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A Survey of Data Communication Devices and Facilities

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The underlying principles and practices of data communications were established in the telegraph field long before the digital computer was a practical reality, but its large scale use and development began only in the mid-1950's when it was recognized that teletypewriter circuits and machines used for transmitting messages could also be used for transmitting data to and from the computer. Because data commu-

nications is a significant aspect of information processing problems, it must naturally be considered by the system designer. There is a case for consideration of this technology whenever the elements of geographic dispersion, impatience for answers, and ultimate involvement of a computer system are present.

In any data communication application there are three major equipment considerations: computational facilities, terminal facilities and communications facilities. This survey is concerned with the third aspect, that is the data communications facility. Particular emphasis has been given to the problems of selecting the communications equipment and services. To aid the perspective user in a comparative evaluation for his needs, comprehensive charts have also been provided. Before proceeding to discuss the communications facilities, it is appropriate to consider the transmission techniques commonly employed and define some of the terms.

Editor's Note: The "Data Communications Terminals, Facilities, and Processing Equipment" section of the 1969-70 Computer Industry Annual is the foundation of this discussion. In addition to the facilities mentioned on the following pages, this section of the annual covers terminal devices, communication modes and processing equipment, data interchange codes, error control, reliability, system structure, design, and applications. Tables have been included illustrating comparative performances of communications-oriented processors, remote multiplexors, audio response units, CRT consoles, teleprinters, and card, tape, and other terminals.

TRANSMISSION TECHNIQUES

Data transmission systems generally consist of three basic elements—a transmitter or source of information message; a transmission channel or carrier, often called a data link; and a receiver of the transmitted message. The channel or data link is a transmission path between two or more terminals and may be a single wire, a group of wires or a special part of the radio frequency spectrum. Channels are generally



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classified on the basis of simultaneity, three basic types being simplex, half-duplex and full-duplex. *Simplex* is strictly unidirectional transmission. *Full-duplex* is the ability to transmit simultaneously in both directions while *half-duplex* is the ability to transmit in both directions but not simultaneously.

In half- or full-duplex modes, the data may be transmitted over 2- or 4-wire facilities. In most instances half-duplex transmission is over a 2-wire circuit. However full-duplex can also be handled by a 2-wire circuit. The 2- or 4-wire selection is the common carrier's responsibility, unless terminal specifications indicate differently.

In addition to simultaneity a channel is characterized by its bandwidth. Generally the greater the bandwidth of a channel, the higher the speed of transmission it will permit. The speed is usually measured in terms of bits per second, though measures such as words per minute or characters per second are still common terminology remnants of telegraphy. These channels are generally classified into three groups:

1. Narrowband channels: characterized by a speed range of 100 to 200 bits/sec; basically capable of handling manual keyboard devices.
2. Voiceband channels: characterized by a speed of 1200 to 3600 bits/sec; basically designed for handling voice transmission; specially prepared voice channels can handle data up to 9600 bits/sec.
3. Broadband channels: basically capable of handling data at a variety of rates ranging from few thousands of bits/sec to well into the megabits/sec range.

While the channels may appear to the user as a single data path, it may take on a variety of guises. The information bits may be transmitted either *serially* on a single wire or in *parallel* over multiple wires. Except for very short distances (up to a few hundred feet), serial transmission is more efficient and is more prevalent. Many facilities, however, use a combination of serial and parallel transmissions.

There are two basic forms of serial transmission: synchronous and asynchronous. In *synchronous* transmission, the characters (and bits) are transmitted at a fixed rate with the transmitter and receiver synchronized. In *asynchronous* transmission the interval of time between characters can vary arbitrarily. This usually means that start and stop elements must be transmitted with each character. Synchronous transmission, though more difficult to implement, is the more efficient of the two as it obviates the need for start and stop elements. For this reason most computer input/output terminals for high-speed automated links have only the synchronous option available. In manual systems using keyboards, where high efficiency in transmission cannot be achieved because of lack of automation and the nature of interaction, the simpler asynchronous transmission is used.

Half-duplex operation generally makes a more efficient use of the communications facilities but requires time for line-turnarounds when the direction of transmission is to be changed. However, there are applications which require simultaneously bidirectional communications and others in which line-turnarounds are so frequent that full-duplex is the more efficient way to operate. Simplex operation is restricted to unidirectional transmission and finds very limited use.

TRANSMISSION LINE FACILITIES

The concept of distance that characterizes most data communications applications is that of "many miles." Consequently it is necessary to think in terms of obtaining communication facilities from the common carriers, the telephone companies and the Western Union Telegraph Company. While microwave and other radio facilities are doing an excellent job in many application areas, wire is still by far the most widely used medium. The wire circuits supplied by the common carriers are essentially of two grades, telegraph grade or narrowband and voice grade.

There are two basically different types of service that the common carriers offer. One is the public or exchange service which consists of subscriber lines connected to a switching system, as the telephone network. The other is the private line or channel leasing service which consists of full time leased point-to-point or multipoint lines connecting locations belonging to only one customer. The cost of the exchange service usually consists of toll charges based on the distance and length of connection, and a monthly service charge to maintain system access. The cost of private line service consists of a monthly rental based on the length and type of lines. The various common carrier offerings are discussed under the heading of common carrier facilities. Although the communications engineer prefers to measure the capacity of a communications channel in terms of bandwidth, it is much more natural to use the bits/sec or character/sec measure. Of the two measures, bits/sec is more universal as character sizes vary between systems. To achieve a desired transmission rate (in bits/sec) at a satisfactory low error rate, it is necessary to specify not only the nominal channel bandwidth, but also the line quality, the number of wires in the channel and the modulating-demodulating equipment (Modem).

MODEMS

These modems or datasets, as they are sometimes called, are necessary to adapt the modern data communications devices to wire transmission over long distances. These are usually furnished by the common carrier in the switched network or exchange service (public), but may be purchased from other vendors and manufacturers for the private leased line. Recently, in the Carterfone case decision the Federal Communications Commission (FCC), the regulating body for the common carriers, declared their blanket foreign attachments prohibition to be illegal, and has ordered the carriers to permit the attachment for harmless customer supplied equipment to the public switched networks. Thus the data communications user would be able to use the lower cost, higher performance modems supplied by numerous vendors. Voice channels have a nominal bandwidth rating of 4 kHz. Several different quality voice channels are available from the common carriers. The differences lie in the actual achievable bandwidth, the frequency responses and the delay characteristics. The better characteristics of the higher quality channels permit the use of modems with very high data transmission capabilities. The net effect of the combination of line

quality and modem may be best illustrated by an example given below using the information provided by the Rixom Electronics Company.

AT & T Voice Channel Type (All channels are 4 kHz nominal)	Rixom Modem	Transmission
4	Sebit-12M	1200 bits/sec
4A	Sebit-24M	2400 bits/sec
4B	Sebit-36M	3600 bits/sec
4C	Sebit-48M	4800 bits/sec

From this example it can be seen that achievement of desired data transmission rate on a communications facility requires careful engineering of the facility in combination with the modem. The remaining consideration in the communications setup choice is the number of wires in the channel. A two-wire channel can support transmission in one direction only (except when special paralleltone modems are used). The two-wire channel can, however, support transmission alternately in either direction. A four-wire channel can support transmission simultaneously in both directions at considerably less than twice the cost of a two-wire facility.

The choice between two-wire and four-wire facilities depends on the requirements for data transmission and acknowledgements. If a facility is to be used to transmit substantial quantities of data in both directions, then the four-wire channel may be favored. If transmission is primarily unidirectional there still exists the problem of delays due to acknowledgements. All modern systems for data transmission use block-by-block acknowledgement procedures. On a two-wire line, the system must halt transmission after each block and wait for acknowledgement. If the transmission rates are high and the blocks short, the delay experienced in receipt of the acknowledgement may reduce the net achievable transmission rate.

Tables I through IV summarize the equipment characteristics for most common carrier and non-carrier data sets. The cost data has also been included wherever possible. The monthly rentals are given for the common carrier equipment as these are almost always leased; but for the non-common carrier modems the purchase cost has been provided as these are usually purchased outright rather than leased. The prices are only approximate and vary with configurations and options. In the case of common carriers, prices also vary with the operating companies and it is recommended that the prospective buyer check with his local representative.

COMMON CARRIER FACILITIES

The common carriers, mainly the American Telephone and Telegraph Company (AT&T) or the Bell System, General Telephone and Electronics (GT&E) and Western Union Telegraph Company offer a wide variety of communications services and facilities both with and without modems. The services mentioned in this section are presented to give a basic indication

of some of the communications facilities available today. The representatives of the communications companies should be consulted in order to obtain current information on rates, availability of service, channels and other devices pertinent to data transmission.

The communications services offered by the carriers take on a variety of forms and names with which the user should become familiar. Some of the communications services of the Bell System are WATS, Telpak, TWX and DATA-PHONE. The names of the services that may be obtained from Western Union are TELEX, INFO-COM, and DIAL-PAK. Western Union also recently placed an advanced digital data network (AUTODIN) service for the Department of Defense. These services are described below:

WATS for Wide-Area-Telephone Service is the name given to a telephone-grade service in which essentially an unlimited number of calls may be made from a single point to any other subscriber within a very large area usually for a fixed monthly charge. Monthly charges are based on the size of the area and not on the number or length of calls. Under the WATS arrangement, the United States is divided into six zones. The subscriber is billed according to the zones to be called on a full-time or measured-time basis. Costs vary widely depending on both the service area and the state in which the customer is located.

TELPAC is the name given to the service in which several telephone-grade lines are leased as a group between two points. It is essentially a pricing arrangement as the rates for service are substantially lower than an equivalent number of voice channels. The group of lines can be employed for any type of usage such as wideband data communications, voice, teletypewriter or facsimile transmission.

TWX and TELEX are the names applied to the teletypewriter exchange services of the Bell System and the Western Union, respectively. These provide direct dial point-to-point connections using input/output equipment such as page printers, keyboards, paper tape readers and paper tape punches.

DATA-PHONE provides for the transmission of data between a variety of terminal equipment using the regular dial telephone network or the WATS service. The cost to the customer is the same as the ordinary communications service cost in addition to a monthly rate for the Data Set.

DATA-PHONE 50 is the name of a recently announced switched wideband data communications service of the Bell system. A subscriber can now dial a call and send data at speeds up to 50,000 bits/sec, a 25-fold increase over the present "voiceband" DATA-PHONE service.

INFO-COM is the name of a new store-and-forward message or data communications service developed by Western Union.

DIAL-PAK is the name of a new concept by Western Union that will provide direct computer-to-computer communications using a 48-kHz wideband switched system.

In addition to the above services, voice grade and telegraph lines can be leased for the exclusive use of the subscriber. Table VI on tariffs for common car-

TABLE I EQUIPMENT CHARACTERISTICS OF COMMON CARRIER MODEMS

MANUFACTURER	AUTOMATIC ELECTRIC	AUTOMATIC ELECTRIC	AUTOMATIC ELECTRIC	BELL SYSTEM	BELL SYSTEM	BELL SYSTEM	BELL SYSTEM	BELL SYSTEM	BELL SYSTEM	BELL SYSTEM
MODEL NUMBER	103C	401A/E	101A/C	103A	103B	103F	201A3	201A4	201B1	201B2
SPEED	----	20 char/sec	10 char/sec	200 bits/sec	200 bits/sec	300 bits/sec	2000 bits/sec	2000 bits/sec	2400 bits/sec	2400 bits/sec
SERIAL or PARALLEL	----	Parallel	Serial	Serial	Serial	Serial	Serial	Serial	Serial	Serial
CHANNEL TYPE	Voice	Voice	TWX	Voice	Voice	Voice	Voice	Voice	Voice	Voice
NUMBER of WIRES	----	----	----	2	2	2	2/4	2/4	2/4	2/4
SYNCHRONOUS or ASYNCHRONOUS	----	Async.	Async.	Async.	Async.	Async.	Sync.	Sync.	Sync.	Sync.
SIMPLEX or DUPLEX	Full	Simplex	Simplex Half/full	Half/full	Half/full	Half/full	Full on 4 wire	Full on 4 wire	Full on 4 wire	Full on 4 wire
PRIVATE LINE MANDATORY?	No	----	No	No	Yes	No	No	No	Yes	Yes
AUTOMATIC CALL UNIT?	No	No	No	Yes	No	No	Yes	Yes	No	No
COMMENTS	Alternate voice/data service	Transmit only	Used with Teletype 33 & 35	----	----	----	No voice command, replacing 210A1	No voice command, replacing 201A2	No voice command	No voice command
COST*										
Rental \$/month	----	----	----	25	25	25	70	70	70	70
Installation \$	----	----	----	25	25	25	100	100	100	100

*Approximate only; prices vary with operating companies. Check with your local representative.

MANUFACTURER	BELL SYSTEM	BELL SYSTEM	BELL SYSTEM	BELL SYSTEM	BELL SYSTEM	BELL SYSTEM	BELL SYSTEM	BELL SYSTEM	BELL SYSTEM	BELL SYSTEM
MODEL NUMBER	202A	202B	202C	202D	X202E	203A	301B	303B/C/D	401A	401E
SPEED	1200 bits/sec	1800 bits/sec	1200 bits/sec	1800 bits/sec	600 bits/sec	3600 bits/sec with reverse channel @ 150bps	40,800 bits/sec	19,200/50,000/230,400 bits/sec	20 char/sec	20 char/sec
SERIAL or PARALLEL	Serial	Serial	Serial	Serial	Serial	Serial	Serial	Serial	Parallel	Parallel
CHANNEL TYPE	Voice	Voice	Voice	Voice	Voice	Voice	Voice	----	Voice	Voice
NUMBER of WIRES	2	2/4	2	2/4	2	2/4	----	----	2	2
SYNCHRONOUS or ASYNCHRONOUS	Async.	Async.	Async.	Async.	Async.	Sync.	Sync.	Sync. Async.	Async.	Async.
SIMPLEX or DUPLEX	Half	Full on 4 wire	Half	Full on 4 wire	Full	Full	Full (voice)	Full (voice)	Simplex Full (voice)	Simplex Full (voice)
PRIVATE LINE MANDATORY?	No	Yes	No	Yes	No	No	No	No	No	No
AUTOMATIC CALL UNIT?	No	No	Yes	Yes	No	Yes	No	No	No	No
COMMENTS	----	----	Replacing 202A	No voice command, replacing 202B	----	Up to 7200 bits/sec on private line	Sync. mechanism can be external	8/12/60 voice circuits	Transmit only; 24 possible characters	Transmit only; 99 possible characters
COST*										
Rental \$/month	----	----	40	40	----	----	250	425/430/450	5	7.50
Installation \$	----	----	50	50	----	----	200	300	15	20

*Approximate only; prices vary with operating companies. Check with your local representative.

TABLE II EQUIPMENT CHARACTERISTICS OF COMMON CARRIER MODEMS (CONT.)

MANUFACTURER	BELL SYSTEM	BELL SYSTEM	BELL SYSTEM	BELL SYSTEM	BELL SYSTEM	BELL SYSTEM	BELL SYSTEM	BELL SYSTEM	BELL SYSTEM	BELL SYSTEM
MODEL NUMBER	401J	401H	X401L	X202F	402C	402D	X403A	X403B & C	602A	603A, B, & D
SPEED	20 char/sec	20 char/sec	20 char/sec	600 bits/sec	75 char/sec	75 char/sec	10 char/sec	10 char/sec	---	---
SERIAL or PARALLEL	Parallel	Parallel	Parallel	Serial	Parallel	Parallel	Parallel	Parallel	---	---
CHANNEL TYPE	Voice	Voice	Voice	Voice	Voice	Voice	Voice	Voice	Voice	Voice
NUMBER of WIRES	2	2	2	2	2/4	2/4	---	---	2	---
SYNCHRONOUS or ASYNCHRONOUS	Async.	Async.	Async.	Async.	Async.	Async.	---	---	Sync.	---
SIMPLEX or DUPLEX	Simplex	Simplex	Simplex	Simplex	Simplex	Simplex	Simplex	Simplex	Simplex	---
PRIVATE LINE MANDATORY?	No	No	No	No	No	No	No	No	No	No
AUTOMATIC CALL UNIT?	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No
COMMENTS	Receive only; 99 possible characters	Transmit only; 99 possible characters	Transmit only	Transmit only	Transmit only	Receive only	Touch tone; receive only	Touch tone; transmit only	Analog transmitter	Analog facsimile transmitter
COST*										
Rental \$/month	35	10	---	---	25	75	---	---	30	12-25
Installation \$	50	20	---	---	40	100	---	---	40	25-50

*Approximate only; prices vary with operating companies. Check with your local representative.

MANUFACTURER	BELL SYSTEM	BELL SYSTEM	WESTERN UNION	WESTERN UNION	WESTERN UNION	WESTERN UNION	WESTERN UNION	WESTERN UNION	WESTERN UNION	WESTERN UNION
MODEL NUMBER	801A & C	811B	1181-A	1601-A	2121-A	2241-A	100	200	300	
SPEED	N/A	10 char/sec	180 bits/sec	600 bits/sec	1200 bits/sec	2400 bits/sec	200 bits/sec	2400 bits/sec	18,000/40,800 bits/sec	
SERIAL or PARALLEL	Serial/Parallel	Serial	Serial	Serial	Serial	Serial	Serial	Serial	Serial	Serial
CHANNEL TYPE	Voice/TWX	TWX	---	Voice	Voice/broadband	Broadband	Voice	Voice	Broadband	
NUMBER of WIRES	2/4	2	---	---	---	---	2/4	2/4	2/4	
SYNCHRONOUS or ASYNCHRONOUS	Asynchronous/Synchronous	Async.	Async.	Async.	Async.	Sync./Async.	Async.	Async.	Sync.	
SIMPLEX or DUPLEX	Simplex/Half/full	Simplex/Half/full	Half/full	Half/full	Half/full	Half/full	Half/full	Half/full	Half/full	
PRIVATE LINE MANDATORY?	N/A	No	No	No	No	Yes	No	Yes	No	
AUTOMATIC CALL UNIT?	N/A	Yes	NO	No	No	No	No	No	No	
COMMENTS	Automatic calling units	Used with teletype units		Alternate voice/data option						
COST*										
Rental \$/month	---	25	30	30	40	42 Async. 72 Sync.	---	---	---	
Installation \$	---	15	None	50	50	50 Async. 100 Sync.	---	---	---	

*Approximate only; prices vary with operating companies. Check with your local representative.

TABLE III EQUIPMENT CHARACTERISTICS OF NON-COMMON CARRIER MODEMS

MANUFACTURER	ANDERSON-JACOBSON	ANDERSON-JACOBSON	COLLINS RADIO	COLLINS RADIO	COLLINS RADIO	GENERAL ELECTRIC	GENERAL ELECTRIC	GENERAL ELECTRIC
MODEL NUMBER	ADC 260	ADC 300	TE-216A-2D	TE-216A-3D	TE-216A-4D	TDM-110	TDM-210	TDM-220
SPEED Bits per second	300	300	2400	3600	4800	300	1000-1800	2400
SERIAL or PARALLEL	Serial	Serial	Serial	Serial	Serial	Serial	Serial	Serial
CHANNEL TYPE	Voice	Voice	Voice, type 3003 or CCITT M89	Voice, type 3004 or CCITT M89	Voice Type 3005	Schedule 4 Type 4 (Voice)	Type 4, 4A, 4B (Voice)	Type 4A (Voice)
NUMBER of WIRES	2	2	4	4	4	2	2/4	2/4
SYNCHRONOUS or ASYNCHRONOUS	Async.	Async.	Sync.	Sync.	Sync.	Async.	Async.	Sync./Async.
SIMPLEX or DUPLEX	Half/full Duplex	Half/full Duplex	Full Duplex	Full Duplex	Full Duplex	Full Duplex	Half/full Duplex	Half/full Duplex
PRIVATE LINE MANDATORY?	No	No	Yes	Yes	Yes	Yes	Yes	Yes
AUTOMATIC UNIT CALL?	No	No	No	No	No	No	No	No
MODULATION SCHEME			Phase-shift (Kineplex)	Phase-shift (Kineplex)	Phase-shift (Kineplex)	Frequency shift	Frequency shift	AM vestigial Sideband
COMMENTS	Portable, originate only	Portable, originate/answer	Various options available	Various options available	Various options available	Compatible with BELL 103F	Compatible with BELL 202D	Internal clock at 2400 bps in sync. model.
PURCHASE COST*	---	---	---	---	---	\$695.	\$975.	\$1,485 (Async.) \$1,950 (Sync.)

*Cost data is approximate. Prices vary with configurations and options.

MANUFACTURER	GENERAL ELECTRIC	GENERAL ELECTRIC	IBM	IBM	IBM	IBM	LENKURT ELECTRIC	MILGO
MODEL NUMBER	TDM-111	TDM-211	Line Adapter 1	Line Adapter 2	Leased Line	Shared Line	26C	4400/24PB
SPEED Bits per second	300	1200	Up to 600	Up to 600	Up to 600	Up to 134	1200/2400	2400
SERIAL or PARALLEL	Serial	Serial	Serial	Serial	Serial	Serial	Serial	Serial
CHANNEL TYPE	Voice	Voice	Voice	Voice	Voice	Voice	Voice Schedule 4A	Voice Type 3002
NUMBER of WIRES	---	2	2/4	2	2/4	2/4	---	2
SYNCHRONOUS or ASYNCHRONOUS	Async.	Async.	Async.	Async.	---	---	Sync.	Sync.
SIMPLEX or DUPLEX	Full Duplex	Half Duplex	Half/full Duplex	Half Duplex	Half/full Duplex	Half/full Duplex	Simplex Full duplex	Simplex Full duplex Half optional
PRIVATE LINE MANDATORY?	No	No	No	No	No	No	Yes	No
AUTOMATIC UNIT CALL?	---	---	No	No	No	No	No	---
MODULATION SCHEME	Frequency shift	Frequency shift	---	---	---	---	Duobinary	Phase-shift (Kineplex)
COMMENTS	Compatible with BELL 103A2	Compatible with BELL 202C	Limited Distance	Limited Distance	---	---	---	Simultaneous voice/teletype-transmission possible
PURCHASE COST*	\$875-970	\$850-1,145	---	---	---	---	---	\$4,995

*Cost data is approximate. Prices vary with configurations and options.

For additional information on products listed, circle these numbers on inquiry card:

- ANDERSON-JACOBSON 150
- COLLINS RADIO 151
- GENERAL ELECTRIC 152
- IBM 153
- LENKURT ELECTRIC 154
- MILGO 155

TABLE IV EQUIPMENT CHARACTERISTICS OF NON-COMMON CARRIER MODEMS (CONT.)

MANUFACTURER	MILGO	PHILCO	PHILCO	PHILCO	PHILCO	PHILCO	PHILCO	RFL INDUSTRIES
MODEL NUMBER	4400/48	MD/NY	MC 12/24-2B	MC 12/24-1	Duplexer	EDC 1224	EDC 61-75	Series 2056
SPEED Bits per second	4800	1200/2400	300-2400	300-2400	75	75-2400	75	1200-1800
SERIAL or PARALLEL	Serial	Serial	Serial	Serial	Serial	Serial	Serial	Serial
CHANNEL TYPE	Voice Type 3002	---	Voice	Voice	Voice	---	Teleprinter	Voice
NUMBER of WIRES	2	2/4	---	---	---	---	---	---
SYNCHRONOUS or ASYNCHRONOUS	Sync.	---	Sync.	Sync.	Sync./ Async.	Sync.	Sync.	Async.
SIMPLEX or DUPLEX	Simplex Full duplex Half optional	Half/full Duplex	Full Duplex	Full Duplex	Full Duplex	---	Full Duplex	Half/full Duplex
PRIVATE LINE MANDATORY?	No	Yes	Yes	Yes	No	Yes	No	Yes
AUTOMATIC CALL UNIT?	---	---	---	---	---	---	---	---
MODULATION SCHEME	Phase-shift (Kineplex)	---	---	---	---	---	---	Frequency shift
COMMENTS	---	High frequency radio modems	---	High frequency radio modems	For sending Teletype/voice signal simultaneously	Increased error detection and correction	Increased error detection and correction	Rack Mounting
PURCHASE COST*	\$5,885	---	---	---	---	---	---	\$625-850

*Cost data is approximate. Prices vary with configurations and options.

MANUFACTURER	RFL INDUSTRIES	RIXON ELECTRONICS	RIXON ELECTRONICS	RIXON ELECTRONICS	RIXON ELECTRONICS	RIXON ELECTRONICS	RIXON ELECTRONICS	RIXON ELECTRONICS
MODEL NUMBER	3227	Sebit-48	Sebit-36	Sebit-24M	PM-24	Sebit Dual 12M	FM-18D	FM-300
SPEED Bits per second	1000	4800	3600	2400	2400	Two channels at 1200	Up to 1800	Up to 300
SERIAL or PARALLEL	Serial	Serial	Serial	Serial	Serial	Serial	Serial	Serial
CHANNEL TYPE	Voice	C-4 Conditioning	C-2 Conditioning	C-1 Conditioning	C-1 Conditioning	C-1 Conditioning	C-2 conditioning, dependent on speed	Unconditioned
NUMBER of WIRES	---	2/4	2/4	2/4	2/4	2/4	2/4	2
SYNCHRONOUS or ASYNCHRONOUS	Sync.	Sync.	Sync.	Sync.	Sync.	Sync.	Sync./ Async.	Sync.
SIMPLEX or DUPLEX	Half/full Duplex	Simplex Half/full Duplex	Simplex Half/full Duplex	Simplex Half/full Duplex	Simplex Half/full Duplex	Simplex Half/full Duplex	Simplex Half/full Duplex	Full Duplex
PRIVATE LINE MANDATORY?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
AUTOMATIC CALL UNIT?	---	No	No	No	No	No	No	No
MODULATION SCHEME	Frequency shift	AM Vestigial sideband	AM Vestigial sideband	AM Vestigial sideband	Phase shift 4-level	AM Vestigial sideband	Frequency shift	Frequency shift
COMMENTS	Rack Mounting	Transmission Speeds Switch-selectable	Transmission Speeds Switch-selectable	Transmission Speeds Switch-selectable	Compatible with BELL 201B, 205 & 207 modem	---	Compatible with BELL 202D modem	Compatible with BELL 103F modem
PURCHASE COST*	\$900-1,100	\$6,000	\$5,800	\$2,500	---	\$5,000	---	---

*Cost data is approximate. Prices vary with configurations and options.

For additional information on products listed, circle these numbers on inquiry card:

- MILGO 155
- PHILCO 156
- RFL INDUSTRIES 157
- RIXON ELECTRONICS 158

rier services also provides a summary of the various common carrier services. These are approximate tariffs currently in use and may change, but they do give a good indication of the likely costs of the data communications service. The perspective user is advised to check with his local common carrier representative, especially for the WATS service, as the cost of service depends on areas of use and state of residence of the user.

In most cases, the telephone-grade service can be employed for the transmission of voice as well as data through the use of dataphone subsets supplied by the telephone company. Frequently, this ability permits considerable savings by combining voice and data needs. Telephone coupler (usually acoustic coupling) data sets are also available from the telephone company and others which allow data to be transmitted over the public telephone network via a conventional telephone set. Table VI exhibits the major characteristics of most telephone coupler data sets on the market.

A number of new developments with special interest to computer/communications systems are taking place in the Bell System. One arrangement (203 Data Set) intended for use on the dial telephone network will operate at 3600 bits per second. Thus it will match the asymmetrical characteristics of information flow found in many situations such as keyboard entry

and display output. On private-line voiceband circuits, the data set will operate at 4800 bits per second and possibly 7200 bits per second. These increases in speed made possible by multi-level vestigial sideband and automatic adaptive equalization will permit very favorable economies to be made in computer/communications systems.

Another development is that of the touch-tone telephones which can be used very effectively as data terminals. In cases where limited input capability is tolerable and no hard copy is needed (such as banking, credit, and some inquiry systems) the push button telephone provides a very inexpensive and reliable terminal.

The introduction of digital transmission techniques into the communications networks is likely to drastically reduce the cost of data communications. Pulse code modulation (PCM) techniques are gradually being introduced into the Bell System. Since PCM systems transmit on the order of 50 kilobits per second for each voice channel, there is a large potential for substantial economies. The digital carrier systems T1 (1.54 megabits per second), T2 (62 megabits per second), and T4 (281 megabits per second) are currently being developed and used in the Bell Systems. These digital transmission system will use time-division multiplexing extensively thus providing a variety of bit rates.

TABLE IV EQUIPMENT CHARACTERISTICS OF NON-COMMON CARRIER MODEMS (CONT.)

MANUFACTURER	SANGAMO	SANGAMO	SANGAMO	SANGAMO	SANGAMO	SANGAMO	SANGAMO	SANGAMO
MODEL NUMBER	T103A	T103F	T201A	T201B	T202C	T202D	T401E	T401H
SPEED Bits per second	300	300	2000	2400	1800	1800	20 char/sec	20 char/sec
SERIAL or PARALLEL	Serial	Serial	Serial	Serial	Serial	Serial	Parallel	Parallel
CHANNEL TYPE	Voice	Voice	Voice	Voice	Voice	Voice	Voice	Voice
NUMBER of WIRES	2	2	2/4	2/4	2/4	2/4	2	2
SYNCHRONOUS or ASYNCHRONOUS	Async.	Async.	Sync.	Sync.	Async.	Async.	Async.	Async.
SIMPLEX or DUPLEX	Full Duplex	Full Duplex	Half/full Duplex	Half/full Duplex	Half/full Duplex	Half/full Duplex	Transmit Only	Transmit Only
PRIVATE LINE MANDATORY?	No	No	No	Yes	No	No	No	No
AUTOMATIC CALL UNIT?	Optional	No	Yes	Optional	Optional	Optional	No	No
MODULATION SCHEME	Frequency shift	Frequency shift	Phase shift	Phase shift	Frequency shift	Frequency shift	3 of 14 code 99 poss. char.	3 of 14 code 99 poss. char.
COMMENTS	Directly com- patible with Bell 103A	Directly com- patible with Bell 103F	Directly com- patible with Bell 201A	Directly com- patible with Bell 201B	Directly com- patible with Bell 202C	Designed for operation with Western EI. 804	Compatible with Bell 401E; works end-end Bell 401J	Compatible with Bell 401H; works end-end Bell 401J
PURCHASE COST*	\$580	\$535	\$2055-2110	\$2130-2200	\$1035-1320	\$790-1015	\$234-254	----

*Cost data is approximate. Prices vary with configuration and options.

For additional information on products listed, circle 159 on inquiry card.

TABLE V TARIFFS FOR COMMON CARRIER SERVICES

COMMON CARRIER	TYPE OF SERVICE	BANDWIDTH or NOMINAL SPEED	TARIFFS* (Dollars)	COMMENTS
AT&T BELL SYSTEM	TWX dial network	100 words per min.	\$1.75 first three minutes 0.60 each additional min. for 2000 miles and over 0.20/min. for 0-50 miles	Charges vary with distance, three minute minimum charge
WESTERN UNION	TELEX dial network	66 words per min.	From \$0.175 to 0.60/min. depending on areas. 40% discount on excess if charges exceed \$87.50/mo.	No 3 minute min. charge, fractions of min. are propor. charged.
AT&T and WESTERN UNION	Private line services low-speed	60, 75 words/min.	\$1.10/channel-mile/month for half-duplex \$1.21 for full-duplex	Charges are telescopic, reduce to half after 250 miles and third after 1,000 miles
		100 words/min.	\$1.21 for half duplex, 1.331 for full duplex	
		sub-voice 150-180 bps	1.375 for half duplex, 1.513 for full duplex	
AT&T BELL SYSTEM	Public telephone network, dial exchange	voiceband 3000 bps	\$1.00 to \$2.00/three min. 0.25 to 0.50 each add'l. min. for 2,000 mi. and over \$0.30/three min. and 0.10 each add'l. min. for up to 30 mi.	charged by time and distance 3 minute min. charge for call.
	WATS unlimited service	voice network 3,000 bps	\$2,300/month for anywhere in USA for unlimited time. \$ 500/month for Area 1	cost depends on service areas and the state.
	WATS measured service	voice network 3,000 bps	\$610/month for first 15 hours, \$34 each add'l. hour for anywhere in USA	cost of service lower for indiv. areas, varies.
WESTERN UNION	BEX Broadband Exchange	2 kc/s	\$0.15/minute to \$0.65/min. 40% discount on excess of \$3000	Rates depend on areas, charges are broken down to tenths of a minute
		4 kc/s	\$0.20/minute to \$0.75/min. 40% discount on excess of \$400	
AT&T and WESTERN UNION	voice-grade leased lines	4KHz	\$2.02 for half duplex \$2.22 for full duplex (channel-mile/month) \$10, \$37.50, and \$56. channel condition charges for schedule 4A, 4B, and 4C respectively	rates are telescopic drop by approx. 15% after 250 mi. and 25% after 500 miles.
AT&T	TELPAK A	48 kc/s	\$15/mile/month	12 voice channels
	TELPAK B	96 kc/s	20/mile/month	24 voice channels
	TELPAK C	240 kc/s	25/mile/month	60 voice channels
	TELPAK D	1,000 kc/s	45/mile/month	240 voice channels

*These are approximate tariffs currently available and may change. Check with your local common carrier representative.

TABLE VI MAJOR CHARACTERISTICS OF ACOUSTIC COUPLERS

MANUFACTURER	ANDERSON-JACOBSON	ANDERSON-JACOBSON	ANDERSON-JACOBSON	COMPUTER COMMUNICATIONS	DATA COMMUNICATIONS SYSTEMS	DATA COMMUNICATIONS SYSTEMS
MODEL	ADC-260	ADC-270	ADC-1210	CC-302	DAC-337	DAC-347
TRANSMISSION Speed bits/sec	300	300	1200	300	165	165
Simultaneity	Half or full duplex	Half or full duplex	Half duplex	Half or full duplex	Half or full duplex	Half or full duplex
Code	any	any	any	any	any	any
COUPLING Transmit	acoustic	acoustic	acoustic	acoustic	acoustic	acoustic
Receive	acoustic	acoustic	acoustic	inductive	acoustic	acoustic
COMMENT	originate only	answer only	originate only; reverse control chan., 202C compat.	originate only	originate only	originate and answer
COST Purchase	\$570	\$645	\$795	\$600	\$495	\$560

MANUFACTURER	GENERAL ELECTRIC	GENERAL ELECTRIC	OMNITECH	OMNITECH	TYMSHARE
MODEL	TDM 114	TDM 115	Telecoupler 700	Telecoupler 723	Mark V
TRANSMISSION Speed bits/sec	300	300	500	500	300
Simultaneity	Half or full duplex	Half or full duplex	Half or full duplex	Half or full duplex	Half or full duplex
Code	any	any	any	any	any
COUPLING Transmit	acoustic	acoustic	acoustic	acoustic	inductive
Receive	acoustic	acoustic	acous. or induc.	acous. or induc.	acoustic
COMMENT	originate only	originate and answer	originate only	originate only	originate only
COST Purchase	\$495	\$595	\$495	\$570	\$570

*All data sets employ frequency shift keying and serial by bit asynchronous transmission and couple the data terminal (via EIA standard RS232B interface) to the public telephone network using a conventional telephone set (Bell 500 telephone set or equivalent).

For additional information on products listed, circle these numbers on inquiry card:

ANDERSON-JACOBSON	160	GENERAL ELECTRIC	163
COMPUTER COMMUNICATIONS	161	OMNITECH	164
DATA COMMUNICATIONS SYSTEMS	162	TYMSHARE	165