IBM

SALES and SYSTEMS GUIDE

Use of Communication Facilities in the Design and Implementation of Tele-processing Systems

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SECTION I. INTRODUCTION

This guide presents, in Section II, a step-by-step approach to the design of a data communications network. Each alphabetic division of that section covers a major step -- most of these steps are used in any one system design.

Various types of reference material are presented in the rest of the sections.

Because of the dynamic nature of some of the reference material in this guide, your Tele-Processing Representative or Industry Technical Assistance should be consulted before making customer commitments. Also, it is intended to revise this guide from time to time. Normal channels of manual announcement should be consulted periodically.

Critical responses from users of this guide are useful in improving its contents. Comments and criticisms will be appreciated.

SECTION II. DESIGNING A DATA COMMUNICATIONS NETWORK

A. Definition

A data communication network refers to a combination of communication channels used to move data between points geographically separate from each other. Such channels may take many forms and are described in Section III, "Communications Facilities." A network of these channels can be as simple as two machines interconnected by a single channel, or as complex as a nation-wide system with several processing centers and many stations using leased and switched lines. Generally, the communication network must be designed before a system proposal is submitted to a customer.

The more complex the network, the more difficult it is to determine the response time and even data handling capacity. This problem is two-sided because it is also difficult to design a network when given a large number of stations and specific throughput and response criteria.

This section covers the design of a network given a number of stations and throughput criteria. Whenever the data-moving requirements include remote locations and throughput and/or response times, the network must be designed rather than just assumed. Design includes the choice of terminals, facilities, processors, and locations. It usually involves several iterations of these choices, separated by cost estimates and re-study of requirements. A procedure for design prior to customer proposal is spelled out in detail in the remaining headings of this section.

B. Communication Facility Information

These facilities are supplied by common carriers (by contract) and by vendors (for purchase). Several steps in network design require information about services, facilities and equipment. Since the network design is done prior to proposal and sale to the customer, IBM has set down specific rules for obtaining information about services, facilities and equipment directly from communication companies. These rules are stated in the Sales Manual on General page 7 "Planning for Teleprocessing." Briefly, it says that when you have to design a system for a specific customer, that customer makes the initial move in making contact with communications supplier. If the customer has a privately owned system this is no problem. If he intends to purchase a system, he must choose the vendor without our involvement, after which we can work directly with the vendor. If the customer wishes to use a common carrier, he has to choose between a

telephone company or the telegraph company, for the domestic U.S. We may work with or without the carrier's representative, as explained below.

1. Working with the common carrier.

   When the customer chooses a carrier, we are free to ask for meetings to obtain specific information about facilities to use in a system solution. This has one possible disadvantage-in some cases we may be alerting the carrier to provide a competitive bid.

2. Working without a common carrier.

   When we would rather not work with a carrier's local representative, or when the customer makes no choice of carrier, we may develop a system independently.

   To obtain specific information about communications facilities, services, availability, equipment, prices, etc., prior to the sale of a system, there are several published sources. This Guide, other publications listed in Section VI-Bibliography, and public file copies of tariffs at regulatory offices, are a few examples. IBM TP Reps, Education Centers, and Regional System Design Centers are additional sources. Also, internal IBM channels have been set up to get specific information without risk of exciting competition or violating our business policy. District Offices and Regional Offices have Teleprocessing Representatives who have contacts with data specialists in each common carrier serving their area.

   For data contacts in the Bell System, lists of their specialists and advisors are distributed periodically to the above locations. Data contacts in other carriers are not as formally organized, thus the Region or District Office must develop them locally.

   Whenever you have a need for general information about common carrier facilities, specific information for a customer who hasn't chosen a carrier, or specific information for a customer who is also being bid by a carrier, the above sources and channels are for you. In addition, Industry Technical Assistance can also help you in any of these areas.

C. Data Required for Network Design

There are many statistics and other data which can be helpful in network design. The following list is considered minimum. Each item is discussed to facilitate estimating it, if unknown.

1. Functions of the Remote Stations

The document requirements of the data to be handled will decide the type of equipment needed: cards require card punching/reading, printed output requires keyboard and card or tape buffering, etc. Also, the characteristics of this data governs how the terminal will operate: for example, an inquiry terminal would have its keyboard polled for inquiries and then its paper tape reader for batch transmission.

The mode of operation is also determined by the type of data. A full duplex line is only slightly more expensive than a half duplex line, but moving traffic both ways at the same time is not possible in all type of applications. Also, the terminal cost increases for full duplex.

The need for error detection and error correction can be decided from the contents of the data to be handled. If the messages contain ordinary words and are not processed by a computer, then error checking probably is not needed. If coded or numeric data are included, or if processing will take place, checking usually is justified.

The speed of operation is not easily decided. Many low-speed terminals have only a narrow choice of speed. Generally, the higher the speed, the less the channel costs, per bit transmitted. Usually, the speed of remote stations is determined from an existing system or after the above criteria have reduced the applicable terminals to only or two. Of course, a station with an obvious requirement for high speed (50-500 char./sec.) will probably require a particular machine just to satisfy speed and document type.

If existing terminals are to be used, their operation must be clearly defined.

2. Traffic Statistics

Ideally, a peak period on a heavy day is determined and all messages moving in the communications system are logged for each origination and destination by length and type. This information is then projected to the date in the future for which the system is to be designed.

Actually, the peak period must be carefully determined from sampling over a long period of time. Care must be taken to get a true peak based on origination frequency rather than on activity of existing channels. The peak period used for design must be a system peak, and is not necessarily one hour. The application will determine

an acceptable peak period length. When a system is to serve more than one time zone, traffic origination may follow a pattern according to local time. In designing for terminals in more than one time zone, design first for system peak and then check each line to make sure it can handle each terminals peak traffic. When actual traffic data is not available on a time basis, the peak period can be estimated. Typical systems have peak hour loads of 15-30 percent of an eight-hour day. If only origination locations are studied, an estimate of the effect of multi-address messages is required. Message length can be estimated. It can be in terms of a simple average, but a distribution of length vs. frequency is most useful.

Message type is needed only when different types are processed or routed differently, or a priority exists. When needed, the traffic data should be separated and shown for each origination point and destination by type.

A growth factor can be based on previous year's growth or customer's expected growth. Typical growth is 5-10 percent per year.

3. Channel Loading

This is the ratio of time used for moving messages, to the time available. The closer this ratio is to 100%, the longer the average response time, which is the total time a message is in transit including all queues. It has been shown that for a contention, multi-point line, the average delay for a message waiting to transmit at a station is 2.5 times its transmission time at 70% utilization; 4 times at 80% utilization; almost 6 times at 90% utilization. These figures assume exponential service times, no order of picking the terminal which will send, and they do not include transmission time. Experience has shown that if specific response criteria (see below) are not known, 80% loading will provide a reasonable compromise between response and economy.

When definite response criteria are given, they are usually in the form of x% of messages delivered in y or less minutes. This includes all transmission and queue time. Care must be taken that these figures are realistic and apply to all the traffic handled in the peak period. Sometimes several sets of x and y are given such as 50%, 80%, and 95%. The system designer is advised not to ask the customer for such figures unless it is evident he understands the meaning.

A method of deriving loading and response time from each other is included under Response Time of Multipoint lines. For design data, only one is required.

4. Terminal Locations

Each geographical location must be defined. If more than one location should be within a city, each location should be shown separately. This list should include all locations to be served in the year for which the system is being designed.

5. Central Switching Locations

Ideally, the machine which will control communications among the terminals is located at the weighted center of the terminals. Actually, other considerations almost always dictate the location. If you are free to locate the machine, pick a city near the apparent geographic center of a map showing all locations, then move toward the more heavily loaded stations. It may be necessary to pick several different centers in order to find the most economical. A Communications Network Design Program (CNDP) will assist in the determination, (See Bibliography). In picking a central switching location, keep in mind any need for communicating with other computers, a function which often is not apparent from studying only terminal locations. Some systems can economically support decentralized switching. This is a matter of trial and error depending on the equipment cost and locations. A program is being developed to help on this problem (See Bibliography).

6. Present System Description

Many opportunities for initial IBM penetration have been the replacement of existing central switching equipment by IBM equipment, using existing lines and terminals. Even if such a "drop-in" replacement is not contemplated, a customer's existing system description will provide much of the above information and may well be a foundation for a new system design. Two important advantages may be:

a. By using existing terminals and/or present message formats, a minimum of remote confusion will result at changeover.

b. The present system may use communication lines which are more economical than those a new design might require, due to existing customer-owned channels or a Telpak.

7. Operating Periods

Some IBM equipment can be leased for less than full time. To take advantage of such rates, the required operating hours of each location served should be noted, with time zone.

8. Operating Constraints

The application of the data moved on the system will generally include burdens for the system design. Exceptional verification or error checking routines, direct communication and message switching, particular speed, inexperienced or part-time operators, unusual environment, non-IBM terminals which have been altered from "standard",etc., are a few of the items which have made system designs unique.

.D. Response Time of Multipoint Lines

The design of a multipoint network, as discussed later in Section III H, is often based on the line utilization or loading. The critical design parameter may be the response time on a line, but this must somehow be converted to line utilization to enable us to manually design the network. This subsection presents a graphical method of finding the necessary line utilization, given the required response time or vice-versa. The graphs used are based on a simulation model for a message switching network. The graphs have been normalized to make them independent of line speeds and message lengths. The assumptions and parameters used in the development of the model and use of the resultant curves is discussed below.

1. Assumption and Parameters for Half Duplex Model

In establishing a network model, there were a number of parameters or variables that could have been considered. It was necessary to make the model as widely applicable and practical as possible.

a. Line Loading

All terminals on a line are assumed to be equally loaded. For an inbalance in terminal loadings a variation of the polling scheme to favor the heavily loaded terminals should make the curves developed applicable.

b. Polling Scheme

The terminals are polled sequentially with a maximum of one message being accepted per terminal in one pass through the polling list. Output messages are handled on a priority basis with a check for output being made after each input message and after each complete pass through the polling list. The output queue for the line is exhausted at each check point with the first message in the queue being transmitted first.

c. Number of Stations Per Line

Several runs were made for various length messages on lines with 2, 6, and 10 stations. It was found that the maximum deviation from the 6 station curve was 10% within 2 to 10 stations. Therefore, only the 6 station curves are shown and they are considered valid for 2 - 10 stations.

d. Ratio of Input to Output

One of the important considerations in message switching systems is the ratio of the number of input messages to the number of output messages in the system. This ratio will be called R_{IO}. Generally, R_{IO} will be 1:1.1 or slightly more messages out than in. This 1:1.1 ratio is due to a small number of multiple address messages. The curves shown can be used for an R_{IO} of from 1:.7 (less out than in), to 1:2, (twice as many out as in).

More output than input would tend to increase message response time, while less would have the opposite effect. There are two sets of curves. The first set, graphs 1 and 2, is to be used where the R_{IO} falls in the range of 1:.7 to 1:1.4. The second set of curves graphs 3 and 4 is to be used where the R_{IO} falls in the range of 1:1.4 to 1:2. These curves hold to within 10% for any R_{IO} in these ranges.

e. Message Generation

Messages are created or are assumed to arrive "randomly" in time at each terminal, that is, follow what is termed a Poisson arrival distribution. The distribution of the message lengths (discussed under Line Holding Time) is assumed to be exponential which may be considered a worst case condition. Constant message lengths would yield considerably better results at higher

line utilizations. The output messages are generated by the multiplexor and the model was run with the assumption that output messages will not be returned to the same line that initiated the input message. The use of the response curves is limited by the number of lines in a system. That is to say, the curves are more accurate for a 10 line system than for a 5 line system where a larger percentage of the messages might be sent back on the same line.

f. Line Holding Time (LHT)

For this model and the resultant curves, the message length is represented as the Line Holding Time or LHT. LHT is the total line holding time for the transmission of a message plus the single poll or selection time that caused that message to move. The LHT includes such fixed functions as End of Block, End of Message, line turn around time, etc., where applicable. The LHT may be expressed as character time units or in time units such as seconds. The LHT is thus independent of line speed and actual message length.

g. Line Control Time (LCT)

In this model as in most message switching systems, all that time not used by LHT is used for unsuccessful polls. LCT is thus the time taken for one unsuccessful poll. The critical factor in normalizing the results of this simulation was found to be the ratio of LCT : LHT. The time to poll for a "no" message response, poll a message or address a terminal is assumed to be 8 characters for this model. (The 8 characters is normal for polling and addressing in many message switching systems.)

It was found that in the R_{IO} range of 1:.7 to 1:1.4, the curve for a 100 character message, with an LCT : LHT ratio of 1:13.5, was significantly different from that for a 300 character message, LCT : LHT ratio of 1:38.5. Thus there are two curves for this R_{IO} range. The upper curve in Graph 1 holds within 10% for LCT : LHT ratio of 1:10 to 1:15, and the other curve holds within 10% for LCT : LHT greater than 1:15.

Where R_{IO} is from 1:1.4 to 1:2 there is no significant difference due to change in the LCT : LHT ratio. Thus there is only one curve for this R_{IO} range. The one curve is valid to 10% for any LCT : LHT ratio greater than 1:10.

h. Mean Response Time (MRT)

In this model we define round trip response time as the time from request-to-send to receipt of last character by addressee. This time includes queue time at terminal, transmission time into CPU, queue time at CPU, and transmission time out to addressee. Message handling or process time by CPU is neglected as it is normally a fixed amount of time and is usually too small, in comparison to transmission time, to be of significance to the model.

The Mean Response Time is the statistical mean of the round trip response times.

2. Use of Curves

In order to use the curves for a system, the following parameters must first be determined:

a. Average message length

b. Polling time or length = LCT

c. R_{IO}

d. LHT

There are three design parameters, maximum line utilization (U), system response time (T), and the percentile of messages (P) that must meet the system response time. Knowing any two parameters, we can find the third by using the curves. Thus if in our system 90% of the messages must experience a round trip response of 5 minutes or less, then we have that P = 90% and T = 5 minutes or 300 seconds. We can now use the curves to find the maximum line utilization, U.

Conversely if the maximum line utilization is given, say 70%, we would like to know what kind of response time most of the messages in the system will experience. Knowing the response time we could then ascertain if the given line utilization will permit us to adequately service the system. For example, we may have been given U = 70%. We will have to pick a P, say 90%, and now we could find T, the response time for most of the messages.

There are two sets of graphs. The first set covers an R_{10} range of 1:.7 to 1:1.4 and the second set an R_{10} of 1:1.4 to 1:2.

The first graph of each set (1 and 3) express the relationship between the utilization (U) and Yu, where $Yu = \frac{MRT}{LHT}$. The second graph of each set expresses the relationship of the percentile (P) to Yp where $Yp = \frac{T}{MRT}$. Thus if we were given a design criteria of 90% of the messages in 5 minutes or 300 seconds for a system where the LHT = 20 seconds. By knowing the R_{10}, say 1:15, we can find U. We have given

P = 90%

T = 300 seconds

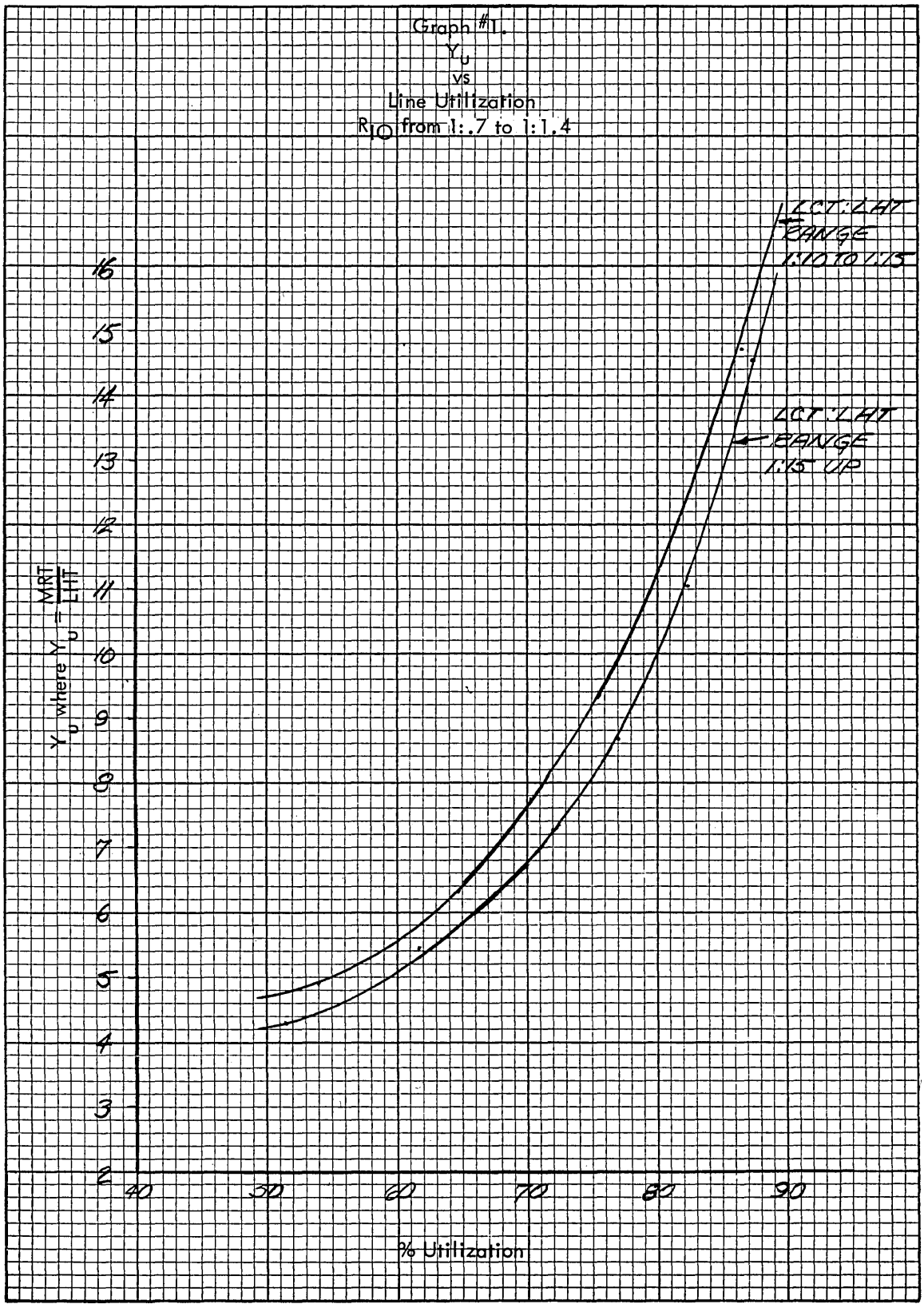
LHT = 20 seconds

Yp is found by entering graph 4 (proper R_{10} range) at 90% and going up to the curve and over to the Y axis. Yp = 2.3.

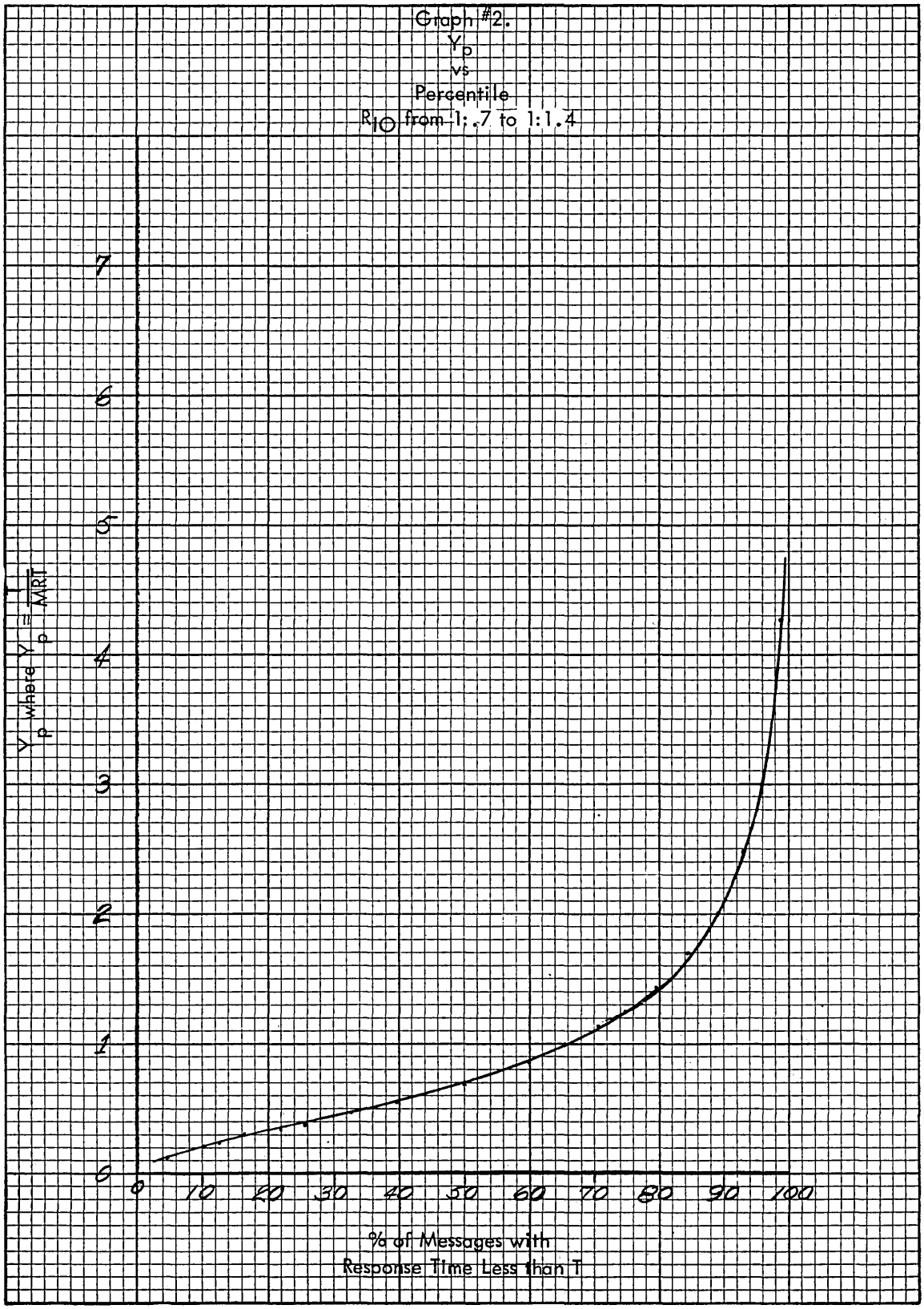
$$Yp = \frac{T}{MRT} \text{ or } MRT = \frac{T}{Yp} = \frac{300}{2.3} \text{ seconds} \approx 130.$$

We now know the MRT and have been given LHT. Therefore $Yu = \frac{MRT}{LHT} = \frac{130}{20} = 6.5$ Entering graph 3 at Yu = 6.5 and reading over to the curve and down we find that U = 63.5%. Thus if each line in the network was loaded to no more than 63.5% of its total message handling capability then 90% of the messages in the system would experience a round trip response time of 5 minutes or less. Notice that to use the graphs we first had to make the units between T, the time, and LHT consistent.

As an exercise trace the alternate path where given a 70% utilization and an LHT of 20 seconds and R_{10} of 1:15 we find that 90% of the messages have a round trip response of _____ .
Answer is T = 6.1 minutes.



Form No. 898—10 Squares to Inch



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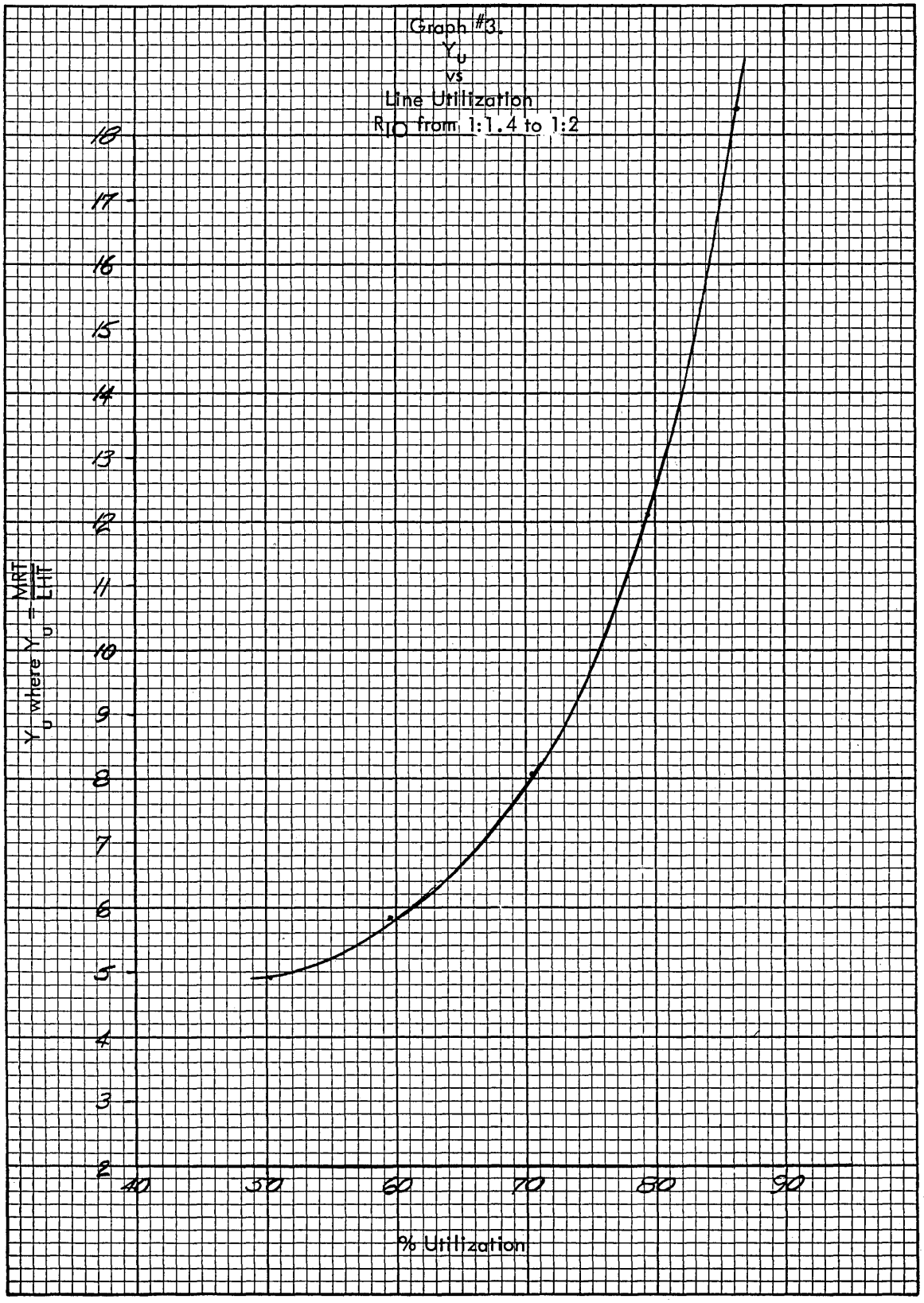

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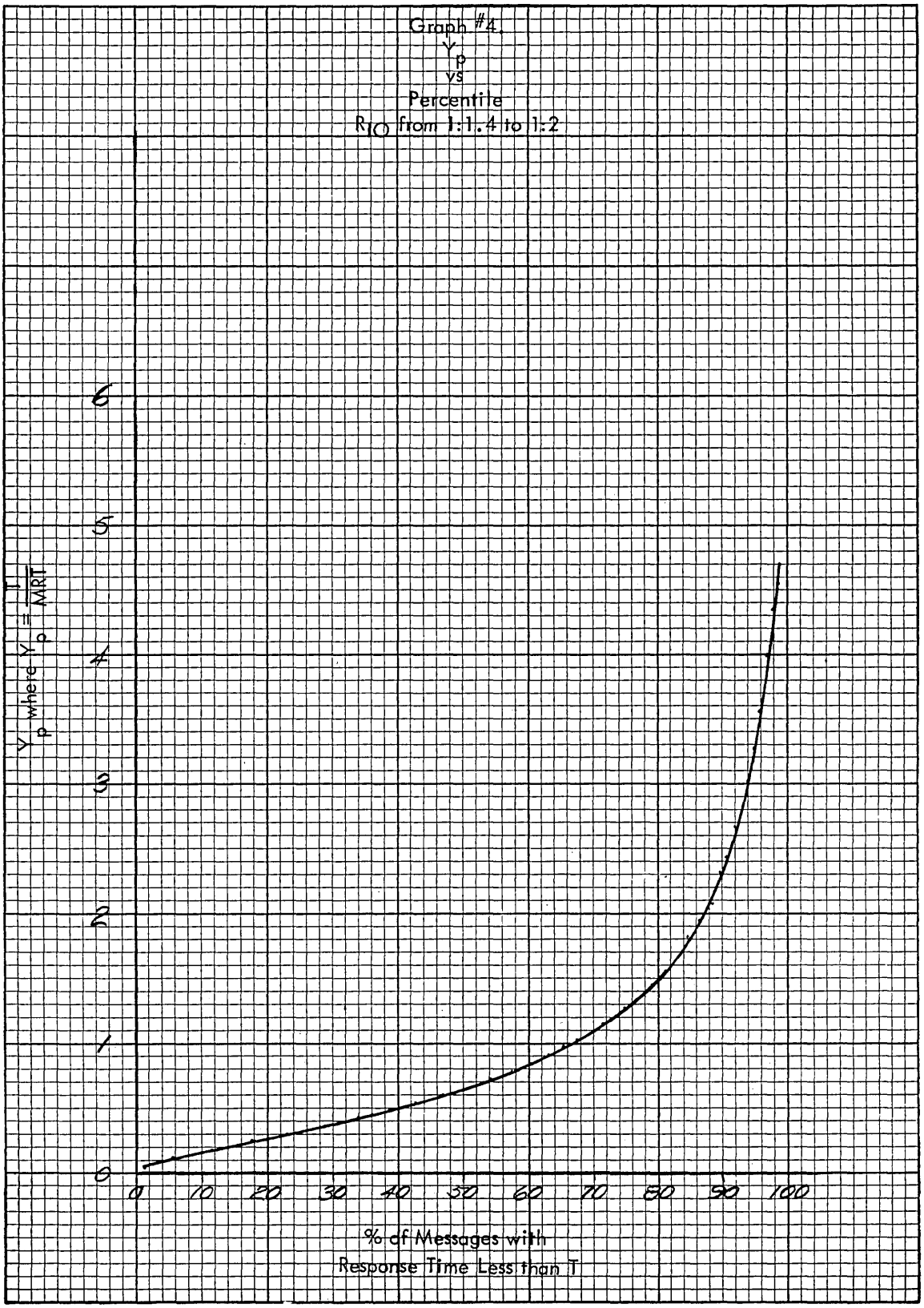


Form No. 898—10 Squares to Inch

E. Pick A Terminal

Several of the data items in C above will help narrow the choice of a terminal. The simplest system will have the same basic terminal at all locations, but this is not necessary.

Familiarity with the IBM product line is assumed. For convenience, the IBM Teleprocessing machines are listed in the Configurator (Section IV). Also, refer to the Terminal Equipment Guide, (See Bibliography) which describes all IBM terminal devices.

There are many non-IBM terminals capable of operating with IBM central equipment. The most common is the line of telegraph equipment manufactured by Teletype Corporation and these machines have punched tape, keyboard, and page printer capability, and can operate at 6, 7.5 and 10 char./sec., HDX or FDX. Often these terminals are used in various Line Control Systems described in Section V.

The choice of terminal, especially speed and code, is a prerequisite to the system design procedure which follows. The central equipment which will operate with these terminals is assumed to be an IBM 7740,1448, or similar machine with communication line capability.

F. Switched Lines vs. Leased Lines

Once a terminal type has been chosen, the amount of time each terminal in the system will be actually moving data can be estimated. If the terminal is geographically separated from other locations, or if it will have very light usage, switched lines may be more economical that leased. However, all the cost factors for both types must be considered.

Switched lines are available from most common carriers on a nationwide basis. There is Telex at 50 baud, TWX at up to 150 baud, and the Telephone System at up to 2,000 baud. All are "public" (accessible to all subscribers), use some type of signalling to originate a call, are HDX (except the Telephone System under 200 baud), and all offer billing on a time - used basis -- varying in details. Also, the Telephone System offers Wide Area calling at various flat rates. A switched Broad Band service is offered by Western Union. All of these services are more fully explained and priced in Section III of this Guide. Terminals on switched lines may be used to communicate with other terminals in the same company or in other companies on the same switched system, but while doing so, they appear busy to an incoming call. A busy condition also may be created by the system itself when all trunks between two

points are busy. Switched terminals can "converse" with each other, but this is an inefficient method at keyboard speed.

Leased lines are available from most carriers on a nation-wide basis. The speeds and signal types available are described in Section III. All are available as HDX or FDX, and usually less cost for HDX. When used with a central machine, such lines, and terminals on those lines, are under control or supervision of the central. The lines are always available, but a terminal can communicate only with the machines on the line. Store and forward message switching/processing is implied in such a system of lines.

Most data communications networks should probably use some switched and some leased lines. As IBM machines become more capable of directly using switched lines, as they can leased lines, the systems designer is freer to choose from the entire offerings of communications facilities. The next two sub-sections provide current knowledge on designing the switched and leased portions of systems, respectively.

G. Switched System Design Procedure (The information specified in headings C and E above, is required.)

1. All Switched Terminals

When the traffic pattern (organization/destination patterns of all messages) is entirely point-to-point among many different points, with all locations lightly loaded, it may be economical to use Telex or TWX for this traffic. The Telephone System can handle higher speed if there are large amounts of such traffic and the Wide Area billing arrangement also becomes attractive for this. This type of system, however, offers no central control of traffic and assumes no one major origination/destination point--hence, no "central" machine configuration for on-line processing. The design of such a system is generally quite approximate, with the number of terminals required at each location based on the peak period send-plus-receive load, the HDX terminal speed, and the amount of control time to get a connection before moving data (see 3 below).

As an example, the system design for a TWX network might be to have the terminals call the CPU when a transmission is required. If this is the case then the network cost and number of TWX access lines could be found in the following manner. From the traffic statistics for each terminal, the number of calls per day per terminal could be obtained. This would require knowing type of messages, message

length, transmission method, and other information discussed in C above. By knowing the location of each terminal, the distance to the CPU can be found by the V-H coordinate method. From the Usage Charge list in Section III, the cost per call per terminal can then be obtained. The total cost for calls per terminal can then be computed and the total cost found.

To then determine the number of TWX stations needed at the CPU such that a calling station will not get a busy signal when it calls, see "IBM 1410 Telephone Inquiry Device Study" referenced in the Bibliography.

2. Some Switched Terminals

Since most data communication networks require some sort of central on-line processing, and leased lines are generally more economical for such traffic, switched terminals usually appear as only part of a communications network. They are used for one or more of these reasons:

a. To back-up other lines and/or machines for priority traffic.

b. Lightly used terminals too far from leased line terminals for an economical leased link.

c. Need to communicate directly with other terminals for conversation or with terminals in other companies.

When a or b is the reason, the central equipment also needs access to the switched system, if the machine is capable. These access lines may only originate calls or may answer and originate. To take advantage of WATS flat rates, for example, the central usually does all originating. In this case, the number of access lines required at the the central is based on connect time, (see 3 below) peak period message load, average message length, and line speed. Additional short messages must be added to the load to account for calls originated to stations so that they can send, but they have nothing to send ("Non-Productive Polls").

If the central must answer and originate calls, the number of access lines (trunks) is based on the same factors above, except there are not any dead polls, but the queueing problems demand less efficient lines at the central. For example, if 95% of the incoming calls are to be delayed less than 0.2 times the constant length message transmission

time: 1 trunk can be 7% occupied, 2 trunks 24%, 3 trunks 35%, 4 trunks 42%, 6 trunks 52%, 12 trunks 68%, 20 trunks 78%, etc. These figures assume that a busy signal results in an immediate retry (which is not exactly true) and that delayed calls are answered in order (also not exactly true). A queueing formulation for determining the number of lines needed has been developed and is discussed in "IBM 1410 Telephone Inquiry Service Study" referenced in the Bibliography.

3. Control Times for Switched Lines

On TWX and the Telephone System, it takes about 25 seconds to "dial" and connect and disconnect, plus about 5 seconds to handshake and disconnect the data sets. Depending on the customer's requirements, identification time may have to be added to this before data starts moving. If "dialing" uses all touch tone equipment, about 15 seconds of "dialing" and connect time is saved.

On Telex, it takes about 24 seconds to "dial" by hand or machine and get connected and disconnected. Identification time is additional, if required.

Portions of the above control times may be chargeable time.

H. Leased System Design Procedure

The data specified in C and E above is required. A list of locations is made with the peak period load itemized for each terminal. Then, one of the two methods outlined below is followed. When a solution is completed, another combination of speed and terminal may be tried, if others are valid. Also changes in traffic patterns, peak period, central locations, loading/response, etc., are ways of getting different solutions. A comparison of all results will enable the designer to pick the one (or several) solution which best meets the customer's communications needs.

A map is necessary or desirable, depending on the method used. We have found that a large-scale map, showing as many location names as possible, is very helpful. Two such U.S. maps are Cleartype, by American Map Co., #783 and #7009. The former is 38 x 25, shows all cities over 5,000 population, and costs $2.00. The latter is 50 x 38, shows all cities over 2,500 population, and costs $5.25. An index book is available for $3.50. A smaller and less expensive map is #732. Any map, showing all the places to be interconnected on one sheet, is satisfactory. For manual design, the scale must be quite accurate in all directions, such as on a "conformal conic" projection.

1. Manual Design (A map is required).

   a. Plot each location on the map, along with its peak load. Also, plot the central location.

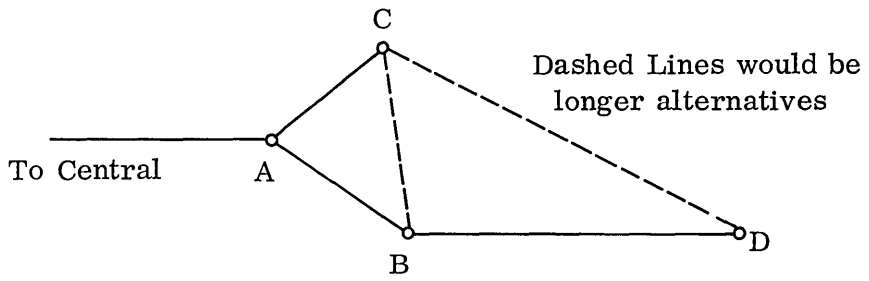
   b. Determine the maximum load per line in the same units as location loads. If response time criteria has been given, convert to a load figure using the method described in the sub-section on Response Time of Multipoint Lines.

   c. If there are locations which exceed the maximum line load, split each location into a number of maximum load lines, with one terminal each, and one terminal for the remainder load. The full-line loads and terminals may be removed from the map and listed separately.

   d. Beginning at a terminal farthest from the central, link terminals together by straight lines with these objectives:

      1.) Get as close to the maximum line load as possible (may be slightly over it), then connect to center and start a new line.

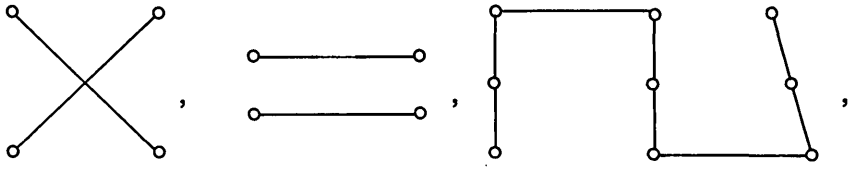
      2.) Keep line mileage to a minimum by pointing the line towards the central with narrow lateral detours to pick up stations.



EXAMPLE OF BRANCHING TO MINIMIZE LINE MILEAGE

      3.) Any three adjacent stations to be linked are connected by the two shortest of the three possible sides of the defined triangle. This will occasionally result in branching. Branches may be any length and number of links and may repeatedly branch. (Step d results in assigning terminals to a multipoint line and connecting them together by a "minimum tree." This is the method used by common carriers to determine the mileage for which to charge, regardless of actual wire routes.)

e. When several lines in the same portion of the map have been completed, review them to try different combinations that will improve the objectives in step d, above. Terminals in, or very near to, the central location can be selectively put on any line to raise its load without increasing cost significantly. Try to avoid making connections which look like this:



as they generally may be designed for a lower line cost.

f. When a satisfactory group of lines has been drawn, the cost of the network can be estimated using the scaled mileage for each link and the method described in Section III.

g. Where a number of lines appear to be nearly parallel to each other, Telpak bundling may reduce the cost. Telpak (explained in Section III) provides groups of channels between two points at a quantity rate. Leased line extensions from a Telpak group at any common carrier location to terminal locations are then used to rebuild the lines designed above. In order to effectively use Telpak, recombinations of stations are usually necessary.

h. The results of this design might be listed as follows:

1. Leased line miles (actual or equivalent)
2. Leased miles cost
3. Telpak cost
4. Number of lines
5. Number of stations
6. Number of loops
7. Cost of loops
8. Number of chan terminals
9. Cost of station charges and chan terminals
10. Total cost of communications facilities

2. Multi-Point Linkage Program (MPL)

This is one of the Communications Network Design Programs (CNDP) which have been announced and will be made available as restricted Type II programs. MPL performs on the 7090 and 7040 steps b, c, d, and f above. The multipoint lines are quite well optimized and the printout is collated by line. Input can specify loading and/or response time. Output includes loading and/or response time analysis of each line. The program is presently available for use through the Regional Systems Design Centers.

There is an SRL Bulletin (Z20-0310-0) available which describes the program operation in general. The programs are still considered under development.

J. V-H Coordinate Sources

Programmed methods of Network Design require the locations to be defined to the computer. One standard method is the V-H Coordinate system developed by AT&T. The primary source of this information is the tariff described in 1 below. Because of the expense of obtaining personal copies, additional sources are also listed which may be helpful.

1. FCC Tariff AT&T 255 - "List of Rate Centers and Central Offices for the U.S., and Canada and Mexico".

This tariff contains two lists for each state. First, a list of V and H Coordinates for a list of Rate Centers in that state and the corresponding "toll center." A toll center does not concern us in leased line design, but is usually a large locality--perhaps more readily found on a map. Second, a list of central offices (numerical and alphabetic) with corresponding rate centers. If a locality can not be found in the first list, perhaps a telephone number will determine the rate center using the second list.

The V and H coordinates were obtained by superimposing a grid on a "Donald Elliptic" projection map of North America. The grid is tilted clockwise about 20° from a normal N-S, E-W grid. 0, 0 is in the far northeast corner. Using the trigonometric rules of a right triangle, the airline distance between any two points is defined as:

$$\sqrt{\frac{(V_1 - V_2)^2 + (H_1 - H_2)^2}{10}}$$

miles for leased line considerations. (Thus, one coordinate unit is a distance of the square root of 0.1 in miles). A different method is used when measuring for toll purposes which usually does not concern us. This tariff was filed by AT&T only but nearly all domestic common carriers have concurred with it, and it includes all the rate centers for all the telephone companies.

Copies of this tariff may be obtained from Cooper Trent, a printing house in Washington, D.C., but charges are per page and very expensive. Within IBM, copies have been made available to the four regional design center managers and a copy is also available at Industry Technical Assistance.

2. Abstract - The Data Communications Handbook (see Bibliography) has a list of around 1500 of the largest cities including their V and H coordinates.

K. Example of Manual Network Design

As an example of the method described in this guide for Manual Design of a Leased System, a small system connecting 11 cities to Jonesboro, Arkansas is designed. The fixed information obtained about the problem is listed below:

1. Cities and total message loads/peak hour (avg. 200 ch/msg input and output):

Auburn, Washington	33.0
Long Beach, California	9.2
Glendale, California	67.5
Napa, California	9.2
Santa Rosa, California	31.7
Watsonville, California	35.3
Jackson, Wyoming	11.1
Magnolia, Arkansas (1)	29.5
Magnolia, Arkansas (2)	61.3
Galveston, Texas	45.6
Humble, Texas	37.6
Monroe, Louisiana	18.5

2. The network we wish to design is a full time, half duplex, 100 wpm, leased telegraph line network with the following network parameters:

   a. A ratio of input messages to output messages of 1:1.1

b. Control of 8 character times

c. Full control polling (one message per poll) of each station.

d. 90% of messages must be delivered in less than 7.5 minutes.

e. Terminals operate at 10 cps line speed.

3. From the parameters given, we find that the control time (or poll time or address time) is 8 character times. Thus LCT is 8 characters. Since the line speed is 10 cps, LCT could also be expressed as .8 seconds. LHT is the average message length + control time = 200 characters + 8 characters = 208 characters or 20.8 seconds. The ratio of LCT:LHT would be 8/208 or 1:26. The R_{IO} is 1:1.1, which means we will be working with graphs #1 and #2. Because the LCT:LHT = 1:26, we will use the lower curve on graph #1.

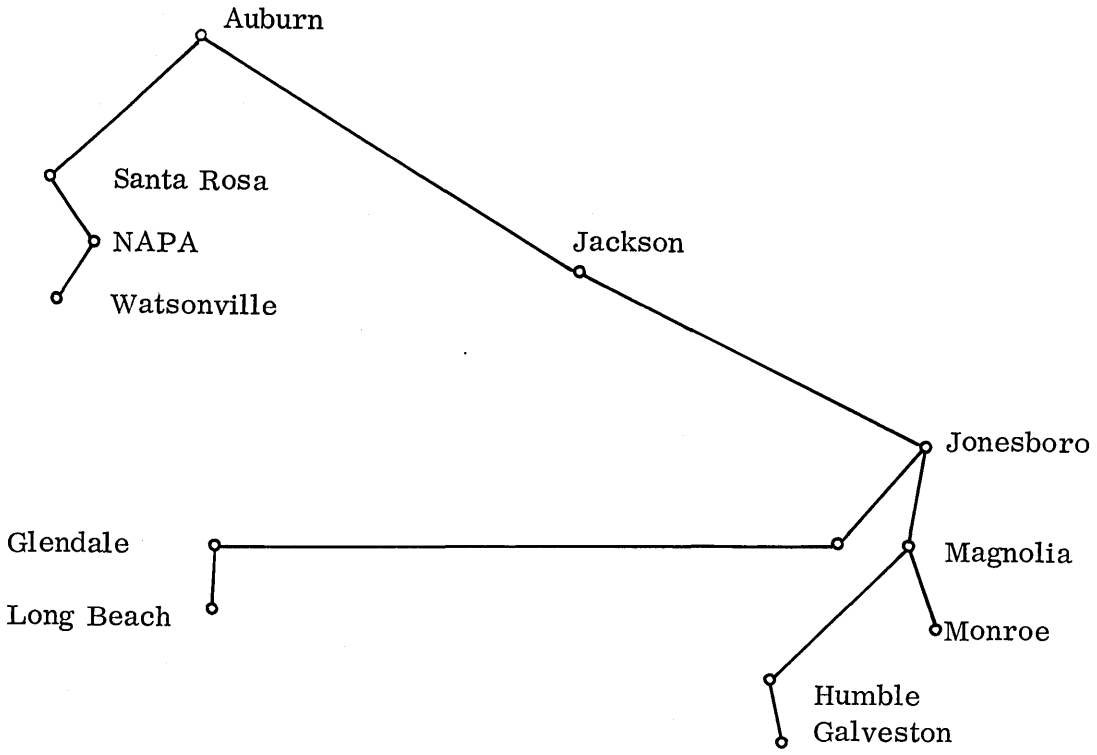
   In the parameters we have been given the percentile of messages P = 90% and the response time T = 7.5 minutes or 450 seconds (7.5 x 60). We are thus looking for the line utilization U. Entering graph #2 at 90%, we find a Yu of 2.1. Since $Yp = \frac{T}{MRT}$ (from D.2.), $MRT = \frac{450}{2.1}$ seconds = 214 seconds. $Yu = \frac{MRT}{LHT} = \frac{214 \text{ seconds}}{20.8 \text{ seconds}} = 10.3$ Entering graph #1 with a Yu of 10.3 and using the lower curve, we find that U = 80.5% utilization. Thus the maximum line utilization for our system requirements is 80.5%. One 100 wpm telegraph line is capable of transmitting 10 characters per second, 600 characters per minute or 3600 characters per hour. Since each message has an average of 208 characters (we must include control time), the line is capable of handling $\frac{3600 \text{ char/hr}}{208 \text{ char/mes}}$ = 172 messages/hour maximum. To load the line to 80.5% utilization, we allow only 172 x .805 = 138 messages/hour on the line. The 138 messages/hour is thus our line loading factor. Notice that this is total messages/hour. The traffic rate from each city is also expressed at total number of messages (both in and out)/hour. If the city traffic rate is expressed in other units, then the line loading factor must be in the same units.

4. By following the procedure outlined in Section H.1, we manually construct a network. We see that Watsonville, Napa and Santa Rosa will all be connected on the same line. Since the distance from Santa Rosa to Auburn is less than Watsonville to Glendale, we make the Santa Rosa - Auburn connection. From Auburn we go to Jackson

and then the DPC. This line now has 120.3 messages/hour which is nearly equal to the line loading factor. By similar analysis the rest of the network was configurated and the cost was then computed. The resultant network is shown below.

	From	To	Load	Distance in Miles	Equivalent Miles
Line 1	Galveston	Humble	45.6	49.5	49.5
	Humble	Magnolia(1)	37.6	247	247
	Monroe	Magnolia(1)	18.5	82.5	82.5
	Magnolia(1)	Jonesboro	29.5	225	225
		Total	131.2		
Line 2	Long Beach	Glendale	9.2	30	30
	Glendale	Magnolia(2)	67.5	1420	722
	Magnolia(2)	Jonesboro	61.3	225	225
		Total	138.0		
Line 3	Watsonville	Napa	35.3	82.5	82.5
	Napa	Santa Rose	9.2	22.5	22.5
	Santa Rose	Auburn	31.7	600	415
	Auburn	Jackson	33.0	610	419
	Jackson	Jonesboro	11.1	990	571
		Total	120.3		3091

The total line cost for the system would be 3091 x 1.21 (from AT&T Schedule 3 cost for 100 wpm telegraph) = $3,740. The local channel costs are 15 x $6.70 or $100. The channel terminal charges are 15 x $12.50 or $187.50. Thus the total cost of the network is $4,027.50. A map of this solution is shown on the next page.



NETWORK CONFIGURATION

SECTION III. COMMUNICATIONS FACILITIES

This section covers common carriers, general description of communication facilities, details of available facilities, and a data set index.

Communications Facilities refers to all lines, channels, circuits, mod/demod, etc, required to move data between two or more geographically separated machines. The majority of customers prefer to obtain these from a common carrier, however privately owned systems are growing in popularity. This section includes information on those facilities available from the common carriers for data transmission. Many private systems provide similar facilities. See the beginning of Section II for a discussion of IBM Marketing Policy with respect to recommending specific common carriers and vendors of private system equipment.

A. Common Carriers

1. Who are they - There are basically two common carriers serving any one point in the U.S.A. One is the Western Union Telegraph Company, the other is a telephone company. These two offer some similar facilities and some unique. The many telephone companies have divided up the country so that only one serves any one spot. AT&T is the largest and consists of over 20 local operating companies interconnected by the facilities of AT&T Long Lines. General Telephone is the largest independent (non AT&T), consisting of over 30 local operating companies. About 2700 other independent companies, all quite small, make up the rest of the "telephone system". Western Union is a single company covering the entire U.S.

2. Tariffs - A tariff describes the service which a common carrier provides to the public. It is the document used by regulating bodies to control the carriers, since every service must eventually be approved by the regulatory office. Common carriers offering interstate facilities are regulated by the Federal Communications Commission. Those offering intrastate facilities are regulated by various state commissions. Many carriers operate at both levels and file tariffs at both levels.

   For the purposes of obtaining tariff information about common carrier facilities, two assumptions can be made:

   a. All telephone companies can offer a service or facility that AT&T offers.

b. Tariffs filed with the F.C.C. are representative of intrastate tariffs.

These assumptions are valid for estimating the cost of geographically large communication systems. However, some telephone companies may have different availabilities and intrastate tariffs can be different.

3. Information Sources - Many sources are discussed at the beginning of Section II. Two IBM documents are the Data Communications Handbook and this Section III of this book.

The Data Communications Handbook contains: F.C.C. tariff abstracts, data set summary sheets, and descriptions of some common carrier systems.

This section III combines the rate information from the tariffs with technical information not found in tariffs to provide a reference source for system design using common carrier facilities. Tariff regulations, restrictions, etc, are purposely omitted because they are in the Data Communications Handbook.

B. General Classifications of Communications Facilities

The index chart on the following page shows all of the common carrier facilities presently capable of attaching to IBM machines. It is arranged by bit speed to provide a quick reference to facility name, type and supplier. Each term used is explained in the following paragraphs. Details of each facility are covered in Tables whose use is explained in Section III C below.

1. Speed - The speed of a communications facility is basically how fast bits can be moved over that facility. A common dimension is bits per second, usually abbreviated bps or baud.

DATA COMMUNICATIONS FACILITIES INDEX
(interstate, usable with IBM Machines)
Terms are explained in Section III B of text.

Speed (bps)	L* S	Name of Facility		HDX FDX	Data Set
		Telephone Co.	WU		
45 max.	L	Sched. 1	Class A	H/F	none
50 max.	S	--------	Telex	H	auto-dial
55 max.	L	Sched. 2	Class B	H/F	none
75 max.	L	Sched. 3	Class C	H/F	none
75 & 110 fixed	S	TWX	--------	H	incl.
150 max.	S	BM TWX	--------	F**	incl.
180 max.	L	--------	Class D	H/F	8500
200 max.	S	Telephone	--------	F**	103A
200 max.	L	Sched. 4	--------	F**	103F***
600 max.	L	--------	Class E	H/F	1601A***
600 max.	S	--------	Broadband Ex.	F	1601A
1200 max.	S	Telephone	--------	H	202C
1200 max.	S	--------	Broadband Ex.	F	2121A
1200 max.	L	--------	Class E	H/F	8501***
1800 max.	L	Sched. 4 (cond. required above 1000)	--------	H	202D***
2000 fixed	S	Telephone	--------	H/F	201A
2000 fixed	L	Sched. 4 (additional conditioning may change the type of service designation)	Class E	H/F	201A***
2400 fixed	L			H/F	201B***
2400 max.	S	--------	Broadband Ex.	F	2241A
40.8 K fixed	L	Telpak A2	Telpak A2	F	301 B
105 K fixed	L	Telpak C2	Telpak C2	F	special
500 K fixed	L	Telpak D1	Telpak D1	F	special

*All facilities designated L may be combined in certain ways into Telpak groups (table 2).

**FDX on HDX line (see text)

***Customer (or IBM) may provide a data set in lieu of the carrier's set shown.

As used in the index, maximum means the highest bit speed permitted or possible, fixed means the facility operates at that particular bit speed. These limitations may be the result of using the data set shown.

The maximum bit speed of a particular communication facility is a function of many interacting technical factors, such as: physical length, physical composition, DC or AC signal, type of modulation, state of the art. Past attempts to directly relate bit speed to frequency bandwidth are being proved inadequate today. For our purposes in designing systems for customers, the primary concern is what speed can be obtained using any particular facility.

To choose the facility required for a particular machine, it is necessary to know the maximum bit speed the machine will use. This may be higher than the average bit speed (char/sec times bits/char on the line) because many serial machines use pauses between characters on the line. The configurator for IBM machines in Section IV shows maximum speed in bps and average data rate in characters per second. Throughput will be affected by several factors, primarily turnaround time. Some data sets require 200 ms to change direction. Machines also may use line time to process or make decisions.

Thus speed must be measured in three ways:

a. Maximum bits/sec to determine needed facilities,

b. Data rate in characters per time unit to allow for inter-character line time,

c. Throughput in transactions per time unit to allow for turnaround.

2. Leased/Switched - this refers to whether or not the facilities are dedicated to the user's machine. As used in this index and the tables which follow, leased means any facility which is contracted for and permanently connected to specific machines. A typical example is a multipoint line linking three 1050's in Washington, New York, and White Plains. The line is always available for use by one of those terminals.

Switched means any facility which uses a publicly accessible switched network. Access lines are permanently connected to specific machines, but such lines are not permanently connected to each other. A typical example is three 1050's in Washington, New York, and White Plains, each attached to the public telephone system. Connection between any two requires placing a call, obtaining an idle network path, determining that the called station is idle and paying some form of charge for the time.

Many leased facilities can be combined into a private, switched system which then take on the characteristics of a switched system. An example of this would be three 1050's located in IBM offices in FRO, ERO, and DPHQ, each attached to the IBM telephone system. This system consists entirely of leased lines but is combined to look and act like a switched system. Prospective customers may have such systems already, or may find one justified as part of our proposal.

3. Name of Facility - Each facility is briefly described in the tables in Section III C.

4. HDX/FDX - The mode of transmission describes how data moves on the communications facility.

   a. Simplex - transmission in one direction only.

   b. Single or Half Duplex (HDX) - transmission in both directions but only one direction at a time.

   c. Duplex or Full Duplex (FDX) - capable of simultaneous transmission in both directions.

   These terms are used in two ways: to describe the technical limitation on use caused by the physical characteristics of the facility, and to describe the way in which the facility is used caused by the machines or application. Thus a facility may be capable of FDX but due to a machine limitation it is only used HDX. The index shows the technical limitation. H/F means the facility can be ordered with a technical limitation of either HDX or FDX - the FDX usually costs 10% more per month.

   There is one case where these terms get confused. The facility used in the public telephone system is technically HDX because it is designed to handle voice in one direction at a time. This is also true of a leased voice grade facility (schedule 4 or class E). Both switched

and leased voice facilities can often handle voice in a FDX mode. Also, both types can always handle data in a FDX mode on a HDX facility when a 100 series data set is used on telephone company facilities.

Any facilities technically capable of a particular mode can be used in that or a simpler mode (except for the case noted above). There are no facilities technically limited to Simplex use.

Two other technical descriptions of transmission mode commonly encountered are:

a. Two-wire: transmission in opposite directions are carried on the same line.

b. Four-wire: transmission in opposite directions are carried over separate lines. Each line is effectively a simplex line.

5. Data Set - This is the major consideration in the general problem of defining the interface — which is how a communication facility is connected to, and controlled by, a machine. The three-digit numbers are AT&T units, the four-digit numbers are WU. See the tables for a fuller description of particular interfaces. Where "none" appears in the index, the facility has a dc serial interface direct to the machine.

C. Communication Facilities Details

1. Organization - All interstate facilities available for data use from the common carriers have been detailed in three tables: 1. Leased Single Facilities, 2. Leased Groups of Facilities, 3. Switched Facilities. In addition, table 4 shows the present status of these facilities. Within each table the different facilities are arranged by maximum bit speed. Each facility is identified by name, tariff from which derived, and a brief description. A chart of rates, interface description and notes on usage follows. Regulations and restrictions are fully covered in the Data Communications Handbook tariff abstracts.

The information in these tables was obtained from tariffs and authoritative sources within the common carriers. The prices herein are accurate enough for estimating purposes; page 7 of the general section of the Sales Manual should be consulted before supplying any communications cost information to customers. Installation charges have been ignored.

2. Definitions - the following terms are used in these tables:

Service Point - A location (city/exchange) where one or more stations are located.

Exchange/City - When leasing from phone companies, the term is exchange; when leasing from WU, the term is city. In all smaller cities, it may be assumed that, for pricing, the entire city is one exchange. Larger cities are broken up by both carriers into exchange areas or zones. In general, it is not necessary to know what part of a zoned city the station is in unless a leased line segment serving the station is less than 40 miles long, or unless it is a switched system station.

Station - An equipment location. This can include all equipment in one building on the same line, but usually not in separate buildings. Extra equipment in the same building is connected as an extension. These rates are lower than local channels and can be found in the tariff abstracts.

Channel Terminal - In Telegraph, Class D, and Voice Grade facilities, a device required at each service point to connect all stations there to one line. In Telpak, a device required at each station.

Local Channel or Loop - Required to connect each station to its channel terminal (except in Telpak).

Press Customers - An exception in the present tariffs requires this definition. It includes newspapers, broadcasting, magazines, etc. See the tariff abstract for a more detailed definition.

Interface - This describes the physical connection between an IBM machine and the facility. The type of signal on the facility, mod/demod, and type of signal to the machine is shown. See Section V for more information on how to control a multipoint line (logical interface).

Interstate/Intrastate - For leased line purposes, a line is interstate if any segment of it crosses a state line. An intrastate line has all of its segments wholly within one state. A system of lines connected to a single machine (but not interconnected to each other) can have some interstate lines and some intrastate lines.

For switched systems the destination is less important. Essentially, a call placed to a point within the state is covered by intrastate tariffs, a call placed to a point in another state is interstate.

Except where noted, all information in these tables is interstate. These can be used as a rough estimate for intrastate.

Full Time - Leased facility contracted for 24 hours/day for the period of contract, usually one month minimum.

3. Cost Estimation - Communications Facilities are priced on a monthly basis. The areas of cost are:

   a. To attach a machine to a facility

   b. To have a facility access at a service point

   c. To provide the facility between various service points.

   When leased lines (Table 1) are used to connect several points on one line, a "minimum tree" of straight lines is designed (see Section II H) to compute the line cost. Each segment or leg of such a tree is priced according to the rates in the table, starting at 0 miles in each segment. This "minimum tree" has no relation to the way the line is installed. Cumulative figures are shown in the tables for specific portions of each segment. To compute the cost of a segment, take the largest cumulative total mileage within the segment, then multiply the balance by the next per-mile rate. For example, a 600 mile (between two service points), 75 bps HDX leased facility would cost $453.50 (for 500) plus 100 x .484, for a total of $501.90. Two channel terminals are required ($27.50) for facility access at the two service points and one local channel ($7.37) is required to attach each machine on the line.

   Another way to compute the cost of a leased facility between service points is to use equivalent miles. The actual straight line mileage is converted to equivalent miles using the percentages in the rate charts. Then the equivalent miles are multiplied by the rate for the first mile. This method is useful for multi-line, multi-point systems where each segment is converted to equivalent miles and all segments are totaled before multiplying by the rate for a first mile. For example, the 600 mile segment above is 250 x 100% + 250 x 50% + 100 x 40% = 415 equivalent miles. An example of pricing a leased system is shown at the end of Section II.

When leased groups (Table 2) or switched (Table 3) facilities are used there is no separate charge for facility access at a service point and the cost between service points becomes a toll charge for time and distance used. For example, two basic telex stations 600 miles apart which converse for 30 hours a month would use 21,600 pulses. If all of these calls originate from one station the toll charge is 3500 x $.025 + 18,100 x $.015 = $359.00. Two service charges are incurred ($70.00) for the machines attached to the system.

TABLE I
LEASED (DEDICATED) INTERSTATE FACILITIES

45, 55, 75 bps (Telegraph, 60, 75, 100 wpm) (AT&T Schedules 1, 2, 3 Tariffs 208 and 237) (WU Classes A, B, C, Tariff 237)

Description - Obtainable as service (with mostly telegraph terminals), or as channel - rates shown below are the same. Character regenerating devices are usually required on multi-point channels or where a channel has long segments of DC signalling. In cases where much of the channel is actually derived from non-DC facilities, regeneration may not be required. When regeneration is required, the device must match both the bit length of the characters being transmitted and the speed of the bits within each character. The standard character length is 7.42 bits/character and the standard speed is that shown on the rate tables below. WU will make available, on request, 9 bit/character regenerating devices. Circuits may be multipoint or point-to-point.

Rates - 45 and 55 bps, full-time for one month. (Except "press customers")

HDX (2 wire)					FDX (4 wire)		
Miles	Equiv %	Per Mile	Total	Cum	Per Mile	Total	Cum.
1-250	100	$1.100	$275.00		$1.210	$302.50	
251-500	50	0.550	137.50	$412.50	0.605	151.00	$453.50
501-1000	40	0.440	220.00	632.50	0.484	242.00	695.50
1001-over	35	0.385			0.424		
Each Channel Terminal (1 per service pt.)				$12.50			$13.75
Each Local Channel (1 per station)				$ 6.70			$13.40

Rates - 75 bps, full-time for one month. (Except "press customers")

1-250	100	$1.210	$302.50		$1.331	$332.75	
251-500	50	0.605	151.00	$453.50	0.661	166.10	$498.85
501-1000	40	0.484	242.00	695.50	0.532	266.20	765.05
1001-over	35	0.424			0.466		
Each Channel Terminal (1 per service pt.)				$13.75			$15.13
Each Local Channel (1 per station)				$ 7.37			$14.74

TABLE I (cont'd)
LEASED (DEDICATED) INTERSTATE FACILITIES

Interface - Telephone Companies - DC, two wire neutral loop, direct connection. 60 ma (±2.5 ma) current supplied from central office with the "tip" wire negative to ground and "ring" wire positive to ground. Current ON = Mark or 1, current OFF = Space or 0. DC resistance of attached machine should be approximately 130 ohms. Open circuit voltage may reach 260 volts; 130 volts from each wire to ground. For FDX, two such loops are required.

Western Union - DC, four wire polar loop, direct connection. Two wires for receive, two for send, one wire of each pair is ground. 35 ma current supplied from central office on receive, current generator required at station to send.

Western Union will include no-cost converters on request, which provide an interface equivalent to the Telephone Companies' described above.

Notes on Usage - These facilities are usually used as a service, with telegraph terminals at remote points and a computer as a master station. Some line control system (see section V of this guide) is used when the lines are multi-point. The carrier must decide if a customer qualifies as "press", and then uses different rates. The press rates are actually the rates in effect for all users prior to October 1, 1964, and may be found in the Data Communications Handbook.

The regenerating devices only present a problem when non-telegraph terminals are used, such as IBM 1050. Only the carrier can determine if regenerating devices are needed on a particular facility; therefore, this facility must be considered available from telephone and Western Union even for non-telegraph use. When regenerators are not used, the speed shown in bps is a maximum.

TABLE I (cont'd)
LEASED (DEDICATED) INTERSTATE FACILITIES

180 bps (WU Class D, Tariff 237)

Description - Basically sub-bands of carrier channels on Western Union's own intercity facilities. No regeneration, no line code restriction, speed shown is a maximum. Circuits may be multipoint or point-to-point.

Rates - full-time for one month

HDX Use					FDX Use		
Miles	Equiv %	Per Mile	Total	Cum.	Per Mile	Total	Cum.
1-250	100	$1.500	$375.00		$1.650	$412.50	
251-500	85	1.275	318.50	$693.50	1.430	350.35	$762.85
501-over	80	1.200			1.320		
Each Channel Terminal (1 per service pt.)				$ 12.50			$ 13.75
Each Local Channel (1 per station)				$ 8.25			$ 16.50

Interface - DC, four wire to a WU Data Loop Transceiver. RS232A standard interface from DLT to the BM. One DLT required per station whether HDX or FDX $ 30.00

Notes on Usage - Originally developed for IBM Transceiver, WU cannot offer these channels where they don't have their own facilities. However, they will consider implementing any proposed network and this facility must be assumed available anywhere.

2400 bps (Voice Grade) (AT&T Schedules 4, 4A, 4B, 4C, Tariffs 135 and 237) (WU Class E, E conditioned, F, Tariffs 237)

Description - Basically lines capable of communicating a voice conversation. When used for data, modulation - demodulation device converts the data to voice type signals. The design of this modem dictates the speed of data transmission. 2400 bps is the technical maximum presently available. See interface for more detail.

TABLE I (cont'd)
LEASED (DEDICATED) INTERSTATE FACILITIES

Facility is available as a service (with handsets and/or data sets for voice and/or data) or as a channel, (customer provides modems). No regeneration, no line code restriction, circuit may be point-to-point or multipoint.

Rates - full time for one month. (Basic Schedule 4, Class E, and Class F)

HDX (2 wire)					FDX (4 wire)		
Miles	Equiv %	Per Mile	Total	Cum.	Per Mile	Total	Cum.
1-250	100	$2.020	$505.00		$2.222	$555.50	
251-500	85	1.717	429.50	$934.40	1.889	472.45	$1027.95
501-over	80	1.616			1.778		
Each Channel Terminal (1 per service pt.)				$ 12.50			$ 13.75
Each Local Channel (1 per station)							
			AT&T	$ 12.50			$ 17.50
			WU	$ 10.00			$ 18.25

Alternate Use Charge

Telephone & Data Set - None	
Telephone & Data Set requiring Automatic Echo Suppression Cutoff	$ 15.00

Channel Conditioning - May be required, at speeds and configurations shown, to reduce distortion which is a cause of errors. AT&T refers to Grades A (min.) to C (max.), WU conditions Class E or specifies Class F channels. The need for such conditioning is only determined by actual experience with each installed channel, but need can be estimated as follows:

Speed (bps)				
Data Set				
201	202	Config.	Suggest AT&T/WU	Charge
2000	up to 1400	Multi-pt.	Sched. 4A/Class E cond.	$20 first sta/city 6 addit. sta/city
2400	up to 1400	pt-pt	Sched. 4A/Class E cond.	$10 first sta/city 6 addit. sta/city
2400	up to 1800	Multi-pt.	Sched. 4B	$47.50 first sta/city 20 addit. sta/city
-	up to 1800	pt-pt	4B/Class F	$37.50 first sta/city 20 addit. sta/city

TABLE I (cont'd)
LEASED (DEDICATED) INTERSTATE FACILITIES

For higher levels of conditioning, Schedule 4C, recently announced for pt-pt or multi-pt at $56.00 first sta/city, $20.00 additi. sta/city.

Interface - AC, two wire for HDX (four wire for FDX) to a modem provided by carrier or customer required for data use. The industry has standardized the multiwire interface between business machines and modem (EIA 232A).

Modems available from the common carriers are as follows: (For more detail, see Section III D of this guide or the Data Communications Handbook, section 70.)

103F (ATT) 0-300 bps, creates FDX operation on HDX line	$25
8501 (WU) 0-1200 bps for HDX or FDX lines	$40
202D (ATT) 0-1800 bps for HDX or FDX lines	$40
201A (ATT) 2000 bps fixed speed, HDX or FDX lines	$72
201B (ATT) 2400 bps fixed speed, HDX or FDX lines	$72
401 series (ATT) 160 bps (parallel, one direction non-standard interface)	varies

Modems available from IBM are Line Adapter Features on terminals and Control Units such as: #4789 or #4791 on 1448, #4790 on 1050, #4636 on 2701, etc. Refer to Section IV of this guide and sales manual for prices and availability. At present, most of the IBM Modems are limited to use on lines 8 miles or less in length.

Modems are also available from many other manufacturers.

Notes on Usage - When using the 103F data set, a multipoint line is forced into a master-slaves configuration. Only one station can be master, and all communication on the line is from slave to master and master to slave(s). All other carrier and IBM modems operate in a HDX mode on a HDX line, allowing full intercommunication between stations.

TABLE I (cont'd)
LEASED (DEDICATED) INTERSTATE FACILITIES

Over 2400 bps (Telpak Broad Band) (AT&T Tariff 250, WU Tariff 237)

Description - Telpak is the name of a unique common carrier offering and includes both broad-bandwidth channels and bundles of smaller-bandwidth channels. Bundles are covered in Table 2.

Telpak broad band channels are available in 3 bandwidths. Each channel must be "arranged for use" at each station as specified by customer. This arrangement includes the local channel and the channel terminal in a single charge. A voice coordination facility is always provided at no charge. The channel mileage charge applies between service points and is constant over the entire length. Each channel is FDX and may be terminated and used as one HDX channel. Channels may be point to point or multipoint and may be combined with other facilities in a Telpak bundle.

Rates - full-time, FDX, per month

Capability (each way)	Base Capacity	Per Mile	Channel Terminal (at each station)
20K cycles per sec. analog	A	$15.	A1 $100
40.8 K bits per sec. data	A	15.	A2 250 (includes data set 301B)
100 K cycles per sec. analog	C	25.	C1 130
105 K bits per sec. data	C	25.	C2 550
500 K bits per sec. data	D	45.	D1 1,300

Interface - For data use - four wire, AC, to a data set (included in channel terminal charge). The interface between the data set and business machine is multiwire and has not been standardized. The only charges at the interface are those included under channel terminal above.

Notes on Usage - AT&T recently announced a Multiway Switch for channels using A2 terminals. This would provide a single switching location with A2 channels connecting this point to each station location. Cost (in addition to a channel terminal at each station and mileage) is $130/month per channel attached to the switching location. Connection are established by touchtone "dialing" and voice coordination is provided. Switching location is dictated by available equipment.

TABLE II
LEASED (DEDICATED) GROUPS OF INTERSTATE FACILITIES

Telpak (AT&T Tariff 250, WU Tariff 237)

Description - Basically a different pricing method for the user who has a quantity of Telegraph, Class D, Voice, and/or Broadband leased facilities between 2 or more service points in his system. All facilities provided in Telpak are full Duplex (4 wire). The word Telpak covers groups of facilities and individual broadband facilities. Broadband is included in Table I.

Telpak A has a Base Capacity of 12 FDX voice channels
Telpak B has a Base Capacity of 24 FDX voice channels
Telpak C has a Base Capacity of 60 FDX voice channels
Telpak D has a Base Capacity of 240 FDX voice channels

For purposes of grouping channels, the following is used:

Up to 12 Telegraph, HDX or FDX	use 1FDX voice channel
Up to 6 Class D, HDX or FDX	use 1 FDX voice channel
Each 1 Voice, HDX or FDX	uses 1 FDX voice channel
Each A2 Broadband channel	uses 12 FDX voice channels
Each C2 Broadband channel	uses 60 FDX voice channels

To determine the level of Base Capacity required, convert each type of channel used between two service points to equivalent voice channels (round upward to whole channels), add together, and specify the Base Capacity which will contain them. Bundles of different Base Capacity may be connected end-to-end without additional charge.

Rates - Telpak Base Capacity for one month.

A	$15/mile
B	20/mile
C	25/mile
D	45/mile

TABLE II (cont'd)
LEASED (DEDICATED) GROUPS OF INTERSTATE FACILITIES

Channel terminals supplied by the carrier are required for each subchannel actually used as follows:

	First Station In City (on each subchannel)	Each Additional Station, Same City
Each station on a voice grade channel (Sched 4/Class E)	$15	$ 5
Each station on a two point conditioned voice grade channel (Sched 4A/Class E cond)	$25	$11
Each station on a multipoint conditioned voice grade channel (Sched 4A/Class E cond)	$35	$11
Each station on a telegraph channel (Sched 1, 2, or 3/Class A, B or C)	$15	$ 5
Each station on a 180 baud channel (WU Class D)	$15	$ 5
Each station on a A2 Broadband	$250	$250
Each station on a C2 Broadband	$550	$550

Interface - Four-wire, same as for individual channels as described in Table I. Each four-wire channel can be terminated as two-wire if desired but this doesn't increase number of channels in first chart above.

TABLE II (cont'd)
LEASED (DEDICATED) GROUPS OF INTERSTATE FACILITIES

Notes on Usage - The carriers may route the various parts of this bundle over different physical paths but this does not affect their use.

All of the facilities combined into a Telpak bundle must be from one common carrier. Interconnection between WU and the telephone companies is somewhat restricted depending on the use of the channel (see abstract of AT&T tariff 135 in Data Communications Handbook).

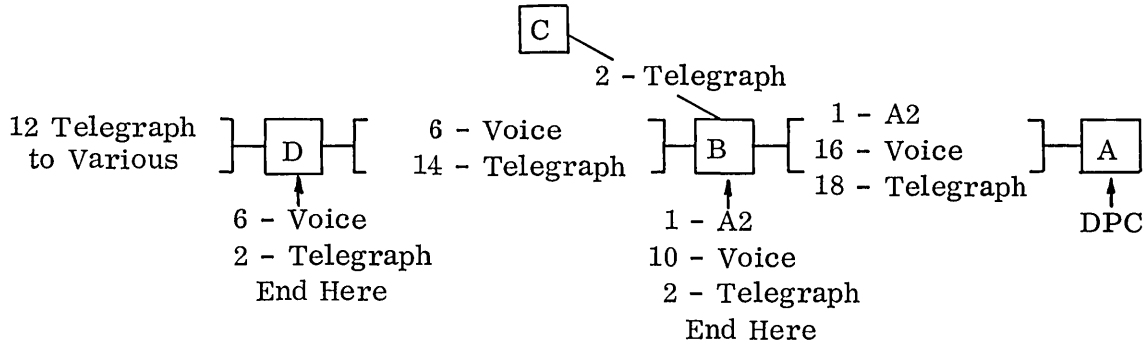
A Telpak bundle is laid out so as to pass through service points with a high density of stations. Individual subchannels can be multipointed. Low density service points are usually connected by single leased line extension (from table I) to the bundle. Such an extension is connected to to the bundle with a channel terminal (from chart above) along with any stations at that service point on the same subchannel. The rest of the single line is priced according to Table I with no channel terminal charge at the bundle end of the line.

To use Telpak bundles in leased network design, a network can be designed using just single lines, then bundles can be created and extensions added on a trial-and-error basis to lower overall cost. Or, a customer may have a Telpak bundle in use with spare channels. In this case, the spare channels will incur no additional mileage cost and extensions would be connected at any service point.

TABLE II (cont'd)
LEASED (DEDICATED) GROUPS OF INTERSTATE FACILITIES

Example

After deciding that single lines could be bundled as below, this portion of a system would be priced as follows:
(for simplicity, all lines are point-to-point from location A)



Intercity facilities:

A-B, Base Capacity required: 12 + 16 + 2 = 32, use Size C Telpak
B-C, use single lines
B-D, Base Capacity required: 6 + 2 = 8, use Size A Telpak

Channel Terminals on Telpak bundles:

at A	1-A2		$250
	16-Voice	15 x 16	240
	18-Telegraph	15 x 18	270
at B	1-A2		250
	10-Voice	15 x 10	150
	4-Telegraph	15 x 4	60
at D	6-Voice	15 x 6	90
	2-Telegraph	15 x 2	30

at C, local charges from Table I.

Mileage charges:

A-B at $25/mile
B-D at $15/mile
B-C from Table I

Multipoint lines would be treated similarly, but it is important to know which subchannel ends at a city, which goes through with no station, and which goes through and has a station, in the city.

TABLE III
SWITCHED INTERSTATE FACILITIES

0-50 bps (Telex) (WU Tariff 240)

Description - This is an automatic dial subscriber-to-subscriber Teleprinter Exchange Service. Telex is a world-wide system of basically telegraph terminals. Operating in over 50 countries, there are about 100,000 stations presently on the system. In the continental United States, there are over 7,000 stations served from over 101 cities. Direct connection to stations in Canada and Mexico is possible; to other countries, operator intervention is usually required. Each call is billed on a time and distance basis with no minimum. Direct interconnection with the TWX system is not provided.

The system is not code sensitive and establishes HDX connections. The maximum speed, using telegraph terminals, is 66 WPM. Business machines are permitted as covered under Interface.

Rates - Consist of Service Charge, Optional Equipment, and Toll Charges.

Service Charge - Each access (number) on the Telex system incurs a flat monthly charge of $35. This charge includes a basic telegraph terminal (keyboard and printer) if desired, and the necessary manual dialing equipment. A Business machine may be attached to this access at no extra charge, subject to the interface requirements below.

Optional Equipment - The following additional or expanded equipment may be obtained for the extra monthly charges shown:

Punched Tape capability on basic telegraph terminal.	$15.00
Separate printer perforator and keyboard for off line tape preparation.	$45.00
Audible/Visual incoming call indicator.	$ 2.00
400 number repertory dialer (manual search and initiation).	$25.00
Mark Sense or Punched Card Reader	$40.00

Several other devices are listed in the tariff.

TABLE III (cont'd)
SWITCHED INTERSTATE FACILITIES

Toll Charge - As each call is established, a pulse generator begins at a speed based on the distance as shown in the following table. These pulses are independent of data bits on the line, and are accumulated for the originating (calling) station until one station disconnects. Conversion of pulse count to dollars is shown below the table.

Interstate Mileage	Generated Pulses Per Minute	
	Intra US	US to Canada or Mexico
0-100	5	6
101-200	7	8
201-400	9	12
401-600	12	15
601-900	15	18
901-1500	18	24
1501-2100	21	30
2101-Over	24	36

The total number of timing pulses recorded per month for each originating station are billed at 2 1/2 cents per pulse for the first 3500 pulses ($87.50) and at 1 1/2 cents per pulse for the remainder.

Interface - Two wire DC, polar calling, neutral data transmission. The calling sequence requires a WU box at both ends of connection. For manual operation, it is included in the basic service charge. For automatic calling or automatic answering, the following equipment is provided, with neutral DC Baudot code interface:

Originate and Answer Unit (one line)	$35.00
Answer Only Unit (one line)	$ 3.00
Answer Only Unit (ten lines)	$30.00

This automatic call equipment presents and accepts Baudot code characters to the Business Machine over the same 2-wire interface used for data. There are no other wires.

A method has been worked out to interface the IBM 1414 to a telex terminal in a manner similar to the 115A/1414 interface.

Notes on Usage - Any terminal located more than 10 airline miles beyond the city limits of the 100-plus cities where telex is available, must lease a 60 WPM HDX telegraph line to that 10-mile point. The available cities are listed in the tariff abstract in the Data Communications Handbook.

Apparently we will find inquiry or back-up as the applications requiring telex interface to our machines. These cases would utilize the telegraph terminals on the system and a computer originating and/or answering.

Until the discount level is reached, telex has roughly the same toll charge as TWX, except the latter has a 3 minute minimum.

0-150 bps (TWX) (ATT Tariff 133 & NYPSC Tariff NYT B1)

Description - This is an automatic dial subscriber-to-subscriber Teletypewriter Exchange Service offered by AT&T and concurring Telephone companies. TWX is a system interconnecting over 50,000 stations in the U.S. and Canada. Terminals are basically telegraph machines, limited to HDX data transmission. Placing (dialing) and answering calls is performed by dial equipment supplied by the carriers. Each call is billed on a time and distance basis with a 3 minute minimum (calls to Canada have a one minute minimum). Direct interconnection with the telex system is not provided. There are basically two systems identified as 60 WPM and 100 WPM. There are also two types of access lines: TWX for telegraph machines and (through a regenerative repeater) Business Machines, TWX! for Business Machines only.

60 WPM service, for telegraph conversation, uses a basic model 15 telegraph KSR terminal at a maximum speed of 6 char/sec (Baudot Code). Business Machines may use this service in two ways: to converse with telegraph machines (TWX), or to converse with other Business Machines (TWX!). The latter is limited to 45.5 bps and is unlikely to be popular.

100 WPM service, for telegraph conversation, use a basic model 33 telegraph KSR terminal at a maximum speed of 10 char/sec (Bell ASCII). Business Machines may use this service in two ways: to converse with telegraph machines (TWX), or to converse with other Business Machines (TWX!). The latter is limited to 150 bps and is capable of FDX transmission of data.

Stations on one service can call stations on the other service, but this uses a code sensitive converter. Therefore, Business Machines must either use the standard code for the service or only call stations on the same service. TWX! stations cannot call TWX stations, and vice versa. However, an alternate arrangement is available on TWX telegraph stations to allow them to converse with TWX! stations.

Rates - Consist of Service Charge, Optional Equipment, and Toll Charges.

Service Charge - Each access (number) on the system incurs a flat monthly charge as follows:

60 WPM TWX	$10 including Mod 15 KSR
60 WPM TWX!	$10 including no equipment
100 WPM TWX	$45 including Mod 33 KSR
100 WPM TWX!	$20 including no equipment

To attach a Business Machine to either speed TWX line requires a $10 regenerative repeater in addition to above. In all cases, the necessary data set is included in above charges.

Optional Equipment - The following expanded equipment may be obtained in lieu of the basic terminal for the extra monthly charge shown:

60 WPM Type 19 ASR	$ 35
60 WPM modern (Type 28) ASR terminal	65
100 WPM Type 35 KSR	75
100 WPM Type 33 ASR (light duty)	50
100 WPM Type 35 ASR (standard)	115
100 WPM Type 35 ASR (with special features)	135-140

The following additional equipment may be obtained:

Card dialer	$ 3.50
"Rapidial" 290 number repertory dialer (manual search and initiate)	12.50

Several other accessory devices are listed in the tariff.

Automatic answering is available on 60 WPM service at $3/month and included free on 100 WPM service.

TABLE III (cont'd)
SWITCHED INTERSTATE FACILITIES

Toll Charge - As each call is established, an initial period charge is incurred to the calling station, based on the distance of the call, as shown in the following table. Three and one-fourth minutes later, and every minute thereafter, an additional minute charge is incurred.

Interstate Miles	First 3 min.	Additional Min.	Interstate Miles	First 3 min.	Additional Min.
0-50	.35	.10	451-500	1.00	.30
51-70	.40	.10	501-575	1.05	.30
71-90	.45	.15	576-650	1.10	.35
91-115	.50	.15	651-725	1.15	.35
116-140	.55	.15	726-800	1.20	.35
141-170	.60	.20	801-900	1.25	.40
171-200	.65	.20	901-1000	1.30	.40
201-235	.70	.20	1001-1100	1.35	.40
236-270	.75	.20	1101-1200	1.40	.40
271-310	.80	.25	1201-1325	1.45	.45
311-350	.85	.25	1326-1575	1.55	.45
351-400	.90	.25	1576-2050	1.65	.50
401-450	.95	.30	2051-3000	1.75	.50

Interface - AC, two-wire to a 100 series data set (which is included in the service charge). For TWX service this is a 101 A, B, C or 105A. For TWX' it is a 103A. The 103A interface to the business machine conforms to EIA 232A.

Where a Business Machine is connected to TWX, a regenerative repeater is required at $10/month additional. This item is available now for 60 WPM and will be available 1Q65 for 100 WPM.

Where a telegraph terminal is connected to TWX, a feature is available to permit it to alternately be a TWX! station. This costs $2/month additional, and is actually a different data set.

The calling sequence requires special control sequences and a telephone company box is required to perform the job. This can be a standard dial box (on data set) for manual use, or an Auto Call Unit which receives specially coded digits for dialing from the business machine over a separate interface from the one used for data interchange after connection. The 801A Auto Call Unit costs approximately $30/month.

Notes on Usage - When a machine on a 100 WPM access line is conversing with a machine on a 60 WPM access, a code and speed converter is automatically included in the connection. When transmitting from the 100 WPM machine at 6 characters per second or faster, a "restrain" signal is returned to slow transmission because only a small buffer is available at the converter.

Apparently this system will be used with large Business Machines requiring telegraph or small machine remote inquiry or backup, or with all small machines for direct delivery of messages.

0-2000 bps (Telephone System) (ATT Tariffs 132 and 248)

Description - This is an automatic dial subscriber-to-subscriber service providing voice grade connections between two telephone devices. Voice or data may be used within the capabilities of the facility. In general, this system will pass frequencies between 300 and 3000 cycles/sec. In practice, data transmission is limited to a maximum of 2000 bits/sec (tariff restriction). Carrier supplied data sets are required for data use. Data transmission may be FDX at speeds up to 200 bps, HDX from 200 to 2000 bps.

Two billing methods are available. One charges a toll charge for each call, the other permits flat rate calling to a specified portion of the country for either an hourly or monthly fee (WATS).

Rates - Consist of Service Charge, Optional Equipment, and Usage Charges.

Service Charge - Each access (number) on the telephone system incurs a flat monthly charge based on the type of service and location. For data use, a business service would be necessary and a telephone would be supplied. In Poughkeepsie a business telephone costs around $8/month. If Wide Area Telephone Service is desired (see below), the WATS charge includes any local service charge.

TABLE III (cont'd)
SWITCHED INTERSTATE FACILITIES

Optional Equipment - The following additional equipment is available:

Card dialer	$ 3.50
"Rapidial" 290 number repertory dialer (manual search and initiate)	12.50

Touch tone calling, where available, costs about $1.50 extra per month.

Usage Charges -

1.) Toll Basis - On this basis, any telephone anywhere may be called. As each call is established, an initial period charge is incurred to the calling station, based on the distance of the call, as shown in the following chart. Three and one-fourth minutes later, and every minute thereafter, an additional minute charge is incurred. Local calls may be free. Some cities have large metropolitan areas for toll-free business calls, some during limited hours.

This chart is for interstate calls placed on Monday thru Saturday from 4:30 AM thru 6:00 PM local time.

Interstate Miles	Station-to-Station First 3 min.	Station-to-Station Additional Min.	Interstate Miles	Station-to-Station First 3 min.	Station-to-Station Additional Min.
24-30	.30	.10	355-392	1.10	.30
31-40	.35	.10	393-430	1.15	.30
41-55	.40	.10	431-468	1.20	.30
56-70	.45	.15	469-506	1.25	.30
71-85	.50	.15	507-544	1.30	.35
86-100	.55	.15	545-600	1.35	.35
101-124	.60	.15	601-675	1.40	.35
125-148	.65	.20	676-800	1.45	.40
149-172	.70	.20	801-925	1.50	.40
173-196	.75	.20	926-1050	1.55	.40
197-220	.80	.20	1051-1175	1.60	.40
221-244	.85	.25	1176-1360	1.70	.45
245-268	.90	.25	1361-1605	1.80	.45
269-292	.95	.25	1606-1910	1.95	.50
293-316	1.00	.25	1911-2300	2.10	.55
317-354	1.05	.30	2301-3000	2.25	.60

Significantly lower rates are in effect during the rest of the time: Evening rates - 6 PM to 9 PM and all day Sunday; Night rates - 9 PM to 4:30 AM every night. These are shown in the tariff abstract.

2.) WATS Basis - On this basis, any telephone within the zone specified may be called without incurring toll charges. For interstate WATS, there are six zones which can be specified. All of them exclude the the telephone in the state where the WATS line is desired. The customer specifies a certain zone and obtains flat rate calling to all telephones in that zone and lower numbered zones. All calls must be originated by the particular access line that has the WATS service to come under the flat rate. Calls to telephones not in the covered zones are billed on a toll basis. Zone definitions are on the first chart following this page. Service charges can be for measured hours actual use or flat for a full month, and are shown on the second chart following this page.

For intrastate WATS, each entire state (a few are divided) is accessible from a particular telephone in that state. This access is used the same as an interstate access (above). Service charges are shown on the third chart following this page. If both intra- and interstate WATS are desired, they must be separate access lines.

Interface - AC, two-wire to a data set provided by the carrier required for data use. The multiwire interface to a business machine conforms to E1A232A. Data sets available are as follows: (For more detail, see Section III D of this guide or the Data Communications Handbook, section 70.)

103A	0-200 bps, creates FDX operation	$25
202C	0-1200 bps	$40
201A	2000 bps	$72

The calling sequence requires special control sequences and a telephone company box is required to perform the job. This can be a standard dial box (on data set) for manual use, or an Auto Call Unit which receives specially coded digits for dialing from the business machine over a separate interface from the one used for data interchange after connection. The 801A Auto Call Unit costs approximately $30/month.

ZONE DEFINITIONS
INTERSTATE WIDE AREA TELEPHONE SERVICE (WATS)

Read down the From Column to the origination state or portion. Then read across to determine the zone assignment of each state or portion to be called.

CHART OF WATS ZONES

NOTE: Charts must first be read down for the location originating the call, and then across for the location being called.

FROM: / TO:	ALABAMA	ARIZONA	ARKANSAS	CALIFORNIA - NO.	CALIFORNIA - SO.	COLORADO	CONNECTICUT	DELAWARE	DIST. OF COLUMBIA	FLORIDA	GEORGIA	IDAHO	ILLINOIS - NO.	ILLINOIS - SO.	INDIANA	IOWA	KANSAS	KENTUCKY	LOUISIANA	MAINE	MARYLAND	MASSACHUSETTS	MICHIGAN - NO.	MICHIGAN - SO.	MINNESOTA	MISSISSIPPI	MISSOURI	MONTANA	NEBRASKA	NEVADA	NEW HAMPSHIRE	NEW JERSEY	NEW MEXICO	NEW YORK - N. E.	NEW YORK - S. E.	NEW YORK - W	NORTH CAROLINA	NORTH DAKOTA	OHIO - NO.	OHIO - SO.	OKLAHOMA	OREGON	PENNSYLVANIA - E.	PENNSYLVANIA - W.	RHODE ISLAND	SOUTH CAROLINA	SOUTH DAKOTA	TENNESSEE	TEXAS - E	TEXAS - S	TEXAS - W	UTAH	VERMONT	VIRGINIA	WASHINGTON	WEST VIRGINIA	WISCONSIN	WYOMING
ALABAMA		5	2	6	6	5	5	4	3	1	1	6	3	2	2	3	4	1	1	1	3	5	4	4	5	1	2	6	5	6	5	4	5	4	4	4	2	5	3	2	3	6	4	4	5	1	5	1	3	3	3	6	5	3	6	3	4	5
ARIZONA	4		4	2	1	1	6	6	6	5	5	3	4	4	5	4	3	5	4	6	6	6	5	5	4	4	4	3	3	1	6	6	1	6	6	6	5	4	5	5	3	3	6	6	6	6	5	3	3	3	3	2	1	6	5	3	5	4	2
ARKANSAS	2	5		6	6	4	5	5	4	3	3	6	2	2	3	3	2	2	1	6	5	6	4	4	4	1	1	5	3	6	6	5	4	5	5	5	4	4	5	5	3	1	6	4	4	6	3	4	1	1	3	3	5	6	4	6	3	3	5
CALIFORNIA - NO.	5	2	4			2	6	6	6	5	5	5	4	4	4	3	3	5	4	6	6	6	4	4	4	4	4	2	3	1	6	6	3	6	6	6	5	3	5	5	5	3	1	6	6	6	6	5	3	3	3	1	6	5	1	5	4	2
CALIFORNIA - SO.	5	1	4			2	6	6	6	5	5	5	4	4	4	3	3	5	4	6	6	6	4	4	4	4	4	3	3	1	6	6	1	6	6	6	5	3	5	5	5	3	1	6	6	6	6	5	3	3	2	1	6	5	2	5	4	2
COLORADO	5	1	3	4	4		6	6	6	6	5	5	3	4	4	4	3	1	5	4	6	6	6	5	5	3	4	4	3	2	1	3	6	6	1	6	6	6	5	3	5	5	5	1	4	6	6	6	5	2	5	3	4	2	1	6	5	4	1
CONNECTICUT	4	6	4	4	6	6	5		2	2	4	3	6	3	3	3	4	4	3	4	2	2	1	3	3	4	4	4	5	4	6	1	1	5	1	1	2	3	5	5	3	3	5	6	2	2	1	3	5	5	3	3	6	2	2	6	3	4	5
DELAWARE	4	6	4	4	6	6	5	2		1	1	4	3	3	3	4	4	4	3	4	3	1	2	3	3	4	4	4	5	5	6	3	1	1	5	2	1	1	2	2	3	5	5	3	3	4	6	1	2	2	3	5	5	5	6	3	2	2	4	5
DIST. OF COLUMBIA	4	6	4	4	6	6	5	2	1		1	4	3	3	3	4	4	4	3	4	3	1	1	3	3	3	4	4	5	5	6	3	1	1	5	2	1	1	2	3	5	5	3	3	4	6	1	1	3	3	5	5	5	6	3	2	1	4	5
FLORIDA	1	5	2	6	6	5	4	2	2			1	6	3	3	2	4	5	2	1	5	2	4	4	4	5	1	3	6	5	6	5	3	5	4	4	4	1	5	3	2	3	6	3	3	4	1	5	1	1	4	4	6	5	2	6	2	5	5
GEORGIA	1	6	2	6	6	5	4	3	3	1		6	3	2	2	4	5	1	2	5	3	4	3	3	5	1	3	6	5	6	5	3	5	4	4	4	1	5	3	2	3	6	3	3	4	1	5	1	4	4	4	5	5	2	6	2	4	5
IDAHO	5	3	4	2	3	2	6	6	6	6	6	5	4	4	5	3	3	5	5	6	6	6	4	4	3	5	4	1	3	1	6	6	3	6	6	6	6	3	5	5	3	1	5	5	6	6	3	5	4	4	4	1	6	5	1	5	4	1
ILLINOIS - NO.	3	6	3	6	6	5	5	4	4	4	5	3	6			1	1	3	3	2	4	5	4	5	2	1	2	3	2	5	3	6	5	4	5	4	4	4	4	3	4	2	2	3	6	3	3	5	4	4	2	5	5	5	6	5	3	6	3	1	5
ILLINOIS - SO.	3	6	2	6	6	5	5	4	4	4	5	3	6			1	1	3	3	1	4	5	4	5	3	2	3	2	1	5	3	6	5	4	5	4	4	4	4	3	4	1	3	3	5	4	4	4	1	3	3	5	5	6	5	3	6	3	2	5	5
INDIANA	3	6	3	6	6	5	4	3	3	3	5	3	6	1	1		3	4	1	4	5	3	4	3	3	1	4	3	2	5	4	6	5	4	5	4	4	4	4	3	5	1	1	4	6	3	2	4	3	4	2	5	5	5	6	4	3	6	2	2	5
IOWA	3	6	3	6	6	5	5	5	5	4	5	5	1	1	2		2	3	4	6	5	6	2	2	1	3	3	1	4	1	6	5	5	5	5	5	3	4	2	1	3	6	4	4	6	5	5	1	3	4	4	5	5	5	6	4	3	6	3	1	3
KANSAS	4	4	2	5	5	1	6	6	6	5	5	4	4	3	3	3	1		4	3	6	6	6	4	4	4	3	3	1	4	1	5	6	6	2	6	6	6	5	3	3	4	4	2	3	2	4	6	5	5	5	6	5	2	3	2	3	2	4	6	5
KENTUCKY	2	6	3	6	6	5	4	3	3	4	4	2	6	2	1	1	3	4		3	5	3	4	3	3	3	4	3	1	5	4	6	6	6	2	6	6	6	5	3	3	5	2	1	4	6	3	3	4	2	5	1	5	5	5	6	4	1	6	1	3	5
LOUISIANA	1	5	1	6	6	4	5	5	4	3	3	2	6	3	2	3	3	3	2		6	4	5	4	4	4	1	2	6	3	6	6	5	4	5	5	5	3	5	3	3	1	6	4	4	5	3	5	6	4	4	1	1	2	5	6	4	6	3	4	5
MAINE	4	6	4	6	6	5	1	2	2	4	4	6	3	3	3	4	5	3	5		2	1	3	3	4	4	5	4	6	1	2	5	1	1	2	3	5	6	3	4	2	3	5	6	2	1	3	4	4	5	5	5	6	1	3	6	3	3	5
MARYLAND	4	6	4	6	6	5	2	1	1	4	3	6	3	3	3	4	4	4	3	4	3		3	3	3	3	4	4	5	5	6	3	1	5	2	2	2	3	1	1	2	3	5	3	3	4	6	1	1	2	3	5	3	3	5	5	5	6	3	1	4	5
MASSACHUSETTS	4	6	4	6	6	5	1	2	2	4	4	6	3	3	3	4	4	3	5	2	1	3	3		4	4	5	4	6	1	1	5	1	1	2	3	5	6	3	4	2	3	5	6	2	2	1	3	4	4	5	5	6	1	2	4	5	5	5
MICHIGAN - NO.	4	6	4	6	6	5	3	3	3	3	5	4	6	1	2	2	1	4	3	5	4	3	3		1	4	2	5	4	6	3	3	5	3	4	2	2	4	6	3	2	3	4	4	3	5	5	5	6	3	3	6	3	1	5	5	5
MICHIGAN - SO.	4	6	4	6	6	5	3	3	3	3	5	4	6	1	2	2	1	4	3	5	4	3	3		3	4	3	5	4	6	3	3	5	3	3	2	4	4	1	1	4	6	2	2	4	4	4	3	5	5	5	6	3	3	6	2	1	5
MINNESOTA	4	6	3	6	6	3	5	5	4	4	6	5	4	2	2	3	1	2	3	5	6	5	5	5	1	2		4	2	3	1	6	5	5	4	4	4	4	5	1	3	3	6	4	4	6	5	1	3	5	5	5	4	5	4	6	3	1	3
MISSISSIPPI	1	5	1	6	6	5	5	4	4	2	1	6	3	2	3	3	3	2	1	6	4	5	4	4	4		2	6	4	6	5	4	4	5	5	5	3	3	2	6	4	4	5	2	5	1	1	3	3	6	5	3	6	3	4	5	5
MISSOURI	3	6	1	6	6	4	5	5	4	4	5	4	6	1	1	2	1	1	1	3	6	4	5	5	3	3	3		2	5	1	6	5	4	5	5	5	4	4	3	3	1	6	4	4	6	4	3	1	3	3	3	5	5	4	6	4	2	5
MONTANA	5	3	4	3	3	2	6	6	6	6	6	6	1	4	4	5	3	3	5	6	6	6	6	4	4	2	5	4		2	6	6	3	6	6	6	6	1	5	5	4	2	6	6	3	6	1	5	5	6	1	1	4	4	4	1	6	6	1	5	3	1
NEBRASKA	4	4	3	5	5	1	6	6	6	6	6	5	4	3	3	3	1	1	4	4	6	6	6	4	4	4	1	3		2	4	1	3	6	6	6	6	2	4	4	2	5	5	5	6	6	1	4	3	3	3	3	6	5	5	4	2	1	1
NEVADA	5	1	4	1	1	3	6	6	6	6	6	5	5	4	4	4	3	3	5	4	4	4	3	3	3	2	4	4	2		6	6	3	6	6	6	6	3	5	5	3	1	5	5	6	5	3	5	5	5	5	3	3	3	1	6	5	2	5	4	2
NEW HAMPSHIRE	4	6	4	6	6	5	1	2	2	4	4	6	3	3	3	4	5	3	4	1	2	1	3	3	4	4	5	5	6	4	2	5	1	1	2	3	4	3	3	5	3	4	6	2	2	1	3	4	4	5	5	5	6	1	2	6	3	3	5
NEW JERSEY	4	6	4	6	6	5	1	1	1	4	3	6	3	3	3	4	4	3	4	3	1	2	3	3	4	4	5	5	6	2		5	2	1	2	2	3	5	3	3	4	6	1	2	2	3	5	3	5	5	5	6	2	2	6	2	4	5	5
NEW MEXICO	4	1	3	3	3	1	6	6	6	6	5	5	3	4	4	5	3	2	5	3	6	6	6	5	5	4	4	3	4	2	6	6		6	6	6	5	4	5	5	5	1	4	4	3	4	6	6	6	5	3	5	5	4	2	2	1	1	6	5	5	4	2
NEW YORK - N. E.	4	6	4	6	6	5	1	2	2	4	4	6	3	3	3	4	4	3	4	2	2	1	3	3	4	4	5	5	6	1	1	5		1	1	1	3	3	5	2	2	5	6	1	1	1	3	4	3	5	5	5	6	1	2	6	2	3	5	5
NEW YORK - S. E.	4	6	4	6	6	5	1	1	2	4	4	6	3	3	3	4	4	3	4	2	2	1	3	3	4	4	5	4	6	1	1	5	1		1	2	5	6	3	5	2	2	5	6	1	2	1	3	4	3	5	5	5	6	1	2	6	2	3	5	5
NEW YORK - W	4	6	4	6	6	5	2	2	1	4	3	6	3	3	3	4	4	3	4	3	2	2	3	2	4	4	4	5	4	6	3	1	5	1		5	2	1	2	5	6	1	1	3	3	4	3	5	1	2	5	6	1	1	3	3	4	3	5		5	6	2	3	6	2	3	5
NORTH CAROLINA	3	6	4	6	6	5	3	1	1	3	1	6	3	3	3	4	4	2	4	4	1	3	4	4	4	3	4	4	5	5	6	4	2	5	3	3	3		5	2	1	4	6	2	2	3	1	5	1	5	5	5	6	4	1	6	1	4	5	5
OHIO - NO.	4	6	4	6	6	5	3	3	2	4	3	6	2	2	1	4	4	1	4	4	2	4	3	1	4	4	3	5	5	6	4	3	5	3	3	1	3	5		4	6	2	1	4	3	5	3	5	5	5	6	4	2	6	1	3	5	5
NORTH DAKOTA	5	4	3	5	5	2	6	6	6	6	6	3	2	3	3	2	2	4	5	6	6	6	2	3	1	5	3	1	1	4	6	6	3	6	6	6	4	4		6	4	4	3	4	4	4	4	4	5	5	6	6	1	4	4	3	6	6
OHIO - SO.	4	6	4	6	6	5	3	3	2	4	3	6	2	2	1	4	4	1	4	4	2	4	3	1	4	4	3	5	5	6	4	3	5	3	3	2	2	5	4		6	2	1	4	3	5	2	5	5	5	6	4	1	6	1	3	5	5
OKLAHOMA	3	4	1	5	5	1	6	5	5	5	4	5	3	3	3	3	1	3	2	6	5	6	3	4	3	3	1	5	2	5	6	6	1	6	6	6	5	4	4	4		6	5	5	6	4	3	3	1	2	1	4	6	4	3	4	4
OREGON	5	3	4	1	2	3	6	6	6	6	6	5	1	4	4	5	3	3	5	5	6	6	6	4	4	3	5	4	2	3	1	6	6	3	6	6	6	6	3	5	5		5	5	6	6	3	5	5	5	3		4	4	4	1	6	5	1	5	4	2
PENNSYLVANIA - E	4	6	4	6	6	5	2	1	2	4	3	6	3	3	3	4	4	3	4	3	1	2	3	3	4	4	4	5	5	6	2	1	5	1	1	2	3	5	5	2	3	4	6		2	3	5	5	3	5	5	5	6	2	2	6	2	4	5	5
PENNSYLVANIA - W	4	6	4	6	6	5	2	1	1	4	3	6	3	3	3	4	4	3	4	3	1	2	3	3	4	4	4	5	5	6	2	1	5	1	1	2	3	5	5	2	3	4	6		3	3	5	5	3	5	5	5	6	3	1	6	1	4	5	5
RHODE ISLAND	4	6	4	6	6	5	1	2	2	4	3	6	3	3	3	4	4	3	4	2	2	1	3	3	4	4	4	5	5	6	2	1	5	1	1	2	3	5	5	2	3	4	6	3		3	5	5	3	5	5	5	6	3	2	6	3	4	5	5
SOUTH CAROLINA	1	6	3	6	6	5	4	2	2	2	1	6	3	3	3	4	4	4	3	4	2	4	4	4	5	3	4	6	5	6	4	3	5	3	3	3	5	1	5	2	2	4	6	2	2		3	5	3	5	5	5	6	1	4	5	5	5	5
SOUTH DAKOTA	5	4	3	5	5	2	6	6	6	6	6	5	3	3	3	1	2	4	1	5	6	6	6	3	3	1	4	2	1	1	4	6	6	3	6	6	6	6	1	4	4	3	4	6	5	5	6	6		4	4	4	3	6	5	4	5	2	1
TENNESSEE	1	6	1	6	6	5	5	4	3	3	1	6	2	2	2	3	4	1	3	5	3	5	3	3	5	1	1	1	6	5	5	6	5	4	5	4	4	4	1	5	5	2	2	4	6	3	3	5	2	5		4	4	4	5	5	1	6	2	3	5
TEXAS - E	2	3	1	5	5	3	6	6	5	4	3	5	3	2	3	3	1	3	1	6	6	6	4	4	4	1	1	5	2	4	6	6	2	6	6	6	4	4	4	4	4	1	6	5	5	6	4	4	3	2				3	6	5	6	4	4	3
TEXAS - S	2	2	1	5	5	2	6	6	5	4	3	5	3	3	3	3	1	3	1	6	6	6	4	4	4	1	4	1	2	5	3	4	6	6	1	6	6	6	4	4	4	1	6	5	5	6	4	4	3	3				3	6	5	6	4	4	3
TEXAS - W	3	2	1	5	5	1	6	6	5	4	3	5	3	3	3	3	1	3	2	6	6	6	4	4	4	1	4	2	2	5	2	4	6	6	1	6	6	6	4	4	4	1	6	5	5	6	4	4	3	3				3	6	5	6	4	4	3
UTAH	5	1	4		2	2	1	6	6	6	6	5	1	4	4	4	4	3	5	6	6	6	5	5	4	4	4	3	3	1	6	6	1	6	6	6	6	3	5	5	5	3	5	5	6	5	3	5	5	5	3	3	3		6	5	3	5	4	1
VERMONT	4	6	4	6	6	5	1	2	2	4	4	6	3	3	3	4	5	3	4	4	1	2	1	3	3	4	4	5	4	6	1	2	5	1	1	2	3	4	2	3	5	6	2	2	1	3	4	4	5	5	5	6		3	6	3	3	5
VIRGINIA	3	6	4	6	6	5	3	1	1	4	3	6	3	3	3	4	4	1	3	3	3	3	4	4	5	5	6	4	4	5	5	6	3	2	5	3	3	2	1	5	2	1	4	6	2	1	3	2	5	1	5	5	6	3		6	1	4	5
WASHINGTON	5	3	4	1	2	3	6	6	6	6	6	5	1	4	4	5	3	3	5	5	6	6	6	4	4	3	5	4	1	3	2	6	6	3	6	6	6	6	6	3	5	5	3	1	5	5	6	6	3	5	5	4	4	4	2	6	6		5	4	2
WEST VIRGINIA	4	6	4	6	6	5	3	2	1	4	3	6	3	3	2	4	4	1	4	4	1	3	3	3	4	4	4	5	5	6	4	2	5	3	3	2	6	2	5	1	1	4	6	2	1	3	2	5	3	3	5	5	5	6	4	1	6		4	5
WISCONSIN	4	6	3	6	6	4	5	4	4	6	4	6	1	2	2	1	3	3	5	4	4	5	1	1	1	4	2	5	3	6	5	4	5	3	3	3	4	3	2	2	4	4	3	3	5	4	4	3	3	5	4	4	4	4	1	6	5	4		4
WYOMING	5	3	4	3	3	1	6	6	6	6	5	1	4	4	5	3	2	5	5	6	6	6	4	4	3	5	4	1	1	2	6	6	2	6	6	6	6	2	5	5	3	3	6	5	5	6	4	4	4	1	6	5	3	5	4	4		

WIDE AREA TELEPHONE SERVICE RATE SCHEDULE
INTERSTATE

	FULL TIME						MEASURED TIME											
							FIRST 15 HOURS						EACH ADDITIONAL HOUR					
	A1	A2	A3	A4	A5	A6	A1	A2	A3	A4	A5	A6	A1	A2	A3	A4	A5	A6
ALABAMA	$ 800	$1,100	$1,300	$1,500	$1,700	$2,100	$300	$370	$400	$430	$460	$550	$17.00	$21.00	$23.00	$25.00	$27.00	$31.00
ARIZONA	1,000	1,300	1,500	1,800	2,000	2,200	350	400	430	490	530	570	20.00	23.00	25.00	28.00	30.00	32.00
ARKANSAS	800	1,100	1,300	1,500	1,700	1,900	300	370	400	430	460	510	17.00	21.00	23.00	25.00	27.00	29.00
CALIFORNIA - NO.	1,100	1,400	1,800	2,000	2,200	2,275	370	415	490	530	570	600	21.00	24.00	28.00	30.00	32.00	33.50
CALIFORNIA - SO.	1,200	1,500	1,800	2,000	2,200	2,275	385	430	490	530	570	600	22.00	25.00	28.00	30.00	32.00	33.50
COLORADO	1,100	1,200	1,300	1,500	1,800	1,950	370	385	400	430	490	520	21.00	22.00	23.00	25.00	28.00	29.50
CONNECTICUT	$ 500	$ 800	$1,400	$1,750	$2,000	$2,300	$200	$300	$415	$475	$530	$610	$11.00	$17.00	$24.00	$27.50	$30.00	$34.00
DELAWARE	500	800	1,200	1,600	1,900	2,275	200	300	385	445	510	600	11.00	17.00	22.00	26.00	29.00	33.50
DISTRICT OF COLUMBIA	500	800	1,100	1,500	1,850	2,250	200	300	370	430	500	590	11.00	17.00	21.00	25.00	28.50	33.00
FLORIDA	1,100	1,400	1,500	1,700	1,850	2,250	370	415	430	460	500	590	21.00	24.00	25.00	27.00	28.50	33.00
GEORGIA	800	1,100	1,300	1,500	1,750	2,200	300	370	400	430	475	570	17.00	21.00	23.00	25.00	27.50	32.00
IDAHO	900	1,200	1,500	1,850	2,050	2,200	330	385	430	500	540	570	18.50	22.00	25.00	28.50	30.50	32.00
ILLINOIS - NO.	$ 700	$ 900	$1,200	$1,400	$1,500	$1,950	$270	$330	$385	$415	$430	$520	$15.00	$18.50	$22.00	$24.00	$25.00	$29.50
ILLINOIS - SO.	700	1,000	1,200	1,400	1,500	1,950	270	350	385	415	430	520	15.00	20.00	22.00	24.00	25.00	29.50
INDIANA	700	900	1,100	1,300	1,600	2,050	270	330	370	400	445	540	15.00	18.50	21.00	23.00	26.00	30.50
IOWA	800	1,100	1,200	1,500	1,600	1,850	300	370	385	430	445	500	17.00	21.00	22.00	25.00	26.00	28.50
KANSAS	900	1,100	1,200	1,500	1,750	1,800	330	370	385	430	475	490	18.50	21.00	22.00	25.00	27.50	28.00
KENTUCKY	700	900	1,100	1,300	1,600	2,100	270	330	370	400	445	550	15.00	18.50	21.00	23.00	26.00	31.00
LOUISIANA	$ 900	$1,200	$1,400	$1,600	$1,800	$2,000	$330	$385	$415	$445	$490	$530	$18.50	$22.00	$24.00	$26.00	$28.00	$30.00
MAINE	900	1,200	1,600	1,800	2,050	2,325	330	385	445	490	540	620	18.50	22.00	26.00	28.00	30.50	34.50
MARYLAND	500	800	1,200	1,600	1,900	2.250	200	300	385	445	510	590	11.00	17.00	22.00	26.00	29.00	33.00
MASSACHUSETTS	500	900	1,400	1,750	2,000	2,300	200	330	415	475	530	610	11.00	18.50	24.00	27.50	30.00	34.00
MICHIGAN - NO.	900	1,200	1,300	1,400	1,750	2,050	330	385	400	415	475	540	18.50	22.00	23.00	24.00	27.50	30.50
MICHIGAN - SO.	800	1,100	1,200	1,400	1,750	2,050	300	370	385	415	475	540	17.00	21.00	22.00	24.00	27.50	30.50
MINNESOTA	$ 800	$1,100	$1,400	$1,600	$1,700	$1,850	$300	$370	$415	$445	$460	$500	$17.00	$21.00	$24.00	$26.00	$27.00	$28.50
MISSISSIPPI	900	1,100	1,300	1,500	1,700	2,050	330	370	400	430	460	540	18.50	21.00	23.00	25.00	27.00	30.50
MISSOURI	900	1,000	1,200	1,400	1,600	1,900	330	350	385	415	445	510	18.50	20.00	22.00	24.00	26.00	29.00
MONTANA	1,100	1,300	1,500	1,750	1,750	2,050	370	400	430	475	510	540	21.00	23.00	25.00	27.50	29.00	30.50
NEBRASKA	900	1,100	1,300	1,500	1,700	1,800	330	370	400	430	475	490	18.50	21.00	23.00	25.00	27.50	28.00
NEVADA	800	1,200	1,600	1,900	2,100	2,225	300	385	445	510	550	580	17.00	22.00	26.00	29.00	31.00	32.50
NEW HAMPSHIRE	$ 600	$1,000	$1,400	$1,750	$2,000	$2,300	$240	$350	$415	$475	$530	$610	$13.00	$20.00	$24.00	$27.50	$30.00	$34.00
NEW JERSEY	500	700	1,300	1,700	1,950	2,275	200	270	400	460	520	600	11.00	15.00	23.00	27.00	29.50	33.50
NEW MEXICO	1,000	1,200	1,400	1,700	1,850	2,050	350	385	415	460	500	540	20.00	22.00	24.00	27.00	28.50	30.50
NEW YORK - N.E.	700	1,100	1,300	1,700	1,900	2,250	270	370	400	460	510	590	15.00	21.00	23.00	27.00	29.00	33.00
NEW YORK - S.E.	500	1,000	1,300	1,700	1,900	2,250	200	350	400	460	510	590	11.00	20.00	23.00	27.00	29.00	33.00
NEW YORK - WEST	700	900	1,300	1,700	1,900	2,250	270	330	400	460	510	590	15.00	18.50	23.00	27.00	29.00	33.00
NORTH CAROLINA	$ 800	$1,000	$1,200	$1,500	$1,800	$2,225	$300	$350	$385	$430	$490	$580	$17.00	$20.00	$22.00	$25.00	$28.00	$32.50
NORTH DAKOTA	900	1,300	1,500	1,700	1,750	1,850	330	400	430	460	475	500	18.50	23.00	25.00	27.00	27.50	28.50
OHIO - NO.	700	900	1,100	1,300	1,750	2,150	270	330	370	400	475	560	15.00	18.50	21.00	23.00	27.50	31.50
OHIO - SO.	700	900	1,100	1,300	1,750	2,150	270	330	370	400	475	560	15.00	18.50	21.00	23.00	27.50	31.50
OKLAHOMA	900	1,100	1,300	1,500	1,750	1,850	330	370	400	430	475	500	18.50	21.00	23.00	25.00	27.50	28.50
OREGON	900	1,300	1,750	1,950	2,200	2,275	330	400	475	520	570	600	18.50	23.00	27.50	29.50	32.00	33.50
PENNSYLVANIA - E.	$ 500	$ 800	$1,200	$1,500	$1,850	$2,225	$200	$300	$385	$430	$500	$580	$11.00	$17.00	$22.00	$25.00	$28.50	$32.50
PENNSYLVANIA - W.	700	800	1,200	1,500	1,850	2,225	270	300	385	430	500	580	15.00	17.00	22.00	25.00	28.50	32.50
RHODE ISLAND	500	900	1,400	1,750	2,000	2,300	200	330	415	475	530	610	11.00	18.50	24.00	27.50	30.00	34.00
SOUTH CAROLINA	800	1,100	1,300	1,500	1,750	2,225	300	370	400	430	475	580	17.00	21.00	23.00	25.00	27.50	32.50
SOUTH DAKOTA	900	1,200	1,300	1,600	1,750	1,850	330	385	400	445	475	500	18.50	22.00	23.00	26.00	27.50	28.50
TENNESSEE	900	1,000	1,200	1,400	1,600	2,100	330	350	385	415	445	550	18.50	20.00	22.00	24.00	26.00	31.00
TEXAS - E.	$1,000	$1,300	$1,500	$1,700	$1,800	$1,950	$350	$400	$430	$460	$490	$520	$20.00	$23.00	$25.00	$27.00	$28.00	$29.50
TEXAS - S.	1,200	1,400	1,500	1,700	1,800	1,950	385	415	430	460	490	520	22.00	24.00	25.00	27.00	28.00	29.50
TEXAS - W.	1,100	1,300	1,500	1,700	1,800	1,950	370	400	430	460	490	520	21.00	23.00	25.00	27.00	28.00	29.50
UTAH	1,000	1,100	1,400	1,750	1,950	2,150	350	370	415	475	520	560	20.00	21.00	24.00	27.50	29.50	31.50
VERMONT	600	1,000	1,400	1,750	1,950	2,300	240	350	415	475	520	610	13.00	20.00	24.00	27.50	29.50	34.00
VIRGINIA	700	800	1,100	1,500	1,800	2,225	270	300	370	430	490	580	15.00	17.00	21.00	25.00	28.00	32.50
WASHINGTON	$1,200	$1,500	$1,800	$2,000	$2,150	$2,250	$385	$430	$490	$530	$560	$590	$22.00	$25.00	$28.00	$30.00	$31.50	$33.00
WEST VIRGINIA	600	800	1,100	1,400	1,800	2,200	240	300	370	415	490	570	13.00	17.00	21.00	24.00	28.00	32.00
WISCONSIN	700	1,100	1,300	1,600	1,600	1,950	270	370	400	430	445	520	15.00	21.00	23.00	25.00	26.00	29.50
WYOMING	900	1,200	1,400	1,600	1,850	2,000	330	385	415	445	500	530	18.50	22.00	24.00	26.00	28.50	30.00

INTERSTATE WIDE AREA TELEPHONE SERVICE (WATS) MONTHLY RATE SCHEDULES

A1, A2, etc., identify the rate for Zone 1, Zone 2, etc., coverage from the origination state or portion shown at the left.

WIDE AREA TELEPHONE SERVICE RATE SCHEDULE
INTRASTATE

STATE	INTRASTATE WATS RATES FULL	MEAS. 15 HRS.	ADD'L HR.
ALABAMA	$500	$250	$15.00
ARIZONA	625	240	14.00
ARKANSAS	530	245	13.00
CALIFORNIA			
COLORADO	625	240	14.00
CONNECTICUT	260	125	5.50
DELAWARE	225	90	4.00
FLORIDA	600	300	17.00
GEORGIA	500	250	15.00
IDAHO	625	240	14.00
ILLINOIS	600	225	12.00
INDIANA	550	220	12.00
IOWA	520	215	12.00
KANSAS	610	280	16.00
KENTUCKY	500	250	15.00
LOUISIANA	500	250	15.00
MAINE	390	135	8.00
MARYLAND	375	140	8.00
MASSACHUSETTS	330	120	7.00
MICHIGAN	700	225	14.00
HOME NPA	300	100	6.00
HOME & CONTIGUOUS	600	200	12.00
MINNESOTA	590	280	15.00
MISSISSIPPI	500	250	15.00
MISSOURI	645	290	17.00
MONTANA	695	270	16.00
NEBRASKA	$550	$245	$13.50
NEVADA			
NEW HAMPSHIRE	250	85	5.00
NEW JERSEY	325	NOT OFFERED	NOT OFFERED
NEW MEXICO	625	240	14.00
NEW YORK	650	240	13.50
NORTH CAROLINA	500	250	15.00
NORTH DAKOTA	590	280	15.00
OHIO	500	170	11.00
OKLAHOMA	545	245	14.00
OREGON	575	230	13.00
PENNSYLVANIA	500	200	11.00
EAST	375	150	6.00
WEST	375	150	6.00
RHODE ISLAND			
SOUTH CAROLINA	500	250	15.00
SOUTH DAKOTA	610	290	16.00
TENNESSEE	500	250	15.00
TEXAS	815	330	20.00
UTAH	500	175	9.00
VERMONT	380	140	8.00
VIRGINIA	575	225	14.00
WASHINGTON	575	230	13.00
WEST VIRGINIA	500	200	11.50
WISCONSIN	600	225	13.00
WYOMING	650	240	14.00

TABLE III (cont'd)
SWITCHED INTERSTATE FACILITIES

Notes on Usage - A Foreign Exchange line is a telephone served by a particular exchange, but physically located beyond that exchanges service area. Usually the extra cost for this line is equivalent to a Schedule 4 line between the location and the exchange. All tolls are figured from the exchange. Sometimes this is economically advantageous. A WATS line cannot be arranged this way.

Most private telephone systems fully interconnect with the telephone system. Arrangements are available which permit a call to be routed over the private system as far as possible, then over the public system for the remainder. Data calls over such connections may not be high quality.

For data use of WATS, it is often desirable to share the use of a WATS line between data and normal voice. It is possible to specify that the WATS line be terminated on a switchboard or in an internal telephone exchange. Then any telephone served by that exchange (including internal trunks if the system permits) can access the WATS line by special code. The business machine would access from an internal telephone in the same manner. Such "second level" connections are permitted but data transmission quality may be affected. To avoid possible incoming calls on a WATS line, it can be connected to a "tandem exchange" in the telephone system.

When several lines are connected from one exchange to one Business Machine (like a 7740), the telephone company has required that calls not be started closer than every 2 seconds.

TABLE III (cont'd)
SWITCHED INTERSTATE FACILITIES

0-2400 bps (Broadband Exchange Service) (WU Tariff 246)

Description - This is a public, switched, fully automatic system similar to the public telephone system but with important differences. Basically a toll system, it is fully available in the following cities: Chicago, Detroit, Kansas City, Los Angeles, New York, San Francisco, Washington, Atlanta, Baltimore, Boston, Buffalo, Cincinnati, Cleveland, Dallas, Denver, Houston, Philadelphia, Pittsburgh, St. Louis. Additional Cities expected in 1965 are: Indianapolis, Miami, Milwaukee, Minneapolis-St. Paul, New Orleans, Oakland, Portland, Oregon, Richmond, Seattle.

Connections are made by manually touch-tone keying a seven digit number into the system. Part of this number specifies the bandwidth to be used for transmission. If 2kc or greater is specified, alternate voice for coordination is available. The data path is FDX with separate circuits maintained for each direction through all switching equipment. Circuits are equalized to reduce error-producing distortion. The maximum speed of transmission over a particular bandwidth is dictated by the data set.

Rates - Consist of Service Charge and Toll Charge.

Service Charge - Based on the maximum bandwidth desired (kc = frequency in kilocycles per second):

0.3 kc bandwidth		*
2 " "	(Schedule 1)	$15/month
4 " "	(Schedule 2)	$30/month
8 " "		*
16 " "		*
48 " "		*

*- Planned but not presently available.

Toll Charge - As each call is established, an initial period charge for one minute is incurred to the calling station as shown in the following chart. Each one-tenth of a minute after the initial period, a charge of one-tenth the amount shown below is incurred, until disconnection.

TABLE III (cont'd)
SWITCHED INTERSTATE FACILITIES

Interstate Miles	0.3 kc	2 kc (Schedule 1)	4 kc (Schedule 2)	8 kc	16 kc	48 kc
0-100	*	.15	.20	*	*	*
101-200		.20	.25			
201-300		.25	.30			
301-600		.30	.35			
601-1000		.35	.45			
1001-1600		.45	.55			
1601-2300		.55	.65			
2301 up		.65	.75			

* - planned but not presently available.

In any one month, Schedule 1 tolls over $300 and Schedule 2 tolls over $500 are discounted 40% for each originating station.

Interface - AC, four-wire to a data set provided by the carrier required for data use. The multiwire interface to a business machine conforms to E1A 232A. Data sets available are as follows (little information elsewhere):

600 bps max	(requires 2 kc band)	$27/month
1200	4	27
2400	4	42
4800	8	*
9600	16	*
38400	48	*

* - Planned but not presently available.

Automatic calling by computers is not available. Calls are placed manually then switched to data mode. WU claims that IBM Transceivers, 1009, 1013, 1050, 7701, 7702 are compatible, but the data sets have not been tested and feature codes will probably be necessary.

Notes on Usage - This is an experimental offering, priced by WU to show an economic advantage for WATS customers using around 75 hours a month measured time.

TABLE III (cont'd)
SWITCHED INTERSTATE FACILITIES

Although WU stated some time ago that different speed data sets would be incompatible, recently they have stated that schedule 1 and 2 may call each other and exchange data at up to the schedule 1 maximum. Further, schedule 2 may call schedule 2 and exchange data at up to the schedule 2 maximum.

TABLE IV
STATUS OF INTERSTATE FACILITIES

The tariffs which provide these facilities may be in various states of approval and/or revision. Nevertheless they are in effect unless otherwise stated.

Leased

Telegraph, Class D, Voice — Final-approved. Prescribed rates went into effect 10/1/64. An appeal is before US Supreme Court.

Telpak Broadband-tentative decision 3/20/64 would study for rate raise.

Telpak Groups - Preliminary decision would throw out A & B, study C & D for raising rates. Final decision may not take any action.

Switched

Telex - Apparently final-approved.

TWX - Revised tariff to become effective 2/1/65. Possible 90 day suspension. Possible future sale to W. U.

Toll Telephone - Revised evening, night, and weekend rates to become effective 2/1/65. Suspension not likely.

WATS Telephone - Recommended decision would approve subject to further study. Rumored revision effective 4/1/65.

Broadband Exchange - Experimental, no approval decision.

WADS - Not in effect. Tariff is dead.

D. Interface Equipment for Communications Channels.

These units are listed here with only a few characteristics to provide a handy reference. Where speed is a factor, the units are arranged by speed.

1. AT&T (Western Electric) Data Sets - Further information is in the Data Communications Handbook, starting on page 70.01. Detailed specifications are available in the Bell Technical Reference Manuals (see Bibliography).

101A, B, C used as part of TWX, 0-150 bps for telegraph, included in TWX charges.

103 Type - 0-200 bps use of voice lines. FM operation, FDX on HDX voice grade. (Caution-this mode forces communication on a multipoint line to be between master and slaves, not between slaves.)

- A - For telephone system and TWX!, handset is separate approximately $25.
- B - Interim for leased voice grade line, handset is separate if required, approximately $25. (Automatic Echo suppression cutoff required on channel.)
- E - May replace A
- F - Now replacing B, essentially same as B, except speed maximum is 300 bps.

106A used as part of TWX to provide alternate feature on telegraph stations.

201 Type - Phase modulation, fixed speeds, HDX on 2-wire line, FDX on 4-wire line.

- A - 2000 bps for telephone system or leased voice grade line approximately $72.
- B - 2400 bps for leased voice grade line approximately $72.
- C and D - anticipated to replace A & B.

202 Type - 150 - 1800 bps. FM, HDX on 2-wire line, FDX on 4-wire line, simultaneous low speed reverse channel, can be arranged to alternate between telephone system and leased line.

- A & B - Superseded by C & D, same except no reverse channel, approximately $40.

C - Integrated handset, 1200 bps max on telephone system, 1800 bps max on leased voice, approximately $40.
D - Separate handset (if desired), 1200 bps max on telephone, 1800 bps max on leased voice, approximately $40.

301 Type - fixed speed, phase modulation, for Telpak broadband leased facilities, FDX.

B - 40,800 bps, includes voice coordinating channel, included in Telpak A2 channel terminal ($250)
C - 18,000 bps and 6 voice channels, experimental, uses Telpak A broadband channel, price unknown.

303 Type - part of new series of "data stations" which are data sets plus controls for use on broadband channels experimental.

401 Type - Parallel multi-freq. one way data with answerback tone, 20 characters/second maximum (equivalent to 160 bps). Dial up telephone or leased voice grade.

A - Numeric Transmitter, approximately $5.
B - Discontinued Receiver.
E - Alphameric Transmitter, approximately $7.
F - Discontinued Receiver.
H - Special model for telemetry, approximately $10.
J - Replaces F, has integrated handset and 2 answerback tones, approximately $30.

402 Type - Parallel, multi-freq, one-way data with electrical answerback, up to 75 characters/second (equivalent to 600 bps).

A - Transmits to B, approximately $10.
B - Receiver from A, approximately $50.
C and D - Anticipated to replace A and B.

804A - A handset, dial, and control buttons for data sets whose bulk dictates a small desk top control box.

2. WU Data Sets - Some information is in the Data Communications Handbook, starting on page 70.51. However, very little information is available on these units.

8500 (Data Loop Transceiver) - 0-180 bps on Class D Channels, HDX on HDX facility, FDX on FDX facility, approximately $30.

1601A - 0-600 bps on voice grade facilities.

8501 (Modem 11152A) (2121A) - 0-1200 bps on voice grade facilities, approximately $40.

2241A - 0-2400 bps on voice grade facilities.

3. IBM Modems - The domestic product line does not include any separate devices similar to data sets. Several products do have similar capability or special features which perform the same function. These special features are shown below and they are shown where needed, in the configurator, Section IV. All of these features are limited to use on customer owned lines under 8 miles in length, are FM and are strictly HDX on HDX lines. They are generally titled IBM Line Adapters.

4790 on 1026, 1051, 1061	$10
4792 on 1071-1, same as 4790	$10
4793 on 1071-2, faster than 4792	$10
4789 on 1448, for one 1030 line	$50
4791 on 1448 for two 1050/1060 lines	$65
4636 on 2701, like 4790	$10
4637 on 2701, like 4793	$10
4612 on 2702, like 4790	$30
4613 on 2702, like 4793	$30

SECTION IV IBM COMMUNICATIONS CONFIGURATOR

The charts on the following pages show, for each operational mode, how to connect the various IBM Teleprocessing machines to communications lines and what machines are compatible at the other end of the line. It is believed to be correct as of the date on this page. Only announced machines and features are included. The purpose of this section is to quickly provide an estimate of complexity and area cost for communication ability on IBM machines in various modes.

In showing the features required for operation, only those features necessary to connect to at least one communication line are specified. For maximums and mixes, refer to the sales manual. Features without prices are standard or no cost.

Where the data rate is shown for serial transmission in char/sec (cps) and bits/sec (bps), the bps rate is the maximum rate that bits move on the line during one character time. When bits/sec times char/bits equals more than the cps rate shown, the particular transmitting machine is designed to pause between characters on the line.

December 10, 1964

MACHINE	DATA RATE	FEATURES	LINE CODE	DATA MODE	MOD/DEMOD REQUIRED	FACILITY	TO
65, 66 with 67 $175, $195	3 full card/ min (45.45) bps	#9711-labelled 60	Serial 4 of 8 (XONR7421) within 10.5 units per character	HDX	None	Leased 60 WPM Telegraph HDX	(An additional speed selector costs $24 on MES). To 65, 66 respectively, similarly equipped, 7740, 7750.
	4 full card/ min (56.8) bps	#9712-labelled 75		HDX	None	Leased 75 WPM telegraph HDX	
	5 full card/ min (74.2) bps	#9713-labelled 100		HDX	None	Leased 100 WPM Telegraph HDX	
65, 66 with 68 $175, $195	11, 10 full card/min (180 bps)	one of #9721-9724	Serial 4 of 8 (XONR7421) within 10.0 units per character	HDX-PT to pt. transmission. Up to 4Pr on one line.	Included in machine	Leased Voice grade HDX (telephone Co. only)	(Additional channel selector costs $80 on MEX.) To 65, 66 similarly equipped. Or 65 to 66 with #7385 speed compatibility feature on 68 attached to 65.
		one of #9725-#9728				Leased Voice grade FDX (Telephone Co. only)	
		One of #9721-#9724 plus #3260 ($20)		HDX-PT to PT-one pair	ATT103A	Telephone System	To 65, 66 similarly equipped, or to 7740. 7750.
					ATT103F or WU1601A	Leased Voice grade HDX	
	10, 9 full cards/min (148 bps)				WU DLT	Leased WU Class D HDX	
					ATT103A (Cost included in TWX chg.)	TWX!	
1001 $15.00	10-12 ch/ sec. 22 numeric char/card		Parallel by bit, serial by char. 2 of 8	Simplex (HDX controls)	ATT401A or E	Leased Voice Grade HDX or Telephone System	24/26 with 401J.
	10-12 cps. 36 alpha-numeric char/card.	#1222-$8.00	Parallel by bit, serial by char. 3 of 11		ATT401E		24/26 with #1221 and 401J.

MACHINE	DATA RATE	FEATURES	LINE CODE	DATA MODE	MOD/DEMOD REQUIRED	FACILITY	TO
1009 (STR) $500.	75/150 cps 600/1200 bps		Binary or BCD, character at a time to 1009. Serial 4 of 8 (1248 ROXN) on line.	HDX	ATT202C or D or WU2121A	Leased Voice Grade HDX	Another STR Device, 1414, 7740, 7750, 2701
					ATT202C	Telephone System	
				HDX with FDX controls	ATT202D or WU2121A	Leased Voice Grade FDX	
	187.5 cps 1500 bps			HDX	ATT202C	Leased Voice Grade HDX	
				HDX with FDX controls	ATT202D	Leased Voice Grade FDX	
	250 cps 2000 bps			HDX	ATT201A externally clocked	Leased Voice Grade HDX or Telephone System	
				HDX with FDX controls		Leased Voice Grade FDX	
	300 cps 2400 bps			HDX	ATT201B externally clocked	Leased Voice Grade HDX. May require conditioning.	
				HDX with FDX controls		Leased Voice Grade FDX. May require conditioning.	
1013 $800	150 cps 600/1200 bps	Note: Punching speed limits receiving thruput to 160 cps.	SAME AS 1009 AT SAME DATA RATE.				
	250 cps 2000 bps						
	300 cps 2400 bps						
1014 $200	12.5 cps transmit 15.5 cps receive		Serial, BCD	HDX	Included in machine	Owned or Leased Voice Grade FDX (up to 8 physical miles) Pt-Pt only	1414 Mod, 4, 5, 6

MACHINE	DATA RATE	FEATURES	LINE CODE	DATA MODE	MOD/DEMOD REQUIRED	FACILITY	TO
1026 $270	14.8 cps 134.49 bps	#1286-$10	Serial, odd parity BCD code 1 start and 1 stop bit (9.0 units)	HDX	ATT103A (cost inc. in TWX chg)	TWX! or Telephone System	Manual dial to, and auto answer from 1050, 1060, 1070 mod 1.
		#1286-$10 #1304-$40			ATT103A and ATT801A (103 cost inc in TWX chg)		Auto dial to, and auto answer from 1050, 1060, 1070 mod 1.
		#4790-$10			WUDLT	Leased WU Class D HDX	1050, 1060, 1070 mod 1.
					ATT103F or WU1601A	Leased Voice Grade HDX	
					Included in machine	Owned or Leased Voice Grade HDX up to 8 Physical miles.	1050, 1060
	60 cps 600 bps (14.8 cps)		Serial, odd parity BCD (10.0 units)		ATT202D or WU1601A	Leased Voice Grade FDX	1030 (1033)
	66.6 cps 600 bps		Serial, odd parity BCD (9.0 units)				1070 mod 2
(1030) 1031A Price de-pends on Model	60-66 cps 600 bps		Serial, odd parity BCD code with 1 start and 1 stop bit (9.0 units)	HDX	Included in machine	Owned or Leased Voice Grade HDX (up to 8 physical miles)	1034 card punch or 1448, 2701, 2702
		#2068-$25			ATT202D or WU1061A	Leased Voice Grade FDX	
(1050) 1051 Model 1-$75 Model 2- 50	14.8 cps 134.49 bps	#9114	Serial, odd parity BCD code 1 start and 1 stop bit (9.0 units)	HDX	ATT103A (cost inc. in TWX chg.)	TWX!	1050, 1448, 1447, 2701, 2702, 7740, 7750, 1414 to 1410/1010
					ATT103A	Telephone System	
		#9115			ATT103F or WU1601A	Leased Voice Grade HDX	
		#9116			WU DLT	Leased WU Class D HDX	
		#9117 #4790-$10			Included in machine	Owned Voice Grade HDX (up to 8 miles)	
	8.33 cps 74.9 bps	#7873-$5			None	Leased 100 WPM Telegraphs HDX	1050, 2701, 7740, 2702

MACHINE	DATA RATE	FEATURES	LINE CODE	DATA MODE	MOD/DEMOD REQUIRED	FACILITY	TO
(1060) 1061 Model 1-$185 Model 2- 250	14.8 cps 134.49 bps	SAME AS 1050 AT SAME DATA RATE					1448, 2701 7740, 2702
(1070) 1071 Model 1-$160	14.8 cps 134.49 bps		Serial, odd parity BCD code 1 start and 1 stop bit (9.0 units)	HDX	ATT103F or WU1601A	Leased Voice Grade HDX	2701, 2702 1050
					WU DLT	Leased WU Class D HDX	
		#4792-$10			Included in machine	Owned Voice Grade HDX (up to 8 miles)	
(1070) 1071 Model 2-$170	66.6 cps 600 bps		Serial, odd parity BCD code 1 start and 1 stop bit (9.0 units)	HDX	ATT202C or D or WU2121A	Leased Voice Grade HDX	2701, 2702
		#4793-$10			Included in machine	Owned Voice Grade HDX (up to 8 miles)	
1094 $40	12 cps		Parallel by bit, serial by char. 2 of 8	Simplex (HDX control)	ATT401A or E	Leased Voice Grade HDX or Telephone System	24/26 with 401J.
(357) 1408 $150	20 cps 600 bps		Serial, odd parity BCD with 1 start bit and 2 stop bits	HDX	Included in Machine	Leased or owned voice grade HDX (up to 8 miles)	1448 (357 system connects to 358 to 1408.)
1414 Model 4-$775 or Model 5-$700 or Model 6-$850 (see next listing for more modes)	10 cps 74.2 bps	#7864-$500	Telegraph (7.42 units)	HDX	1 HDX telegraph station with serializer-deserializer	Leased 100 WPM telegraph HDX	Multipoint line to similar telegraph stations.
				FDX	1 FDX telegraph station with serializer-deserializer	Leased 100 WPM telegraph FDX	
				1 input 1 output	2 telegraph stations- 1 with serializer, 1 with deserializer	Leased 100 WPM telegraph FDX (or 2 HDX)	
	75, 150, 250, 300 cps	#3238-$200	Binary or BCD char at time to 1009. Serial 4 of 8 (1248 ROXN) on line.	HDX	1009 and its required Mod/Demod.	As required by 1009.	Another STR device.
	12.5 cps receive 15.5 cps transmit	#6136-$200	Serial, BCD	HDX	Included in machine	Owned or leased Voice Grade FDX (up to 8 physical miles) Pt-Pt only	1014

MACHINE	DATA RATE	FEATURES	LINE CODE	DATA MODE	MOD/DEMOD REQUIRED	FACILITY	TO
1414 Model 4-$775 Model 5-$700 (see previous listing for more modes)	14.8 cps 134.49 bps	#2075-$440 #3232- 10 #4705- 10 or #6165- 10	Serial, odd parity BCD (9.0 units)	HDX	Included in machine	Owned Voice Grade HDX (up to 8 miles)	1050
		#2075-$440 #6165- 10			ATT103A (cost inc. in TWX chg.)	TWX!	
					ATT103A	Telephone System	
		#2075-$440 #4705- 10			ATT103F or WU1601A	Leased Voice Grade HDX	
					WU DLT	Leased WU Class D HDX	
1447 Model 2-$170 Model 3- 200 Model 4- 230	14.8 cps 134.49 bps	#1390-$25 #6149- 25	Serial, odd parity BCD (9.0 units)	HDX	1050 Master station and its required mod/demod.	As required by 1050	1050
1448 $1,150	20 cps (14.8 cps	#1274-$150 #8710- 45 #4789- 50 #(1227)- 50	Serial, odd parity BCD 1 start 2 stop	HDX	Included in machine	Owned or Leased Voice Grade HDX (up to 8 miles)	1408, 1030 (1033)
	60 cps 600 bps (14.8 cps)	#1274-$150 #8710- 45 #(1277)- 50 #2069- 40			ATT202D or WU1601A	Leased Voice Grade FDX	1031A (1033)
	14.8 cps 134.49 bps	#1275-$150 #2070- 45	Serial, odd parity BCD 1 start 1 stop (9.0 units)	HDX	ATT103F or WU1601A	Leased Voice Grade HDX	1050/1060 with same data set
					WU DLT	Leased WU Class D HDX	
		#1275-$150 #4791- 65			Included in machine	Owned Voice Grade HDX (up to 8 miles)	
		#1033-$ 20 #1282-$ 50 #2070-$ 45 #1275-$150			ATT103A and ATT801A (103A cost inc. in TWX chg.)	Telephone System	To initiate calls to 1050/1060's
						TWX!	
		#1275-$150 #1032- 10 #2070- 45			ATT103A	Telephone System TWX!	To answer calls from 1050/1060's
	74.2 bps	#1283-$400 #5640- 100			None	Leased 100 WPM telegraph HDX	Terminals on ATT 83B2 or WU 115A lines.

MACHINE	DATA RATE	FEATURES	LINE CODE	DATA MODE	MOD/DEMOD REQUIRED	FACILITY	TO
2701 $200	6 cps 45.45 bps	#7860-$75	Telegraph (7.42 units)	HDX	None	Leased 60 WPM Telegraph HDX	Telegraph terminals. (If line is controlled, must be ATT83B2 or WU115A.)
	7.5 cps 56.8 bps	#7861-$75				Leased 75 WPM Telegraph HDX	
	10.0 cps 74.2 bps	#7862-$75				Leased 100 WPM Telegraph HDX	
	8.33 cps 75.0 bps	#4633-$75	Serial, odd parity BCD (9.0 units)				1050
	10 cps	#7885-$75	Serial, ASCII (no parity) (11.0 units)		ATT103A (cost inc. in TWX chg.)	TWX or TWX!	Manual dial to and auto answer from teletype mod 33/35 term.
		#7885-$75 #1302- 35			ATT103A and ATT801A (103 inc. in TWX chg.)		Auto dial to and auto answer from teletype mod 33/35 terminals
	14.8 cps 134.49 bps	#4645-$75	Serial, odd parity BCD (9.0 units)		ATT103F or WU1601A WU DLT	Leased Voice Grade HDX Leased WU Class D HDX	1050/1060/1070 with same mod/demod.
		#4645-$75 #4636-$10			Included in machine	Owned Voice Grade HDX (up to 8 miles)	
		#4645-$75 #1302-$35			ATT103A and ATT801A (103 inc in TWX chg)	Telephone System or TWX!	1050/1060 with same mod/demod
	66.6 cps 600 bps	#4646-$75	Serial, odd parity BCD (9.0 units)	HDX	ATT202C or D or WU1601A	Leased Voice Grade FDX	1070
		#4646-$75 #4637-$10			Included in machine	Owned Voice Grade HDX (up to 8 miles)	
	60 cps 600 bps	#4648-$75	Serial, odd parity BCD (10.0 units)		ATT202D or WU1601A	Leased Voice Grade FDX	1030
		#4648-$75 #4637-$10			Included in machine	Owned Voice Grade HDX (up to 8 miles)	

(continued)

MACHINE	DATA RATE	FEATURES	LINE CODE	DATA MODE	MOD/DEMOD REQUIRED	FACILITY	TO
2701 (continued)	150 cps 1200 bps	#7696-$200 #4703-$ 45 #1303-$ 35	Serial 4 of 8 (1248ROXN)		ATT202C and ATT801A	Telephone System	STR, 7740, 7750, another 2701 (can have FDX control operation over FDX line with another line appearance)
		#7696-$200 #4703-$ 45			ATT202C or D or WU 1601A	Leased Voice Grade HDX	
	250 cps 2000 bps	#7696-$200 #4703-$ 45 #1303-$ 35			ATT201A and ATT801A	Telephone System	
		#7696-$200 #4703-$ 45			ATT201A internally clocked	Leased Voice Grade HDX	
	300 cps 2400 bps				ATT201B internally clocked		
	5100 cps 40,800 bps	#7695-$200		HDX with FDX control	ATT301B (included in cost of chan terminal) internally clocked	Leased telpak A2	7710, 7711 2701
Higher speeds are feasible but must be RPQ at present.							
2702 $850	6 cps 45.45 bps	#7895-$20 #7911-$35 #9680-NC	Telegraph 7.42 units	HDX	None	Leased 60 WPM telegraph HDX	Telegraph terminals (If line is controlled, must be ATT83B2 or WU115A.)
	7.5 cps 56.8 bps	#7895-$20 #7911-$35 #9681-NC				Leased 75 WPM Telegraph HDX	
	10.0 cps 74.2 bps	#7895-$20 #7911-$35 #9682-NC				Leased 100 WPM telegraph HDX	
	8.33 cps 75 bps	#4615-$35 #7895-$20 #9683-NC	Serial, odd parity BCD (9.0 units)				1050
	10 cps 110 bps	#3233-$20 #7911-$35	Serial, ASCII no parity 11.0 units		ATT103A (cost inc in TWX chg)	TWX or TWX!	Manual dial to and auto answer from teletype mod 33/35 terminals.
		#1290-$15 #1310-$60 #3233-$20 #7911-$35			ATT103A ATT801A (103 inc in TWX chg)		Auto dial to and auto answer from teletype Mod 33/35 terminals.

(continued)

MACHINE	DATA RATE	FEATURES	LINE CODE	DATA MODE	MOD/DEMOD REQUIRED	FACILITY	TO
2702 (continued)	14.8 cps 134.49 bps	#4615-$35 #3233-$20 #9684-NC	Serial, odd parity BCD 9.0 units		ATT103F or WU1601A	Leased Voice Grade HDX	1050/1060/1070 with same mod/demod.
					WU DLT	Leased WU Class D HDX	
		#4615-$35 #4612-$30 #9684-NC			Included in machine	Owned Voice Grade HDX up to 8 miles	
		#4615-$35 #3233-$20 #9684-NC #1290-$15 #1310-$60			ATT103A and ATT801A (103 inc in TWX chg)	Telephone System or TWX!	1050/1060 with same data set
	66.6 cps 600 bps	#4615-$35 #9685-NC #7387-$75 #3233-$20	Serial, odd parity BCD 9.0 units	HDX	ATT 202C or D or WU1601A	Leased Voice Grade FDX	1070
		#4615-$35 #9685-NC #7387-$75 #4613-$30			Included in machine	Owned Voice Grade HDX (up to 8 miles)	
	60 cps 600 bps	#4616-$35 #7387-$75 #3233-$20	Serial, odd parity BCD 10.0 units		ATT202D or WU1601A	Leased Voice Grade FDX	1030
		#4616-$35 #7387-$75 #4613-$30			Included in machine	Owned Voice Grade HDX (up to 8 miles)	
7701 (STR) $1,175	75/150 cps 600/1200 bps		SAME AS 1009 AT SAME DATA RATE				
7702 (STR) $1,300	150/250/300 cps 1200/2000/2400 bps		SAME AS 1009 AT SAME DATA RATE				
7710 (STR) $1,575	150 cps 1200 bps	#9111-NC	Serial 4 of 8 (1248ROXN) on line	SAME AS 1009 AT SAME DATA RATE			Same as 1009 at same data rates
	250 cps 2000 bps	#9111-NC #4703-$145		HDX	ATT201A externally clocked	Leased Voice Grade HDX or Telephone System	
		#9111-NC		HDX with FDX controls	ATT201A internally clocked	Leased Voice Grade FDX	

(continued)

MACHINE	DATA RATE	FEATURES	LINE CODE	DATA MODE	MOD/DEMOD REQUIRED	FACILITY	TO
7710 (STR) (continued)	300 cps 2400 bps	#9111-NC #4703-$145		HDX	ATT201B externally clocked	Leased Voice Grade HDX	
		#9111-NC		HDX with FDX controls	ATT201B Internally clocked	Leased Voice Grade FDX	
	5100 cps 40,800 bps	#9112-NC			Included with facility (301B with int clock)	Leased Telepak A2	7710-7711
7711 (STR) $1100	150 cps 1200 bps	#9111-NC	Serial 4 of 8 (1248 ROXN) on line	SAME AS 1009 AT SAME DATA RATE			Same as 1009 at same data rates
	250 cps 2000 bps	#9111-NC #4704-$25		HDX	ATT201A externally clocked	Leased Voice Grade HDX or Telephone System	
		#9111-NC		HDX with FDX controls	ATT201A internally clocked	Leased Voice Grade FDX	
	300 cps 2400 bps	#9111-NC #4704-$25		HDX	ATT201B externally clocked	Leased Voice Grade HDX	
		#9111-NC		HDX with FDX controls	ATT201B internally clocked	Leased Voice Grade FDX	
	5100 cps 40,800 bps	#9112-NC		HDX with FDX controls	Included with facility (301B with internal clock)	Leased Telpak A2	7710-7711
7741 Mod 1-$3,400 2-$3,900 3-$4,900	3 cards/min 45.45 bps	#7900-$40 #7856-$35	Serial 4 of 8 (XONR7421) 10.5 units or Telegraph 7.42 units	HDX	NONE	Leased 60 WPM	65/66 with 67
	6 cps 45.45 bps	#1082-$30 #1475-$5 (#1297-$325 #1291-$ 35)			ATT103A (cost inc in TWX chg) and (ATT801A)	TWX or TWX!	Telegraph terminals type 19/28 (Auto dial)
	4 cards/min 56.8 bps	#7900-$40 #7856-$35 #1082-$30 #1477-$5			NONE	Leased 75 WPM Telegraph	65/66 with 67
	7.5 cps 56.8 bps						Telegraph
	5 cards/min	#7900-$40 #7856-$35 #1082-$30 #1477-$5				Leased 100 WPM Telegraph	65/66 with 67
	10 cps 74.2 bps						Telegraph

(continued)

MACHINE	DATA RATE	FEATURES	LINE CODE	DATA MODE	MOD/DEMOD REQUIRED	FACILITY	TO
7741 (continued)		(#1297-$325 #1291-$35)			(ATT801A and)		(Provides auto dial into TWX)
	10, 9 cards/ min 148 bps	#1076-$35 #1473-$5	Serial 4 of 8 (XONR7421) 10.5 units		ATT103A (cost inc. in TWX chg)	TWX!	65/66 with 68
	11, 10 cards/ min 180 bps	#1076-$35 #1474-$5			ATT103F or WU 1601A	Leased Voice Grade HDX	
					WU DLT	Leased WU Class D HDX	
		#1076-$35 #1474-$5 (#1297-$325 #1291-$35)			ATT103A (and ATT801A)	Telephone System	(Provide auto dial to Telephone System)
	8.33 cps 75.0 bps	#7900-$40 #7856-$35 #1082-$30 #1495-$5	Serial BCD odd parity 9.0 unit		NONE	Leased 100 WPM Telegraph	1050
	14.8 cps 134.49 bps	#1076-$35			ATT103A (cost inc. in TWX chg.)	TWX	
		#1076-$35 (#1297-$325 #1291-$35)			ATT103A (and ATT801A)	Telephone System	(Provides auto dial into Telephone System)
		#1076-$35			ATT103F or WU1601A	Leased Voice Grade HDX	1050/1060
					WU DLT	Leased WU Class D HDX	
	6.6 cps 50 bps	#7900-$40 #7856-$35 #1082-$30 #1463-$5	Serial Telegraph 7.42 unit		WU Auto Dial	Telex	Telex Telegraph Terminals
	10 cps 110 bps	#1076-$35 #1472-$5 #1297-$325 #1291-$75	Serial ASCII no parity 11.0 units		ATT103A (cost inc. in TWX) and ATT801A	TWX	Telegraph Terminals type 33/35
	150 cps 1200 bps 250 cps 2000 bps 300 cps 2400 bps	For HDX line #4588-$260 For FDX line #4588-$260 #4589-$120	SAME AS 1009 AT SAME DATA RATE.				
7750	Capability similar to 7741 up through 1200 bps.		SEE SALES MANUAL				

SECTION V LINE CONTROL SYSTEMS

This section contains descriptions of line control systems sufficiently detailed to program and specify a machine like the 7740.

A summary of the character control sequences for frequently encountered telegraph line control systems appears on pages V-2 and V-3.

TELEGRAPH LINE CONTROL SEQUENCES
(See Notes on Following Page)

Line Signal Description

Signal Type	AT&T 83B2 HDX	WU 115 HDX	AT&T FINAC FDX	WU 117 FDX	AT&T 81D1 FDX	WU 57 FDX	WU 111 Conten.
Station Request to Send	①	①	①	①	①	Space or ①	3.0 Sec Open
Polling Sequence Initial (from central)	EOM	EOM	③	FIGS Z	Blank .4 Sec Pause Space	Y	②
Transmitter Start Code (from central)	ALPHA MorG	X ALPHA	CR 3 ALPHA	ALPHA	ALPHA	ALPHA	②
Positive Response (from station)	Msg	Msg	Msg	Msg	Msg	Y	②
Negative Response (from station)	V or 2 Sec	V or 10 Sec	1.0 Sec	V or 2 Sec	H or 5 Sec	Space	②
End of Polling (from central)			③	④	2 LTRS .2 Sec Pause	CR	②
Selection Sequence Initial SOM (from sender)	LTRS LTRS LTRS	LTRS LTRS LTRS	LTRS LTRS LTRS	FIGS H LTRS ⑦	FIGS H LTRS (optional)	W	LTRS
Selection Code (from sender)	ALPHA ALPHA	ALPHA ALPHA	(ALPHA) (option) ALPHA LTRS	Q ⑥ 3 LTRS 2 ALPH	ALPHA ALPHA	ALPHA ALPHA ⑤	ALPHA
Positive Response (from addressee	V	V	None	V ⑥	None	ALPHA (complement of Selection)	None
Negative Response (from addressee)	10 Sec	?	None	? ⑥	None	?	None
End of Selection (from sender)	CR LF	Space CR LF	CR	Space	CR LF LTRS	Space Space	CR LF Space LTRS
EOM	FIGS H LTRS	FIGS H LTRS	FIGS H LTRS	FIGS H LTRS	FIGS H LTRS	FIGS H LTRS	Not Fixed
EOT					H LTRS		

GENERAL NOTES:

1. Polling Sequences normally include several TSC codes, each followed by a response, except as noted.

2. The term ALPHA refers to any alphabetic character from the specific list for the particular system.

3. In HDX systems, a message must start with a selection sequence, even if no selections are included.

4. In FDX systems, a message from a station can only be sent to a central or control station. Messages to stations are only sent from the central or control station.

SPECIFIC NOTES:

(1) Station Request recognized only as result of a poll.

(2) This is a contention system - each station controls its own entry to the line using a Way Station Selector 7304.

(3) A TSC is sent following every C.R. in the text. If there is traffic on the incoming line (no poll required), a BLANK is sent instead of the ALPHA. Terminals on this system automatically initiate a CR and LF when receive a CR.

(4) The TSC code unblinds all previously selected printers for continuing outgoing traffic; thus, each TSC must be preceded by FIGS Z, but no end-of-polling code is needed.

(5) Each WU57 Selection Code is always one alphabetic character repeated once.

(6) Response to Selection is optional, a Q and 3 LTRS preceding the Selection Code will trigger the answer. Only the last Selection on each message can be required to answer back and only one of a group code.

(7) Must precede the first message in each transmission.

AT&T 81D1 LINE CONTROL SYSTEM

A. Line, Signal, and Outstation Equipment

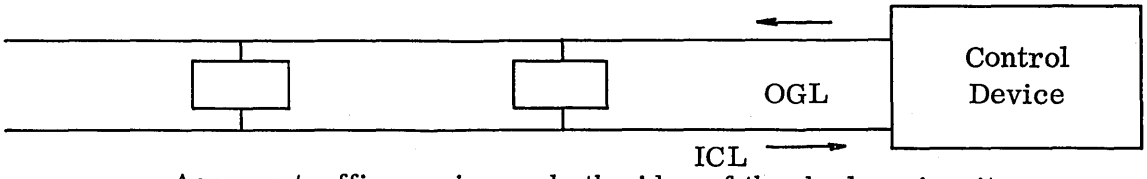
A standard 7.42 unit line telegraph code is used with 60 ma neutral current loops. Speed is 100 wpm (100 ms/char.). All lines are FDX, four wire. Outstations consist of standard Model 28 telegraph tape and page equipment with stunt boxes and necessary control gear. Any resistance added to a telegraph loop by non-telegraph equipment should not exceed 150 ohms; any line equipment should be capable of 260 volts DC, 265. ma. maximum under trouble conditions.

B. Line Control (Specific character sequences are typical and may differ between customers)

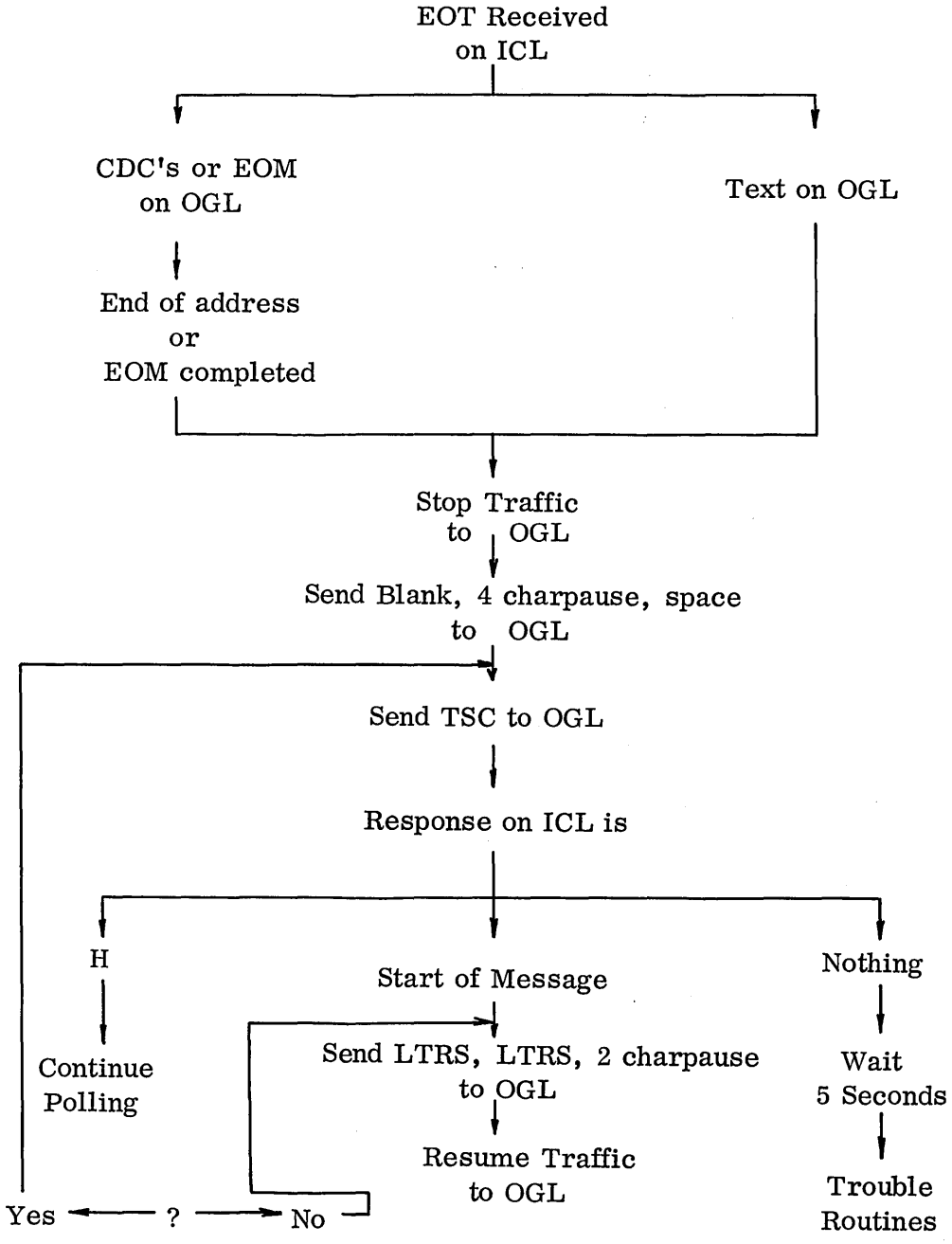
1. Addressing - uses a two character code, CDC, containing any combination of alphabetic characters, except M, O, T, V, H, Z. (No answerback).
2. Polling - uses a one character code, TSC, from the following lists:

   Priority U, F, C, B, J, P, Y, W, M, G.
   Regular A, S, I, D, R, H, Z, L, N, O
3. End of Address CR, LF, LTRS
4. End of Message and Start of Message FIGS, H, LTRS
5. End of Transmission H, LTRS
6. No Traffic Response H
7. Transmitter Stop BLANK, 4 charpause, X, LTRS, LTRS, 2 charpause.
8. Addressing Control Sequence required by outstation at beginning of every message (commas not used) FIGS, H, LTRS, CDC's as required, CR, LF, LTRS, TEXT, EOM.

9. Polling Control Sequence required by outstation



Assume traffic moving on both sides of the duplex circuit



AT&T 83B2 LINE CONTROL SYSTEM

A. Line, Signal, and Outstation Equipment

A standard 7.42 unit line telegraph code is used with 60 ma neutral current loops. Speed is 100 wpm (100 ms/char). All lines are HDX, two wire. Outstations consist of standard model 28 telegraph tape and page equipment with stunt boxes and necessary control gear. Any resistance added to a telegraph loop by non-telegraph equipment should not exceed 150 ohms; any line equipment should be capable of 260 volts DC, 265 ma. maximum under trouble conditions.

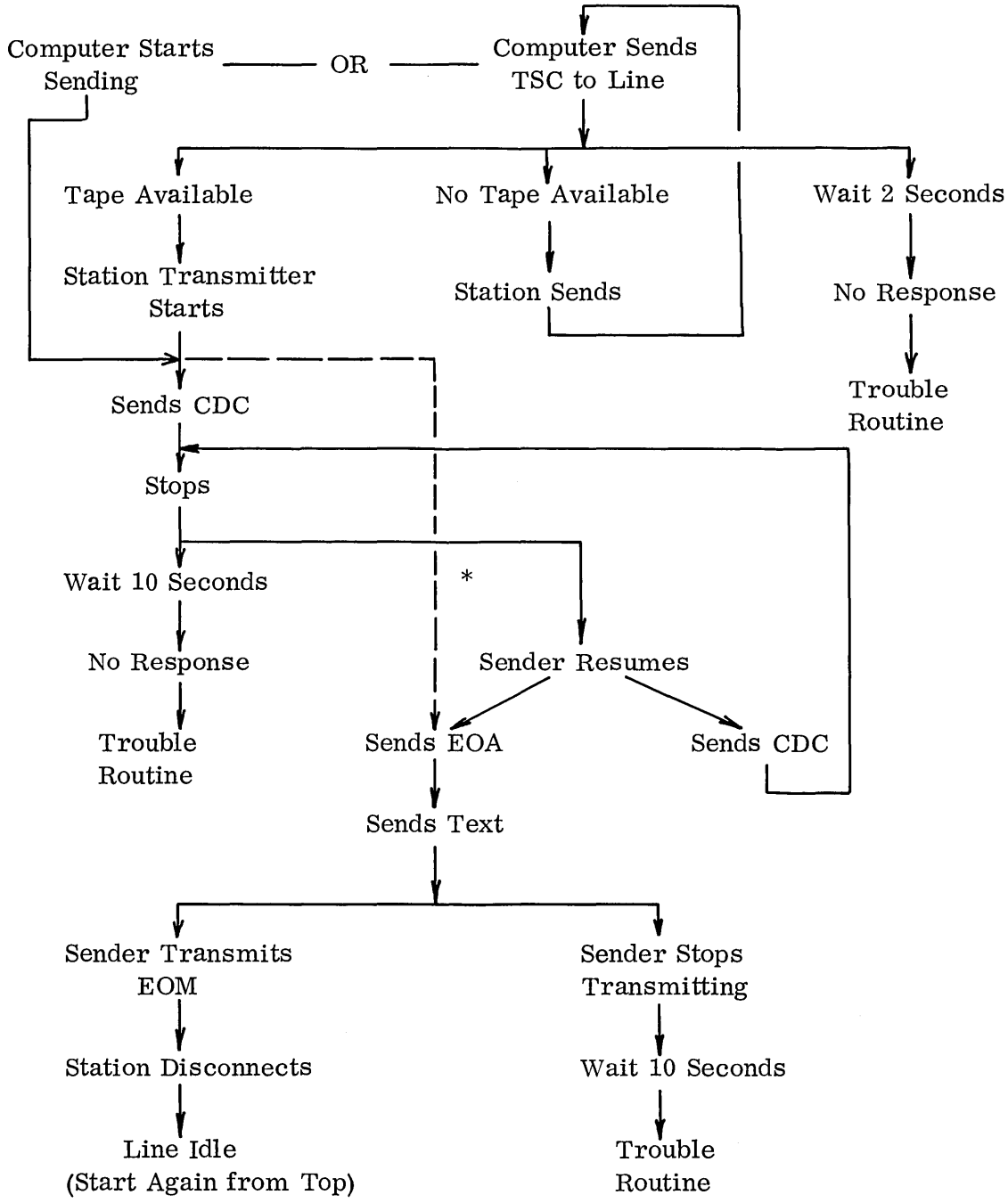
B. Line Control (Specific character sequences are typical and may differ between customers)

1. Addressing - uses a two character code, CDC, containing any combination of alphabetic characters, except T, O, M, V, H, and Y.
2. Broadcast - One CDC per line may be assigned as a broadcast code to address all stations. Normally one station (or the computer) generates the answer back for this code.
3. Polling - uses a two character code, TSC, containing a first character from the following list: A, C, E, I, L, N, P, R, S, Z, W, K, D, U, X, Q, J, F, B. The second character is usually M. If over 19 stations are on the line, the second character can be G for those stations, choosing first characters from the above list.
4. End of Address - CR, LF
5. End of Message - FIGS H, LTRS
6. End of Transmission - Same as EOM, no separate sequence.
7. Addressing Answer Back - V
8. No Traffic Response - V
9. Transmitter stop - Double blank, or open line for two character times.
10. Line Control Sequence required by outstation - When line is idle, all station control units are in Receive-Select condition. Addressed stations shift into Print condition and copy text after EOA. Unaddressed stations shift into Lockout condition and do not print after EOA. All stations shift into Receive-Select at EOM. 83B3 multipoint lines may be controlled with the same sequence.

    The sequence is shown in flow-chart form on the next page.

83B2 LINE CONTROL SEQUENCE

(Assume Line is Idle)



*Station can skip via this path if message is to go only to computer

SECTION VI BIBLIOGRAPHY

This section contains a list of publications containing information either specifically referred to herein or else generally applicable to the subject of this guide. The short description is not exhaustive, or even highlights, but points out the communications systems information in the reference.

1. Bell System Data Communications Technical Reference Manuals

   These booklets are published by AT&T and available retail through your local Graybar Electric Company Sales Office, or from Graybar Electrical Company Inc., 21-15 Bridge Plaza North, Long Island City 1, New York. Except for the binder, prices vary from 30 cents to $1.50. The available items are:

   Bell System Data Communication Services
   Data Set Interface Connectors
   Data Set 103A Interface Specification
   Data Set 103B Interface Specification
   Data Set 103F Interface Specification
   Data Set 201 A/B Interface Specification
   Data Set 202 A/B Interface Specification
   Data Set 202 C/D Interface Specification
   Data Set 301 B Interface Specification
   Data Set 401 A/B Interface Specification
   Data Set 401 E/F Interface Specification
   Data Set 401 J Interface Specification
   Data Set 402 A/B Interface Specification
   Data Set 602 A Interface Specification
   Data Auxiliary Set 801A (Auto Call) Interface Spec
   Matching Looseleaf Binder

   The manuals on data sets contain very good operating descriptions as well as detailed information about wires and electrical specifications.

2. Principles of Electricity Applied to Telephone and Telegraph Work

   Published by American Telephone and Telegraph Company - latest edition 1961. This is a basic text on elementary electrical principles for internal training at AT&T. We find it particularly helpful on telephone and telegraph principles, telephone transmission theory, modulation, and carrier. It is available in many libraries, public and IBM, and from Graybar as in #1 above at $4.20.

3. Data Communications Handbook

IBM Form Z20-1939, controlled circulation via Communications Control Department, DPHQ, White Plains. It contains, primarily, an excellent set of resumes of tariffs filed with the FCC by AT&T and WU that are pertinent to data communications. Common carrier terminal equipment and data sets are also described. There is at least one copy at every IBM location.

4. Data Communications Concepts and Communications Facilities

IBM Form E20-8158, an excellent basic manual on the subject. An education guide based on this manual, Form Z23-4023, may also be available.

5. IBM Tele-Processing Bibliography

IBM Form A24-3089, a further source for titles not included herein.

6. IBM Tele-Processing Systems Summary

IBM Form A24-3090-1, brief description of IBM machines and systems designed for tele-processing.

7. Capabilities of the telephone network for data transmission - by Alexander, Gryb and Nast - Presented at AIEE Winter General Meeting, New York, February 1960, also published in the Bell System Technical Journal, Vol. 39, pg. 431-476, May 1960. You should be able to get copies from IEEE.

This is a basic paper on the subject, aimed at the FM method of transmission now used up to 1200 baud. Except for increases in speed now possible with new technology, this paper is still very pertinent.

8. Communications Network Design Programs

IBM Confidential. Form Z20-0310-0 Description for these programs: Multi-Point Linkage Program, Multi-Switching Centers Allocation, Concentrator Networks Optimization, Telpak Optimization Program, Communications Facilities Determination, Determination of a Network Center.

9. IBM Tele-Processing Components Physical Planning

IBM Form A24-3233, a description of physical requirements for communications ability on two GP machines.

10. Terminal Equipment Guide

A publication available from same source as this Guide. Contains the history and principles of operation of the families of IBM remote terminal equipment, a selection chart, and a description of each terminal including a configuration and references. A feature of this guide is the inclusion of some 1900 line devices.

11. EIA Standard RS-232-A October 1963

Interface Between Data Processing Terminal Equipment and Data Communication Equipment. Published by EIA, 11 West 42nd Street, N.Y. 36, N.Y., at 90 cents.

12. Data Communications by Charles R. Doty, Sr.

Review of IBM role in communications. Available from Development Laboratory, IBM Poughkeepsie.

13. IBM 1410 Telephone Inquiry Device Study by S.C. Naggar. Report AP 61-3236, June 9, 1961.

Available from IBM Poughkeepsie Technical Information Center.

14. Tele-Guide

A System 360 design tool for communications systems. Systems Engineering Techniques Dept., WRO.

SECTION VII SYSTEM IMPLEMENTATION

This section includes information on the problems which arise after proposal acceptance.

At this time, two reports are included. Additional information may be added in future editions.

The subject of implementation of communications systems is covered in great detail in a new publication now in preparation. Called the System 360 Design and Implementation Guide, it will be available from the same source as this guide.

A. Switchover Methods for Communication Lines Served by Duplexed 7740's.

(This is derived from a memorandum written December 27, 1963 and based on conferences with common carriers, 7740 Engineering, and Customer Engineering. The term "Duplexed 7740's" means an installation using one 7740 to control all the communication lines and a second 7740 is available for rather rapid takeover in the event of failure of the first 7740. This memorandum is only concerned with the physical lines, not with programs, updating, files, etc. In general, these methods are applicable to other machines similar to 7740.)

1. General Methods of Duplexing

   a. Transfer some or all of the lines from a failed 7740 to a backup 7740. One backup machine might serve three or four online machines.

   b. Combine some or all of the lines from a failed 7740 with working lines on a second, online 7740. This would result in a certain level of degraded service.

   c. Put one online 7740 and one backup 7740 in "series" on some or all of the lines. This permits a simpler switchover and can permit monitoring or even load sharing when desired.

2. Implementing these methods for DC Lines.

   a. Transferring can be accomplished using either a Special Engineering IBM box (RPQ) or common-carrier-designed equipment. The latter could be plugs and jacks, manual keyswitches, or relays. The particular common carrier for each installation will be able to build a unique box from standard parts. Typical lead times have been 3-5 months to installation.

      A transfer of DC lines should be accomplished in such a manner that the second machine is placed in parallel with the first, then the first is disconnected from the local loop. This prevents an open condition which can affect certain kinds of control and line equipment.

   b. Combining is apparently quite difficult at a customer's premises because of problems inherent in direct current loops. We have no definite information from the carriers that we can do it.

c. Series - This is a very practical method where a one-for-one backup is desired. There is no physical change of lines to effect switchover. The off-line machine can either be in a monitoring mode or it's interface can be resistor shunted by a CE switch.

The two wires from each line interface on each machine should be brought to a demarcation strip. At this strip they can either be put in series and the local loop connected accordingly, or both machine lines and the local loop can be further connected to a common carrier jack panel which puts them in series and provides plug and jack versatility.

3. Implementing these methods for voice type lines. (It is assumed that all of this type will use data sets with some kind of tones on the line side.)

a. Transferring can be accomplished on either side of the data set. On the line side of leased line data sets, the switch may be supplied by IBM (box must be approved by carrier), or by the carrier. Only two wires are involved for each line and they are simply transferred from the data set for the online machine to the data set for the offline machine using plugs and jacks, key-switches, or relays.

On the line side of switched network (DDD or TWX) data sets, the switch must be supplied by the carrier. Its function is the same as for leased lines.

On the business machine side of data sets, the switch may be supplied by either the carrier or IBM. However this is definitely beyond the usual carrier demarcation (the plug into the data set) and the carriers are reluctant to perform this function. This is a multi-wire interface, and it is defined by the industry standard RS-232. Depending on the particular data sets used, and the application, simplifications such as common leads might be possible.

b. Combining requires special considerations but is a practical means of duplexing leased lines. It cannot be used for switched network lines. On the line side of data sets, a bridge network is required to balance impedances and provide gating of signals. Such a bridge can be supplied by the carriers. A typical one costs $10/month per connection and each connection must be adjusted in advance for the particular lines to be combined.

On the business machine side, two data sets may be connected to the same 7740 channel in parallel, remembering that we must maintain the standard interface voltages on both data sets when sending and must provide adequate line control to permit only one line to send to the 7740 at a time. It is difficult to have one line monitor signals origima ted on the other line, so line control programs must provide adequate control signals from the 7740.

c. Series - With a modification to the 7740's, this method is practical. Because the interface uses voltage levels, rather than make-break currents, it is not as simple as in the DC case.

B. Customer/Common Carrier/IBM Conference

(This is derived from a memorandum written November 12, 1964 and based on several conferences leading to installations of 7740's. All of them were connected to DC telegraph lines. The purpose of this memorandum is to show what subjects must be covered at this conference, and applies generally for any similar machine.)

1. Why have such a conference: About 5 to 6 months prior to scheduled machine installation, it is necessary to firm up common carrier service orders (the lines may or may not have been ordered previously). It is also necessary to plan the orderly transition from a present communications system to the proposed one. A three-sided conference brings all necessary people together to decide on all the items listed below. These decisions then allow each side to proceed with their own function: customer with programming details, common carrier with equipment design and installation, IBM with installation details.

2. Attendees: Normally, the customer communications manager and one or two of his assistants; the common carrier representative and several of his technical men; IBM account representative, and SE. Ideally the IBM CE force directly concerned should be represented. The meetings usually run a total attendance of 10 or more with several people attending "just to observe". It is important to have people who can make decisions during the meeting.

3. Subjects Discussed: (Documentation of these items should be at the meeting for possible reference.)

   a. Description of present system, lines and equipment, both remote and central.

b. Description of system to be installed, lines, and equipment both remote and central.

c. Specific, detailed description of logical control of line by the computer.

d. Discussion of the 7740 telegraph front end electrical specifications, the trouble shunt resistor and line current specifications.

e. Design of duplex switching arrangements, if required.

f. Design and use of the patch panel.

g. Physical location of the demarcation strip.

h. Backup procedures.

i. Local terminals for testing (before and/or after cutover).

j. Testing plans and procedures.

k. Cutover plans and procedures.

l. Schedule and service orders, including installation dates of all lines, remotes, patch panels, and IBM equipment.

m. Miscellaneous items of mutual interest to some parties present but not directly concerning installation.

4. Summary of Results: The general or easiest resolution of problem area and some typical items for each topic listed in 3 above with respect to 7740 installations with d.c. telegraph lines.

a. Description, present system: Typically these have been mixtures of older telegraph systems like 83A, 111, direct lines. Most of them were in need of reconfiguration, speed up, expansion. Central equipment was torn tape or 81D.

b. Description, new system: (Although some people at meeting are intimately familiar with new systems, this brings everybody up to latest version.) Typically these are all one type of line control, like 83B3 or 115, terminated on our 7740, with or without duplexing. Usually just handling message traffic, but some were order entry, with specific format descriptions necessary. Features such as open line stop, 20 ma. line current, down-shift on space, etc., are agreed on here.

c. Description of line control: This is usually done with specific message types. Each character moving on the line is noted chronologically. All three parties have the opportunity to approve or question these character actions. Such things as impossible customer formats, unexpected EOM's, etc., are occasionally redesigned at this time. Also examined at this time are the failure situations where a format is incorrect or line fails or remote equipment fails. This includes both operator procedures and line or equipment reactions.

Since the line control systems are usually 83B3, 83B2, 115, 81D1, which are documented in another section, a detailed description is omitted here.

d. 7740 Front End: The information available in the field was, until recently, too general to satisfy common carriers. Today, the Physical Planning and Installation manuals are fairly complete. For my use, I find a combination of these sources and others is necessary. See Figure I.

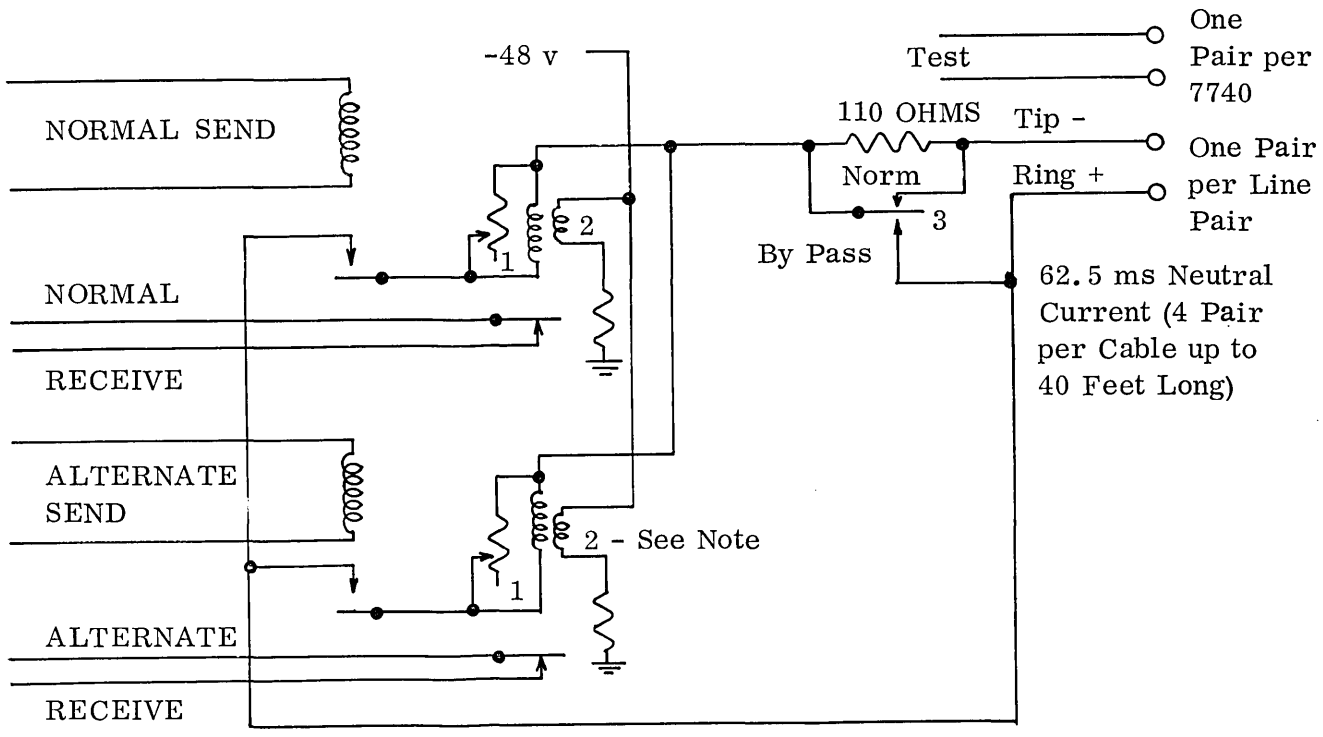


FIGURE I. 7740 TELEGRAPH FRONT END

The send logic of the relay set not in use keeps the associated send contact open. Therefore, only one relay coil is in the telegraph line at any one time. The variable shunt across this relay is used to set the switching point (31.25 ma.) of the relay contacts. Its two extremes will cause total resistance of the circuit (measured across the TIP/RING Terminals) to be between 70 and 150 ohms.

For CE maintenance purposes, the test pair and all line pairs must appear at a patch panel. Each line pair must go through a jack, wired in such a way that when the test pair is patched to this jack, the external line is removed from the 7740 pair and the test pair is connected directly to the 7740 pair.

Note (1:)

Each main relay coil in the telegraph line is approximately 190 ohms.

Note (2:)

Each bias coil is approximately 665 ohms with 2000 ohms resistor in series.

Note (3:)

These contacts are on a relay which is NORMAL whenever power is up and a CE switch is in normal position.

e. Duplex Switching: Where this is required, we have followed one of these basic methods outlined in the duplexing memorandum, December 27, 1963: (See previous subsection.)

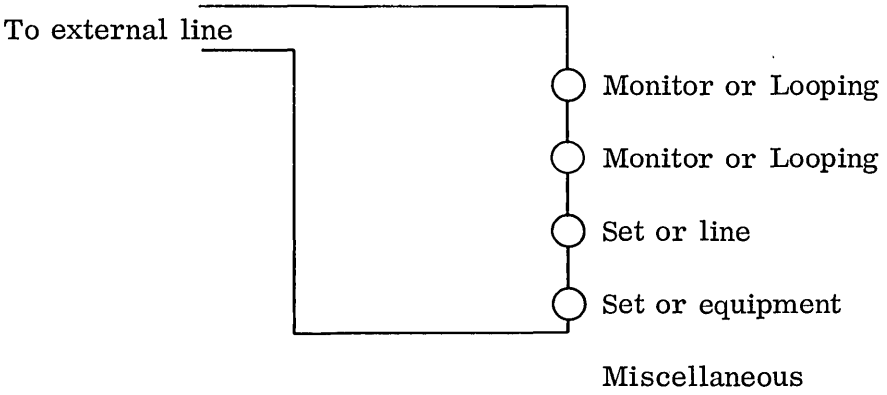
1.) A patch cord system where the patch panel shows all lines and all 7740 front ends and patches are moved or added to transfer any or all lines.

2.) A toggle switch system where each line comes to a toggle and each 7740 front end comes to the same switch.

3.) A programmed system where the two 7740 front ends are in series across each line.

f. Patch Panel: The 7740 installation manual requires a patch panel for CE maintenance of front end relays. We recommend that the common carrier install it, since they usually can use it also. All of these projects are using a similar panel, usually referred to as a "Loop Jack Switchboard" or "63B2 Switchboard". When installed as common carrier equipment, only they have access to the inside, but all parties have access to patching area.

The figure below shows a functional schematic of one line appearance on this panel. The line goes through contacts on each jack. By inserting a plug into the jack, contacts are opened and/or closed and the wires in the plug are electrically connected to some part of the circuitry connected to the jack.



Actual wiring may differ since these panels are wired up on request, not carried in stock. Sometimes not all these jacks are provided. A typical patch panel has 30 line appearances in a standard 19 inch rack, taking about 4-5 inches vertical spaces.

Where 2-7740's are used, the same line from each can be wired to contacts on the SET jacks. With no plugs inserted, the two 7740's can be in series across the line. A plastic (dummy) plug in either or both SET jacks can open that computer loop and close the line circuit across that jack. The MON jacks are used for monitoring by printer, meter or lamp. The patch panel can also be used to change a line assignment from a failed 7740 telegraph channel to a spare channel on the same 7740. A patch cord from SET of the spare channel to MON of the line and a dummy plug in SET of the failed channel performs this function. Other ways of wiring the panel are possible. The specific way of wiring must be agreed on at this meeting.

CE maintenance is performed on the 7740 front end relays through patching on this panel. The test pair output from the 7740 is terminated on a MISC jack. For adjustment, a patch cord from this jack to the SET jack of the channel provides a known signal. The relay shunt is adjusted to provide 0 bias at the receiving contacts.

g. Demarcation: This is also installed by the common carrier. It is placed between the 7740 and the patch panel and marks the physical dividing line between common carrier responsibility and IBM (or customer) responsibility. The actual design may differ, but functionally it provides a place where the common carrier's wires are screwed down and IBM's wires are screwed down. A metal strip may connect two screws for this purpose, or they may both be on one screw. (In the latter case, carrier's wires should be on bottom.) It is handy to use lugs here and the size should be agreed on at this meeting. (7740 uses lugs which fit #8 screws.) This strip can be used for line reassignment and meter testing if desired.

h. Back Up: Aside from duplexed 7740's, other methods include:

1.) A few master control stations at the central location to be patched into each line to send and canned message or actually handle traffic.

2.) Procedure rules at stations for using telephone or telegram as alternate.

3.) Automatic takeover by standby master control units on every line.

Of importance here is a clear understanding by all parties of what will happen at outstations at the moment of 7740 failure and what will be done with messages in hand or in process.

i. Local Terminals: For testing a 7740 at installation and partially testing its programs, a few terminals installed in the same room are desireable. Ideally these would be set up exactly like the terminals to be actually connected. This permits hands on testing of a "system" all in one room.

Sometimes this installation is not possible due to space or economics. An alternative is to use the nearest actual terminals, connecting them onto the computer first and testing.

After cutover, local terminals in the computer room can be used for network control service messages, or actual traffic messages generated for adjacent offices, or the terminals can be removed.

Reasonable common carriers (assuming their terminals) have temporarily installed terminals in the computer room for testing and then moved them to an actual traffic location after cutover.

Telegraph terminals in the same building require rectifiers in the terminal to power the line.

j. Testing: Ideally, the entire communication system is connected to the computer and real traffic is run in quantities similar to anticipated load. The program can be tested on the Environmental Simulator. On site, testing has proceeded in one of several ways:

1.) Where all new terminals are being installed, a side-by-side type of testing is possible. All messages sent on the old system (line traffic) are later resent on new system (as test traffic). This method permits day time testing and can simulate full loading. It requires completely separate communication lines, which have been provided by the carrier for free, depending on the type of new terminals.

2.) Where the terminals are remaining, partial testing can be arranged by monitoring the line with the 7740 to receive, and simulate sending by program.

3.) Testing can also be done outside of business hours, resending previous traffic for test. This requires extra hours for operators and often cannot simulate full loading.

4.) Testing can be performed with just local terminals, but this is far from valid for full load and all lines.

k. Cutover: None of these systems planned a sudden cutover of an entire system at one instant from an old central to a new one. This might be attempted if a complete test on a side-by-side basis had been made. Most practical systems have cutover on a piecemeal basis, usually a few lines or a geographic area at one time. This requires temporary means for intercommunication between the old central and the new. It also requires careful planning to let the cutover portion be returned to the old central.

Both of these requirements depend on the type of traffic. Systems with essentially one way traffic (to or from HQ) can live with little intercommunication between centrals. Systems with long response requirements do not need immediate return to the old central on failure of the new.

Cutover and testing plans usually involve the common carrier lines and the two plans must be coordinated so that testing is easily done but cutover is completed with line equipment in the status desired for long term installation. This means that a patch panel or demarcation strip or set of switches is designed with the present and final systems as primary criteria and all interim steps as temporary wiring or patching.

1. Schedule and service orders: Every item of equipment (central and remote) and lines must be listed on the schedule and approved by all sides. At this time, service orders can be drafted in cooperation with the common carrier for actual submission within a few days. They cannot agree to schedules without these. By drafting these at this meeting, all-sides agreement on quantities, functions, etc., is obtained.

   (A service order defines equipment and/or lines ordered by a customer from a common carrier).