

Advances in switching technology, diverse operating requirements, and constant needs for new services have stimulated PBX evolution. These stimulants, always coupled with the objective of lower costs, have led to modern, flexible, electronic PBX systems.

Sixty Years of PBX Development

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OVER SIXTY YEARS AGO, the Bell System's first standard private branch exchange (PBX) was developed for interconnecting a small group of telephone stations within a customer's office and providing switching among them. Since then, PBX services have changed to meet and anticipate various forms of business, industrial, and large residential needs for reliable, economical, and modern telephone communication.

A manual cord-type, nonmultiple switchboard, the No. 4 PBX (upper left) was the first standard private branch exchange in the Bell System.

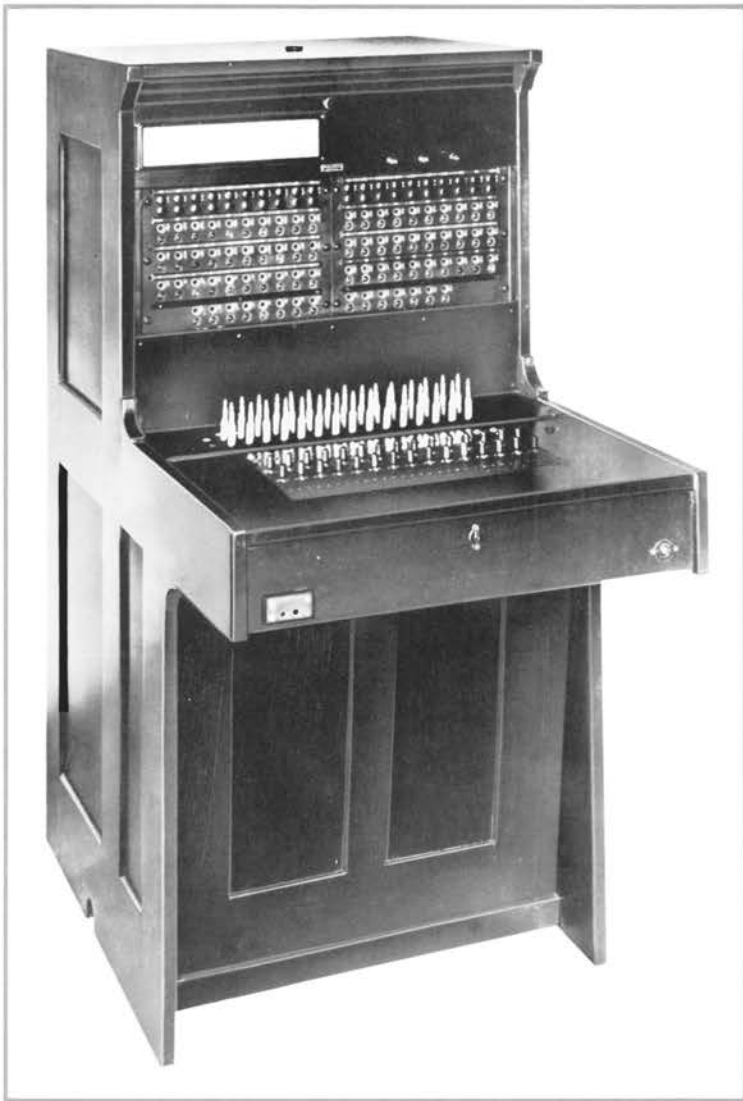
The 606A of 1929 (upper right) used smaller plugs and jacks to handle up to 5000 lines. Special customer options were also available for the first time and established a new trend in PBX service.

The 800A PBX provides flexibility, economy, and small size for the customer who needs basic service at low price. This PBX for up to 80 lines has modular equipment packages so that additional features and options can be included.

A number of definite trends mark the evolution of PBX service. One trend runs from manual, through electromechanical, to electronic switching. Another traces the increasing variety of operating procedures for both PBX attendants and station set users. Still another is the continual introduction of new and convenient services in response to customer demand. All these trends have advanced within the bounds of the Bell System's constant objectives—reduction of manufacturing costs, improvement in installation and maintenance methods, and flexibility to meet customer requirements. These factors have been the major influence on transitions in equipment, service, and applications which have resulted in today's PBX systems.

The 800A electronic PBX (see *Electronic Switching for Small PBX's*, RECORD, February 1967) and the No. 101 ESS (see *The No. 101 Electronic Switching System*, RECORD, November 1963) are the latest of today's modern generation of PBX's. Their evolution can be viewed conveniently by decades from early 1900.

Before the turn of the century, when the need for private branch exchange service first origin-



In 1916, the electrically and mechanically improved 550 PBX replaced the No. 4 which had been the standard since 1904.

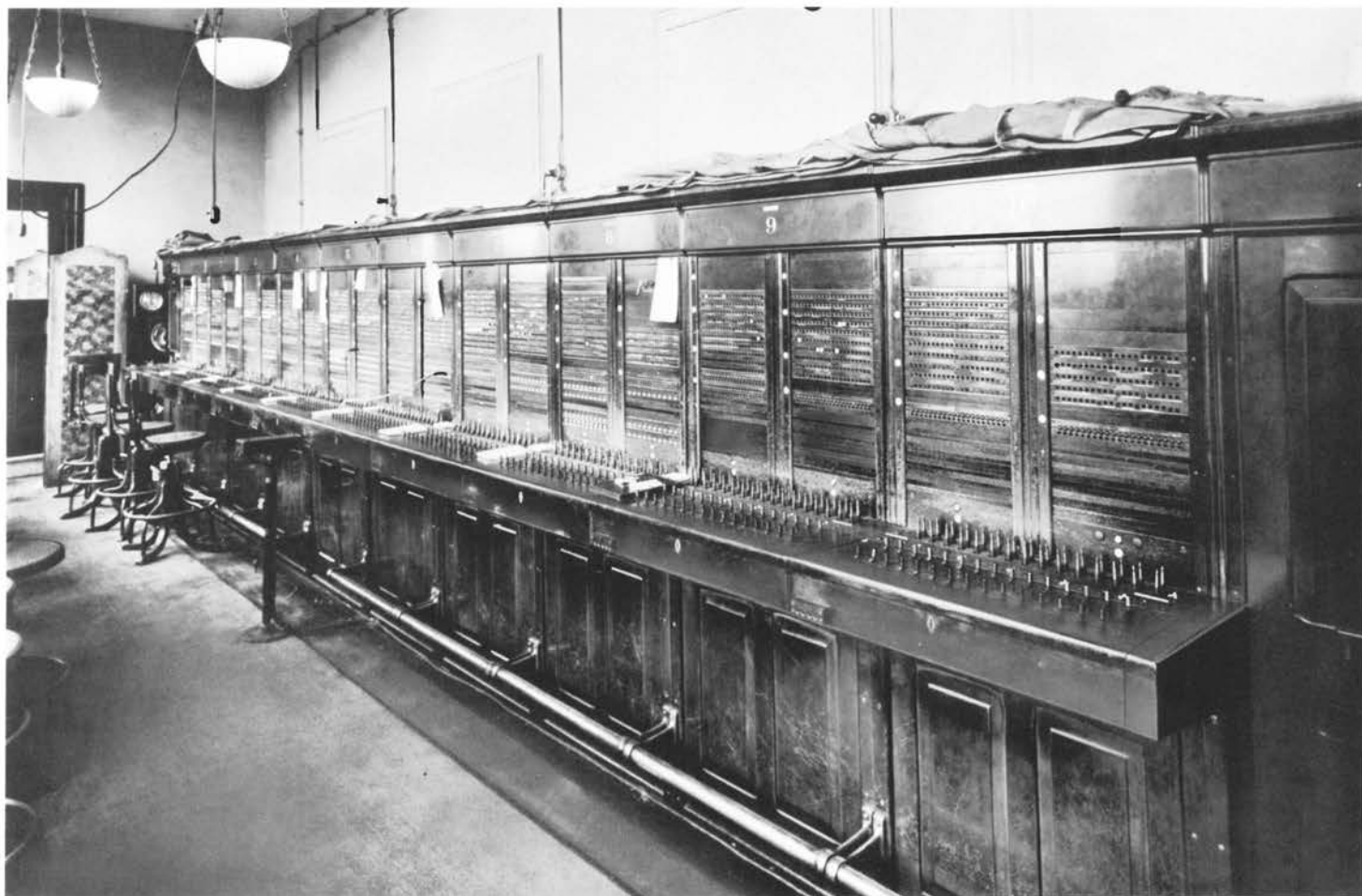
ated, the operating companies designed equipment themselves to meet a variety of customer requirements. Obviously, this resulted in a large number of styles and systems, nonstandard designs, and uneconomical production methods. The No. 4 PBX, a manual cord-type, nonmultiple switchboard, designed to meet the common needs of all the operating companies, was manufactured in 1904 and became the first standard PBX in the Bell System.

The demand for PBX service grew rapidly, and in 1916 the mechanically and electrically improved 550 manual PBX replaced the No. 4. Between 1916 and 1920, the 550 had progressed through series A, B and C. The 550A and 550B could have 30, 80, or 320 station lines. The 550C had the same traffic capacity but included a new design modification which permitted interconnections with dial central offices.

Although the era of the manual PBX was far from over, the 1920's saw the real emergence and growing importance of dial PBX systems. Dial central office installations were proliferating, and the dial PBX with step-by-step switching and cord switchboards was well suited to large businesses. The first standard dial PBX for interconnection with dial central offices, the 700C, was in use in the early 1920's. Its capacity was more than 1000 station lines. However, the 700C was uneconomical for less than 100 station sets, and a smaller PBX was marketed in 1926. This system, the 740A, brought two notable innovations to dial PBX service: a cordless attendant's cabinet called a "turret," which could be mounted on a desk and which reduced the work of the operator so that she had more free time to perform other duties; and factory-wired switching equipment, which reduced installation costs. The demand for the 740A stimulated additional improvements, and in 1928 this system was followed by the 740B and 740C. Switching equipment for the B and C types was smaller, and the attendant's cabinet for the 740C was a small ornamental wooden box resembling an expensive radio. The primary markets for the 740C in the booming late 1920's were large residences or estates which required equipment designed to harmonize with fine furniture and the luxurious decor of the times. Also in 1928 improvements in large station capacity PBX's for dial service resulted in the 701A, which replaced the 700C. The major improvement in the 701A was the full use of step-by-step switches for line finders, as well as for selectors and connectors. This promoted uniform installation and simplified maintenance.

The 750A dial PBX, another development of 1928, was designed for even smaller business applications—those requiring less than 15 stations and no more than three central office trunks. This was an all-relay type PBX except for dial pulse counting by simple, rotary, step-by-step selectors. Like a key telephone system, the 750A used a "pickup button" to select central office trunks. This reduced the cost of trunk equipment because it eliminated the trunk code dialing used for other PBX's.

While dial PBX systems were gradually increasing in importance as dial central offices became widespread, a major portion of the PBX market in the 1920's still called for manual equipment. The requirements for small capacity manual systems were met by the 551 PBX, which replaced the 550 type first developed in 1916. The 551A with 40 lines and the 551B with 320



The first standard dial PBX system for interconnection with dial central offices, the 700C, was in use in the early 1920's. Using cord switchboards and step-by-step switching equipment, this PBX was well suited to the requirements of large businesses and could handle from 100 to 1000 station lines.

lines were the result of the first real design efforts aimed at improved manufacturing and maintenance methods. The development of the 551 types introduced manufacturing methods based on progressive assembly, an early approach to mass-production techniques. Phenol fibre keyshelves and plug faces were used on these models to improve durability and reduce field repairs.

The larger manual PBX systems, in the "600" series serving up to 9600 station lines, were also receiving close attention in the years just prior to 1930. This series had an extremely wide range of application for larger installations. The 600C served 640 lines; the 604C, in a typical location in New York City, served 1650 stations. The 605A, developed in 1928, was designed for compatibility with dial equipment but was essentially a manual, multiple switchboard PBX. The 605A

multiple board served 1760 lines when used alone, but its capacity could be nearly doubled by coupling it to dial switching equipment.

Smaller systems could be arranged by combining boards and switching equipment. The 552A PBX, which consisted of the 605A circuitry in the housing of the earlier 551A, served 100 or fewer station lines; the 552A used with 740A dial equipment became the 740AX PBX and served 300 station lines. Even in these early stages of PBX evolution, attempts were being made to standardize basic equipment while providing the versatility and range of service that the customer required.

The business boom of the late 1920's continued to stimulate demand for large manual PBX systems. The capacity of the 605A system was limited by the relatively large jacks and plugs on



These dial PBX systems were marketed after 1926 to meet the needs of small business and residential customers. The 740A in



the left photograph had a unique cordless attendant's "turret", while the 740C offered an even smaller, more luxurious cabinet.

the switchboard. Therefore, in 1929, the 606A PBX was developed with the smaller plugs and jacks ordinarily used in central office boards. This system could handle up to 5000 lines. Even more significant changes were incorporated: automatic machine ringing when the cord connection was made to the station set; audible-flashing recall to signal the attendant when service was desired; and symmetrical cord circuits for easier operation by the attendant. At that time, these features could be considered luxury options, providing improved service and more efficient operation at extra cost. The first such options to be offered to the customer established a new trend.

During the 1930's, two dominant factors arose which affected the evolution of the PBX. One of the most serious and negative influences was the business depression in the early years of the decade, which stifled demand for new equipment and slowed development efforts on PBX systems. A positive factor, and one which marked another major transition in equipment design, was the development of crossbar switching systems. The first crossbar central office was installed in 1938, and a crossbar PBX, the 755A, appeared at the same time.

The 755A was a small, dial-type exchange, designed to replace the all-relay type 750. It could handle 20 station lines, compared to 15 for the 750. Both systems employed key telephone

sets, but a six-button key set for the 755A replaced the five-button set used on the 750. A larger crossbar PBX, the 745A, was also developed and given a field trial in the late 1930's. This PBX served 600 lines and introduced two new features: a switching network with only five links accessible to ten lines on each primary subgroup of switches (crossbar central offices provide a minimum of ten links for each primary subgroup); and a call-back feature which allows the links used during dialing to be released for reuse after dialing is completed. Unfortunately, the onset of World War II diverted nearly all development effort to war projects, and the 745A was not developed finally.

In spite of reduced demand for PBX systems in the early 1930's, other efforts to improve service and equipment were continued. Improvements in the circuitry of the large capacity 606A PBX brought about the 606B system. Basically, the modification involved connecting the cord circuit directly to a step-by-step line circuit and eliminating an extra relay for each line. This arrangement provided for convenient growth without extensive modifications to original equipment.

A notable trend of these years, which would have a strong impact in future equipment design, stemmed from a consideration of the attendant's functions. After several years of experience with the 740 PBX systems of the late 1920's, certain problems became apparent which centered on the



The 555 PBX, developed after World War II, was the first system to use the efficiency of plug-in units for many circuits.

operating efficiency of the attendant and the effectiveness of the table top turret compared to cord switchboard equipment. The attendant cabinets, such as for 505 and 506 series key switching and for 740 dial-key switching, anticipated reduced size and simplified operation of the equipment, and increased availability of the attendant to perform duties other than handling telephone calls. The objectives were not entirely met. Most of the cabinets, except for the 740C, were still relatively large, difficult to operate, and not really very attractive. The small 740C was an ornamental cabinet designed for applications which were appropriate at the time, but the market rapidly evaporated during the depression. General functional problems also were apparent in the key-type cabinets. On incoming calls, the attendant had no way of knowing whether a station line was busy and had to dial successively until the line became idle; there was no automatic disconnect from a central office trunk on station hang-up. The main result of the situation was a reversion to cord switchboards. The 740AX PBX filled this need very adequately and was relied on heavily throughout the 1930's and even later.

In the early 1940's, the major effort was directed toward systems and equipment needed for the war. Very little time could be spent on consumer products, and PBX developments were largely curtailed. One interesting application

from the point of view of size was the development of a PBX for the War Department building in Washington. This system, using standard equipment, served more than 15,000 station sets. It also had separate information-intercept facilities so that fast, accurate service could be given without involving normal switchboard operations.

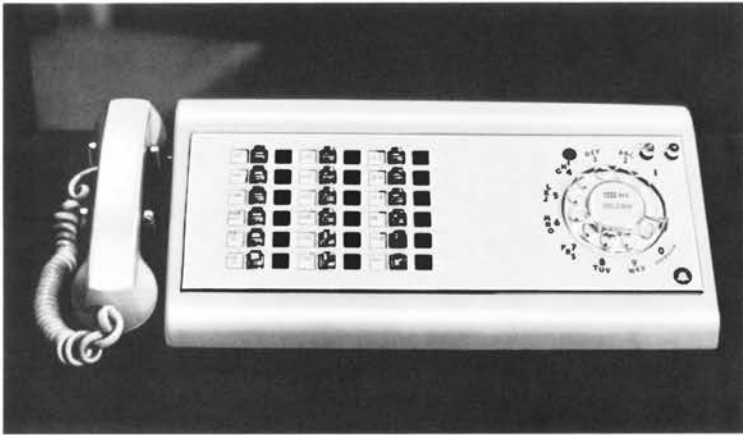
After World War II, some new and improved manual PBX's were developed. The 555 and 556 replaced the 550 and 551 types of 20 to 30 years earlier, and the 607 PBX consolidated the improvements accumulated in developing the 606B of the late 1930s.

The 555 PBX was a nonmultiple manual cord switchboard with a capacity of 120 lines. The board was designed for more efficient attendant functions, and used new U and Y relays instead of E and R types. It also provided another significant step in PBX evolution. The 555 PBX was the first system to use plug-in units for many circuits to minimize field maintenance and utilize centralized repair facilities. The plug-in system meant less investment in permanent equipment to anticipate expansion, easy addition or removal of units to alter capacity, and economical shop-wired production methods.

The first improved dial PBX of the decade beginning in 1940, the 740E, was designed in response to economic factors. Available dial PBX equipment consisted of the 701A with a 9600 line capacity, and two smaller systems—740A (88 lines) and 755A crossbar (20 lines). Although the 701A was practical temporarily for relatively small applications when expansion was definite, it was largely uneconomical for much less than 100 lines. At the same time, the 740A was limited to 88 lines. The 740E, a step-by-step system using the 556 cord switchboard, supplied the need for an intermediate range of service—a basic equipment package for up to 80 lines with readily available and economical expansion to 300 lines. A cord switchboard in place of the earlier cabinet of the 740A was also appealing, and other improvements in design were evident. Installation costs were lower, since most of the equipment was assembled and wired in the shop, and more flexibility was provided, including direct station dialing over tie trunks, group line hunting, and restricted service.

The decade of 1950-60 was another era of change and innovation in PBXs. The crossbar PBX, which first emerged in the late 1930's, was firmly established in the PBX family, and exploratory work with an electronic PBX (now known as No. 101 ESS) began in the mid-1950's.

The 756A crossbar PBX for 20 to 60 lines was



In 1953, 756A crossbar PBX introduced features such as camp-on and delayed through supervision. A radical change in equipment is also evident in the new, more attractive attendant's console.



A cord-type, multiple switchboard, the 608A presents a new, modern appearance, occupies less space than earlier models, and has additional service features. The board was first introduced in the late 1950's and still remains as a popular standard today.

developed in 1953 and offered many new features. The system was housed in two modular cabinets combining crossbar switches and wire spring relays as basic switching components. Many of the wire spring relays were new two-in-one types which provided two relays in the space normally required for one. The common control circuits for the system offered high reliability through redundant circuit arrangements. For example, two marker channels were provided for simultaneous use on each call. The marker determines the busy and idle state of called points, performs an idle hunting function for grouped lines and trunks, and controls the establishment of talking connections. If trouble was encountered in one of the marker channels, the other marker would complete the call.

The following new features in the 756A were important steps toward the ultimate development of modern electronic systems:

Camp-on service for calls from central office trunks, which "held" the call to a busy line and automatically completed the call when the line became idle.

Delayed through supervision on central office trunk connections, which allowed a station user to recall the attendant by a brief disconnect with the receiver hook.

A split transmission circuit on incoming central office trunks, which permitted private conversation between attendant and station user before the central office circuit was connected.

Restricted service facilities, including toll call diverting to the attendant on individual lines instead of only a common group basis.

A new attendant's console was also an important feature of the 756A system. This was the first large scale deviation from switchboard equipment since the introduction of the turret in 1926. The console had push-button keys and the capacity to handle all ordinary calls requiring the assistance of an attendant. It was small and attractive enough for table or desk top mounting.

In 1959, development was started on the 757A crossbar PBX. This development increased the capacity of crossbar PBX's up to 200 station lines. The 757 PBX required a minimum of three equipment cabinets for the smallest installation and could grow in line size and traffic capacity up to its maximum of 200 lines. The cabinets of the 757 are the same in appearance as those of the 756A. The common control is arranged to pro-



The switch unit of the No. 101 ESS is installed on the customer's premises, while the control unit is located in a central office. The switch unit cabinets are designed to blend with modern office decor.

vide reliability beyond that of the 756. The attendant's console is larger to accommodate the increased capacity of the system.

Even with the approach of electronic systems for PBX's, manual switchboards were still an important part of the PBX market. In the late 1950's, the 608A cord-type multiple switchboard was developed to provide an attractive, versatile product for this market. The 608A had all the service features of the old 607A PBX but occupied less space, offered new, additional services, and had a much more modern appearance. Push-buttons replaced the usual lever-type keys, and plug-in units were used for all cord relays. Flexibility was the major advantage of the board, since it could be used with or without dial equipment and could handle a wide range of station sets from 80 to as many as 2400. The 608A has become quite popular, and manufacture of all other PBX cord switchboards has been very limited.

Since 1960, the economic advantages and serv-

ice capabilities of electronic switching systems for PBX's have been exploited in two steps. First was the No. 101 ESS, the second the 800A. No. 101 ESS was designed primarily for business areas served by a single central office building, where from 1000 to 3200 station lines are needed by a combination of several customers in the 80-to-2000-line range. The 800A was designed to serve customers requiring not more than 80 lines.

No. 101 ESS has a common control unit located in a central office. Switching units are on the customer's premises and are controlled from the central office over data channels. This system offers the important new features being designed for PBX's: TOUCH-TONE® calling, Speed Calling, conference calling, individual call transfer, and centrex. Centrex service provides direct inward dialing to a PBX extension, direct outward dialing with automatic message accounting (AMA) for individual station billing, and incoming call transfer.

The 800A electronic PBX was designed for the customer who needs a small, economical service for more than 20 and less than 80 telephone extension lines. This customer accounts for a large part of the demand for PBX service. The 800A provides economy and flexibility of basic service at the lowest price but can also be modified to include additional features and options for extra service. Modular, building-block principles in system, circuit, and physical design make this versatility possible.

The basic 800A package consists of an attendant's console and an equipment cabinet about the size of two five-drawer files. Service for up to 60 lines can be provided by one cabinet. A second equipment cabinet provides maximum service for heavy traffic on 80 station lines. Basic features of the 800A include station-to-station

calling, direct outward dialing, group station hunting, internal dial code restrictions, and night connections. Additional features such as station dial transfer, camp-on, and conference calling are also available. Optional features, including TOUCH-TONE service, dial conference, tie trunks, paging, and recorded telephone dictation, can be provided as desired by the customer.

This latest electronic PBX system, 800A, is the result of many years of changing trends but constant objectives. The Bell System's attention to the needs of the customer, the desire to provide continuously improving and modern service, and the ability to give the best telephone service at the lowest possible cost have dominated the course of developments throughout these past 60 years. The 800A PBX is another chapter in a continuing story of progress.

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