

LECTURE 1

GENERAL

1. SERVICES

In introducing a study of telegraph transmission it seems desirable to review briefly first the place which telegraph work fills in the general scheme of Bell System service, and to discuss the general service requirements of the telegraph part of the Bell Companies' business.

Communication from the Bell System standpoint means direct, practically instantaneous communication from one person in one place to another person in some other place. The instrumentality which is furnished generally for this communication is the telephone, but there are cases where the passing of the written word from one person to another is more desirable than the spoken word, and for these cases telegraph instrumentalities are furnished. This telegraph service generally is not in competition with but supplementary to the telephone service.

The telegraph service of the Bell System is either a private line or an "exchange" service\* as distinguished from the message service furnished by the telegraph companies. Private line service consists of furnishing the requisite facilities including channels and station equipment to enable users to communicate between specified locations, for continuous use or specified periods. For many years this was the only type of service given, and involved only the furnishing of telegraph service under contract for certain periods each day with a fixed layout of all facilities.

The only exception to this is a certain amount of public message telegraph business done by The Pacific Telephone and Telegraph Company.

As the private line telegraph service grew and became more a part of the general commercial and industrial activity of the country, there was an increasing demand for telegraph service which would be available for shorter periods, which would better lend itself to reaching different points at different times. This demand had long been recognized, and as a preliminary step toward meeting it the minimum daily period for private line teletypewriter service was reduced to one hour in 1930. As a further step consideration was given to the providing of a switched service, similar to that of the telephone. A review of the various elements required for the giving of such service indicated that this could be done without extensive development of new means. The teletypewriter had been in service for many years and a very concerted effort had been

made to make it reliable, accurate and flexible in its application. The telegraph channels of the Bell System had been continually improved in stability and transmission characteristics. Experience with private line switchboards had provided the fundamental basis for switching arrangements for an exchange service.

In 1931, the work had reached the stage where definite plans were formulated for making the exchange teletypewriter service available and on November 21, 1931, the Bell System announced the introduction of teletypewriter exchange service. The subscribers to this service are furnished with teletypewriters connected to suitable switchboards which allow for interconnection of the various stations upon request.

The essential points of difference between the private line service and teletypewriter exchange service (known as TWX) furnished by the Bell System and message telegraph service are as follows:

Bell System Private Line Service

1. This service provides a fixed layout of facilities, immediately available for use at any time during the hours specified in the contract.
2. The communication channels may be one-way, two-way or independent channels for simultaneous use in the two directions as desired.
3. The arrangements are thoroughly flexible and adaptable to meet special requirements of customers as regards such details as type arrangement, width of paper, use of forms, or special switching devices.
4. A large volume of traffic is usually required to justify private line telegraph service, particularly where long distances are involved.

Bell System Teletypewriter Exchange Service

1. This service provides a teletypewriter at each subscriber station which can be connected through switchboards to any other teletypewriter in the system.
2. The service is two-way, facilitating questions and answers.
3. Conference connections are possible.

4. Connections are put up on demand as required, and charges are therefore based on the actual time the service is required (except that there is a three minute minimum per call, and a requirement of a \$10 per month business guarantee).
5. The service is available at all hours.

Message Telegraph Service

1. Message telegraph service may be used to send messages to practically anyone, anywhere.
2. The service is available at all hours.
3. It is available for persons having occasional short messages as well as those with larger communication requirements.

The special contract telegraph service of the Bell System is now used by a large number of business organizations, especially those doing a nation-wide business. The press associations are large users of this service. Their private line systems distribute news to about 1200 newspapers in the United States located in more than 800 cities and towns with a combined daily circulation of over 35 millions. More than 300,000 miles of telegraph circuits are used in the services for the press. Commercial and industrial concerns, such as brokers, banks, automobile manufacturers, flour mills, etc. use Bell System telegraph service for keeping in close contact with their many branches for handling their day-to-day routine business. Since the introduction of the TWX service, many business concerns both large and small whose communication requirements between certain points could not justify private line service, have found that TWX filled a need in the proper conduct of their business.

The approximate Telegraph Company mileages in the following comparison of the Telegraph Companies and the Bell System are based on reports to the Federal Communications Commission as of December 31, 1937.

	<u>Telegraph Circuit Miles in Service</u>
Western Union Telegraph Company	1,900,000*
Postal Telegraph - Cable Company	400,000*
Bell System, Private Line and TWX Service	2,000,000

\*The figures for the Western Union and Postal Telegraph Companies are the wire miles in plant. Considerable use is made of multiplex methods of transmission to secure high efficiency in the use of this plant.

In connection with the general consideration of our telegraph service the question often comes up as to why the Telephone Companies favor the giving of a complete service rather than just furnishing the wire facilities, allowing our customers to furnish their own station or telegraph repeater apparatus. This preference towards giving them a complete service is based upon the principle that the subscriber can get a better service at less cost by this method. It has been found by experience that it is more difficult to give a high grade of service when all of the instrumentalities are not under the Telephone Company's control, and when all of the factors are taken into account, the subscriber generally loses under such an arrangement.

There is an additional factor present in connection with the telegraph service, and that is the joint use of our plant for telephone and telegraph purposes must not in any way interfere with the major business of the Telephone Companies, namely, the giving of high grade telephone service. If the Telephone Companies were to lease wires promiscuously for use with non-telephone company apparatus it would be difficult to keep control of the situation to such an extent that interference would not occur. However, cases sometimes arise where a customer has special need for such a service, and in such cases if the service can be given without interference, the Telephone Companies usually make arrangements to furnish the wire facilities.

Another factor which should be considered in connection with the telegraph service is the necessity for giving a uniform type of service throughout the Bell System. A large number of the telegraph patrons are national in their business relations and therefore must deal with several different Telephone Companies. These contacts with different organizations must be such that the customer feels he is dealing with the same Bell System and that he will receive the same Bell System service in every case.

Reciprocal contracts have been arranged between the Telephone Companies and the Telegraph Companies for the rental of spare facilities such as pole space, wires, and telegraph facilities in those cases where such rental is helpful in the rendering of services of the respective companies.

2. REQUIREMENTS

The general requirements of the telegraph service of the Bell System may be expressed in three words - the service must be reliable, flexible and profitable.

(a) The Service Should be Reliable

The telegraph service must be such that it can be depended upon at all times. It must have those qualities which merit the

confidence and trust which the users of the service have in the Bell System. The larger business concerns are depending upon this telegraph service and in furnishing it the Telephone Companies must accept the responsibility for meeting this service requirement of reliability.

One of the principal factors upon which reliability of telegraph service depends is the so-called "operating margin" of the facilities used. Telegraph facilities are subject to certain fluctuations and variations due to weather conditions or changes in mechanical adjustment. In order that these variations or changes in the circuit conditions will not cause interruptions to service or errors in transmission, it is necessary to have a certain margin through which the variations can go without affecting the service. This means that the overall distortion of any given circuit must be as low as practicable and the factors which cause the variations must be eliminated as far as possible.

The telegraph art is continually changing and the requirements are getting more and more severe. A few years ago a telegraph circuit which would transmit Morse code at thirty or thirty-five words per minute over a 1,000-mile circuit was good enough. Today the Telephone Companies are required to give simultaneous two-way teletypewriter service across the continent at 60 words per minute.

With the demand for higher speeds, larger and more complicated networks of circuits and other more exacting requirements the Telephone Companies must improve their methods and means in order that the service may continue to be reliable. This necessity for reliability should be foremost in engineering telegraph facilities. It should be borne in mind when engineering for the future in making recommendations regarding the type of facilities to be furnished, so that spare facilities will always be available where needed and so that emergency routes can be used in cases of line failure. The use of cable plant to as great an extent as practicable promotes reliability. A factor of safety to insure the giving of reliable service should be considered when engineering telegraph power plants or layout of central office telegraph equipment, or in assigning specific telegraph facilities for service.

There are a great many factors which must be considered in connection with the question of making the telegraph service reliable. It must, of course, be realized that even a very minor fault such, for instance, as the paper getting caught in one teletypewriter set may put a complete circuit out of business until a spare set may be substituted or the trouble remedied. This brings up the question of spare standby apparatus at subscriber's premises which must always be considered in the telegraph ser-

vice. The requirements of any particular service must be studied and if a high degree of continuity in service is required the spare apparatus may be necessary and should be recommended. If the service is of a local nature where a delay of an hour or two in the service is not serious, the spare apparatus may not be required. It does not follow, however, that no local services should be provided with spare apparatus. One subscriber having a local service entirely within his own plant reported that he lost \$1,000 for every minute the service was out. In any case arrangements should be available whereby the subscriber may report trouble and whereby this trouble may be readily located and remedied by the plant forces.

In connection with the matter of engineering in advance so that spare facilities may be available when the contract is signed, it might be pointed out that in some cases where facilities are desired between two given points, plant may not be available for this service over the most direct route but may be available at once over another route. This alternate route may involve considerably more wire mileage and perhaps more repeater offices than the direct route, but it would, in general, be found preferable to start the service over the longer route, possibly transferring to the direct route at a later date. In other words, every effort should be made to meet the customer's desired dates even if at times it means that the service has to be given over other than would appear to be the ideal layout.

The same logic applies to the giving of service at points where it is necessary to back-haul a circuit, as for instance, where a service point is required on a cable route. The particular type of office might be a metallic telegraph repeater office where no carrier terminals are available. The service required, let us say, is a 60-speed service and cannot be given over the large number of metallic sections which would be involved. The Telephone Company then is confronted with the proposition of either saying "No" to the subscriber or of carrying the service to the nearest carrier telegraph terminal and back-hauling to the station involved, thereby making the wire mileage somewhat longer than the pricing mileage. While it is, of course not advisable to have a large portion of the service given in this way, it may be found necessary to do so temporarily in order to give promptly a satisfactory service to the subscriber.

#### (b) The Service Should be Flexible

Flexibility is the second requirement of the telegraph service. By this is meant the service must be responsive or readily adjustable to meet the requirements of changing conditions. The telegraph facilities might be set up to meet what is considered the ultimate requirements for the service and then as the requirements change, the

users of the service might be persuaded that the additional requirements could not be met. This is not the point of view existing at the present time in connection with telephone service and is not the point of view in connection with telegraph. As the requirements for the service continue to change every effort is made to meet these requirements. Of course, it may not always be possible to meet the special requirements of every customer but the general trend of requirements must be watched and the Telephone Companies must be in a position to make the services conform to the needs of the public.

A special requirement which has come to the front is that the teletypewriter should handle forms. Modern business has been built around the use of organized forms for all sorts of business communications. These have been designed originally for use with typewriters or billing machines and may involve many copies with rather complicated arrangements. In order to keep pace with this trend of modern business, arrangements have been worked out enabling the use of multiple copy organized forms in connection with page teletypewriters, and the application of teletypewriters to this type of service has grown to such an extent that 40 per cent. of the page teletypewriters delivered for private line service during 1936 were equipped with sprocket feed for the use of forms.

As an illustration of what is meant by flexibility in a telegraph service, some of the special features which are now required by different customers might be mentioned. For instance, the service which is furnished to the news distributing agencies has many special features. In some cases the circuits are operated on a one-way basis and are furnished for receiving only. This, of course, complicates to some extent the plant operating problem in connection with reporting back to the sending station any trouble occurring at these receiving stations. Many of the contracts require that certain legs be added to the circuit for certain specified periods each day and removed during the remainder of the day. Some of the contracts are for 60-speed service and others are for 40-speed service which, of course, complicates the monitoring problem. Some of the circuits furnished to the press are provided with special operating or switching arrangements in order to facilitate transmission of news from the various transmitting centers and its instant dissemination to all of the stations connected to the circuit.

Press services and also many commercial services require an automatic sending arrangement, using perforated tape for storing the transmitted message so as to get maximum speed over the line, and in addition require direct keyboard operation for handling messages of immediate importance. Another requirement which has grown up in con-

nection with the use of automatic transmission, involves the preparation and careful checking of the perforated tape before the signals are sent to the line. This has been met by arrangements permitting simultaneous keyboard transmission and tape perforation thus providing a typed record during perforation. Other special arrangements involve the necessity for remote control of the power supply at distant stations. This has been provided for by the installation of time switches at certain stations or by motor control arrangements of a type designed to suit the individual service in question. Other customers desire selective calling arrangements so that any given station or group of stations may be arranged to receive messages as desired.

Where several circuits contracted for by a single customer are concentrated in one office, the heavy flow of traffic through this office may require that special arrangements be worked out in order to permit the most efficient handling of the flow of traffic. In some cases reperforators may be required so that incoming messages may be recorded in the form of perforated tape for retransmission on other circuits. Special switching or signaling arrangements may also be necessary.

The brokers in their use of teletypewriter service have introduced special requirements. The tape printer is largely used on these services and it was found that too much delay was occasioned by the necessity of feeding the tape out of the machine before it could be torn off or even read. To get away from this difficulty, a cutaway cover was developed. It was also necessary to develop a special type of scissors for cutting the tape from the machine in brokers' service. Other special arrangements were worked out in order to permit more efficient handling of messages received on a tape printer.

These special requirements have been mentioned merely to illustrate the need for studying the individual requirements of the telegraph customers and where these requirements show a real need for something new or additional furnishing it, if possible.

#### (c) The Service Should be Profitable

The third requirement is that the service must be profitable. This is meant to apply to both the user of the service and to the Telephone Company furnishing the service. The rates cannot be less than the cost, and the telegraph facilities must be designed and operated in such a way that the cost will allow the service to be given at rates which the public can afford to pay. A large amount of attention has been given to reducing the cost of telegraph service without in any way jeopardizing the first two requirements, that is, reliability and flexibility. Improvements in central office telegraph apparatus have become available,

also a type of telegraph repeater that may be installed at outlying subscriber stations resulting in considerable reduction of annual charges and at the same time providing improvement in the stability of the telegraph service.

It is realized that at the present time there is still considerable room for improvement in meeting all three of these requirements. One thing that must always be kept in mind in connection with telegraph service is that the customers are usually

people with extensive business connections paying comparatively large sums for service upon which they are depending for conduct of large scale business operations.

It is often the case that a service interruption, even though it be of comparatively short duration, may result in a service complaint. However, if the Bell System people concentrate on designing and operating telegraph facilities to meet the three requirements mentioned above, they should be able to give a highly satisfactory service.