	1	1	1	0	0
General Electric Co.	51	2.98	16	30	5	0	20	26	5	0	19	23	9	0	15	28	6	0	12	25	12	1	7	31	16	6	4	19	21	6
Honeywell Information Systems, Inc.	3	2.81	0	2	1	0	0	3	0	0	0	3	0	0	0	1	2	0	1	1	1	0	0	2	1	0	0	3	0	0
Interactive Data Corp.	2	2.57	0	1	1	0	0	2	0	0	0	1	1	0	0	2	0	0	0	2	0	0	0	0	2	0	0	1	0	1
International Time-sharing Corp.	7	3.20	2	5	0	0	2	5	0	0	2	5	0	0	2	4	0	0	1	4	1	0	3	1	2	0	2	3	2	0
Leasco Response, Inc.	6	2.63	1	4	0	0	1	1	3	0	1	1	3	0	0	3	1	1	0	1	4	0	0	2	2	1	2	2	1	0
Manufacturing Data Systems, Inc.	2	2.86	0	2	0	0	1	1	0	0	1	1	0	0	0	2	0	0	0	2	0	0	0	1	1	0	0	0	1	1
McDonnell Douglas Automation Co.	2	2.93	1	1	0	0	1	1	0	0	0	2	0	0	0	2	0	0	1	0	1	0	0	1	1	0	0	0	2	0
McGill University	3	2.90	0	2	1	0	1	1	1	0	0	3	0	0	2	1	0	0	1	1	0	1	1	0	1	1	1	0	1	0
Metridata Computing, Inc.	3	3.19	1	2	0	0	2	1	0	0	2	1	0	0	2	1	0	0	0	1	1	1	2	0	1	0	0	2	1	0
National CSS, Inc.	15	2.97	4	8	2	0	3	9	0	2	2	9	3	0	6	8	0	0	3	5	4	0	2	7	3	2	0	7	5	2
On-Line Systems, Inc.	5	3.03	1	3	0	0	1	3	0	0	2	2	1	0	2	2	0	1	1	3	0	0	1	2	2	0	0	2	2	0
Rapidata, Inc.	6	3.12	1	4	1	0	4	2	0	0	1	5	0	0	3	3	0	0	3	3	0	0	1	3	1	1	0	3	2	1
Remote Computing Corp.	5	2.74	1	2	1	1	1	3	0	1	1	1	2	1	1	3	0	0	1	3	0	1	0	4	0	1	1	2	2	0
Scientific Time Sharing Corp.	3	3.50	2	0	0	0	1	1	0	0	1	1	0	0	1	1	0	0	2	0	0	0	1	1	0	0	0	1	1	0
Service Bureau Corp.	28	3.01	9	17	2	0	10	12	6	0	10	13	5	0	6	17	5	0	6	17	4	0	10	12	5	1	2	7	16	3
Tymshare, Inc.	12	2.98	4	6	1	1	6	4	0	2	0	7	5	0	6	5	0	0	2	6	1	1	3	7	0	2	1	6	3	1
United Computing Systems, Inc.	8	2.79	2	4	2	0	4	1	3	0	3	2	2	1	2	4	2	0	2	3	1	2	2	0	4	2	0	5	3	0
University Computing Company	2	2.57	1	0	1	0	1	1	0	0	0	1	1	0	1	0	1	0	0	1	0	1	0	1	1	0	0	0	1	1
All others*	41	3.00	14	20	4	1	11	23	4	1	9	26	1	4	4	22	6	2	7	8	16	2	15	13	8	3	15	16	5	3

*Only the remote computing companies mentioned by two or more users are listed individually. The 41 companies rated by only one user each are combined in the "All others" entry.

**User's ratings are expressed in terms of number of user responses; the legend is E for Excellent, G for Good, F for Fair, and P for Poor. The "Weighted Average of All Ratings" was calculated by assigning a value of 4 to each Excellent rating, 3 to Good, 2 to Fair, and 1 to Poor.

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The remote computing applications reported by the survey respondents spanned virtually the entire spectrum of business and scientific applications. The reported applications can be broadly classified as follows:

Application	No. of Users	% of Total
Business (including accounting, market research, financial modeling, manufacturing, report generation, data base inquiry, etc.)	109	77
Scientific and engineering (including simulation, statistical analysis, graphics, etc.)	70	50
Program development	6	4
Educational	4	3

Thus, it is clear that among DATAPRO 70 subscribers, at least, remote computing services are now being used more heavily for business-related applications than for the scientific and engineering applications that spawned the industry.

SELECTING A REMOTE COMPUTING SERVICE

In most metropolitan areas of the United States, prospective remote computing users can choose from literally dozens of suppliers. Choosing the company that will provide you with the most effective service at the lowest overall cost isn't easy, but it can be done. What's needed is a straightforward, logical selection process that will guide you around the numerous pitfalls which await the unwary. The following procedure, if judiciously applied, will virtually assure the satisfaction of your remote computing requirements in a reliable, economical manner.

1. *Get all the help you can.* Remote computing is a complex, fast-changing field. Though the ultimate goal is to make life easier for computer users, selection of the most suitable commercial remote computing service requires consideration of complex and interrelated hardware, software, communications, and economic factors. Therefore, it's wise to learn as much as you can before making your choice. This report and other related material in DATAPRO 70 will help a lot. So will reading other articles and books, attending remote computing seminars, talking with various sales representatives, and studying their technical documentation. The services of an independent consulting firm with broad remote computing experience can also be well worth their cost.

2. *Define your requirements.* Before shopping for remote computing services, it's essential to know what you want them to do for you. Try to list all the reasonable applications for remote computing in your organization. Then rank these applications according to their relative importance and urgency. For each of the key applications, define the required computer functions – usually in terms of the inputs to be supplied, the calculations to be performed, the outputs to be produced, and their associated volumes. Specify the exact manner in which all computer inputs and outputs must interface with your existing procedures, forms, and/or data files, as well as any turn-around time requirements that must be met. Finally, determine the present overall cost of processing each application, so that you'll be in a position to know whether or not remote computing can really save you money.

3. *Survey the available remote computing services.* The first step in narrowing down the field is to find out which remote computing companies are actively marketing their services in your locality and collect the basic information about their capabilities, specialties, and pricing. The comparison charts in this report can help a lot. So can the Yellow Pages of your local telephone directory, the advertisements of the remote computing companies, and the experience of any acquaintances who are using remote computing. The salesmen for the various remote computing companies will usually be more than pleased to give you brief presentations describing their firm's capabilities and to present you with brochures, price schedules, and sample contract forms.

4. *Choose the most likely candidates.* Now it's time to reduce the list of contenders to the three to six that seem best able to meet your requirements. This can usually be accomplished by a selective "weeding out" process. You simply eliminate from consideration those suppliers that fail to measure up on one or more critical questions such as these:

   - Are the company's services available in your area at a competitive cost (including all communication and terminal costs)?
   - Does the company offer the programming and technical support services you need?
   - Does the company offer the specific programming languages and/or application programs you need?
   - Does the company support the type of terminal equipment you need (or already own)?

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- Can the company satisfy the requirements, if any, for compatibility with your existing programs and/or data files?

- Does the company appear to be able to meet your requirements for operational reliability and data security?

- Are you satisfied that the company is soundly financed and in the business to stay?

5. *Learn all you can about each remaining candidate.* Now it's time to call in the sales representatives of each of the remaining contenders for in-depth discussions about their capabilities, services, and pricing. By now you'll have a good idea what questions to ask them – and what answers you're looking for. Be sure to find out exactly what each company offers in the way of equipment configuration, program library, programming services, training, documentation, security measures, contract terms, etc. Get the details of each company's pricing structure, including possible "extra" charges for programming, training, manuals, application programs, and other products and services you'll need. Be sure to ask for reference lists of current users. Contact these users, and learn all you can about what their experiences have been; it's likely to be a remarkably informative exercise. Also, check the results of the Datapro user survey on page 70G-900-01h.

6. *Conduct benchmark tests.* This is probably the most important – and yet the most frequently ignored or misguided – phase of any remote computing selection project. The essence of benchmark testing is the actual preparation and execution of one or more problems which are representative of the user's planned computer workload. The purpose is threefold:

   - To find out exactly what's involved in using each supplier's services.

   - To determine the service availability, response time, and anticipated throughput that each supplier can deliver at both peak hours (usually around 10 to 11 a.m. and 3 to 4 p.m.) and off-peak times.

   - To determine the cost factors for each service on the types of problems you'll be running regularly.

   If you'll be writing your own programs, go ahead and prepare one or more of them, in the language of your choice. Then ask each of the prospective suppliers to loan you an appropriate terminal plus the computer time required to compile, test, and execute your programs. If you'll be using a ready-made application program supplied by the vendor, prepare some representative test data, borrow the necessary terminal, and give the program a real tryout. In either case, be sure to: (1) control all test conditions as carefully as you can; (2) make the benchmark programs and data as representative of your actual workload as time permits; (3) run each test at both peak and off-peak hours (and at the same times of day for all prospective suppliers); and (4) keep detailed records of all pertinent timing and cost data, as well as your impressions about the comparative ease or difficulty of using each service.

7. *Make your selection.* By now, you've amassed a great deal of pertinent information. Now it's time to "put it all together." From the results of your benchmark tests, calculate the estimated overall costs of satisfying all your remote computing needs with each supplier's services. Compare these costs with your present costs, and (if appropriate) with the estimated costs of alternative approaches such as a computer of your own or a conventional service bureau. In many cases, one of the remote computing suppliers will now stand out as a clear-cut choice. In others, it may be practical to contract with two or more suppliers and use the one whose offerings turn out to be the most economical for each of your applications.

   If neither of the above solutions is appropriate, you may want to turn to some type of weighted point scoring system, in which each supplier is awarded an appropriate number of points for every desirable characteristic (such as availability, response time, languages, terminals, application programs, costs, etc.). But frankly, if it still looks like a really close race, we'd recommend giving preference to the company that made the best showing on your benchmark tests; there's no more convincing evidence than impressive performance on your own problems.

8. *Negotiate a suitable contract.* At this point, virtually every remote computing company will ask you to sign its standard contract form. But that's not necessarily your best move. There's a good chance the supplier will offer considerably more favorable contract terms if that's what it takes to land your account. So read the contract carefully. Make sure it clearly defines the company's pricing structure, charges for all additional products and services, hours of service availability, length of commitment, termination provisions, etc. If the supplier writes any programs for you, make sure it's clear whose property they will be. If you're not completely satisfied with the standard contract terms, ask the supplier to amend them.

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You'll notice that most of the standard contracts disclaim any liability for damages arising either from the use of the suppliers' services or their failure to provide the agreed-upon services. If you feel you need more protection, such as guaranteed file security, it certainly can't hurt to ask for it. Discussions with other customers of the service may be especially helpful in this area. And the advice of your company's lawyer is likely to be well worth having to help ensure that you'll get the services and the protection you need.

9. *Make periodic re-evaluations.* Once you've selected the most suitable remote computing service for your needs, it's unwise to assume that it will *continue* to represent your best choice. As a remote computing network becomes more heavily loaded, its performance tends to degrade. As the network's saturation point is approached, the response times to each user's requests are likely to become unbearably long. In addition to user frustration, this condition leads to longer connect times and higher costs. Therefore, it's wise to rerun your benchmark problems every month or two under the original test conditions. This will enable you to spot any deterioration in the service and present your supplier with documentary evidence of the fact. If the supplier cannot satisfy you that the original quality of service will soon be restored, remember that numerous other suppliers are anxious for your business. And, if you've written your own programs and used one of the common programming languages, it should be relatively easy to make the switch.

THE COMPARISON CHARTS

The principal characteristics of 97 commercially available remote computing services are presented in the accompanying comparison charts. Except where otherwise indicated, all information in the charts was furnished by the suppliers in October 1973; their close cooperation with the Datapro Research staff in the preparation of these charts is greatly appreciated.

DATAPRO 70 sent repeated requests for information to more than 200 companies known or believed to be in the remote computing business. The 97 usable responses summarized in our charts represent a good cross-section of the commercial remote computing services that are currently available in the United States and Canada. *The absence of any specific company from our charts means that the company either failed to respond to our repeated information requests or was unknown to us.*

The comparison chart entries and their significance to potential remote computing users are explained in the following paragraphs, together with additional useful guidelines for selecting the remote computing service that will most effectively meet your needs.

General Information

Name of service. The name under which a company's commercial remote computing services are marketed may or may not be the same as the corporate name. Where they differ, this entry indicates the name of the remote computing service. Some suppliers offer several different levels of service with different names and capabilities, and in these cases the chart entries differentiate between the various levels.

Date operational. This entry tells when each company's remote computing services first became available for regular commercial use. Most remote computing networks require lengthy shakedown periods before settling down to normal operations, so the length of time a service has been operational may serve as a reasonable indication of its reliability — as well as its financial stability. But it is also important to note that few remote computing networks remain really stable for long periods of time; disruptions can occur at any time through addition or consolidation of computer centers, changes in systems software, communications breakdowns, etc.

Areas currently served. Each remote computing company was asked to state the geographical areas it can service effectively, and their answers are reported in the charts. Where specific cities are named, the companies generally offer toll-free service in those cities through local computer centers, communications multiplexers, or foreign exchange facilities.

Where a company professes to serve a large region (such as "Eastern Seaboard and Mid-West"), the implication is that the company either offers INWATS (Inward Wide Area Telephone Service) or maintains computer centers, multiplexers, or other toll-free entry points in strategic cities throughout the area. Unfortunately, this is not true in all cases. It's wise to contact all the companies whose services appear to meet your needs, and find out exactly what communications and computational facilities they offer in your area.

Equipment

Computers. This entry describes the number and type of central processors that each company currently employs in its remote computing network. The cities in which the computers are located are also indicated in most cases. The smaller supporting computers which are frequently used as communications processors or remote multiplexers are not listed here because of space limitations.

Space limitations have also precluded the reporting of configuration details such as main storage capacity, type and capacity of mass storage units, number and speed of central-site peripheral devices, etc. These configuration

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details may or may not be significant, depending upon your applications. Conventional scientific applications are typically coded in FORTRAN or BASIC, require little or no permanent file storage, and can be run without difficulty on most of the commercial remote computing systems. Conversely, many business data processing applications impose special requirements for mass storage units, central-site peripheral equipment, and compatibility with existing programs and data files. In these cases, it will be necessary to contact the remote computing vendors for details about their equipment configurations and capabilities.

Number of simultaneous users. This entry indicates the maximum number of users at remote terminals that each remote computing company claims to be able to serve simultaneously. This figure can serve as a useful – though far from precise – indication of the power of a remote computing system. The response time to each user's requests will naturally tend to increase as the number of simultaneous users gets larger, and in many cases an attempt to serve the indicated number of simultaneous users will lead to response times which are far too long for effective conversational-mode use.

Conversational terminals supported. The specific remote terminals that each remote computing system can accommodate for interactive, conversational-mode operations are listed in this entry. The abbreviation "TTY 33/35" stands for the Teletype Model 33 and Model 35 Teletypewriters, which are still by far the most widely used timesharing terminals. These units have conventional typewriter-style keyboards and transmit an 11-unit ASCII code, usually at 110 bits per second. The Model 33 terminals are designed for "standard-duty" usage (up to about four hours a day) and are priced at about $450 to $1,300, depending on whether or not an integrated paper tape reader and punch and various options are included. The Model 35 terminals are functionally similar but are beefed up for heavy-duty usage, offer a broader range of options, and cost about three times as much as their Model 33 counterparts.

Teletype's newer Model 38 terminals are transmission-compatible with the model 33 and offer a 132-character print line and upper-and-lower-case printing at prices just above those of the Model 33. The Teletype Model 37 terminals, which feature a higher speed (15 characters per second) as well as expanded printing control facilities, are supported by comparatively few remote computing companies to date.

To capitalize upon the widespread acceptance of the Teletype Model 33 and 35 terminals, numerous peripheral equipment makers have introduced "Teletype-compatible" printers, display units, and other terminals which have the same interface characteristics and can utilize the same software support as the Teletype units.

Multiple Honeywell computers in a "supercenter" in Cleveland provide the computing power for users of the General Electric Company's international Information Services Network.

These Teletype-compatible terminals are described in the Peripherals section of DATAPRO 70. Examples include the GE TermiNet 300 and 1200, Memorex 1200 Series, NCR 260, Texas Instruments Silent 700 Series, and UNIVAC DCT 500 terminals, plus CRT display terminals such as the Hazeltine Model 1000 and 2000 and the ITT 3501 Asciscope. In general, any Teletype-compatible terminal can be connected to any remote computing network that supports the Teletype Model 33 or 35 Teletypewriters – but it will generally not be possible to take advantage of the replacement terminal's higher speed and/or improved functional capabilities unless the remote computing company makes suitable modifications in its equipment and supporting software.

The IBM 2741 is another widely supported conversational-mode terminal. Built around an IBM Selectric Typewriter, it provides keyboard input and typed output in both upper and lower case. Its rated transmission speed is 134.5 bits (14.8 characters) per second. The 2741, however, cannot be equipped with paper tape I/O or any other medium for local storage of programs or data.

Typewriter-style terminals that are compatible with the IBM 2741 are marketed by Anderson Jacobson, Computer Devices, GTE Information Systems, Harris, Memorex, Texas Instruments, and several other companies. All are described in the Peripherals section of DATAPRO 70. In addition to these and other typewriter terminals, many remote computing companies also support the use of CRT display units, digital plotters, and/or portable terminals. Σ

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Although many of the remote computing companies offer to supply and maintain the terminals which their systems support, you'll retain more flexibility if you obtain your terminals from the manufacturer or some other independent source. The Teletype terminals, for example, can be leased from the various telephone companies or from sources such as the RCA Service Company and Western Union Data Services.

Batch terminals supported. In addition to the low-speed, conversational-mode terminals which are usually associated with time-sharing, many of the remote computing networks now support faster terminals designed for batch-mode transmission and reception of comparatively large volumes of data. Batch terminals greatly extend the spectrum of practical applications for remote computing systems by permitting the entry of previously recorded data and the printing of results at comparatively high speeds.

The most widely supported batch terminal is the IBM 2780 Data Transmission Terminal. Four models of the 2780 provide different combinations of card reading, card punching, and/or line printing capabilities, at transmission speeds ranging from 1200 to 4800 bits (150 to 600 characters) per second. Data is transmitted under IBM's Binary Synchronous Communications (BSC) line discipline technique in one of three codes: ASCII, EBCDIC, or Six-Bit Transcode. Rental prices for the 2780 range from about $680 to $1,255 per month, so its installation must be carefully justified by virtue of a real need for the faster input/output speeds it provides.

As in the case of the Teletype terminals, the widespread acceptance of the IBM 2780 has led to the introduction of competitive terminals which offer functional compatibility with the 2780, usually at lower prices. Examples include the Data 100 Model 70 and the Remcom 2780. Numerous "intelligent" (programmable) terminals, such as the Badger DTS-100, Data 100 Model 78, and Westinghouse 2550, can emulate the functions of the IBM 2780 and other popular batch terminals. And IBM itself now offers a pair of newer terminals, the 2922 and 3780, which perform the same functions as the 2780 at substantially higher speeds.

Many of the remote computing companies also support the use of small digital computers, such as the Honeywell (nee GE) 105, IBM 1130, IBM System/360 Model 20, and UNIVAC 9200, as remote batch terminals. These independently programmed computers can serve as "intelligent terminals," processing some data locally and providing great flexibility in their communications functions. Their costs, as might be expected, are comparatively high.

All the terminals mentioned above are described in detail in the Peripherals or Computers section of DATAPRO 70; please refer to the Index, beginning on page 70A-100-01a.

Software

Conversational programming languages. This entry lists the programming languages offered by each company for interactive use by customers at remote terminals. The term "conversational" implies a high degree of interaction between the programmer and the computer system throughout the program entry and debugging process.

In most cases, each statement of the source-language program is checked for proper syntax as the user enters it, and any necessary corrections can be made immediately. After the whole program has been entered and checked, one of two basic techniques is usually followed to get it into operation: the program may either be compiled into a machine-language object program and then executed in conventional fashion, or it may be executed immediately in an interpretive mode. Interpretive execution saves compilation time and facilitates program changes, but it also requires that each source-language statement be translated into the appropriate machine instructions every time it is executed – an inherently inefficient process.

FORTRAN and BASIC are by far the most popular conversational programming languages for remote computing use. Between the two, experienced computer users tend to favor FORTRAN because of its greater power and flexibility, while first-time users often choose BASIC because it is generally considered easier to learn and use.

FORTRAN has been most widely used scientific programming language for more than a decade. It uses symbols and expressions similar to those of algebra to express the procedures for performing computational and logical processes. Though it was designed strictly for scientific applications, FORTRAN has been successfully used for a wide range of business data processing functions as well. There are many different versions of the FORTRAN language, but conversions of FORTRAN programs from one version to another can usually be made with comparatively little difficulty. Thus, programs which are prepared and debugged in conversational mode can later be converted into efficient production programs through recompilation by a batch-mode compiler.

BASIC (Beginners' All-purpose Symbolic Instruction Code) was developed at Dartmouth College to provide nonprogrammers with the capability to write programs in an easy-to-use language that resembles standard mathematical notation. BASIC is well suited for use in conversational-mode programming and debugging, and has rapidly gained wide acceptance among suppliers and users of remote computing services. Like FORTRAN, BASIC was designed for scientific and mathematical programming but has also been successfully used for business data processing. Many of the remote computing companies offer extended "supersets" of the BASIC language which considerably increase its capabilities. (Note, however, that

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the use of these extended language facilities in your programs may effectively cause you to become "locked in" to the particular company that offers them.) Most of the existing BASIC compilers emphasize rapid compilation and ease of use rather than efficiency of object-program execution; efficient batch-mode compilers for the BASIC language are rare.

APL is a comparatively recent and noteworthy arrival on the remote computing language scene. Conceived in the early 1960's by Dr. Kenneth E. Iverson of IBM, APL was designed to permit clear, concise expression of computational algorithms. APL's proponents claim (with some justification) that it is "more powerful than FORTRAN and easier to learn than BASIC." APL uses a much larger set of symbols and operators and a considerably different syntax than either FORTRAN or BASIC. Its facilities for handling vectors and arrays are especially powerful, yet simple to use. Some of the commercial implementations of APL include file-handling and formatting facilities that make them quite effective for business as well as scientific applications. The conciseness of the language, however, is a mixed blessing in that it often makes APL programs hard to read and comprehend. Moreover, nearly all of the current implementations of APL are interpreters, which means that the efficiency of object-program execution is likely to be comparatively low.

Though COBOL is by far the most widely used programming language for business applications, comparatively few companies offer a conversational-mode COBOL compiler.

Other general-purpose languages offered in conversational implementations include ALGOL, CAL, JOVIAL, and PL/1, together with a variety of symbolic assembly languages. In addition, many of the remote computing companies offer special-purpose languages designed for specialized functions such as list processing (e.g., LISP and SNOBOL), text editing, and program debugging.

Batch-mode programming languages. The languages offered by each remote computing company for batch-mode (i.e., non-interactive) compilation are listed in this entry. In general, the batch-mode language processors place a considerably greater emphasis upon the generation of efficient object programs than do their conversational-mode counterparts. Therefore, their use can lead to substantial savings in computer time for "production" programs which are run on a regular basis. Batch-mode compilers for virtually every programming language currently in use are offered by one or more of the remote computing companies.

Principal applications. For most remote computing users, the range and capabilities of the available application programs rank among the most important factors in choosing a particular supplier. Thousands of dollars worth of programming efforts can often be saved through the use of suitable ready-made programs, and many of the remote computing companies now offer a broad spectrum of programs to choose from.

Because of space limitations, the main comparison charts show only the principal application areas supported by each company – and the entry "business & scientific" is used for the many suppliers that offer hardware and software designed to support both commercial and scientific applications. The special chart on the last two pages of this report shows which of 25 important classes of application programs are available from each of the remote computing companies.

Charges

One of the most complex and confusing aspects of the current remote computing scene is the pricing of the services. There has been no general agreement to date as to the best technique for accounting and charging for the system resources used by each customer. As a result, prospective users are confronted by a bewildering array of rate schedules. The diverse pricing policies make cost comparisons very difficult and accentuate the desirability of benchmark testing.

Some remote computing companies impose no minimum monthly charge, while a few charge *only* a single, all-inclusive monthly service fee and a number of companies offering specialized services bill their customers on a per-transaction or per-item basis. Most companies bill the user for each second of central processor time, while others include the processor time as part of the terminal connect charge. Some companies provide each user with a certain amount of "free" mass storage space, while others do not. Some companies impose a one-time charge for initiation of service, and some have special pricing schedules for certain application programs. In addition, there are usually separate charges for the use of central-site peripheral devices (such as card readers and printers), for punched cards and printer forms, and for extra programming manuals and training courses.

The principal pricing elements for each remote computing company, in both the interactive and remote batch modes, are summarized in the comparison chart entries under the "Charges" heading. The indicated rates are for prime-time use. Many suppliers offer lower rates during non-prime hours, and discounts for volume usage are common. Remember that in addition to the charges listed in the charts, users must bear the cost of their terminals, modems, and communications facilities.

Minimum monthly charge. This is the minimum charge, if any, that is imposed for each month of remote computing service. (The companies that impose no

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minimum charge will naturally be of particular interest to users who plan to deal simultaneously with several different suppliers.)

Terminal connect time. This entry shows the charge for each hour of time during which an interactive or remote batch terminal is "on-line" (i.e., connected to the central computer).

Central processor time. Most remote computing companies impose a specific charge for each minute (or second) of time during which the central processor is working on the user's program. In some cases, this charge varies with the amount of main memory occupied by the program. Other companies allocate their central processor charges on the basis of more complex units with names like "Core Unit" or "Computer Resource Unit." Typically, such units are functions of the amount of processor time, main memory space, and input/output activity required by each program.

Mass storage. Virtually every remote computing company has large-capacity disk or drum units at its computer site. Users can rent as much of this mass storage space as they need for on-line storage of programs and files, at the rates indicated in this entry. The storage space is usually rented in units of one track or sector, whose capacity depends upon the physical format of the available mass storage device. Storage charges may be computed on the basis of either the average or maximum amount of storage used during each month; it's important to find out which basis your prospective suppliers use. Discounts are frequently granted for large-volume storage requirements.

Comments

This final entry on the comparison charts is used to explain or amplify the preceding entries and/or to provide other pertinent information about each company's services.

SUPPLIERS

Listed below, for your convenience in obtaining additional information, are the headquarters addresses and telephone numbers of the 97 remote computing companies whose services are described in the comparison charts.

ACTS Computing Corporation, 29200 Southfield Road, Southfield, Michigan 48076. Telephone (313) 557-6800.

APL Services, Inc., 684 Whitehead Road, Trenton, New Jersey 08638. Telephone (609) 883-0050.

Applied Data Research, Inc., Timesharing Division, Route 206 Center, Princeton, New Jersey 08540. Telephone (609) 921-8550.

Applied Logic Corporation, 900 State Road, Princeton, New Jersey 08540. Telephone (609) 924-7800.

Axicom Systems, Inc., 615 Winters Avenue, Paramus, New Jersey 07652. Telephone (201) 262-8200.

Beloit Computer Center, Inc., 423 State Street, Beloit, Wisconsin 53511. Telephone (608) 365-2206.

Boeing Computer Services, Inc., 7598 Colshire Drive, McLean, Virginia 22101. Telephone (703) 356-6900.

Bowne Time Sharing, Inc., 345 Hudson Street, New York, New York 10014. Telephone (212) 741-4700.

Chi Corporation, 11000 Cedar Avenue, Cleveland, Ohio 44106. Telephone (216) 229-6400.

Community Computer Corporation, 185 West Schoolhouse Lane, Philadelphia, Pennsylvania 19144. Telephone (215) 849-1200.

The Computer Company, Inc., Seventh and Franklin Building, Richmond, Virginia 23219. Telephone (804) 644-1841.

Computer Innovations, 70 West Hubbard Street, Chicago, Illinois 60610. Telephone (312) 329-1561.

Computer Network Corporation (Comnet), 5185 MacArthur Boulevard, Washington, D.C. 20016. Telephone (202) 244-1900.

Computer Research Company, 200 North Michigan Avenue, Chicago, Illinois 60601. Telephone (312) 346-1331.

Computer Resource Services, Inc., 1600 West Camelback Road, Suite 1F, Phoenix, Arizona 85015. Telephone (602) 266-8444.

Computer Sciences Canada, Ltd., Room 367, Place du Canada, Montreal 101, Quebec. Telephone (514) 878-9811.

Computer Sciences Corporation, 650 North Sepulveda, El Segundo, California 90245. Telephone (213) 678-0311.

Computer Sharing Services, Inc., 2498 West Second Avenue, Denver, Colorado 80223. Telephone (303) 934-2381.

Computer Spectrum, Box 8666, Chattanooga, Tennessee 37411. Telephone (615) 396-3131.

Computercraft Services, Inc., 1200 Lincoln Street, Suite 301, Denver, Colorado 80203. Telephone (314) 962-8810.

Computility, Inc., 131 Tremont Street, Boston, Massachusetts 02111. Telephone (617) 423-6780.

Compu-Time, Division of ACTS Computing Corporation, 327 Orange Avenue, Daytona Beach, Florida 32104. Telephone (904) 255-7511.

Computone Systems, Inc., 361 East Paces Ferry Road N.E., Atlanta, Georgia 30305. Telephone (404) 261-0070.

Com-Share, Incorporated, P.O. Box 1588, Ann Arbor, Michigan 48106. Telephone (313) 761-4040.

Com-Share Limited, 41 Voyager Court North, Rexdale 605, Ontario. Telephone (416) 678-1363.

Control Data Corporation, Cybernet Services, 8100 34th Avenue South, Minneapolis, Minnestoa 55440. Telephone (612) 853-8100.

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This bank of Xerox Sigma 7 and 9 computers in Los Angeles serves users of Xerox Computer Services' Interactive Accounting System.

Cyphernetics Corporation, 175 Jackson Plaza, Ann Arbor, Michigan 48106. Telephone (313) 769-6800.

Data Resources Inc., 29 Hartwell Avenue, Lexington, Massachusetts 02173. Telephone (617) 861-0165.

Data-Tek Corporation, University City Science Center, 3401 Market Street, Philadelphia, Pennsylvania 19104. Telephone (215) 349-9900.

Datacrown Limited, 650 McNicoll Avenue, Willowdale, Ontario. Telephone (416) 499-1012.

Dataline Systems Limited, 40 St. Clair Avenue West, Toronto, Ontario. Telephone (416) 964-9515.

Datalogics, Inc., 12025 Shaker Boulevard, Cleveland, Ohio 44120. Telephone (216) 721-9035.

Dialcom, Inc., 1104 Spring Street, Silver Spring, Maryland 20910. Telephone (301) 588-1572.

Fedder Data Centers, Inc., 412 West Redwood Street, Baltimore, Maryland 21201. Telephone (301) 685-6773.

First Data Corporation, 400 Totten Pond Road, Waltham, Massachusetts 02154. Telephone (617) 890-6701.

First National Bank of Memphis, Timesharing Division, P.O. Box 62, Memphis, Tennessee 38101. Telephone (901) 523-5362.

Fulton National Bank, 55 Marietta Street, Atlanta, Georgia 30302. Telephone (404) 577-3500.

General Electric Company, Information Services Business Division, 7735 Old Georgetown Road, Bethesda, Maryland 20014. Telephone (301) 654-9360.

Genesee Computer Center, Inc., 20 University Avenue, Rochester, New York 14605. Telephone (716) 232-7050.

Grumman Data Systems Corporation, 1111 Stewart Avenue, Bethpage, New York 11714. Telephone (516) 575-3284.

GTE Data Services Incorporated, First Financial Tower, P.O. Box 1548, Tampa, Florida 33601. Telephone (813) 877-8021.

HDR Systems, Inc., 8404 Indian Hills Drive, Omaha, Nebraska 68114. Telephone (402) 393-5775.

Honeywell Information Systems, Inc., 2701 Fourth Avenue South, Minneapolis, Minnesota 55408. Telephone (612) 332-5200.

Information Systems Design, Inc., 7817 Oakport Street, Oakland, California 94621. Telephone (415) 562-4204.

Interactive Data Corporation, 486 Totten Pond Road, Waltham, Massachusetts 02154. Telephone (617) 890-1234.

Interactive Sciences Corporation, 60 Brooks Drive, Braintree, Massachusetts 02184. Telephone (617) 848-2660.

International Timesharing Corporation, I T S Building, Jonathon Industrex, Chaska, Minnesota 55318. Telephone (612) 448-3061.

ISC/Pryor Computer, 400 North Michigan Avenue, Chicago, Illinois 60611. Telephone (312) 644-5650.

Kaman Aerospace Corporation, Old Windsor Road, Bloomfield, Connecticut 06002. Telephone (203) 242-4461.

Keydata Canada, 74 Victoria Street, Toronto, Ontario. Telephone (416) 362-2688.

Keydata Corporation, 108 Water Street, Watertown, Massachusetts 02172. Telephone (617) 924-1200.

Leasco Response Incorporated, 20030 Century Boulevard, Germantown, Maryland 20767. Telephone (301) 428-0500.

Management Systems Corporation, 215 North State Street, Salt Lake City, Utah 84103. Telephone (801) 363-1511.

Manufacturing Data Systems, Inc., 320 North Main Street, Ann Arbor, Michigan 48104. Telephone (313) 761-7750.

Mark/Ops, Division of Northeastern Systems Associates, Inc., 475 Commonwealth Avenue, Boston, Massachusetts 02215. Telephone (617) 266-1930.

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McDonnell Douglas Automation Company, P.O. Box 516, St. Louis, Missouri 63166. Telephone (314) 232-8071.

Merlin Systems Corporation, 1044 Northern Boulevard, Roslyn, New York 11576. Telephone (516) 484-4545.

Metridata Computing, Inc., P.O. Box 21099, Louisville, Kentucky 40221. Telephone (502) 361-7161.

Multiple Access Limited, 885 Don Mills Road, Don Mills, Ontario. Telephone (416) 443-3900.

National CSS, Inc., 300 Westport Avenue, Norwalk, Connecticut 06581. Telephone (203) 853-7200.

Ohio Valley Data Control, Inc., 2505 Washington Boulevard, Belpre, Ohio 45714. Telephone (614) 423-9501.

On-Line Business Systems, Inc., One Embarcadero Center, San Francisco, California 94111. Telephone (415) 391-9555.

On-Line Systems Inc., 115 Evergreen Heights Drive, Pittsburgh, Pennsylvania 15229. Telephone (412) 931-7600.

Pacific Applied Systems, Inc., 4835 Van Nuys Boulevard, Suite 108, Sherman Oaks, California 91403. Telephone (213) 986-7515.

Pacific International Computing Corporation, 50 Beale Street, San Francisco, California 94105. Telephone (415) 764-7652.

Paden Data Systems, Inc., 5838 Live Oak, Dallas, Texas 75214. Telephone (214) 823-3773.

Philco-Ford Corporation, Computer Services Network, 515 Pennsylvania Avenue, Fort Washington, Pennsylvania 19034. Telephone (215) MI 6-8600.

Phoenix Data Limited, 550 Berry Street, Winnipeg, Manitoba R3H OR9. Telephone (204) 786-5831.

PRC Computer Center, Inc., 7670 Old Springhouse Road, McLean, Virginia 22101. Telephone (703) 893-4880.

Profile Technology, Inc., Collegedale, Tennessee 37315. Telephone (615) 396-3131.

Programs & Analysis, Inc., 21 Ray Avenue, Burlington, Massachusetts 01803. Telephone (617) 272-7723.

Proprietary Computer Systems, Inc., 16625 Saticoy Street, Van Nuys, California 91406. Telephone (213) 781-8221.

Rapidata, Inc., 20 New Dutch Lane, Fairfield, New Jersey 07006. Telephone (201) 227-0035.

Remote Computing Corporation, 525 University Avenue, Suite A40, Palo Alto, California 94301. Telephone (213) 629-2532.

SBC Data Services, Division of the Service Bureau Corporation, P.O. Box 402, Paramus, New Jersey 07652. Telephone (201) 262-8700.

Scientific Process & Research, Inc., 24 North Third Avenue, Highland Park, New Jersey 08904. Telephone (201) 846-3477.

Scientific Time Sharing Corporation, 7316 Wisconsin Avenue, Bethesda, Maryland 20014. Telephone (301) 657-8220.

Sci-Tek Incorporated, 1707 Gilpin Avenue, Wilmington, Delaware 19899. Telephone (302) 658-2431.

The Service Bureau Corporation, 500 West Putnam Avenue, Greenwich, Connecticut 06830. Telephone (203) 661-0001.

I.P. Sharp Associates Limited, Suite 4206, Box 71, Toronto Dominion Centre, Toronto, Ontario. Telephone (416) 364-5361.

The Singer Company, Singer Information Systems Network, 30 Rockefeller Plaza, New York, New York 10020. Telephone (201) 256-5004.

Statistical Tabulating Corporation, 2 North Riverside Plaza, Chicago, Illinois 60606. Telephone (312) 346-7300.

Structural Dynamics Research Corporation, 5729 Dragon Way, Cincinnati, Ohio 45227. Telephone (513) 272-1100.

Systems Dimensions Limited, 770 Brookfield Road, Ottawa, Ontario K1V 6J5. Telephone (613) 731-6910.

Technical Advisors, Inc., 4455 Fletcher Street, Wayne, Michigan 48184. Telephone (313) 722-5010.

Technology for Information Management, Inc., 1654 Central Avenue, Albany, New York 12205. Telephone (518) 869-0928.

Tel-A-Data, Inc., 1500 Northwest 167th Street, Miami, Florida 33169. Telephone (305) 625-8266.

Telstat Systems, Inc., 150 East 58th Street, New York, New York 10022. Telephone (212) 826-0640.

Texas Instruments Incorporated, Information Services Division, P.O. Box 5621, Mail Station 933, Dallas, Texas 75229. Telephone (214) 238-3374.

Time Sharing Resources, Inc., 777 Northern Boulevard, Great Neck, New York 11022. Telephone (516) 487-0101.

Tymshare, Inc., 10340 Bubb Road, Cupertino, California 95014. Telephone (408) 257-6550.

Uni-Coll, 3401 Market Street, Philadelphia, Pennsylvania 19104. Telephone (215) EV 7-3890.

United Computing Systems, Inc., 3130 Broadway, Kansas City, Missouri 64111. Telephone (816) 221-9700.

University Computing Company, 7720 North Stemmons Freeway, P.O. Box 47911, Dallas, Texas 75247. Telephone (214) 741-5781.

USS Engineers and Consultants, Inc., 600 Grant Street, Pittsburgh, Pennsylvania 15230. Telephone (412) 433-6515.

Westinghouse Tele-Computer Systems Corporation, 2040 Ardmore Boulevard, Pittsburgh, Pennsylvania 15221. Telephone (412) 256-7799.

Xerox Computer Services, 5310 Beethoven Street, Los Angeles, California 90066. Telephone (213) 390-3461. □

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COMPANY	ACTS Computing Corporation	APL Services, Inc.	Applied Data Research, Inc.	Applied Logic Corporation	Axicom Systems, Inc.
GENERAL					
Name of service	ACTS RJE and Timesharing	Action/APL	Teleplex	AL/COM	Tymsharing
Date operational	Feb. 1969	July 1970	Nov. 1969	1967	Jan. 1969
Areas currently served	Michigan, Ohio, and the Midwest; New York, Los Angeles, and Oklahoma	Local dial service in New York City Boston, Phila., Atlanta, Houston, Miami, Tallahassee, Hartford, Princeton	Toll-free dial-up service throughout continental U.S.; multiplexers in Boston, Chicago, New York, Phila., Princeton	Toll-free access in 19 states in the East, Midwest, and Far West; service centers in 8 cities	Middle Atlantic States, New England, and Southeastern U.S.
EQUIPMENT					
Computers	Honeywell 430 & 440 in Detroit; Honeywell 430 & 440 in Daytona, Fl; IBM 370/155 (RJE) in Grand Rapids	IBM 370/155 in Richmond, Va.	DEC PDP-10 (2) in Princeton, N.J.	DEC PDP-10 (8) in Princeton, N.J.	UNIVAC 1108 (2) in Paramus, N.J.; UNIVAC 418 (2) in Greenville, S.C.
No. of simultaneous users	197 total	96	64	200	64
Conversational terminals supported	Any 10, 15, or 30 cps terminal using ASCII, EBCDIC, BCD, or correspondence code	IBM 2741 and compatible units at 15 or 30 cps; AJ 630, AJ 840, Memorex 1240, etc.	Any full-duplex ASCII terminal at 10 or 30 cps	Any ASCII terminal at 10 or 30 cps	TTY 33/35 and compatible units
Batch terminals supported	IBM 2770, 2780, 2922, 3780, 360/20, System/3; Data 100 Models 70, 74, 78	—	Data 100, IBM 2780, UNIVAC DCT 2000, and compatible units	IBM 2780 & compatible units	UNIVAC 1004 & 9200 and "all intelligent terminals"
SOFTWARE					
Conversational programming languages	FORTRAN, COBOL, PDP-8 & PDP-11 Assembler	APL	FORTRAN, BASIC, COBOL, Macro-10, AID, SNOBOL	FORTRAN BASIC, COBOL, SNOBOL, LISP, Macro-10, AID	FORTRAN, BASIC, COBOL, APL, Assembler
Batch-mode programming languages	FORTRAN, COBOL, PL/1, RPG	—	FORTRAN, COBOL, BASIC, Macro-10, SNOBOL	—	FORTRAN, COBOL, Assembler
Principal applications	Business & scientific	Business & scientific	Business & scientific	Business & scientific	Scientific & message switching
CHARGES					
Min. monthly charge:					
Interactive	$100	$100	None	$100 (after 2 mo.)	None
Remote batch	None	—	None	—	Not specified
Terminal connect time:					
Interactive	$10/hr.	$10-15/hr.	$10/hr.	$10/hr.	$10/hr.
Remote batch	None	—	$25/hr.	—	Not specified
Central processor time:					
Interactive	$0.06/second	$24/min.	$0.01/RAM	$0.10/Core Unit	$8.40/min.
Remote batch	$250/hr.	—	$0.01/RAM	—	Not specified
Mass storage:					
Interactive	$1.00/1000 chars./month	$8-10/million bytes/day	$0.45/1000 chars./month	$3.75/5120 chars./month	$0.04/11,000 chars./day
Remote batch	$0.50/cylinder/ month	—	$0.45/1000 chars./month	—	Not specified
COMMENTS	Subsidiary of Lear Siegler, Inc. Reduced rates for non-prime time. Remote Job Entry service uses HASP Multileaving.	Offers large file capabilities and shared files for data base manipulation. Affiliated with The Computer Company	Reduced rates for non-prime time and volume usage.	Offers deferred unattended execution at reduced rates. Volume discounts of 40 to 70% on mass storage. Offers full ANS COBOL.	

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COMPANY	Beloit Computer Center, Inc.	Boeing Computer Services, Inc.	Bowne Time Sharing, Inc.	Chi Corporation	Community Computer Corporation
GENERAL					
Name of service	BCC/ATS and BCC/RJE	Mainstream and CTS	Word/One	Chi Time-Sharing, Chi Remote Batch	—
Date operational	Nov. 1969	May 1970	Nov. 1969	May 1969	Jan. 1969
Areas currently served	Dial-up access in Beloit & Janesville, Wis.; Rockford & Chicago, Ill.; New York City; Washington, D.C.	Continental U.S. and Canada via nationwide data network and communication system	Atlanta, Boston, Chicago, New York, New Jersey, Phila., and Washington, D.C. areas	Ohio, Pennsylvania, Michigan, New York	Delaware Valley, New Brunswick, N.J.
EQUIPMENT					
Computers	IBM 360/50 in Beloit, Wis.	IBM 370/168 in McLean, Va. (Mainstream); IBM 370/158 in Wichita, Kan. (CTS)	IBM 370/155 in New York City	UNIVAC 1108 & Honeywell 430 in Cleveland	HP 2116B (2) in Philadelphia
No. of simultaneous users	200	80 on Mainstream; 90 on CTS	175	60 total	32
Conversational terminals supported	IBM 2741, AJ 841, Trendata 1000, Novar 5-41 & 5-50, Datel, Datapoint, etc.	TTY 33/35 and compatible units at 10 or 30 cps; IBM 2741 and compatible units at 14.8 cps	IBM 2741, TTY, and compatible units at 10, 14.8, 15, or 30 cps	TTY 33/35/38, Datapoint 3300, GE TermiNet 300, UNIVAC DCT 500, etc., at 10 or 30 cps	TTY and other ASCII-coded terminals at 10 or 30 cps
Batch terminals supported	IBM 2780, 3780, 360/20, System/3; Data 100, NCR 399, Remcom, Sycor, etc.	IBM 2780, 3780, 360/20, 1130, or any other HASP RJE terminal	—	UNIVAC 1004, 9200; IBM 2780, 1130, 360/20; Data 100, etc.	—
SOFTWARE					
Conversational programming languages	ATS (Administrative Terminal System)	FORTRAN, COBOL, ALGOL, BASIC, PL/1, APL, etc. (all in CTS only)	Word/One (text editing)	BASIC, FORTRAN, EDIT, SAM	BASIC
Batch-mode programming languages	FORTRAN, COBOL, PL/1, Assembler, Foresight	FORTRAN, COBOL, PL/1, ALGOL, Assembler	—	FORTRAN, BASIC, ALGOL, COBOL, RPG, etc.	FORTRAN, ALGOL
Principal applications	Business & scientific	Business & scientific	Text editing & typesetting	Business, scientific, & phototypesetting	Business & scientific
CHARGES					
Min. monthly charge:					
Interactive	$50	None	$150 (after 3 mo.)	None	None
Remote batch	None	None	—	Not specified	—
Terminal connect time:					
Interactive	$2.00-3.50/hr.	$9-11/hr.	$2.65-4.80/hr.	$6.00/hr.	$8.00/hr.
Remote Batch	$10-15/hr.	$8-16/hr.	—	Not specified	—
Central processor time:					
Interactive	$5.00-7.80/min.	$21.60/min.	$0.09/Proc. Unit	$3.60/min.	None
Remote batch	$5.00-7.80/min.	$15.00/min.	—	Not specified	—
Mass storage:					
Interactive	$0.13/1000 chars./month	$10-18/cylinder/ month	$0.28/1550 chars./month	$0.25/1152 chars./month	$0.20/160 chars./month
Remote batch	$0.065/1000 chars./month	Not specified	—	Not specified	—
COMMENTS	Features ATS text editing system	Charges shown are for CTS service. Mainstream service offers RJE at a range of service times (10 minutes to overnight) and charges.	Specializes in text editing, typesetting, and address file maintenance. Volume discounts available.	Offers both time-sharing and remote batch services. Substantial volume discounts. Lower rates for non-prime time.	Storage beyond 80,000 characters is priced at $0.04/ 160 chars./month.

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COMPANY	The Computer Company	Computer Innovations	Computer Network Corp. (Comnet)	Computer Research Company	Computer Resource Services, Inc.
GENERAL					
Name of service	Action/APL	Advanced APL, Enhanced ATS	Alpha	—	Response
Date operational	Oct. 1969	June 1969	Dec. 1967	Sept. 1971	1969
Areas currently served	Boston, Chicago, Denver, Hartford, Los Angeles, Miami, Newark, New York, Phila., D.C., and 6 other cities.	Illinois, Indiana, Michigan, Minnesota, Wisconsin	Continental U.S. via INWATS; local dial-up access in the New York, Washington, & Pittsburgh areas	Midwestern U.S. via Band 2 INWATS	Phoenix metropolitan area
EQUIPMENT					
Computers	IBM 370/155 in Richmond, Va.	IBM 360/65 in Van Nuys, Calif.	IBM 360/65 (2) in Washington, D.C.	IBM 370/158 in Chicago	HP 2000 (2) in Phoenix, Ariz.
No. of simultaneous users	156	120	75	20	32
Conversational terminals supported	IBM 2741, TTY 33, AJ, CDI, Datel, HP 7200, Memorex 1240, Novar, Tektronix	Selectric/ASCII type terminals	IBM 2741, TTY 33/35, and compatible units at 10 to 120 cps	TTY 33/35, IBM 2741 & 3270, Datapoint, etc.	Any ASCII or Correspondence Code terminal at 10 to 30 cps
Batch terminals supported	—	—	IBM 2780, 1130, 360/20, and compatible units at 2000 to 9600 bps	IBM 2780, 360/20, System/3; Data 100	—
SOFTWARE					
Conversational programming languages	APL	APL	All OS/360 languages	FORTRAN, COBOL, PL/1, Assembler	BASIC
Batch-mode programming languages	—	All OS/360 languages	All OS/360 languages	FORTRAN, COBOL, PL/1, Assembler	—
Principal applications	Business & scientific	Business, scientific, & text editing	Business & scientific	Business, scientific, & text editing	Business & scientific
CHARGES					
Min. monthly charge:					
Interactive	None	None	$100	None	$25
Remote batch	—	—	$100	None	—
Terminal connect time:					
Interactive	$10-13/hr.	$12.50/hr.	$12/hr. (to 120 cps)	$7.50/hr. (TSO)	$8/hr.
Remote batch	—	—	$20-36/hr.	$10/hr. (RJE)	—
Central processor time:					
Interactive	$24/min.	$12.50/min.	$0.20/CUU	$10.80/min. (TSO)	None
Remote batch	—	—	$0.20/CUU	$7.20/min. (RJE)	—
Mass storage:					
Interactive	$300/million bytes/month	$12.50/million bytes/day	$1.00/7296 chars./month	$0.024/1000 chars./day	$0.75/1024 chars./month
Remote batch	—	—	$1.00/7296 chars./month	$0.024/1000 chars./day	—
COMMENTS	Offers remote job entry and file management system for shared files.	Affiliated with Proprietary Computer Systems, Inc.	Offers "OS-compatible time-sharing services" and remote job entry at a wide range of service times, terminal speeds, and charges	Offers System/370 batch RJE, TSO, IMS, and ATS. Reduced rates for non-prime time. CPU charges above are for 60K bytes of main storage.	$50 initiation fee.

All About Remote Computing Services

COMPANY	Computer Sciences Canada, Ltd.	Computer Sciences Corporation	Computer Sharing Services, Inc.	Computer Spectrum	Computercraft Services, Inc.
GENERAL					
Name of service	Infonet	CSTS	DTSS, TSS	The Computer Spectrum	Computercraft
Date operational	July 1967	Jan. 1970	Nov. 1967	Sept. 1972	Nov. 1970
Areas currently served	Calgary, Edmonton, Montreal, Ottawa, Quebec, Toronto, Vancouver, Winnipeg	Local access in 23 metropolitan areas throughout continental U.S.	Colorado and the Mountain States via leased lines and INWATS	Southeastern U.S.: AL, FL, GA, KY, LA, MS, NC, SC, and TN	Denver, St. Louis, Detroit, & Chicago areas; local dial-up service available in 15 other cities nationwide
EQUIPMENT					
Computers	UNIVAC 1108 (2); 1 in Toronto and 1 in Calgary	UNIVAC 1108 (8); 5 in El Segundo, Calif., and 3 in Oak Brook, Ill.	Honeywell 635 & Honeywell 430 in Denver	HP 2000F & Spectrum 3000 in Chattanooga, Tenn.	DECsystem 1050 (4) in Columbus, Ohio
No. of simultaneous users	180 total	400-640 total	140 total	48 total	252 total
Conversational terminals supported	TTY 33/35 and compatible units at 10, 15, or 30 cps; IBM 2741 or equivalent	TTY 33/35 and compatible units at 10, 15, or 30 cps; IBM 2741 or equivalent	TTY 33/35, IBM 2741, and compatible units at 10, 14.8, 15, 30, or 120 cps	TTY and any other ASCII terminal at 10, 15, 30, 60, 120, or 240 cps	TTY and any other ASCII terminal at 10, 15, or 30 cps; Selectric terminals at 14.8 cps
Batch terminals supported	IBM 2780 & 1130, UNIVAC 9200, 1004, & DCT 2000, Honeywell Series 200, etc.	IBM 2780 & 1130, Data 100, Remcom 2780, Qantel, M&M, etc.	IBM 2780 and compatible units (in 1st quarter 1974)	—	DEC PDP-8 and PDP-11 computers
SOFTWARE					
Conversational programming languages	FORTRAN, BASIC	FORTRAN, BASIC, COBOL, Assembler	FORTRAN, BASIC, COBOL, ALGOL, APL, LISP, SNOBOL, QED, GMAP	FORTRAN, BASIC, Assembler	FORTRAN, BASIC, COBOL, AID, SNOBOL, LISP, Macro 10
Batch-mode programming languages	FORTRAN, COBOL, Assembler	FORTRAN, BASIC, COBOL, Assembler	All conversational languages can be used in background or batch mode	FORTRAN, COBOL, Assembler	FORTRAN, BASIC, COBOL, GASP, SNOBOL, Macro 10
Principal applications	Business & scientific	Business & scientific	Business & scientific	Business, scientific, & educational	Business & Scientific
CHARGES					
Min. monthly charge:					
Interactive	$25	$25	$35	$70	None
Remote batch	$25	$25	$35	—	—
Terminal connect time:					
Interactive	$11.25-13.25/hr.	$11-15/hr.	$5-6/hr.	$7/hr.	$9-13/hr.
Remote batch	$11.50/hr.	$10/hr. (2000 bps)	$5-6/hr.	—	—
Central processor time:					
Interactive	$0.70/sec.	$0.25/SRU	$0.05-0.25/sec.	None	$0.02/SRU
Remote Batch	$0.21-0.45/sec.	$0.05-0.25/SRU	$0.05-0.25/sec.	—	—
Mass storage:					
Interactive	$1.50/3072 chars./month	$0.025/2048 chars./day	$2.00/4096 chars./month	$0.33/1000 chars./month	$1.50/3200 chars./month
Remote batch	$0.065/10,752 chars./day	$0.025/2048 chars./day	$2.00/4096 chars./month	—	—
COMMENTS	CPU charges for remote job entry vary with priority. Discounts for high-volume usage.	CPU charges for remote batch use vary with priority. Discounts for high-volume usage. Lower rates for non-prime time.	Honeywell 635 is first commercial installation of Dartmouth Time-Sharing System. All Dartmouth programs are available.	Specializes in educational, information retrieval, inventory control, personnel, school administration, and text editing applications.	Marketing affiliate of Compu-Serv Network, Inc., of Columbus. Also offers batch processing on IBM 370/135 and 360/40

All About Remote Computing Services

COMPANY	Computility, Inc.	Compu-Time Div., ACTS Computing Corporation	Computone Systems, Inc.	Com-Share, Incorporated	Com-Share Limited
GENERAL					
Name of service	Comp/Utility	Compu-Time	—	Commander I & Commander II	Com-Share
Date operational	June 1969	Oct. 1967	1966	1967	1969
Areas currently served	Middle Atlantic and Northeastern States; also national INWATS service	Southeastern U.S.; Fla., Ga., N.C., S.C., Ky., Tenn., Ala., La.	Entire U.S. via national INWATS service	Continental U.S.; multiplexers in 31 cities and foreign exchange lines in 27 others	Multiplexers in Montreal, Ottawa, Hamilton, & London; local dial-up service in Toronto; also see Comments
EQUIPMENT					
Computers	DECsystem 1077 in Boston	Honeywell 430 and Honeywell 440 in Daytona Beach, Fla.	IBM 360/50 in Atlanta	Xerox 940 (9) and Sigma 9 (3) in Ann Arbor, Mich.	Xerox Sigma 9 in Toronto
No. of simultaneous users	128	94	48	42 per 940, 64 per Sigma 9	64
Conversational terminals supported	Any ASCII terminal	TTY 33/35/38, GE TermiNet 300, Datapoint 3300; most 10 & 30 cps terminals	TTY, TI, Memorex 120 cps; Keypact portable insurance terminal (made by Computone)	TTY 33/35 and any compatible unit at 10, 30, or 60 cps	TTY 33/35 and compatible units.
Batch terminals supported	—	—	—	IBM 2780 & 3780, Remcom 2780 & 4780, Data 100 Model 70, Mohawk 2400, etc.	IBM 2780 and compatible units (as of Jan. 1974)
SOFTWARE					
Conversational programming languages	FORTRAN, BASIC, COBOL, ALGOL, AID, LISP, Macro 10	FORTRAN, BASIC	—	FORTRAN, BASIC, CAL, SNOBOL, TAP, etc.	FORTRAN, BASIC, COBOL, APL, SNOBOL, QED, Metasymbol
Batch-mode programming languages	FORTRAN, BASIC, COBOL, ALGOL, SNOBOL, LISP, Macro 10	FORTRAN, COBOL, RPG	—	FORTRAN, COBOL, BASIC	FORTRAN, BASIC, COBOL APL, SNOBOL, QED, Metasymbol
Principal applications	Business & scientific	Business & scientific	See Comments	Business & scientific	Business & scientific
CHARGES					
Min. monthly charge:					
Interactive	None	$50	—	None	$100
Remote batch	None	—	—	None	$100
Terminal connect time:					
Interactive	$8/hr.	$10/hr.	—	$7.20-20.00/hr.	$8-12/hr.
Remote Batch	None	—	—	$8.40/hr. plus $0.15/10,000 chars.	$8-12/hr.
Central processor time:					
Interactive	$0.03/sec.	$0.06/Unit	—	$0.03-0.07/CCU	$0.08-0.10/CCU
Remote batch	$0.015/sec.	—	—	$0.03-0.07/CCU	$0.08-0.10/CCU
Mass storage:					
Interactive	$0.25/640 chars./month	$1.50/1620 chars./month	—	$0.30/2048 bytes/month	$0.20-0.80/1000 bytes/month
Remote batch	$0.25/640 chars./month	—	—	$0.30/2048 bytes/month	$0.20-0.80/1000 bytes/month
COMMENTS	Core memory is charged at the rate of $0.01/1024 words/second.	$100 initiation fee. Offers guaranteed maximum hourly rates, with substantial volume discounts.	Dedicated system for life insurance sales, feed and meat formulation, and turkey market information. Prices upon request.	Commander II service provides time-sharing, remote batch, and data management facilities. Datagrid is Com-Share's nationwide comm. network.	Offers service in most major Canadian cities via Dataline 2 and Dataroute. An affiliate of Com-Share, Inc.

All About Remote Computing Services

COMPANY	Control Data Corporation	Cyphernetics Corporation	Data Resources Inc.	Data-Tek Corporation	Datacrown Limited
GENERAL					
Name of service	Cybernet	Cyphernet System	DRI Economic Info. System	—	Shared Processing
Data operational	1971	Aug. 1969	Sept. 1969	Dec. 1971	June 1972
Areas currently served	Entire U.S. via nationwide communications network	Full service offices in 15 cities throughout the U.S., plus London, Brussels, and The Hague; also serves many other cities.	All major U.S. cities plus Montreal, Quebec, Toronto, & Central Europe, all via local-call access	New York, New Jersey, and Pennsylvania (Area Codes 201, 212, 215, 609, & 717)	All of Canada (via Dataroute, Bell Multicom, & CNCP) plus United States
EQUIPMENT					
Computers	CDC 6400 (4) in Rockville, Md.	DECsystem-10 (9) in Ann Arbor, Mich.	Burroughs B 6700 and B 7700 in Lexington, Mass. (both are duplex systems)	Xerox Sigma 9 in Plainfield, N.J.	IBM 370/168 in Willowdale, Ont.
No. of simultaneous users	512 total	300 total	Over 275 total	64	Not specified
Conversational terminals supported	ASCII-compatible units at 10 or 30 cps; Correspondence units at 14.8 cps.	All 10, 14.8, and 30 cps terminals, including extensive support for Tektronix graphic terminals	TTY-compatible units at 10, 15, 30, 60 or 120 cps; IBM 2741; AT&T Dataspeed 40	TTY-compatible units at 10, 15, or 30 cps	IBM 2741, 2260, 3270, 3735; Sycor 250; Vucom I; TI Silent 700; TWX; etc.
Batch terminals supported	CDC 200 User Terminal and compatible units at 2000, 3600, or 4800 bps	IBM 2780 and compatible units	IBM 2780, Burroughs DC 1100, or equivalent units	—	IBM, Data 100, Remcom, Sycor, Mohawk, Singer, etc.
SOFTWARE					
Conversational programming languages	FORTRAN, BASIC, COBOL, APL, Simula, Simscript	FORTRAN, BASIC, COBOL, Macro 10	FORTRAN, BASIC, COBOL, APL, PL/1, AID, Simula, etc.	FORTRAN, BASIC, COBOL, APL, SNOBOL, Metasymbol	TSO Command Language
Batch-mode programming languages	FORTRAN, BASIC, COBOL, ALGOL, Compass, etc.	FORTRAN, BASIC, COBOL, Macro 10	FORTRAN, BASIC, COBOL, APL, PL/1, AID, Simula, etc.	FORTRAN, BASIC, COBOL, APL, SNOBOL, Metasymbol	FORTRAN, COBOL, PL/1, ALGOL, Assembler
Principal applications	Business & scientific	Business & scientific	Business & scientific	Business & scientific	Business & scientific
CHARGES					
Min. monthly charge:					
Interactive	None	None	$125	$10	None
Remote batch	None	None	None	$10	None
Terminal connect time:					
Interactive	$8-15/hr.	$10-15/hr.	$10/hr.	$10/hr.	$6-9/hr.
Remote batch	$10/hr.	Variable	$40-60/hr.	$15/hr.	$6-9/hr.
Central processor time:					
Interactive	$12/min.	$1.20/min	$36-54/min.	$0.15-0.30/sec.	$25/min.
Remote batch	$12/min.	$0.60-1.20/min.	$36-54/min.	$0.12-0.25/sec.	$15/min.
Mass storage:					
Interactive	$0.21-0.36/1280 chars./month	$0.06-1.00/1000 chars./month	$0.20-0.80/1000 chars./month	$0.50/1000 chars./month	$0.015/track/day (IBM 3330)
Remote batch	$0.12-0.36/1280 chars./month	$0.06-1.00/1000 chars./month	$0.20-0.80/1000 chars./month	$0.50/1000 chars./month	$0.015/track/day (IBM 3330)
COMMENTS	Also see Service Bureau Corporation, which is now a subsidiary of Control Data Corp.	International data communications network can link any client to any system. Charges depend upon volume and type of contract.	Specializes in economic planning and analysis; offers Economic Information System at a fee of $1500 to $18,000/year.	Offers municipal bonds program.	Offers discounts for volume usage and non-prime time. Dedicated high-speed access ports available.

All About Remote Computing Services

COMPANY	Dataline Systems Limited	Datalogics, Inc.	Dialcom, Inc.	Fedders Data Centers, Inc.	First Data Corporation
GENERAL					
Name of service	Dataline Interactive System	DL/70	–	–	–
Date operational	Sept. 1969	Jan. 1969	July 1970	1959	1969
Areas currently served	All of Canada (via multiplexers, foreign exchanges, and Dataroute)	Ohio	Middle Atlantic States; local service in Washington, D.C., Baltimore, New York, & Philadelphia	U.S. and Canada	New England and Middle Atlantic States
EQUIPMENT					
Computers	DECsystem-10 (3) in Toronto	Xerox Sigma 7 in Cleveland	Honeywell 1648A (2) in Silver Spring, Md.	IBM 370/155 in Baltimore	DEC PDP-10 (4) in Waltham, Mass.
No. of simultaneous users	185 total	Over 50	128 total	Over 200	Over 100
Conversational terminals supported	TTY 33/35, IBM 2741, and compatible units; all ASCII CRT's	TTY 33/35 and all compatible units at 10 or 30 cps	TTY and other ASCII terminals at 10 or 30 cps; Correspondence units at 14.8 cps	–	"All available terminals" (TTY, IBM 2741, and compatible units)
Batch terminals supported	IBM 2780 and compatible units	–	–	Fedder APT-1000, Fedder Fastback, or any IBM-compatible RJE terminal	FDC-73
SOFTWARE					
Conversational programming languages	FORTRAN, BASIC, COBOL, APL, ALGOL, LISP, SNOBOL, Macro-10	FORTRAN, BASIC, COBOL	FORTRAN, BASIC, COBOL, TEACH, SOLVE, DAP, Text Editor	–	FORTRAN, BASIC, COBOL, APL, ALGOL, LISP, SNOBOL, AID, etc.
Batch-mode programming languages	FORTRAN, BASIC, COBOL, APL, ALGOL, Macro-10, etc.	FORTRAN, BASIC, COBOL, Manage, Metasymbol		None required by user	FORTRAN, BASIC, COBOL, APL, ALGOL, LISP, SNOBOL, etc.
Principal applications	Business & scientific	Business & scientific	Business & scientific	Business	Business & scientific
CHARGES					
Min. monthly charge:					
Interactive	$5.00	$100	$25	–	None
Remote batch	$5.00	None	–	See Comments	None
Terminal connect time:					
Interactive	$7.50-12.00/hr.	$9.00-14.50/hr.	$6.00/hr.	–	$7.50/hr.
Remote batch	None	Not applicable	–	See Comments	$7.50/hr.
Central processor time:					
Interactive	See Comments	$0.08/Unit	None	–	$3.00-18.00/min.
Remote batch	See Comments	$0.08/Unit	–	See Comments	$1.50-9.00/min.
Mass storage:					
Interactive	$0.01/640 chars./day	$0.50/2048 Chars./month	$0.50/512 chars./month	–	$0.50/1000 chars./month
Remote batch	$0.01/640 chars./day	$0.50/2048 chars./month	–	See Comments	$0 50/1000 chars./month
COMMENTS	CPU charges vary with amount of main storage used. Rates are much lower during non-prime hours.	"Virtual port" contracts available. Offers discounts for volume usage and non-prime time.	Offers special rates for large data bases and dedicated ports. Offers tax return preparation service.	Specializes in remote batch services for accountants. Charges are based on number of transactions processed and frequency.	CPU charges vary with amount of main storage used. Offers discounts for large-volume mass storage and non-prime time.

All About Remote Computing Services

COMPANY	First National Bank of Memphis	Fulton National Bank	General Electric Company	Genesee Computer Center, Inc.	Grumman Data Systems Corporation
GENERAL					
Name of service	Compu-Serv	Fulton Data	Mark III	Genesee Services	Calldata
Date operational	March 1969	1966	1965	Aug. 1968	Feb. 1970
Areas currently served	Memphis area plus 23 other cities nationwide	Southeastern U.S. via multiplexers in major cities and INWATS service	Local-call service to more than 300 cities in North America, and (via satellite) Western Europe, Australia, and Japan	Continental U.S. and Toronto via multiplexers and INWATS service	Middle Atlantic and New England; INWATS service to Conn., Del., Mass., N.H., N.J., Pa. R.I., & Vt.
EQUIPMENT					
Computers	DECsystem 1050 (4) in Columbus, Ohio	Honeywell 6050 (2) and Honeywell 440 in Atlanta	More than 100 computers, including Honeywell 635 and 6000 systems, in one "supercenter" in Cleveland	CDC 6600, 6400, and 3500 systems belonging to Control Data (Cybernet) and Multiple Access Ltd.	IBM 360/67 in Bethpage, N.Y.
No. of simultaneous users	400 total	125 total	Up to 100 per computer	Not specified	96
Conversational terminals supported	Any ASCII, BCD, Correspondence, or EBCDIC terminal at 10, 14.8, 15, or 30 cps	TTY and all compatible units at 10 to 30 cps	ASCII, EBCDIC, or Correspondence terminals at 10, 14.8, 15, or 30 cps	TTY and all compatible units at 10 or 30 cps	TTY 33/35, IBM 2741, and compatible units
Batch terminals supported	DEC PDP-8 and PDP-11 computers in some cities	"All"	IBM 2780, Data 100, Remcom 2780, MDS 2400, and Honeywell G-115	CDC 200, DEC PDP-11, IBM 1130, UNIVAC 9200/9300, Data 100, etc.	IBM 2780, 1130, 360/20, and compatible units
SOFTWARE					
Conversational programming languages	FORTRAN, BASIC, COBOL, ALGOL, SNOBOL, LISP, Macro 10	FORTRAN, BASIC	FORTRAN, BASIC, ALGOL, Editors, DATOOL	FORTRAN, COBOL, Compass	BASIC, BRUIN, SNOBOL, SCRIPT, EDIT
Batch-mode programming languages	FORTRAN, BASIC, COBOL, ALGOL, SNOBOL, LISP, Macro 10	COBOL, ALGOL, JOVIAL, Simscript, Databasic	FORTRAN, COBOL	FORTRAN, COBOL, Compass	FORTRAN, COBOL, PL/1, Assembler, GPSS
Principal applications	Business & scientific	Business & scientific	Business & scientific	Business & scientific	Business & scientific
CHARGES					
Min. monthly charge:					
Interactive	None	None	$100/catalog	None	None
Remote batch	None	None	$300/catalog	None	None
Terminal connect time:					
Interactive	$9-13/hr.	$7/hr. (300 bps)	$7-13.50/hr.	$8-15/hr.	$7.50-12.50/hr.
Remote batch	Not specified	$15/hr. (2000 bps)	$7-16/hr.	$10-20/hr.	$7.50-12.50/hr.
Central processor time:					
Interactive	$1.20/min.	$0.03/unit	$0.33-0.40/CRU	$0.18-0.20/sec.	$0.35/sec.
Remote batch	$1.20/min.	$8.33/min.	$0.07/BCRU	$0.20-0.60/sec.	$5.60-11.20/min.
Mass storage:					
Interactive	$1.50/3200 chars./month	$1.00/1280 chars./month	$0.20-1.10/320 36-bit words/mo.	$0.01/1280 chars./day	$3.75-12.50/ cylinder/month
Remote batch	$1.50/3200 chars./month	$1.00/1280 chars./month	$0.20/320 36-bit words/mo.	$0.01/1280 chars./day	$3.75-12.50/ cylinder/month
COMMENTS	Marketing affiliate of Compu-Serv Network, Inc., of Columbus.		Offers extensive data management facilities. CPU charges depend on resources required and other factors. Discount for deferred processing.	Provides specialized technical services, and resells Control Data or Multiple Access computer services, at the supplier's rates, in the process.	Deferred processing option allows TS jobs to be set up during prime time and processed overnight at reduced rates ($0.20/CPU second).

All About Remote Computing Services

COMPANY	GTE Data Services Incorporated	HDR Systems, Inc.	Honeywell Information Systems, Inc	Information Systems Design	Interactive Data Corporation
GENERAL					
Name of service	GTEDS Time-Sharing Service	HDR Systems KRONOS	Datanetwork	—	—
Date operational	Nov. 1971	Oct. 1972	July 1972	June 1968	1968
Areas currently served	Continental U.S. plus Hawaii and Alaska	Omaha and surrounding area	Entire U.S.; local service in most large cities plus INWATS service	Western States	Entire U.S. via INWATS and foreign exchange lines
EQUIPMENT					
Computers	CDC 6500, CDC 6600, and CDC Cyber 73-28 (2)	CDC 6400 in Omaha, Neb.	Honeywell 6080 (2) in Minneapolis	UNIVAC 1108 (2) in Oakland, Calif.	IBM 360/67 (2) in Waltham, Mass.; IBM 360/67 in San Francisco; IBM 360/40 in New York City
No. of simultaneous users	1000 total	150	130	63	120 total
Conversational terminals supported	"Any"	TTY 33/35, CDC 713, Execuport, etc.	TTY and compatible units at 10, 15, or 30 cps; Honeywell VIP displays; IBM 2741	TTY and compatible units at 10, 30, or 120 cps	TTY 33/35, IBM 2741, and compatible units at 10 to 30 cps
Batch terminals supported	CDC 200 User Terminal and all compatible units	CDC 200 & 731, Data 100, M&M 500, Mohawk 2400, etc.	Honeywell G100 G200, G400, H200/2000 Series, H58, Mohawk 2400, etc.	UNIVAC 1004, COPE, Data 100, IBM 1130, M&M, etc.	IBM 2780 and compatible units
SOFTWARE					
Conversational programming languages	FORTRAN, BASIC	FORTRAN, BASIC, COBOL, APL, Text Editor	FORTRAN, BASIC, Text Editor	FORTRAN, BASIC, Text Editor	FORTRAN, BASIC, COBOL PL/1, Assembler
Batch-mode programming languages	FORTRAN, BASIC, COBOL, Simscript, Compass	FORTRAN, COBOL, Compass	FORTRAN, COBOL, ALGOL, JOVIAL GMAP, COBOL/IDS	FORTRAN, COBOL, ALGOL	FORTRAN, BASIC, COBOL, PL/1, Assembler
Principal applications	Business & scientific	Business & scientific	Business & scientific	Business & scientific	Business & scientific
CHARGES					
Min. Monthly charge:					
Interactive	None	None	$90	$30	None
Remote batch	None	None	$90	$30	None
Terminal connect time:					
Interactive	$10.50-16.50/hr.	$4/hr. (10/30 cps)	$10/hr. (10-30 cps)	$4-7/hr.	$10/hr.
Remote batch	$13.50/hr.	$10/hr. (2000 bps)	$30/hr. (2000 bps)	$10/hr.	None
Central processor time:					
Interactive	$1.20-19.80/min.	$0.20/sec.	$1.00/TSU	$10-16/min.	$16.80/min.
Remote batch	$7.05/min.	$0.20/sec.	$1.00/RBU	$10-16/min.	$16.80/min
Mass storage:					
Interactive	$0.50/1280 chars./month	$0.20/640 chars./month	$0.15-0.65/320 36-bit words/mo.	$9.00/85,000 chars./month	$1.00/6000 chars./month
Remote batch	$0.50/1280 chars./month	$0.20/640 chars./month	$0.15-0.65/320 36-bit words/mo.	$9.00/85,000 chars./month	$1.00/6000 chars./month
COMMENTS	Offers general time-sharing services plus large library of applications programs for telephone companies.	Offers powerful text editing system and professional consulting services.	Offers 160 hours/week nationwide access to GCOS multidimensional computing, plus 24-hour customer service hotline.	Specializes in high-speed remote job entry at up to 1000 cpm and 1200 lpm. Rates are lower during non-prime hours.	Offers on-line financial data bases with proprietary software for accessing and processing the data.

All About Remote Computing Services

COMPANY	Interactive Sciences Corporation	International Timesharing Corporation	ISC/Pryor Computer	Kaman Aerospace Corporation	Keydata Canada
GENERAL					
Name of service	ISC Time-Sharing	3300 Network & 1640 Network	ISC/Pryor	Kaman TS Systems	Keydata
Date operational	1968	May 1968	June 1969	Aug. 1971	1969
Areas currently served	New England, Middle Atlantic, & East Central States; lines to New York, Phila., Detroit, & 6 other cities	Atlanta, Boston, Chicago, Cleveland Dallas, Denver, Detroit, Houston, Los Angeles, Phila., & 10 other cities	Illinois and Ontario	Central Connecticut	Major Canadian metropolitan areas; current subscribers in Toronto, Montreal, and Vancouver
EQUIPMENT					
Computers	DEC PDP-10 (2) in Braintree, Mass.	CDC 3300 (2) & Honeywell 1648A (4) in Chaska, Minn.	Honeywell 440 in Toronto, Ont.	HP 2000C in Bloomfield, Conn.	UNIVAC 494 (2) in Watertown, Mass.
No. of simultaneous users	128 total	194 total	50	32	2000 total
Conversational terminals supported	TTY and compatible units at 10 or 30 cps; IBM 2741 and campatible units at 14.8 cps	TTY 33/35, IBM 2741, and compatible units, including displays	TTY 33/35, GE TermiNet 300, Memorex 1240, UNIVAC DCT 500, Olivetti	Any ASCII terminal at 10, 15, or 30 cps	TTY Model 28, GE TermiNet
Batch terminals supported	—	—	—	—	—
SOFTWARE					
Conversational programming languages	FORTRAN, BASIC, COBOL, ALGOL, LISP, Macro 10	FORTRAN, BASIC, BPL, IMS, Assembly, TEACH, SOLVE, EDIT, etc.	FORTRAN, BASIC	BASIC	Not specified
Batch-mode programming languages	—	—	—	—	—
Principal applications	Business & scientific	Business & scientific	Business & scientific	Business & scientific	Business
CHARGES					
Min. monthly charge:					
Interactive	None	$200	$50	None	$800
Remote batch	—	—	$500	—	—
Terminal connect time:					
Interactive	$9/hr.	$10/hr.	$10/hr.	$5.50-8.00/hr.	See Comments
Remote batch	—	—	—		—
Central processor time:					
Interactive	$0.01/CRU	$0.12/CRU	Not specified	No charge	See Comments
Remote batch	—	—	—	—	
Mass storage:					
Interactive	$0.01/640 chars./day	$0.15-0.60/640 chars./month	$0.75/1000 chars./month	$0.16-0.30/1000 bytes/month	See Comments
Remote batch	—	—	—	—	—
COMMENTS	Offers business planning service, professional services, 30-inch plotter, and lower rates for non-prime time.	Charges shown are for 3300 Network; 1640 Network was acquired from Honeywell in April 1973. Business Planning Language aids in financial planning.	Specializes in remote processing of billing, accounts receivable, sales analysis, and inventory control.	Offers dedicated port (i.e., unlimited access) for $500 (local to Hartford) or $825 (statewide access) per month.	All charges are based on number of transactions processed. Dedicated system for business data processing applications.

All About Remote Computing Services

COMPANY	Keydata Corporation	Leasco Response, Inc.	Management Systems Corporation	Manufacturing Data Systems, Inc.	Mark/Ops
GENERAL					
Name of service	Keydata	Response/360, Response I	Time Sharing Services	Compact II N/C Parts Programming	Mark/Ops
Date operational	1965	1969	April 1970	March 1969	April 1967
Areas currently served	Continental U.S. & Eastern Canada; 23 concentrators	Eastern and Midwestern U.S. plus Los Angeles;	Salt Lake City, Provo, and Ogden, Utah	All of U.S. and Canada, United Kingdom, & France	New England States and New York City area
EQUIPMENT					
Computers	UNIVAC 494 (2) in Watertown, Mass.	IBM 360/65 in Maryland; HP HP 2116 in each branch office	IBM 370/145 & IBM 360/65 in Salt Lake City	Xerox 940 systems in Ann Arbor (Com-Share) and Palo Alto (Tymshare)	DEC PDP-10 in Boston
No. of simultaneous users	2000 total	Not specified	44 total	Not specified	64
Conversational terminals supported	"Almost all" (e.g., TTY Model 28, GE TermiNet, TI Silent 700, Computer Devices)	TTY 33/35 & other ASCII terminals at 10 to 30 cps; IBM 2741	Trendata 1000, Trendata 1500, IBM 2741	TTY ASR 33, Western Union DT300, GE TermiNet	All ASCII units at 10, 15, or 30 cps; IBM 2741 and compatible units
Batch terminals supported	—	—	—	—	—
SOFTWARE					
Conversational programming languages	Keydata On-Line Processing Language (KOP)	BASIC, FORTRAN, PL/1	APL	Compact II	FORTRAN, BASIC, COBOL, Macro 10
Batch-mode programming languages	Keydata Report Generator (KRG)	Full OS/360 capabilities	—	—	FORTRAN, BASIC, COBOL
Principal applications	Business	Business & scientific	Business & scientific	Numerical control	Business & scientific
CHARGES					
Min. monthly charge:					
Interactive	See Comments	$100	None	$50	None
Remote batch	—	—	—	—	None
Terminal connect time:					
Interactive	See Comments	$9.40-13.75/hr.	$3.75/hr. (local)	$10-14/hr.	$8/hr.
Remote batch	—	—	—	—	$8/hr.
Central processor time:					
Interactive	See Comments	$18.60/min.	$0.11/sec.	$35/min.	$0.10/sec. (4K)
Remote batch	—	—	—	—	$0.05/sec. (4K)
Mass storage:					
Interactive	See Comments	$1.05/3440 chars./month	$1.00/7294 chars./month	$1.00/1000 chars./month	$0.01/640 chars./day
Remote batch	—	—	—	—	$0.01/640 chars./day
COMMENTS	Dedicated system for business data processing applications. All charges are based upon application volume and customer usage.	Charges shown are for Response/360 service on IBM 360/65. Response I service on HP costs $6-8/hr. of connect time (no CPU charge).	Offers Text Processing System (TPS) to facilitate preparation of publications, proposals, etc.	Offers numerical control parts processing system, using Com-Share and Tymshare computers and communications networks.	Division of Northeastern Systems Associates. Specializes in large systems for specific customers. Lower rates for non-prime time.

All About Remote Computing Services

COMPANY	McDonnell Douglas Automation Co.	Merlin Systems Corporation	Metridata Computing, Inc.	Multiple Access Limited	National CSS, Inc.
GENERAL					
Name of service	Direct Access Computing (DAC)	Merlin Systems	Metrinet	—	VP/CSS
Date operational	Jan. 1968	Jan. 1970	Jan. 1969	Oct. 1969	Dec. 1968
Areas currently served	Continental U.S. plus Montreal, Toronto, Windsor, and Vancouver, Canada	Continental U.S.; toll-free access from all zones	Multiplexers in Chicago, Cincinnati, Dayton, and Indianapolis; foreign exchange in Columbus, O.	All of Canada & Northeastern U.S.	East Coast, Midwest, West Coast, Arizona, Houston, Canada, London
EQUIPMENT					
Computers	IBM 370/195 (2) in St. Louis; IBM 370/165 (2) in Long Beach; Xerox Sigma 9 (2) in St. Louis; etc.	Burroughs B 5500 (2) in Roslyn, N.Y.	Honeywell 430 (2) in Louisville	CDC 3500 and CDC 6600 in Toronto	IBM 360/67 (6) & 370/145 in Stamford, Conn.; IBM 360/67 (2) in Sunnyvale, Calif.
No. of simultaneous users	128 (time-sharing); 56 (RJE)	50	80 total	48 on CDC 3500, 32 on CDC 6600	500 in Conn. & 160 in Calif.
Conversational terminals supported	All ASCII units at 10 or 30 cps; IBM 2741 and compatible units; Computek & Tektronix graphics	Any ASCII terminal at 10 or 30 cps, including Hazeltine & ARDS graphic terminals	Any ASCII terminal at 10 or 30 cps	TTY and all compatible units at 10 or 30 cps	TTY and all compatible units at 10, 15, 30, 60, or 120 cps
Batch terminals supported	IBM 2770, 2780, 3780, 1130, 360/20, System/3, and compatible units	—	—	IBM 360/20 & 1130, UNIVAC 9200/9300, CDC 200, Harris COPE .38, etc.	1200-bps dial-up terminals
SOFTWARE					
Conversational programming languages	FORTRAN, BASIC, COBOL, SYMBOL	FORTRAN, BASIC, COBOL, ALGOL	FORTRAN, BASIC	FORTRAN, BASIC, COBOL, Compass	FORTRAN, BASIC, COBOL, PL/1, Assembler
Batch-mode programming languages	FORTRAN, COBOL, PL/1, RPG, Assembler, IMS/DL-1, etc.	FORTRAN, BASIC, COBOL, ALGOL	COBOL	FORTRAN, BASIC, COBOL, Compass	FORTRAN, BASIC, COBOL, PL/1, Assembler
Principal applications	Business & scientific	Financial & statistical	Business & scientific	Business & scientific	Business & scientific
CHARGES					
Min. monthly charge:					
Interactive	None	None	None	None	None
Remote batch	None	On request	—	None	None
Terminal connect time:					
Interactive	$8/hr.	$9/hr.	$10/hr.	$3.75-12.00/hr.	$10-20/hr.
Remote batch	Varies with speed	On request	—	$20.00/hr.	None
Central processor time:					
Interactive	$12/min. on Sigma	$7.20/min.	$0.04/CPU unit	$0.16/sec. (3500)	$0.19/VPV
Remote batch	$13/min. on 165; $42/min. on 195	On request	—	$0.23-0.50/sec. (6600)	$0.08-0.12/VPU
Mass storage:					
Interactive	$0.10/1024 bytes/week	$0.15-0.50/1000 chars./month	$0.75-1.75/1000 chars./month	$0.35/1280 chars./month	$20/120,000 bytes/month
Remote batch	$0.035-0.04/1024 bytes/week	—	—	$7.00/32,000 chars./month	$20/120,000 bytes/month
COMMENTS	Offers time-sharing on Sigma 9's, RJE on 370's, and full range of graphics services. High-speed links interconnect the computers.	Offers on-line financial data bases of securities, bonds, options, and commodities prices.		High-speed link between CDC 3500 and 6600 gives all users on-line access to both systems. Offers financial planning packages.	

All About Remote Computing Services

COMPANY	Ohio Valley Data Control, Inc.	On-Line Business Systems, Inc.	On-Line Systems, Inc.	Pacific Applied Systems, Inc.	Pacific International Computing Corp.
GENERAL					
Name of service	—	—	—	TASC system	ATS, COMSPEC, Honeywell TSS
Date operational	July 1972	July 1971	Dec. 1967	1971	Nov. 1969
Areas currently served	Ohio Valley — Eastern Ohio and West Virginia	West Coast, Nevada, Arizona	Northeastern, Middle Atlantic, Midwestern, and Southern U.S.; toll-free access from 16 cities	Continental U.S.	Los Angeles, Palo Alto, San Francisco, Ann Arbor, Boston, Chicago, Dayton, New York, Phila., Richmond, Washington, D.C.
EQUIPMENT					
Computers	Burroughs B 3500 (2) in Belpre, Ohio	IBM 370/145 in San Francisco	DEC PDP-10 (7) in Pittsburgh	GRI 99 in Sherman Oaks, Calif.	IBM 360/50 in New York; Honeywell 6080 in San Francisco
No. of simultaneous users	Over 100	100	448	6	212 in New York, 35 in San Fran.
Conversational terminals supported	Burroughs TD 700 and TD 500	All IBM-compatible terminals (e.g., 2260, 2740, 3270)	TTY 33/35/37, IBM 2741, and compatible units, including plotters and CRT displays	—	Correspondence, ASCII, EBCDIC, and BCD units at 10, 15, or 30 cps
Batch terminals supported	Burroughs B 345	All IBM-compatible terminals	Data 100, etc.	UNIVAC 1004, Harris COPE, etc. (tie into UNIVAC 1108 computer)	Honeywell 105 and 115
SOFTWARE					
Conversational programming languages	FORTRAN, COBOL	None	FORTRAN, BASIC, COBOL, APL, Telcomp	Test Oriented Language	FORTRAN, BASIC
Batch-mode programming languages	Assembler	None	FORTRAN, BASIC, COBOL, APL, Telcomp	Test Oriented Language	FORTRAN, COBOL, GMAP
Principal applications	Business, banking, cash dispensing	Specialized business systems	Business & scientific	Terminal access simulation	Construction & text editing
CHARGES					
Min. Monthly charge:					
Interactive	Not specified	None	$5/user no.	—	Not specified
Remote batch	Not specified	None	$5/user no.	$3,000 (2-year lease)	Not specified
Terminal connect time:					
Interactive	$10/hr.	See Comments	$10/hr.	—	$2.50/hr.
Remote batch	$30-48/hr.	$30/hr.	None	Not applicable	—
Central processor time:					
Interactive	Varies with application	Not applicable	$0.05/CP unit	—	$0.01/unit
Remote batch		$4/min.	$0.05/CP unit	Not applicable	—
Mass storage:					
Interactive	$20/100,000 bytes/month	$0.05/1000 bytes/month	$0.05/3200 chars./day	—	$0.24/PSR
Remote batch	$20/100,000 bytes/month	$0.02/1000 bytes/month	$0.05/3200 chars./day	Not applicable	—
COMMENTS	Specializes in banking services. Offers time-sharing, remote batch processing, and "Mister Cash" on-line cash dispensing service.	Limited to applications such as reservations, order entry, POS, inventory, data base retrieval, etc. Billing is on a transaction basis.	Service available 24 hours/day, 7 days/week. Offers on-line data management, financial modeling, & resource management systems.	Dedicated system tests simulation models for program development for automatic test equipment (ATE). Uses UNIVAC 1108 at service bureau.	Specializes in COMSPEC service for construction industry and ATS text editing system.

All About Remote Computing Services

COMPANY	Paden Data Systems, Inc.	Philco-Ford Computer Services Network	Phoenix Data Limited	PRC Computer Center, Inc.	Profile Technology, Inc.
GENERAL					
Name of service	Paden Data Base (PDB)	Computer Services Network (CSN)	KRONOS	—	The Computer Spectrum
Date operational	Summer 1973	Dec. 1968	July 1972	1970	1972
Areas currently served	Dallas-Fort Worth metropolitan area	Middle Atlantic States, Chicago, Detroit	Alberta, Manitoba, Ontario, Saskatchewan	Continental U.S.	Southeastern U.S.
EQUIPMENT					
Computers	Burroughs B 3500 in Dallas	Burroughs B 5700 (2) and B 6700 in Fort Washington, Pa.	CDC 6500 and CDC 1700 in Winnipeg	IBM 370/155 in McLean, Va.	HP 2000F in Chattanooga, Tenn.
No. of simultaneous users	15	168 total	512 timesharing, 46 remote batch	96	32
Conversational terminals supported	Burroughs TC 500 and TD 700	ASCII terminals at 10 or 30 cps	TTY 33/35 and compatible units	—	TTY and other ASCII terminals
Batch terminals supported	—	Burroughs DC 1000, IBM 2780, and compatible units	CDC 200 & 731, IBM 360/20, Comterm, Mohawk, Remcom	IBM 2780 & 360/20, Data 100, Harris COPE, etc.	NCR printers & card readers, etc.
SOFTWARE					
Conversational programming languages	None	FORTRAN, BASIC, COBOL, ALGOL	FORTRAN, BASIC, APL, Text Editor	—	FORTRAN, BASIC
Batch-mode programming languages	None	FORTRAN, BASIC, COBOL, ALGOL	FORTRAN, COBOL, Compass, Spectre	FORTRAN, COBOL, ALGOL, PL/1, Assembler	FORTRAN, Assembly
Principal applications	Business	Business & scientific	Business & scientific	Business & scientific	Business & scientific
CHARGES					
Min. monthly charge:					
Interactive	$750	None	None	—	$70
Remote batch	—	None	None	None	—
Terminal connect time:					
Interactive	See Comments	$9/hr. (to 30 cps)	$5/hr.	—	$7/hr.
Remote batch	—	$25/hr. (over 30 cps)	$7/hr.	None	—
Central processor time:					
Interactive	See Comments	$7.20/min.	$12.00/min.	—	No charge
Remote batch	—	$14.40/min.	$5.40-12.00/min.	$12.00/min.	—
Mass storage:					
Interactive	$0.0375/200 bytes/month	$1.00/1000 chars./month	$0.28/1280 chars./month	—	$1.00/3000 chars./month
Remote batch	—	$0.50/1000 chars./month	$0.28/1280 chars./month	Not specified	—
COMMENTS	Offers integrated business data processing service. Charges $0.125 per input transaction plus telephone line costs.	Bulk storage and dedicated lines are available at large discounts. Interactive rates shown are for B 5700, remote batch for B 6700.		Offers OS/370 remote job entry service. Additional charges for core usage, disk & tape mounts, and I/O device usage.	

All About Remote Computing Services

COMPANY	Programs & Analysis, Inc.	Proprietary Computer Systems, Inc.	Rapidata, Inc.	Remote Computing Corporation	SBC Data Services
GENERAL					
Name of service	Thrift Line Service	PCS/APL, PCS/RJE, Advanced ATS	Rapidnet	RCC Network	RTS, TSO, RJE, CRJE
Date operational	1969	Oct. 1968	Jan. 1968	Oct. 1968	March 1968
Areas currently served	New England and Middle Atlantic States plus Cincinnati	California, Mountain States, & Midwest; multiplexers in San Francisco, Palo Alto, San Diego, Santa Ana, Denver, & Chicago	Continental U.S. via INWATS and foreign exchanges; offices in New York Atlanta, Boston, L.A., & other cities	Local coverage throughout Calif.; nationwide tollfree INWATS service	Continental U.S.
EQUIPMENT					
Computers	Honeywell 6050 and 435 in Burlington, Mass.	IBM 360/65 in Van Nuys, Calif.	Honeywell 437 (12), DECsystem-1070, and IBM 370/145 in Fairfield, N.J.	Burroughs B 5700 (3) and B 6700 in Palo Alto; Burroughs B 5700 (2) in Los Angeles	IBM 360/65, 370/155, 360/40, and 360/30 in Paramus, N.J.
No. of simultaneous users	64 total	120	55 per H 437	32 per system	100 total
Conversational terminals supported	TTY and compatible units	ASCII terminals at 10 to 30 cps; IBM 2741 and compatible units; IBM & Hazeltine CRT displays	TTY and compatible units at 10, 15, 30, 60 or 120 cps; IBM 2741 and compatible units at 14.8 cps	TTY 33/35/37, IBM 2741, and compatible units at 10 to 120 cps	TTY 33/35/37/38, IBM 2740 & 2741, and compatible units
Batch terminals supported	Data 100, Harris COPE, Mohawk, Remcom	IBM 2780, 3780, and compatible units	IBM 2780, Data 100, and compatible units	—	Various IBM and compatible units
SOFTWARE					
Conversational programming languages	FORTRAN, BASIC	APL	FORTRAN, BASIC, COBOL, RIPS	FORTRAN, BASIC, COBOL, ALGOL	FORTRAN, BASIC, COBOL, PL/1, Assembler
Batch-mode programming languages	FORTRAN, COBOL	FORTRAN, COBOL, PL/1, LISP, GPSS	FORTRAN, COBOL	FORTRAN, BASIC, COBOL, ALGOL	FORTRAN, COBOL, PL/1, Assembler
Principal applications	Business	Business & scientific	Business & scientific	Business & scientific	Business & scientific
CHARGES					
Min. monthly charge:					
Interactive	See Comments	None	$10	None	None
Remote batch	—	None	$10	—	None
Terminal connect time					
Interactive	See Comments	$3.25-9.00/hr.	$5-25/hr.	$7/hr. and up	$10/hr.
Remote batch	—	$8.00-9.00/hr.	$30/hr.	—	Not specified
Central processor time:					
Interactive	See Comments	$18.00/min.	$1.44-3.60/min.	$7.20/min.	$0.03/CWU
Remote batch	—	$3.83-12.46/min.	$1.44-3.60/min.	—	Not specified
Mass storage:					
Interactive	See Comments	$10.00/million bytes/day	$0.20-0.60/1000 char./month	$0.01-0.24/2400 chars./day	$0.01/Storage Unit/day
Remote batch	—	Depends on EXCP's	$0.20-0.60/1000 chars./month	—	Not specified
COMMENTS	Offers dedicated business data processing services. Each application is charged on a unit transaction basis.	PCS services are available on the East Coast through affiliation with The Computer Company, of Richmond.	Offers several financial data bases: stock markets, economics, etc.	Connect charge ranges from $7/hr. at 110 bps to $25/hr. at 1200 bps. Rates are 40% lower after 5 p.m. PST.	A division of The Service Bureau Corp. (formerly ITT Data Services).

All About Remote Computing Services

COMPANY	Scientific Process & Research, Inc.	Scientific Time Sharing Corporation	Sci-Tek Incorporated	The Service Bureau Corporation	I.P. Sharp Associates Limited
GENERAL					
Name of service	SPR	APL*Plus	Sci-Tek	CALL/370 Management Time Sharing	Sharp APL
Date operational	1969	Aug. 1969	Jan. 1967	1964 (QUIKTRAN)	1969
Areas currently served	Continental U.S.	Local access in 36 cities throughout the U.S. plus Toronto and London	Eastern Seaboard	New England, Middle Atlantic States, Midwest, Mountain States, Texas, West Coast, Toronto, & Montreal	Contintal U.S., Canada, and United Kingdom
EQUIPMENT					
Computers	DEC PDP-10 (2) in Princeton, N.J.	IBM 370/155 in Bethesda, Md.	UNIVAC 1108 (2) In Wilmington, Del.	IBM 370/155 (5) in Cleveland	IBM 370/145 (2) in Toronto
No . of simultaneous users	60	Over 100	96 total	Over 150/system	150
Conversational terminals supported	TTY 33/35 and other ASCII terminals at 10 or 30 cps	IBM 2741, AJ 841, GTE Novar, Ontel, Computer Devices, Delta Data, Hazeltine 2000, Tektronix, etc.	TTY 33/35, Tektronix 4010	IBM 2741, TTY 33/35, and 30 cps ASCII terminals	IBM 2741 and compatible Correspondence, EBCDIC, or ASCII units, including Tektronix
Batch terminals supported	—	IBM 2780, Harris COPE, etc.	UNIVAC 1004, 9200, & 9300; IBM 2780 & 1130; Harris 1200	IBM 2780 or equivalent	—
SOFTWARE					
Conversational programming languages	FORTRAN BASIC, COBOL, Macro-10, etc.	APL*Plus	BASIC, RALPH	FORTRAN, BASIC, PL/1, Data Management	APL
Batch-mode programming languages	—	—	FORTRAN, COBOL, SLEUTH	FORTRAN, BASIC, PL/1, Data Management	All System/370 languages
Principal applications	Engineering & simulation	Business & scientific	Business & scientific	Business & scientific	Business & Scientific
CHARGES					
Min. monthly charge:					
Interactive	None	None	None	$100	None
Remote batch	—	—	None	—	—
Terminal connect time:					
Interactive	$10/hr.	$12/hr.	$10/hr.	$11-15/hr.	$12/hr.
Remote batch	—	$50/hr.	None	—	—
Central processor time:					
Interactive	$2.25-22.50/min.	$24/min.	$30/min.	$0.15/PU	$18/min.
Remote batch	—	—	$12-30/min. based on priority	$0.06-0.12/PU	—
Mass storage:					
Interactive	$0.015/1000 chars./day	$0.30/1000 chars./month	$1.20/10,752 chars./month	$0.44/1000 bytes/month	$0.15-0.24/1000 chars./month
Remote batch	—	—	$1.20/10,752 chars./month	$0.18-0.30/1000 bytes/month	—
COMMENTS	Offers simulators for plastics processing and optimization package.	APL*Plus File Subsystem facilitates processing of large shared files and data bases.	Offers APT, file management system, graphics systems, and Securities Validation System.	Subsidiary of Control Data Corp. since January 1973. Offers conversational time-sharing, remote batch, and local batch service. Wide range of pricing plans.	Company also offers systems consulting services and makes portable computer terminals.

All About Remote Computing Services

COMPANY	The Singer Company	Statistical Tabulating Corporation	Structural Dynamics Research Corp.	Systems Dimensions Limited	Technical Advisors, Inc.
GENERAL					
Name of service	Singer Information Systems Network	STAT:COM	SDRC Computer Operations	STS/WYLBUR, STS/INFO, etc.	TECH-MAC
Date operational	1970	Spring 1972	Jan. 1969	June 1969	June 1967
Areas currently served	United States and Europe	Continental U.S.	Nationwide access	Batch services throughout North America; toll-free 300 bps dial-up service in Toronto, Montreal, Ottawa, New York, & Boston	Continental U.S. except Alaska (toll-free except in Michigan)
EQUIPMENT					
Computers	IBM 370/165 & 370/168 in Wayne, N.J.; IBM 370/155 in Sunnyvale, Cal.; four IBM 370's in Europe	IBM 360/65 & 370/158 in Chicago	CDC 6500 in Pittsburgh; CDC 6600 in Minneapolis; Xerox 940 in Ann Arbor; Honeywell 635 in Cleveland, etc.	IBM 360/85 in Ottawa	Varian 622i (2); 1 in Wayne, Mich., and 1 in Phoenix, Ariz.
No. of simultaneous users	128 in N.J. & 64 in Cal.	99	Varies with system	100	20 in Wayne, 5 in Phoenix
Conversational terminals supported	TTY, IBM 2741, and all compatible units	TTY 33/35/38, IBM 2740/2741, Memorex 1240/1250, Hazeltine 2000, Datapoint 3300, etc.	TTY 33/35 and other ASCII terminals at 10 or 30 cps	IBM 2741 and compatible units; TTY and compatible ASCII terminals	TTY 33/35 or equivalent, including CRT displays
Batch terminals supported	Singer System Ten, 1500, or M&M 500; IBM 2780, 360/20 or any HASP-compatible terminal	IBM 2780, 3780, 2770, 2790, and System/3; Data 100, Badger DTS 100, Mohawk 2400, etc.	CDC 200 & 1700, IBM 1130, Data 100, Mohawk 2400, UNIVAC 9200, etc.	IBM BSC terminals and equivalents	—
SOFTWARE					
Conversational programming languages	WYLBUR, ATS	Hyperfaster/II	FORTRAN, BASIC	—	—
Batch-mode programming languages	All OS/360 languages, Mark IV, WATFOR	FORTRAN, COBOL, PL/1, ADPAC, RPG, Assembly	FORTRAN, BASIC, COBOL, ALGOL, Assembly	FORTRAN, COBOL, PL/1, RPG, Assembler, Mark IV	—
Principal applications	Business & scientific	Business & scientfic	Engineering & business	Business & scientific	Civil engineering & surveying
CHARGES					
Min. monthly charge:					
Interactive	None	None	None	None	None
Remote batch	None	None	None	None	—
Terminal connect time:					
Interactive	$3/hr.	$10/hr.	$9.50-13.00/hr.	$12/hr.	$10-28/hr.
Remote batch	$10/hr.	$10/hr.	Varies with system	Based on resource usage	—
Central processor time:					
Interactive	$9/min.	See Comments	$1.80-24.00/min.	$1200/task hour	None
Remote batch	By algorithm	See Comments	Varies with system	$1200/task hour	—
Mass Storage:					
Interactive	$4.05x10^{-7}/track/second (3330)	$0.25/7294 bytes/week	$0.10-1.75/1000 chars./month	$2.00/million bytes/day	$10.00/2000 chars./month
Remote batch	By algorithm	$0.25/7294 bytes/week	Varies with system	$2.00/million bytes/day	—
COMMENTS		Charges $8/1000 cards read and $4/1000 lines printed. Express processing is available at higher CPU charges.	Sells time on U.S. Steel, CDC, ACTS, GE, Com-Share, & Metridata systems. Features mechanical design and structural analysis programs.	Offers System/360 remote job entry services under OS/MVT, plus an interactive file editor (WYLBUR) and data retrieval system (INFO).	Offers specialized service for civil engineers and surveyors only. Plotter available for $45/hour.

All About Remote Computing Services

COMPANY	Technology for Information Management, Inc.	Tel-A-Data, Inc.	Telstat Systems, Inc.	Texas Instruments Incorporated
GENERAL				
Name of Service	TIM-Sharing	Tel-A-Data	TELAC/70	Texas Instruments Information Services
Date operational	Sept. 1968	Dec. 1966	Jan. 1971	1970
Areas currently served	New York State	State of Florida	New York City metropolitan area.	United States, Canada, and Western Europe
EQUIPMENT				
Computers	Honeywell 440 in Detroit, operated by ACTS Computing Corp.	Burroughs B 500	Xerox Sigma 7	IBM 370/195, 165, 158, & 155 in Dallas; IBM 370/168, 360/65, & 360/50 in London
No. of simultaneous users	50	64	64	33 in Dallas, 7 in London
Conversational terminals supported	TTY 33/35 and other ASCII terminals at 10 or 30 cps	TTY 33/35, GE TermiNet 300, Burroughs TC 500	TTY 33/35, IBM 2741, GE TermiNet 300, Datapoint 3300, Execuport, etc.	TI Silent 700; IBM 1050, 2260, and 3270
Batch terminals supported	—	—	XDS 7670, IBM 1130, UNIVAC DCT 2000	IBM 360/20, 1130, and 2922; Data 100
SOFTWARE				
Conversational programming languages	FORTRAN, BASIC	Assembler, COBOL	FORTRAN, BASIC, Symbol, ASSIST	DL/1, ITS, CRJE
Batch-mode programming languages	—	—	FORTRAN, COBOL, BASIC, Symbol, Metasymbol	FORTRAN, COBOL, BASIC, PL/1, Assembler
Principal applications	Business & scientific	Business	Financial services	Business & scientific
CHARGES				
Min. monthly charge:				
Interactive	$25	$800	None	Not specified
Remote batch	—	—	Not specified	Not specified
Terminal connect time:				
Interactive	$10/hr.	No extra charge	$10/hr.	$11.70/hr.
Remote batch	—	—	Not specified	Not specified
Central processor time:				
Interactive	$3/min.	No extra charge	$9/min.	Not specified
Remote batch	—	—	Not specified	$5-8/min.
Mass storage:				
Interactive	$0.75/1000 chars./month	$0.30/330 digits/month	$0.01/1000 chars./day	Not specified
Remote batch	—	—	Not specified	Not specified
COMMENTS	Offers services on ACTS system. $50 initiation fee. Reduced rates for non-prime hours and volume usage.	Main emphasis is on statistical reports and inventory control. Monthly charge includes CP and connect time.	Provides access to TELPRICE/70, an extensive financial data base, at a cost of $350/month.	Offers OS/MVT remote job entry services on triplex ASP configuration, plus systems analysis and design services.

All About Remote Computing Services

COMPANY	Time Sharing Resources, Inc.	Tymshare, Inc.	Uni-Coll	United Computing Systems, Inc.
GENERAL				
Name of service	Total-APL	TYMCOM-IX, TYMCOM-X, TYMNET	Uni-Coll	UCS-II, UCS-III, UCS-VI
Date operational	July 1970	1966	July 1972	1968
Areas currently served	Middle Atlantic States plus Boston Chicago, Los Angeles, San Francisco, and St. Louis	Local access in all major U.S. metropolitan areas, plus INWATS; local access in London, Paris, & Brussels	Delaware Valley	Major cities nationwide, using remote multiplexers, foreign exchanges, and INWATS
EQUIPMENT				
Computers	IBM 360/65 in Great Neck, N.Y.	Xerox 940 (24) in Cupertino, CA, Houston, Paris, & Englewood Cliffs, NJ; DEC PDP-10 (4) in Cupertino	IBM 370/168 in Philadelphia	CDC 6500, CDC 6600, CDC Cyber 73 (2), & Honeywell 265 in Kansas City; IBM 370/155 in Columbus, O.
No. of simultaneous users	95	40 per Xerox 940; 55 per PDP-10	200	640 total
Conversational terminals supported	IBM 2741 & 1050, AJ, GTE Novar, Delta Data, Hazeltine, Memorex 1240-1280, Tektronix	TTY 33/35/37, IBM 2741, and compatible units, including displays, at 10, 15, or 30 cps	"Any"	Any ASCII terminal at 10, 15 or 30 cps; Selectric or EBCDIC units at 14.8 cps
Batch terminals supported	IBM 2780, Data 100	IBM 2780 and compatible units	"Any"	CDC 200 and equivalent units; any IBM-compatible unit on 370/155
SOFTWARE				
Conversational programming languages	APL	FORTRAN BASIC, COBOL, PL/1	All System/370 languages	FORTRAN, ALGOL, BASIC
Batch-mode programming languages	FORTRAN, COBOL, BASIC, APL, PL/1, Assembler	—	All System /370 languages	FORTRAN, COBOL, Compass, all TS compilers
Principal applications	Business & scientific	Business & scientific	Business & scientific	Business & scientific
CHARGES				
Min. Monthly charge:				
Interactive	None	$80	None	$100
Remote batch	None	—	None	$100
Terminal connect time:				
Interactive	$11-19/hr.	$16/hr.	$3.60/hr.	$17.50/hr.
Remote batch	$120/hr.	—	None	$16.50/hr.
Central processor time:				
Interactive	$18/min.	$2.40/min.	$45.00/min.	$0-36/min.
Remote batch	—	—	$27.00-58.50/min.	Varies
Mass storage:				
Interactive	$1.50/7200 chars./month	$0.50-1.00/1000 chars./month	$0.046/1000 bytes/month	$0.50/1280 chars./month
Remote batch	—	—	$0.046/1000 bytes/month	$0.50/1280 chars./month
COMMENTS	Total-APL File Subsystem facilitates processing of large shared files and data bases. Also offers financial modeling system.	Charges shown are for Type A service on Xerox 940; other service plans are available. Also operates an IBM 370/158 in Palo Alto, CA.	Offers System/370 RJE and TSO services to educational and commercial customers. Rates vary with time of day, priority, and storage utilization.	Rates depend on computer and pricing option used. Offers nationwide access to common data bases and RJE service. Royalties for special applications.

All About Remote Computing Services

COMPANY	University Computing Company	USS Engineers and Consultants, Inc.	Westinghouse Tele-Computer Systems Corp.	Xerox Computer Services
GENERAL				
Name of service	FASBAC	UEC	Remote Input Terminal System	Interactive Accounting System
Date operational	May 1969	May 1970	Nov. 1968	1970
Areas currently served	Entire U.S. (thru WATS and multiplexers), plus England, Western Europe and Australia	Pittsburgh, Phila., New York, Houston, Los Angeles, Chicago, Detroit, & 5 other cities in the Mid-West	Middle Atlantic & New England States plus Illinois, Ohio, & Michigan	Los Angeles, San Francisco, San Diego, Chicago and New York metropolitan areas
EQUIPMENT				
Computers	UNIVAC 1108's in Dallas (2), Chicago, El Segundo (2), East Brunswick, London (2), and Sydney	CDC 6500 (2 central processors)	IBM 370/165, CDC 6600	Xerox Sigma 7 (3), Sigma 9, & Sigma 3 (3) in Los Angeles; Sigma 3 in San Francisco & Chicago
No. of simultaneous users	25 per FASBAC system	Not specified	32/system	256 total
Conversational terminals supported	ASCII devices at 10, 15, & 30 cps, IBM 2741, Datel, and plotters	TTY 33/35, GE TermiNet 300, Datapoint 3300, Syner-Data, Incoterm	Various terminals at 10, 15, or 30 cps	TTY 35, IBM 2741, Datel, Execuport, Olivetti
Batch-terminals supported	UCC COPE IBM 2780 and System/360, UNIVAC 1004, etc.	CDC 1700, CDC 200, IBM 1130, Incoterm	IBM 360 & 370 computers, IBM 2770 & 2780, CDC 200, etc.	—
SOFTWARE				
Conversational programming languages	BASIC, CASH, CALC, SHOBOL, Fastext	FORTRAN, COBOL, BASIC, ALGOL	—	"Plain English" user language for data entry and maintenance
Batch-mode programming languages	FORTRAN V, COBOL, ALGOL, Assembly	FORTRAN, COBOL, BASIC, ALGOL	FORTRAN, COBOL, PL/1, APT	—
Principal applications	Business & scientific	Scientific & engineering	Business & scientific	Business
CHARGES				
Min. monthly charge:				
Interactive	$100	None	—	$1,000
Remote batch	Not specified	None	None	—
Terminal connect time:				
Interactive	$7.50/hr.	$9/hr.	—	See Comments
Remote batch	Not specified	Not specified	See Comments	—
Central processor time:				
Interactive	$20/min.	$24/min.	—	See Comments
Remote batch	Not specified	Not specified	See Comments	—
Mass storage:				
Interactive	$0.50/2096 chars./month	$1.00/10,000 chars./month	—	$1.40/1000 chars./month
Remote batch	Not specified	Not specified	$0.02/5760 chars./day	—
COMMENTS	Also offers remote batch service on CDC 6400 in Calif. and IBM 370/165's in Dallas, Chicago, & East Brunswick. (Information supplied in Nov. 1972.)	Subsidiary of U.S. Steel Corp. Lower rates for batch mode and volume usage. Surcharges for certain software.	Emphasizes remote batch processing. Prices depend upon system, type of port, and monthly volume.	Offers integrated on-line accounting system. Charges are based upon transactions entered and lines printed. All programming is done by Xerox.

All About Remote Computing Services

AVAILABILITY OF APPLICATION PROGRAMS

COMPANY \ APPLICATION	Accounts payable	Accounts receivable	Banking	Billing	Data base management	Educational	Engineering	General ledger	Hospital administration	Information retrieval	Insurance	Inventory control	Numerical control	Operations research	Payroll	Personnel	Project control	Sales analysis	Scheduling	School administration	Scientific	Simulation	Statistical	Text editing	Typesetting
ACTS Computing Corporation	●	●	●		●	●	●	●		●		●	●	●	●	●	●	●	●	●	●	●	●	●	
APL Services, Inc.			●		●	●	●			●	●	●	●	●			●	●	●		●	●	●		
Applied Data Research, Inc.	●	●		●			●			●		●			●	●		●			●	●	●	●	
Applied Logic Corporation			●		●		●			●				●			●		●		●	●	●	●	
Axicom Systems, Inc.							●														●	●	●	●	
Beloit Computer Center, Inc.	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●
Boeing Computer Services, Inc.			●	●	●	●	●			●			●	●			●		●		●	●	●	●	
Bowne Time Sharing, Inc.																								●	●
Chi Corporation	●	●	●	●	●	●	●	●		●		●	●	●	●		●	●	●	●	●	●	●	●	●
Community Computer Corporation		●	●	●	●	●	●	●				●			●		●	●					●	●	
The Computer Company, Inc.			●		●		●			●				●	●		●	●	●		●	●	●	●	
Computer Innovations					●	●	●	●	●	●	●	●		●	●	●	●	●	●		●	●	●	●	
Computer Network Corporation	●	●		●	●	●	●	●		●		●	●	●	●	●	●	●			●	●	●	●	●
Computer Research Company																								●	
Computer Resource Services, Inc.	●	●	●	●	●	●	●	●		●	●	●		●	●		●	●					●		
Computer Sciences Canada, Ltd.	●	●			●		●	●		●		●		●	●		●	●				●	●		
Computer Sciences Corporation			●		●		●			●				●			●		●		●	●	●		
Computer Sharing Services, Inc.	●	●	●	●	●	●	●	●	●		●	●		●	●		●	●	●	●	●	●	●	●	
Computer Spectrum	●	●		●	●	●	●	●	●	●		●			●	●	●	●	●	●	●		●	●	
Computercraft Services, Inc.	●	●		●	●	●	●	●		●	●	●	●	●	●	●	●	●	●		●	●	●	●	
Computility, Inc.					●		●			●				●		●	●				●	●	●	●	
Compu-Time		●	●	●		●	●	●		●		●			●		●	●	●		●	●	●	●	
Computone Systems, Inc.											●			●											
Com-Share, Incorporated	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●		
Com-Share Limited	●	●		●	●	●	●	●		●	●	●	●	●	●	●		●	●		●	●	●	●	
Control Data Corporation					●		●			●			●	●	●	●	●	●	●		●	●	●	●	
Cyphernetics Corporation					●		●			●		●		●			●	●	●		●	●	●	●	●
Data Resources Inc.										●			●					●				●	●		
Data-Tek Corporation	●	●		●	●		●	●		●	●	●		●	●		●	●			●	●	●	●	
Datacrown Limited					●		●			●					●		●		●		●	●	●	●	
Dataline Systems Limited	●	●		●	●	●	●			●		●		●	●		●	●	●		●	●	●	●	
Datalogics, Inc.								●			●						●	●	●		●	●	●		
Dialcom, Inc.	●	●				●		●		●		●			●	●			●	●	●	●	●	●	
Fedder Data Centers, Inc.	●	●						●				●			●		●	●							
First Data Corporation			●		●	●	●			●		●		●			●	●	●		●	●	●	●	●
First National Bank of Memphis	●	●	●	●	●	●	●	●		●	●	●	●		●		●	●			●	●	●	●	
Fulton National Bank		●	●		●	●	●	●			●	●	●	●	●	●		●			●	●	●	●	
General Electric Company	●	●			●		●	●	●			●	●	●	●	●	●	●	●		●	●	●	●	
Genesee Computer Center, Inc.							●					●	●	●			●				●	●	●		
Grumman Data Systems Corporation					●		●		●	●			●	●		●	●		●		●	●	●	●	
GTE Data Services Incorporated					●		●			●				●							●	●	●	●	
HDR Systems, Inc.							●							●			●		●		●	●	●	●	
Honeywell Information Systems, Inc.	●	●			●		●	●		●		●	●	●	●	●	●	●	●		●	●	●	●	●
Information Systems Design					●		●						●	●			●		●		●	●	●	●	
Interactive Data Corporation			●		●					●				●					●			●	●		
Interactive Sciences Corporation	●	●			●		●	●		●		●		●		●	●				●	●	●	●	●
International Timesharing Corporation	●	●	●	●	●	●	●	●		●		●	●	●	●	●	●	●	●		●	●	●	●	
ISC/Pryor Computer	●	●		●				●				●			●		●	●				●	●	●	
Kaman Aerospace Corporation						●	●			●				●		●	●		●		●		●	●	
Keydata Canada	●	●		●				●				●						●							

All About Remote Computing Services

AVAILABILITY OF APPLICATION PROGRAMS (Continued)

COMPANY \ APPLICATION	Accounts payable	Accounts receivable	Banking	Billing	Data base management	Educational	Engineering	General ledger	Hospital administration	Information retrieval	Insurance	Inventory control	Numerical control	Operations research	Payroll	Personnel	Project control	Sales analysis	Scheduling	School administration	Scientific	Simulation	Statistical	Test editing	Typesetting
Keydata Corporation	●	●		●	●			●	●	●		●					●	●					●		
Leasco Response Incorporated		●			●	●	●	●		●	●			●	●		●	●	●		●		●		
Management Systems Corporation	●	●		●		●	●	●			●			●	●		●	●	●		●	●	●	●	●
Manufacturing Data Systems, Inc.													●												
Mark/Ops	●	●	●	●	●		●	●		●		●			●	●	●	●			●	●	●	●	
McDonnell Douglas Automation Co.	●	●			●	●	●	●	●	●			●	●	●	●	●		●	●	●	●	●	●	
Merlin Systems Corporation																							●		
Metridata Computing, Inc.	●	●	●				●							●								●	●		
Multiple Access Limited		●			●		●	●						●			●	●			●	●	●	●	
National CSS, Inc.		●		●	●		●	●		●		●		●		●		●			●	●	●	●	
Ohio Valley Data Control, Inc.		●	●						●	●					●										
On-Line Business Systems, Inc.								●		●		●					●								
On-Line Systems Inc.			●		●		●			●		●	●	●			●		●		●	●	●	●	
Pacific Applied Systems, Inc.																					●	●			
Pacific International Computing Corp.										●		●							●		●	●	●	●	
Paden Data Systems, Inc.	●	●		●				●				●			●			●							
Philco-Ford Corporation		●	●	●	●	●	●	●		●		●			●	●					●		●		
Phoenix Data Limited	●	●			●	●	●	●		●		●	●		●	●	●	●	●	●	●	●	●	●	
PRC Computer Center, Inc.					●		●	●	●	●					●	●	●				●	●	●		
Profile Technology, Inc.	●	●		●		●	●	●		●	●	●			●	●			●	●	●		●	●	
Programs & Analysis Inc.	●	●		●				●				●			●		●	●	●	●					
Proprietary Computer Systems, Inc.	●	●	●	●	●		●	●		●		●	●	●	●	●	●	●	●		●	●	●	●	
Rapidata, Inc.					●	●	●			●	●	●		●		●	●	●	●		●	●	●	●	
Remote Computing Corporation	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●		●	●	●	●	
SBC Data Services	●	●	●				●			●					●	●		●	●		●	●	●	●	
Scientific Process & Research, Inc.							●															●			
Scientific Time Sharing Corp.	●	●		●	●		●	●		●	●	●		●	●	●	●	●			●	●	●	●	
Sci-Tek Incorporated					●		●			●			●	●					●		●	●	●		
The Service Bureau Corporation			●		●		●			●	●			●		●	●				●	●	●		
I.P. Sharp Associates Limited	●	●	●	●	●	●	●	●	●	●	●	●		●			●	●	●		●	●	●	●	
The Singer Company	●	●			●		●			●		●	●	●	●		●	●			●	●	●	●	
Statistical Tabulating Corporation	●	●					●	●		●	●	●			●		●	●			●	●	●		
Structural Dynamics Research Corp.							●						●								●				
Systems Dimensions Limited		●		●	●		●			●		●		●	●		●		●		●	●	●	●	
Technical Advisors, Inc.							●																		
Technology for Information Management	●	●		●	●		●	●		●	●	●			●		●	●	●		●	●	●	●	
Tel-A-Data, Inc.		●								●		●		●	●			●					●		
Telstat Systems, Inc.			●							●				●											
Texas Instruments Incorporated	●	●		●	●	●		●	●			●	●	●	●	●	●	●	●		●	●	●		
Time Sharing Resources, Inc.	●	●	●	●	●	●	●	●		●	●	●	●	●		●	●	●	●		●	●	●	●	
Tymshare, Inc.	●	●	●		●		●	●		●		●		●			●	●	●		●	●	●	●	
Uni-Coll	●	●		●	●	●	●		●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	
United Computing Systems, Inc.	●	●			●		●	●		●			●								●	●	●	●	
University Computing Company					●	●	●			●		●	●	●	●		●				●	●	●	●	●
USS Engineers and Consultants, Inc.							●			●			●		●		●				●	●	●		
Westinghouse Tele-Computer Systems							●						●	●			●		●		●	●	●		
Xerox Computer Services	●	●		●					●			●			●	●	●	●	●						