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DEMODULATOR

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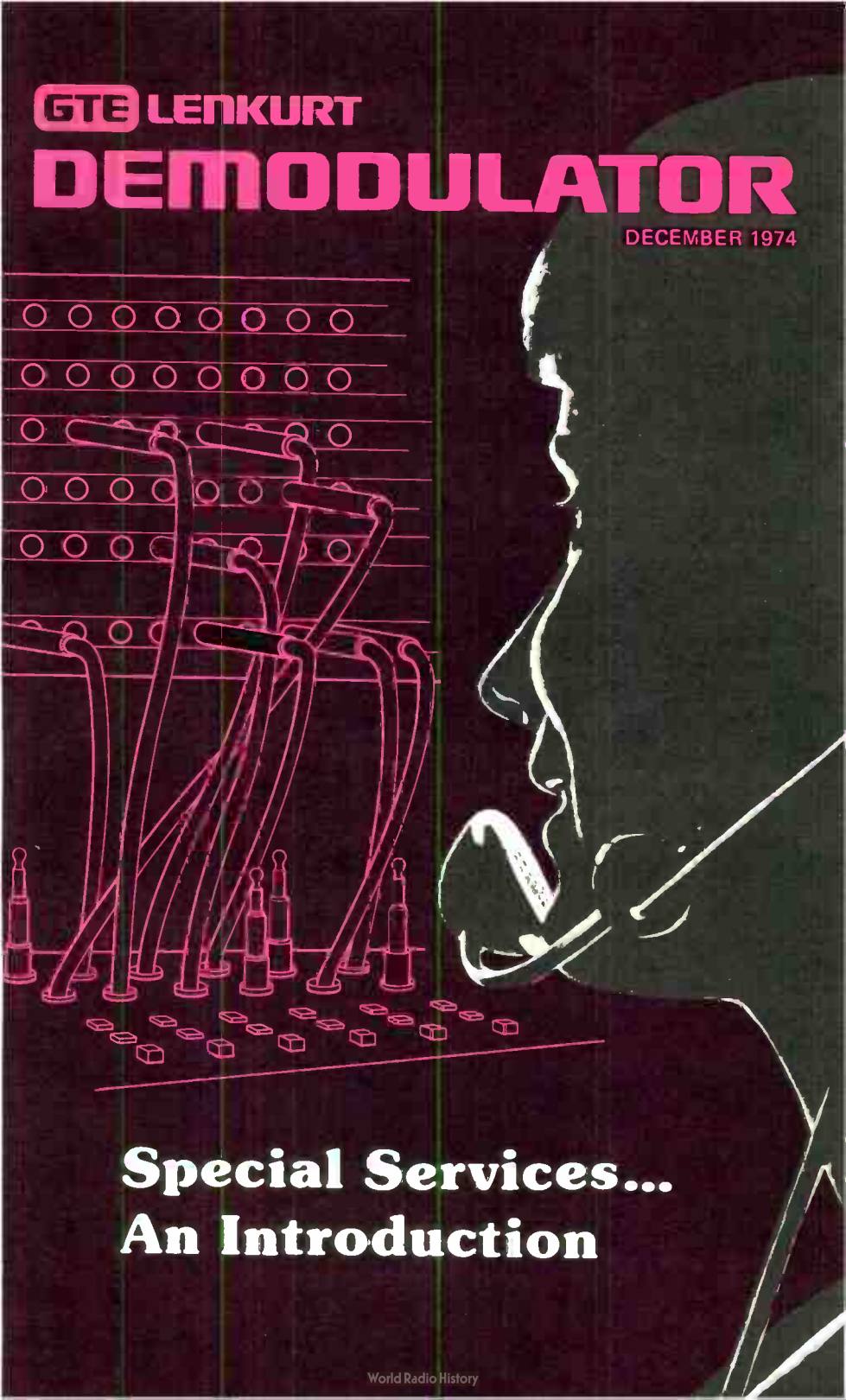
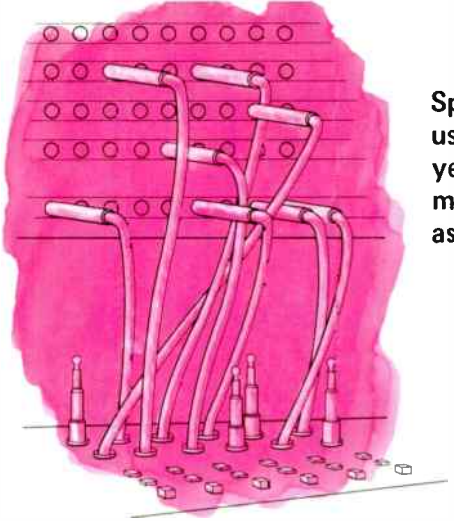


Special Services... An Introduction



Special telephone services are widely used throughout the business world, yet their versatility and multiplicity make understanding their technical aspects a difficult task.

Special services" is a nebulous term which may be used in reference to a range of literally thousands of telephone applications, or to a portion of that range; the exact definition of the term depends upon what telephone company, customer, or equipment supplier is doing the defining. It is generally accepted, however, that special services are supplements to the traditional standard services known as "plain old telephone service," or POTS, and that they encompass all applications other than residence, coin, and non-PBX business telephones.

POTS

Standard telephone service accepts and routes the telephone number codes, ranging from the single-digit zero (operator) to the seven-digit local and ten-digit direct distance dialing numbers, that are used to identify non-special service telephone subscribers, or customers.

The telephone service with which most people are familiar is the simple residence phone (see Figure 1), consisting of a subscriber station set connected by a 2-wire loop or cable pair to a central office (C.O.), and generally using a loop signaling technique. Equipment in the C.O. provides switching arrangements that enable connection of the subscriber station to lines leading to other subscriber stations. When both are within the same telephone exchange area, the connection would be to the called station's subscriber loop. For calls outside of the local area, the connection would be to a trunk leading to the central office serving the called station (a trunk is a communications channel commonly used to carry all calls of the same class that are generated between two switching centers, such as central offices; a loop is associated with one particular subscriber location). Signaling functions, also provided by the C.O. in a POTS system, allow a caller on the originating end of a line to inform a particular party at the receiving end that a message is to be communicated, and also monitor the on-hook/off-hook condition of the stations involved (supervisory signaling).

In this simple form, when a subscriber removes the handset from the cradle of his instrument (the station goes "off-hook"), a switch contact in the instrument closes, completing a dc path through a loop consisting of the

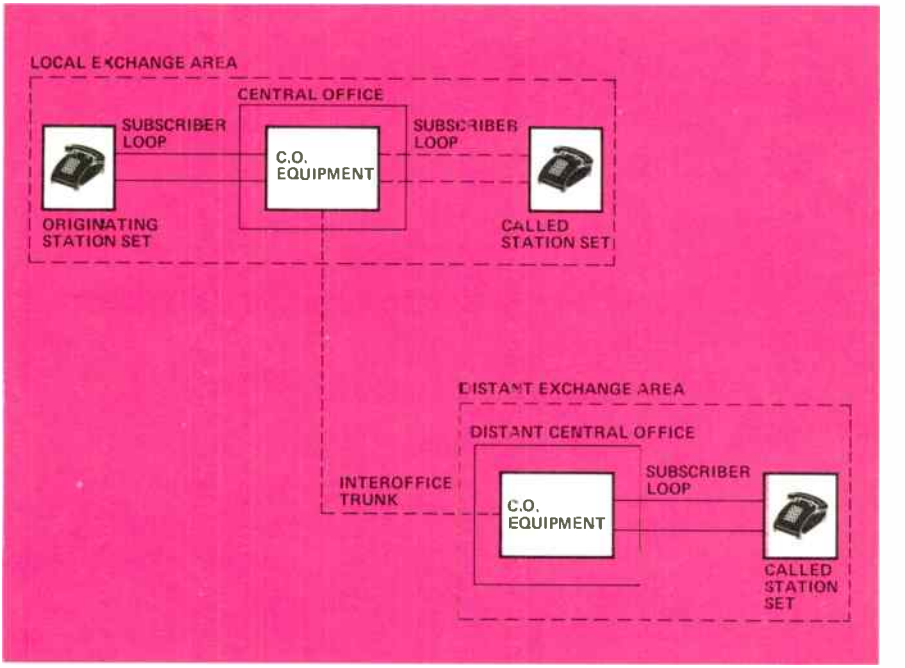


Figure 1. In POTS, C.O. equipment connects an originating station set directly to any other station within the same local exchange area (exchange service), or to a trunk circuit for connection to a distant station (toll service).

subscriber station set, a line relay, and either a battery or ground in the central office.

When this loop is completed, the line relay is energized, connecting the subscriber's line to the C.O. equipment. The C.O. then extends dial tone to the station; the dialing process generates pulses which indicate to the C.O. equipment what station is being called. The originating station is connected to the line associated with the desired station; when the called party answers, the two stations are linked and the signaling function becomes merely supervisory until the call is terminated.

Besides this loop signaling technique, which places the signaling current on the same conductors as those used for voice transmission, the telephone network uses a technique known as "E&M" signaling, which is characterized by the use of separate facilities for the signaling and voice transmission. This method employs two leads, designated E and M, to connect the signaling equipment to the signaling facility. The M lead transmits a battery or ground indication from the central office to the distant end of the circuits, while incoming signals are received on the E lead. (See the July, 1966, *Demodulator* for a more extensive discussion of signaling techniques.)

Special Service Categories

Special services are usually some form of extension of the local-tele-

phone type of service, and almost always make use of the same facilities and techniques provided for regular telephone service. In the broadest sense, they are intended to extend signaling functions to subscriber stations whose locations preclude standard telephone loop service.

A residence phone would be provided special service, for example, if the station were beyond the pulsing limit of the standard C.O. equipment. This limit is the maximum amount of distortion — caused by the loop line impedance — that a central office can tolerate in the dial pulses generated by a subscriber's telephone before the C.O. equipment begins to make errors. To compensate for this distortion, a long-line adapter can often be placed in the 2-wire loop at the central office as an impedance-matching device, extending the dial pulsing and ringing ranges. When the station is so far from the C.O. that the voice transmission and signaling function are both impaired, a voice-frequency (VF) repeater is commonly used in conjunction with a long-line adapter to keep the over-all system operation within acceptable limits. However, if the loop is so long that the repeater-adapter combination cannot make up for all of the line loss, the 2-wire loop can be replaced by a 4-wire circuit. In this application, two cable pairs — one for each direction of transmission — are used between the station and the central office. Because the station set and C.O. are essentially 2-wire facilities, a 4-wire terminal set is generally installed to act as a 2-wire to 4-wire conversion device in this special service.

Special services find their greatest application in the business community, where their uses extend beyond voice transmission to include such services as data, facsimile, and television transmission. It is possible, despite the number of variations and the frequent overlapping of implementations, to group all of these special services into four very general categories: foreign exchange (also known as special access), private lines, tie trunks, and common control switching arrangements (switched service networks).

A private branch exchange (PBX) switching system is very often included in the implementation of a special service. PBX systems are placed on subscribers' premises to allow limited-digit dialing—typically two or three digits are used—between telephones on the premises, and to provide access to the central office equipment.

Foreign Exchange

The foreign exchange (FX) category includes services similar to those provided by regular subscriber lines (POTS), but differs from these in transmission and signaling requirements, and in the location of the station relative to the central office serving it. A few of the classes of service in the FX category are PBX foreign exchange, wide area telecommunications service (WATS), and off premises extension.

In a typical application, a subscriber's station is served by a switching system remote from its local central office, providing service to and from a telephone exchange other than the one which would normally serve the station location. This allows calls to and from the distant C.O. area without a toll charge; the subscriber typically pays the normal rate for local service plus a fixed monthly fee for the interoffice mileage. If, for example, the subscriber were a busines

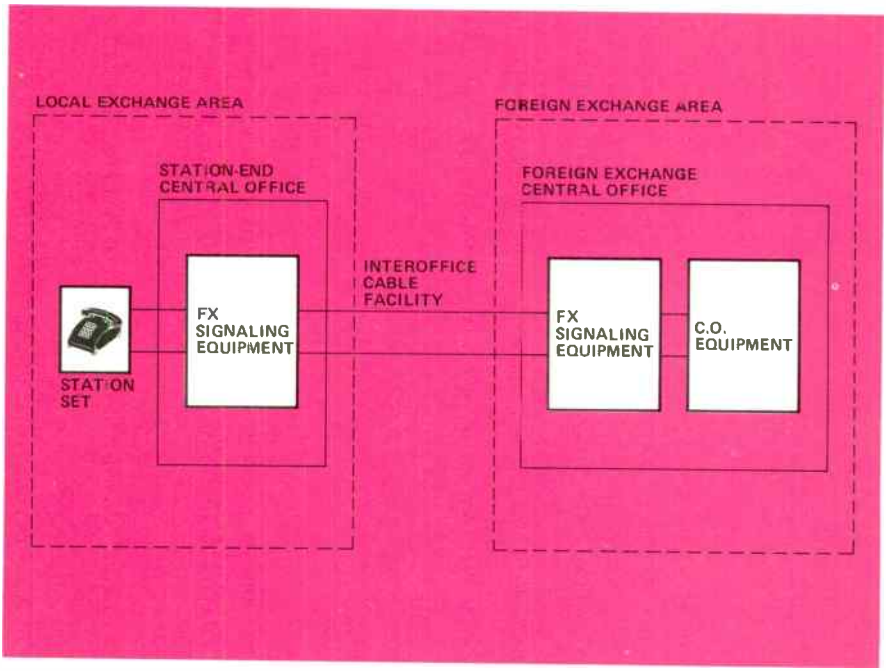


Figure 2. Implementation of foreign exchange service means that a subscriber's station set is served by equipment in a remote telephone exchange area.

with a large number of customers in an area not connected to his local central office, foreign exchange service would allow the customers to dial a number in their area and reach the business without paying toll charges.

Figure 2 shows one form of FX application. In this instance, a local cable pair connects the subscriber's set (which may actually be a PBX system) to the station-end central office, and a cable facility links the station-end and foreign exchange offices. When the subscriber's set is a telephone instrument, the service is generally referred to as a "foreign exchange line"; when it is a PBX system, the service is a "foreign exchange trunk."

Assuming that E&M signaling is being used, when the subscriber goes off-hook, the E lead at the FX end receives the signal and causes the line relay to energize, just as in POTS. This completes the loop, allowing the FX office to extend dial tone back to the subscriber set. Dial pulses are passed through the facility to the central office equipment, which determines what station is being called, and completes the call.

A call to the subscriber station set causes the FX office equipment to send ringing current through the station-end C.O. to the set. When the subscriber lifts the handset, an off-hook signal is returned to the FX office, which then closes the loop to link the two voice paths together.

The off-premises extension (OPX) class of service shown in Figure 3A allows connection of an OPX station set to the same line that serves a main

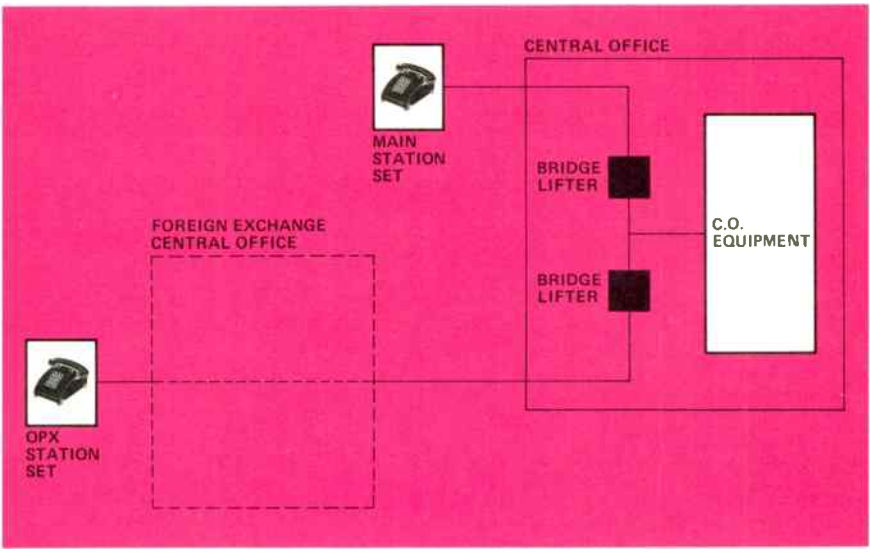


Figure 3A. An off-premises extension is commonly bridged at the central office. If the OPX station is in a foreign exchange area, it is implemented as an FX service.

station set. Typical of this application is the small businessman who, upon leaving work, throws a key switch to route calls from the office directly to his home where the OPX is located. An off-premises extension is commonly bridged at the central office rather than at the primary station location, although when used with a PBX switching system—in which the extension is generally assigned its own number, and is referred to as an off-premise station (OPS)—the bridging is often done at the main PBX station, as shown in Figure 3B.

Private Lines

Private line services are those which employ dedicated transmission facilities to link two or more subscriber station locations. The simplest private line service consists of two subscriber station sets permanently linked together by a communication channel, and provided with a signaling function.

The methods for implementing signaling in private lines are as varied as the applications, and are determined by customer requirements. These requirements may vary from no signaling at all, through signaling in one direction only, to the case where each station in a network is able to signal any one of the other stations individually, or all of the stations simultaneously.

Ringdown signaling is frequently used in private line applications; it utilizes a continuous or pulsing ac signal transmitted over the line to ring the other station or stations on the line. A simple private line using automatic ringdown signaling is shown in Figure 4. When one of the stations in this "hot line" application goes off-hook, it causes the other station to be automatically rung. This service is used a great deal at airports and other locations to allow rapid connection with taxicabs and hotels.

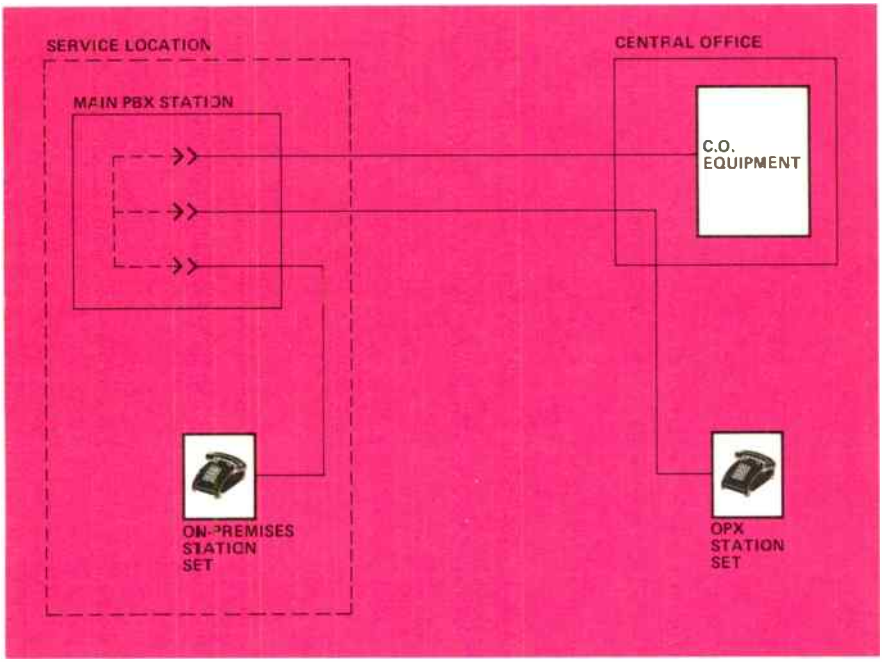


Figure 3B. An off-premises extension in a PBX system is commonly bridged at the main station location.

Another common application of private lines is the multi-station network. Generally designed for conference-type service, this application allows a large number of stations to be interconnected, with any number off-hook, without interfering with the transmission quality.

Besides the applications outlined here, private lines also are used in such areas as telemetry, mobile radio, and alarm circuit extension.

Private line service can offer both economic and technical advantages over standard telephone service. If the subscriber's telephone traffic is heavy enough between the dedicated locations, the fee for private line service could be significantly less than the charges for a large number of toll calls. Also, because they are dedicated and their performance characteristics known, private line communication channels afford a subscriber a great deal of flexibility in establishing his system.

The nature of private lines is such that they cannot be switched directly to the exchange and toll networks. However, a PBX termination provides access to these networks, as well as to other private line circuits and services (such as off-premises extensions) that may terminate at the PBX station.

Tie Trunks

Basically, a tie trunk or tie line is a communications channel used to directly connect two PBX switching systems; it is, in effect, a private line terminated at both ends by PBX facilities. Tie trunk applications can range

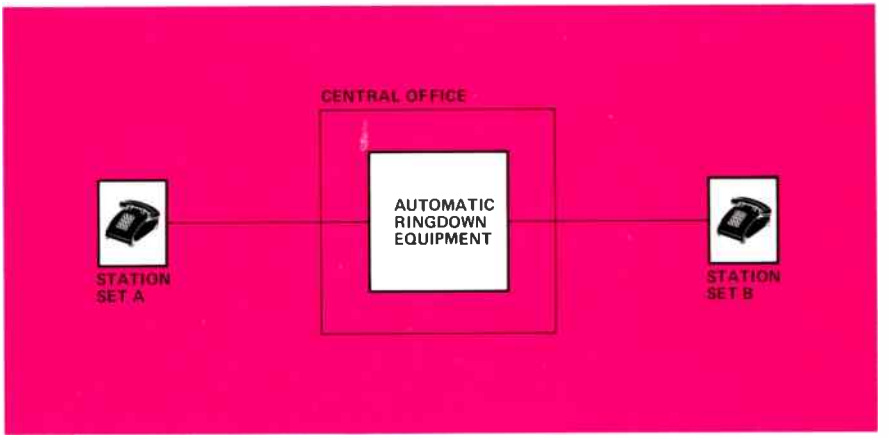


Figure 4. An automatic ringdown private line allows one station to ring the other as soon as the handset is lifted. One application of this service is in airports and similar facilities to summon taxicabs and make hotel reservations.

from a simple one-link, voice-only connection to a complex and flexible tandem network for both voice and data transmission.

Classification of tie trunks is generally in terms of their signaling and switching requirements. For example, a "tandem PBX network" employs a specific type of switching at the PBX locations, but may use any suitable signaling technique; a "ringdown tie trunk" uses a ringdown signaling technique, but may employ any suitable switching method.

The non-tandem tie trunk application shown in Figure 5 is used mainly to connect two PBX systems that are not associated with other PBX's. Besides making this connection, the trunk may also be linked to the exchange and toll networks through C.O. equipment.

If the tie trunk in Figure 5 were a dial repeating tie trunk, a user at either one of the PBX stations could pick up a handset and dial an access code — generally a single digit — to receive dial tone from the distant PBX. He could then dial the number of a station at the distant end and be automatically connected to the desired station. In some applications, the caller could access the distant PBX and place a call to any station within the distant exchange area. In a ringdown tie trunk, dialing the distant access code would connect the caller to a PBX attendant, who would then manually complete the call.

The tie trunk provides for very rapid connection of PBX stations at both ends of the line; many subscribers, however, have PBX systems at widely separated locations. Such a subscriber may have a high community of interest between these locations and require more than individual tie trunks between pairs of systems. For such a subscriber, a common control switching arrangement (CCSA), or switched service network (SSN), is available.

Common Control Switching Arrangement

The common control switching arrangement (CCSA) is a private line

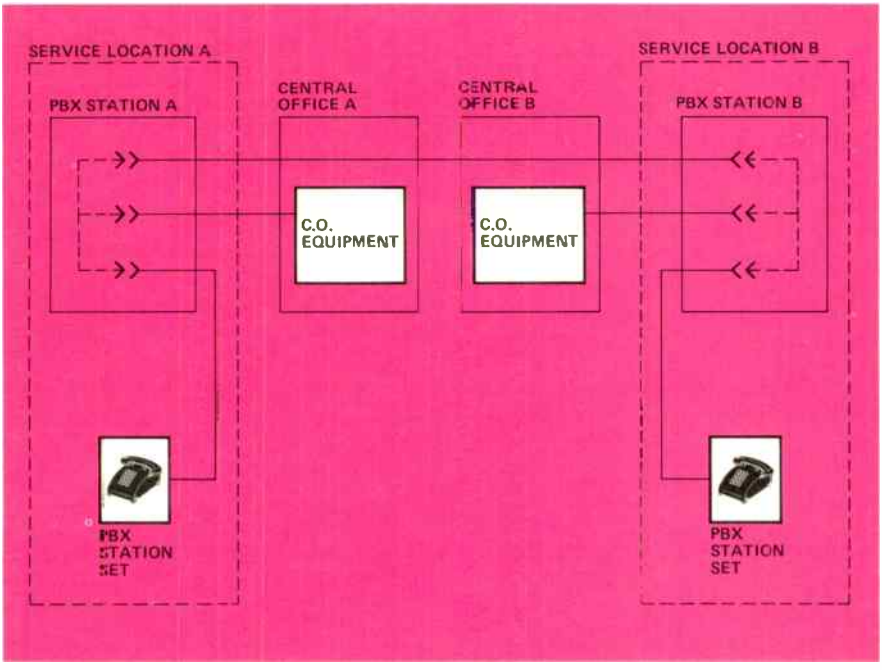


Figure 5. A tie trunk links two PBX systems, and may also provide access to the regular switched networks through the central office equipment.

service designed to allow dialed connection between scattered subscriber PBX switching systems. As shown in Figure 6, each PBX system is connected by dial tie lines to a CCSA switching machine in its local central office. Thus, a user in one location can dial an access code, receive dial tone from the nearest CCSA switching machine, and dial a 7-digit code to reach any PBX station in the network. The first three digits are used by the machine to determine which PBX location is being addressed; the last four digits are then extended to the selected location, enabling the system there to ring the desired station set.

Just as the direct distance dialing (DDD) network contains all of the voiceband trunks needed to provide toll and exchange message service between central offices, the CCSA network includes the access lines and trunks necessary to connect the PBX stations and systems into the switching network. Any service normally provided by a PBX system on the toll and exchange network can be provided by the CCSA, including both voice and data transmission.

Special Service Equipment

Throughout this discussion, the various special services have been considered in simplified terms, with blocks representing equipment and single lines representing communication channels. In practice, however, implementation of a special service may entail use of a large number of features and considerable amounts of equipment; a foreign exchange link, for

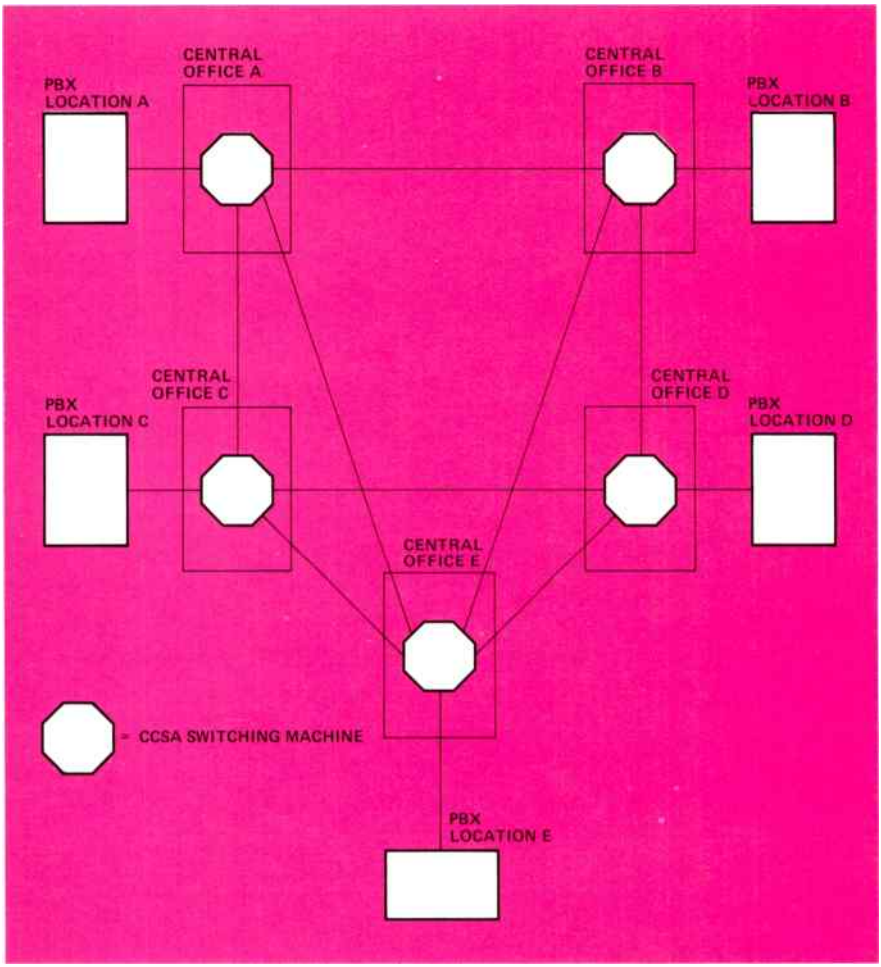


Figure 6. A CCSA network provides interconnection of subscriber PBX systems which are spread among several locations.

example, may actually extend through many central offices, employing several types of carrier and physical facilities in its application.

Traditionally, the individual circuit components of a given transmission facility terminal have been grouped together in a central office area dedicated to that function, and have been connected through distributing frames to the other equipment required for the circuit. This method has a certain amount of flexibility, but also creates problems such as noise and crosstalk aggravation by congested office cabling, and difficulty in maintaining components which are scattered through a large building.

To overcome these problems, plug-in units and direct wiring have come into use, providing all of the circuit features required at a transmission

facility terminal in standard shelf arrangements that require no local cross-connection. The end objective of this technique is to eliminate the need for any distributing frame connections except where the circuit leaves and enters the plant building.

Implementation of this "consolidated equipment" concept is achieved by using plug-in units designed to meet the facility interface needs of the various special services; equipment shelves provide a direct-wired position and socket for each special service function, allowing the function to be changed or modified by simply removing a plug-in unit from the socket and inserting a different unit.

This approach has been extended to the point where terminal equipment, such as GTE Lenkurt's 11A Signaling Equipment arranged for private line and special service applications, can be installed on a subscriber's premises rather than in a central office. By placing an equipment housing on the premises and equipping it with appropriate plug-in units, any desired special service can be implemented.

Voice frequency equipment and the services it afford have both evolved considerably since the telephone system first began to extend beyond the capabilities of a simple pair of wires. Because of the progressing state of the communications art and the pressure created by the growing demands of communications users, special services have been developed which can meet virtually any need, whether VF or data.

The multiplicity and overlapping of the various special service applications can be overwhelming if one attempts to view each service individually; looking at the way in which the services interrelate, even in such a cursory manner as has been adopted in this discussion, can put the entire field into its proper perspective.

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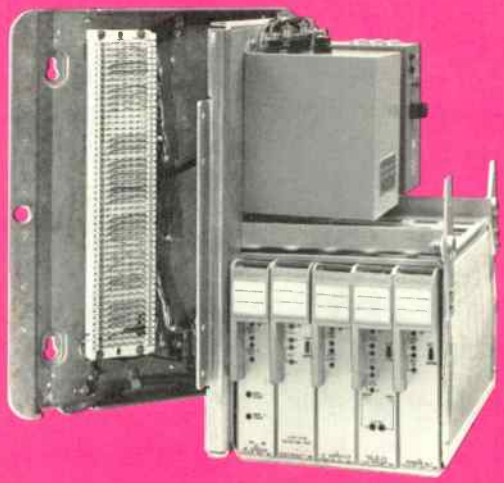

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