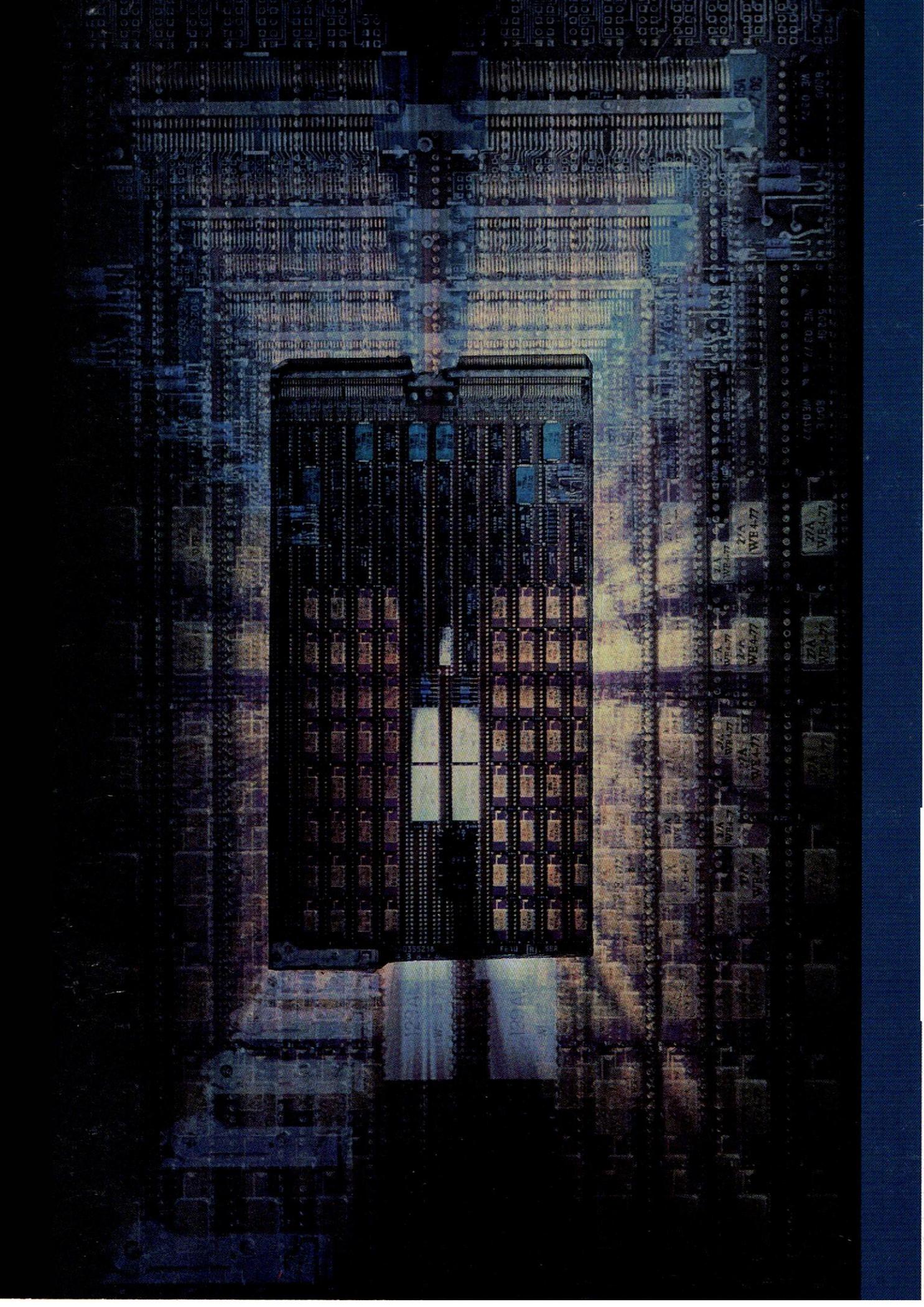


Local Electronic Switching Systems

Tailor services to your customer needs



Western Electric



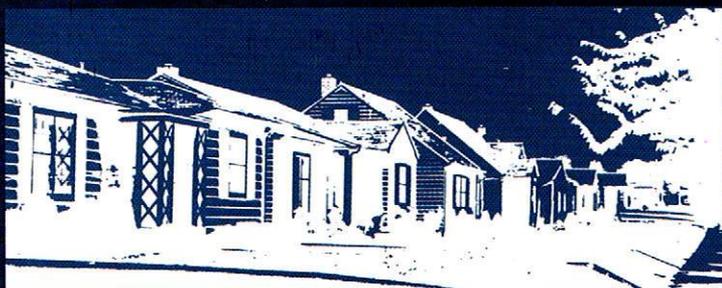
Local Electronic Switching Systems

Add flexibility. Lower costs. Give your customers better services with any of three Western Electric Electronic Switching Systems. Tailor your services to your customer's needs in...

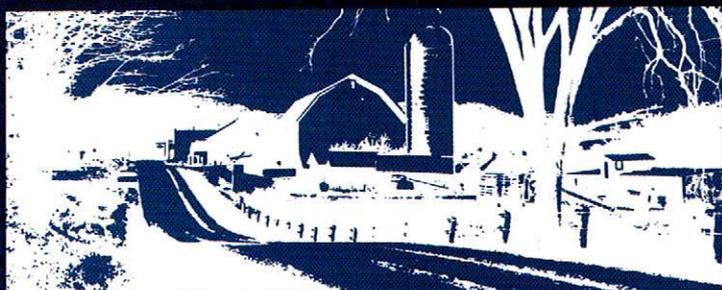
- a city with No. 1/1A ESS



- the suburbs with No. 2B ESS



- a rural area with No. 3 ESS



Regardless of geographical location, your customers will enjoy the broadest range of telephone services through Electronic Switching Systems. From standard telephone service to Call-Transfer and a host of other advanced service features, No. 1/1A, No. 2B, and No. 3 Electronic Switching Systems are computer programmed to give special services to telephone subscribers.

STORED PROGRAM CONTROL

Since its inception, the concept of storing instructions in an electronic memory to control network switching has been successfully applied and implemented in electronic switching systems. System actions in No. 1/1A, No. 2/2B and No. 3 ESS are determined by sequences of instructions coded and stored in memory. The instructions, grouped in categories called programs, contain all the data required to complete a specific task. Instructions are read from the main storage memory and transmitted one at a time to the processor for execution. Stored translation data contains information on customer lines and system parameters. To alter system operation, changes are made to the data rather than to hardware or wiring.

STORED PROGRAMS ARE GROUPED ACCORDING TO FUNCTIONS THEY PERFORM.

- **Operational Programs** - pertain to operation of the system and include input/output data, digit receiving, digit interpretation and digit out-pulsing.
- **Administrative Programs** - include control of administrative tasks, such as adjustment of equipment to meet changing traffic conditions.
- **Maintenance Programs** - relate to maintenance of the system hardware or stored programs, such as detection of equipment troubles and system diagnosis to pinpoint their location.



No. 1/1A Electronic Switching System



No. 1/1A Electronic Switching Systems, currently in Bell System use, connect millions of telephone calls each day. The No. 1/1A ESS was designed to do this with a projected "downtime" of only a few hours over a period of 40 years. Such high reliability is related to the duplication of critical parts, the easily replaceable plug-in circuit boards, and the virtual absence of moving parts. These factors have also yielded a substantial reduction in maintenance.

In addition to switching local calls, No. 1/1A ESS is a member of the long-distance switching family. It satisfies a need in sparsely populated areas and communities where demand is growing for long-distance switching but does not yet warrant a separate long-distance office.

NO. 1/1A ESS IS MODULAR

Components are arranged in packaged functional units, each unit serving a separate function. Smaller units are combined to serve a wide range of residential and business customers. Up to 129,000 telephones may be served by one No. 1A ESS office.

New components for No. 1/1A ESS add up to second generation Electronic Switching Systems.

- 1A Processor
- Remreed Line and Trunk Switching Frames
- Junctor Grouping Frames - 12 File (JGF-12)
- HILO 4 - Wire Trunk Frames
- Miniature Trunk Frames

THE 1A PROCESSOR - THE DECISION MAKER

The 1A Processor is a stored program control, real time data processing machine. Compared with earlier processors, it is organized for greater call processing capacity and growth. New controls are smaller, faster, lighter and more reliable.

The 1A Processor is the decision maker. It decides what network switches must be set, then directs the network to give each customer reliable service at a speed of 700-nanosecond completion cycle on most non-memory instructions.

This decision maker utilizes a high speed memory, fast execution of each instruction, and a powerful set of instructions. It means significant call carrying capacity — up to 240,000 telephone calls processed during a busy hour.

It needs only 22 equipment frames, compared with 50 frames required by its predecessor to handle the same traffic.

Total floor loading of the 1A Processor is well within 150 pounds per square foot.

The concept of primary and secondary stores was introduced with the 1A Processor. Primary memory capacities of Call Store and Program Store for No. 1A ESS, with converted No. 1 ESS programs, are approximately one million words each.

Although the generic program is stored in primary memory, primary storage is not required for all programs. Many maintenance/administrative programs are kept in secondary storage on memory disks and brought into primary storage as needed. Since these programs represent a significant portion of generic programs, placing them in secondary storage saves a large number of Program Store words. More thorough diagnostic programs and extensive administrative programs can be written without using costly primary storage. The electronically writable No. 1A ESS Program Store can be changed under program control and a new program updated from magnetic tape. Since translations and parameters are in writable storage, much of the labor required to update these areas is eliminated.

THE 1A PROCESSOR HAS THESE ADVANTAGES

- Can be tested as a unit at the factory without peripheral components.
- Can be retrofitted into a working No. 1 ESS central office with little interference in office operation.



Maintenance Control Center

No.1A Processor Features

PRIMARY MEMORY

Call Stores and Program Stores use the same hardware: a Call/Program Store Frame using 1A technology. Factory installed interframe cabling determines the application either as a Call Store or Program Store component. Call and Program Stores are greatly expanded using modular plug-in semiconductor elements. One frame holds six memory modules. Each module has a memory capacity of 65,536 words of 26 bits each, and a 1400-nanosecond cycle time.

The new Call/Program Store Frame is compatible with existing Core Stores and is suitable for processor growth or as a direct replacement for Core Store Frames.

- TTY printouts identify each core or semiconductor frame to aid craftspeople
- The Call/Program Store Frame requires only 32.5 feet of floor space, compared with 45.5 feet of Core Store
- Power requirements are reduced by two-thirds
- No extraordinary ducts or cooling needed

SECONDARY MEMORY

A backup scheme for No. 1A ESS, includes Disk File and the Magnetic Tape units on an auxiliary bus system.

- Disks hold backup information for Program Stores and translation Call Stores.
- Multi-function tape units are used for telephone billing and system updating. Tape units are used to introduce non-generic, special programs for processor growth, administration and maintenance, and to locate trouble in the processor.

CENTRAL CONTROL

Many features enhance central control processing powers:

- Compatible with No. 1 ESS peripheral equipment
- Operates with 1400-nanosecond Call Stores and Program Store memory units
- Double word instruction format
- Memory protection through secure area write orders
- Extended test access for maintenance programs
- Comprehensive processor configuration circuit for system recovery, including program reload

RETROFIT/REUSE

The 1A Processor hardware and software are compatible with No. 1 ESS peripheral equipment.

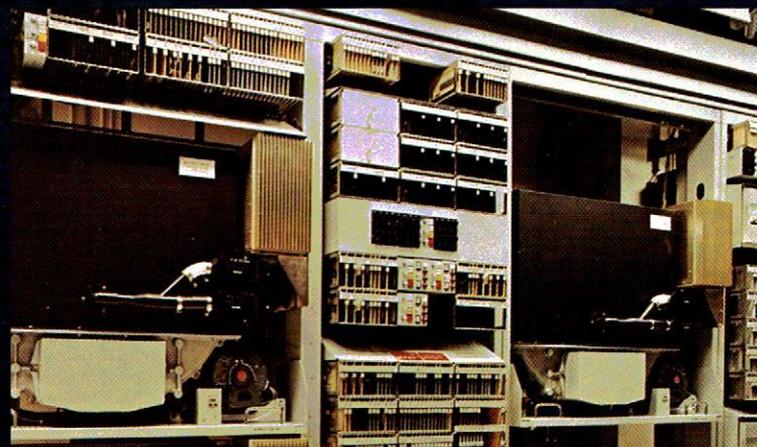
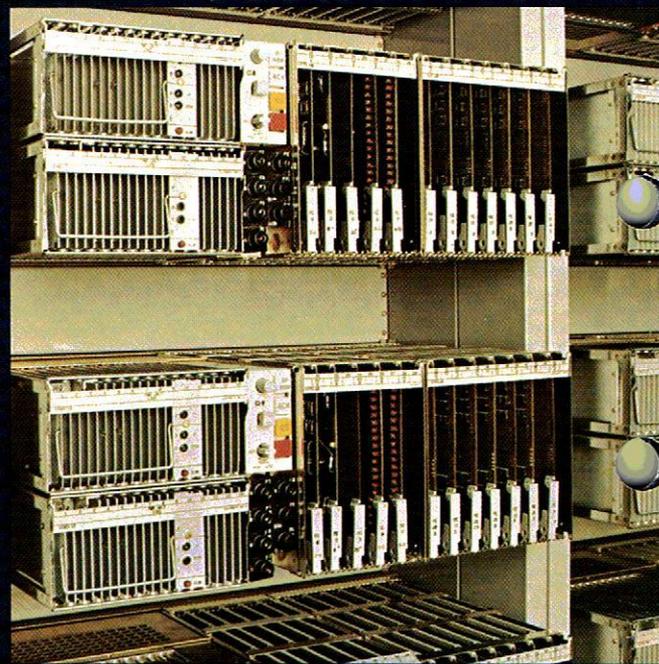
Retrofit of a No. 1 ESS Processor consists of replacing it with the 1A Processor.

1A Processor retrofits will make a substantial amount of equipment available for reuse, providing an opportunity to minimize capital expenditures.

The National Reuse Administration System (NARADS) is the primary tool to advertise surplus material for intercompany reapplication within the Bell System.

No. 1 ESS equipment normally removed for Retrofit/Reuse includes:

- Central Controls
- Program and Call Stores
- Signal Processors
- Master Control Center
- Magnetic Card Writer
- Magnetic Card Storage Frame



Top: Primary Memory Call/Program Store Hardware
Center: Secondary Memory - Disk Files
Bottom: Processor Frames



Testing Line Link Frames

REMREED NETWORK

A maximum of 16 networks include standard Line Link Network concentration ratios. Up to 16 Trunk Link Networks can be used with either 1,024 or 2,048 junctor terminations for each network.

- Junctor Grouping Frame-12 File has 33 percent more junctor capacity but it reduces maximum JGF lineup length from 39 to 30.3 feet.
- Network capacity is increased to 210,000 CCS for local originating and incoming traffic.
- Extended Line Link Networks (up to 28 LLN's instead of the present 16) will be ready in 1978. Combined with 16-TLN's, total incoming network capacity will be 366,000 CCS.

HILO 4-WIRE TRUNKS

You can expand the versatility and efficiency of No. 1 ESS to include toll and local/toll switching with HILO 4-wire trunks. Similarly, No. 1A ESS will become a member of the long distance switching family in 1978.

- Real time savings in trunk-to-trunk calls. Cross-office answer delay is reduced to 8-16 milliseconds.
- Transmission balance adjustments are not required
- In local/toll offices, equipment arrangements allow a smooth transition into separate local and toll offices
- One half the floor space required by CMT trunks

MINIATURE TRUNKS

Introducing two new minitrunk frames —

- Miniaturized Universal Trunk (MUT)
- Combined Miscellaneous Trunk (CMT)

Smaller versions of the Universal Trunk and Miscellaneous Trunk Frames are intended for new No.1A ESS offices, or to expand or to retrofit existing No.1 ESS offices.

Through 1A technology, a new signal distributor and an electronically controlled scanner are included, plus extensive use of printed circuit boards and solid-state components.

The Miniaturized Universal Trunk Frame is only 4'-4" wide, one third the space occupied by the UT Frame home-and-mate combination.

The Combined Miscellaneous Trunk Frame allows floor space reductions that vary between ratios of 4 to 1 and 7 to 1, depending upon the type of trunks or service circuits used.

MINIATURE TRUNKS OFFER:

- Reduced floor space requirements
- Reduced installation and maintenance time
- Improved transmission quality
- Improved reliability

No. 2B Electronic Switching System



No. 2B Electronic Switching System, an improved No. 2 ESS, includes the latest telecommunications service features needed to serve the most demanding customers in suburban communities. Starting with a minimum of 1,000 lines, No. 2B ESS has a growth potential up to 20,000 lines. It offers a full range of Custom Calling features and business customer features, including CENTREX.

2B PROCESSOR

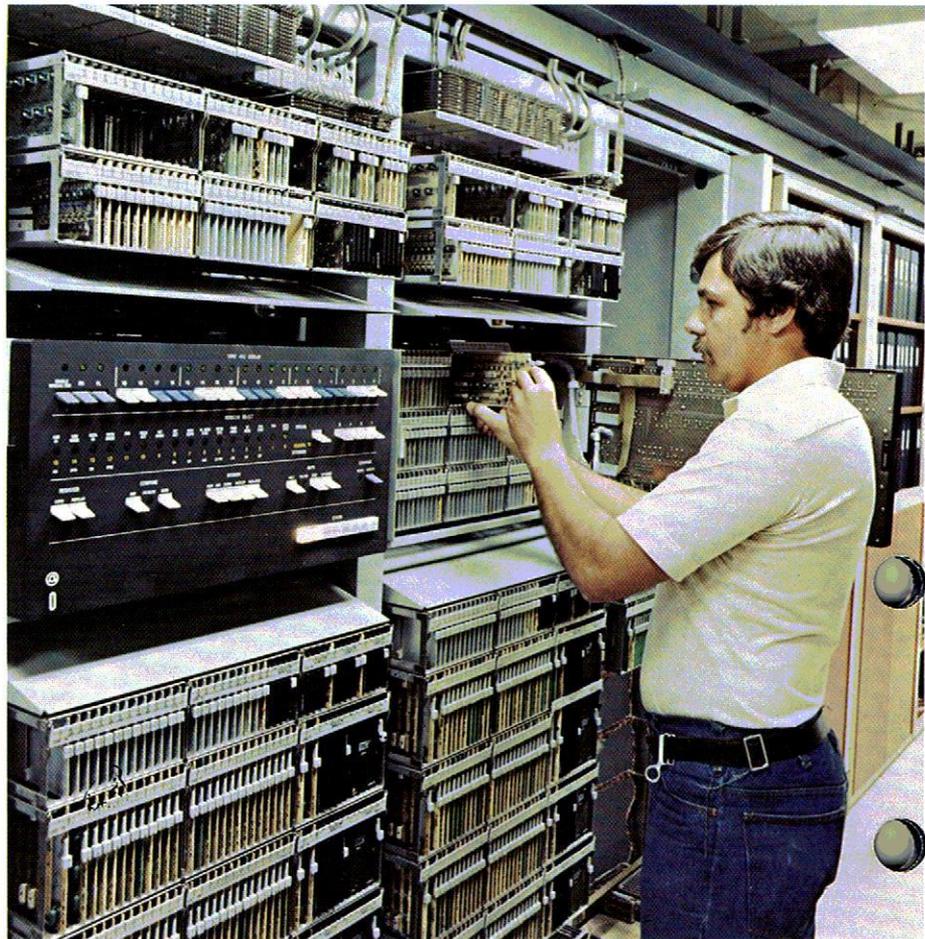
The new 2B Processor uses the latest integrated circuit technology to increase call-handling up to 38,000 calls per hour. It occupies only five bays of equipment—a 2-bay Processor Frame, one or two supplementary Store Frames, and a 2B Maintenance Frame.

3A CENTRAL CONTROL

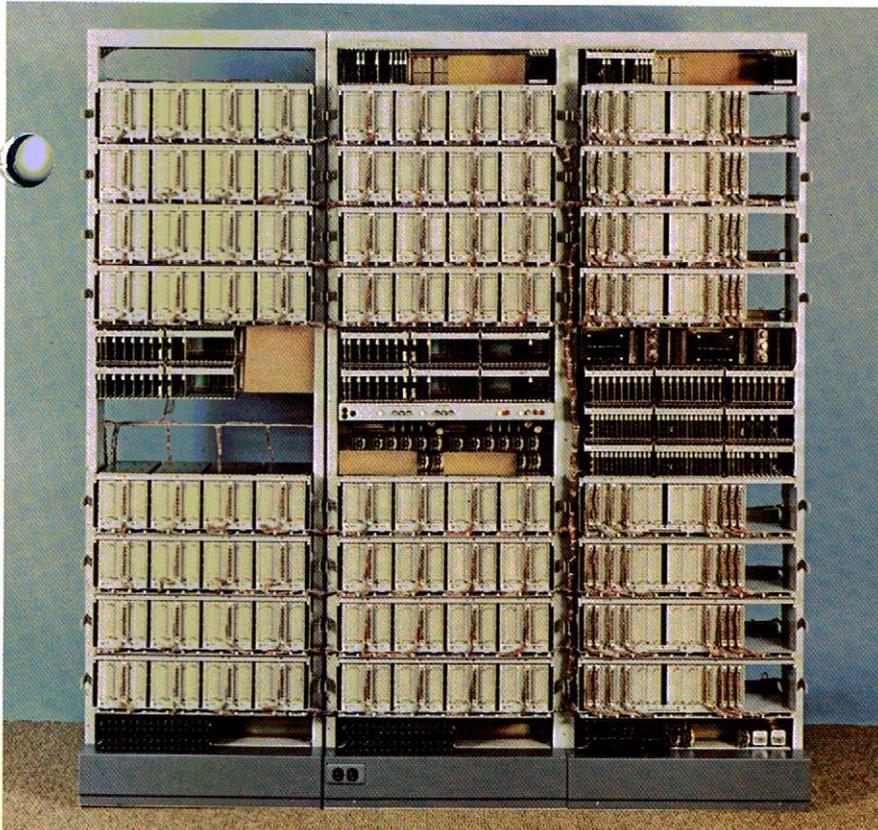
The 3A CC contains all the necessary logic required to direct and control data processing within No. 2B ESS. Duplicate control units are used. One 3A CC always has active control over the system. The other operates asynchronously in a standby mode. The on-line 3A CC keeps both the on-line and standby memories up to date so that the standby 3A CC may assume control of the system.

MAIN STORE

Program instructions and temporary memory used by the 3A CC are stored in the Main Store. Up to four Main Store memory units, each containing 64,000 words, are located in the Processor Frame. Additional memory modules may be added in supplementary memory frames to make up a one million word Main Store memory.



Top: No. 2BESS Central Office
Bottom: No. 3A Central Control



Top: Line Link Network Frame
 Bottom: Tape Data Controller

REMREED NETWORK

The Remreed Network for No. 2/2B ESS provides 2-wire switching capability:

- For new office installations
- For growth in existing No. 2 ESS offices to expand ferreed networks

The Remreed Network Frame includes the necessary controllers, and 1,024 terminals with a 2:1 concentration ratio. Used with a supplementary network frame, it provides 2,048 terminals with a 4:1 concentration ratio. From 2,048 to 30,720 terminals are available for line trunk and service circuits — and up to 127 CENTREX customer groups.

GENERIC PROGRAMS

No. 2B Extended Features generic program, coded EF-2, retains all of the call processing and administrative features of generic EF-1 and extends call handling capacity to 30,000 engineered busy-hour calls. The EF-2 generic program will boost No. 2B ESS capacity to 38,000 busy-hour calls.

PROGRAM BACKUP

For system reliability, a backup image of the system program and current translation data is kept on tape. A copy of translation data in use before the last update is also kept on tape.

Tape data controllers and cartridges are duplicated.

2B ESS RETROFIT

In fast growing No. 2 ESS wire centers, the 2B Processor enables operating telephone companies to give greatly expanded service with:

- Improved call handling — twice the capacity
- Reduced size — one-fifth the floor space
- Decreased power consumption
- Improved maintenance

All of No. 2 ESS's peripheral equipment and hardware designs have been retained. Existing call processing and maintenance programs can be used in No. 2B.

No. 3 Electronic Switching System



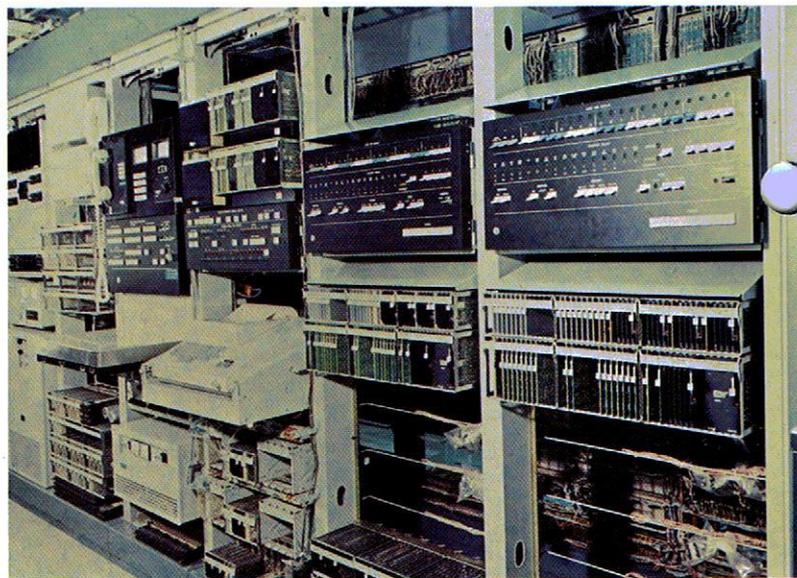
A compact, self-contained switching system that brings to small communities the benefits of metropolitan area telephone service similar to those offered with No. 1A and No. 2B ESS.

To increase revenue, No. 3 ESS offers the Community Dial Office replacement market many vertical service features, such as Call Forwarding, Call Waiting, Speed Calling and 3-Way Calling. In addition, it offers an expandable capacity to include Automatic Identification of Outward Dialing and other service features of the future.

No. 3 ESS has remote maintenance and administrative advantages. It operates unattended with self-testing tasks to:

- Access, test and exercise the system
- Remove equipment from service
- Make class of service and directory number assignments

No. 3 ESS has sufficient network terminations to connect service circuits for communities with a need for 100 up to 4,500 lines. It has a switching capacity of 8,000 average busy-hour calls with an SO-2 generic program.



3A CENTRAL CONTROL

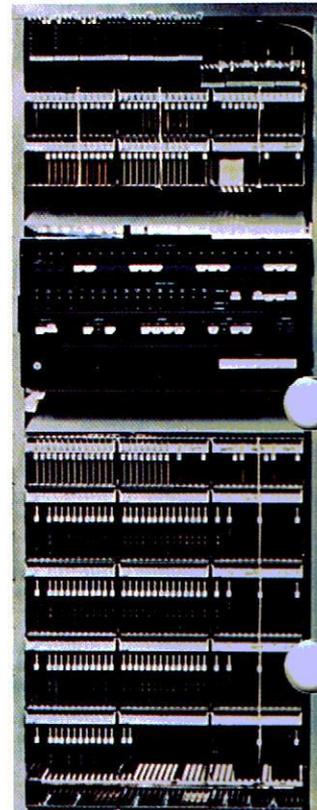
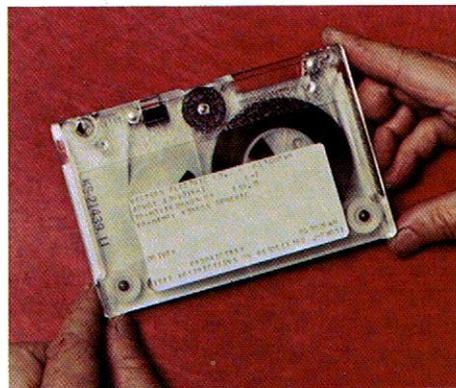
System organization includes the same 3A CC used in No. 2B ESS. Located in the Central Control is a 1,536-word, read/only memory, microprogram store arranged on semiconductor circuit-packs. It provides many of the micro-instructions required to implement system operation.

MAIN STORE

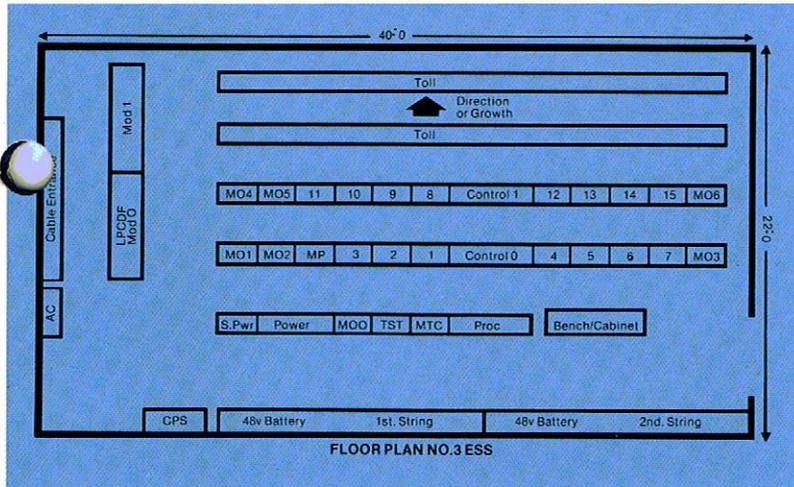
The Main Store is an electrically alterable read/write memory. One memory module stores 32,000 18-bit words. Eight Main Store modules fit in the Processor Frame with space for additional modules as required for future growth and new features. Resident programs are stored in the "write-protected" portion of the Main Store.

TAPE CARTRIDGE

The tape cartridge holds a backup image of these programs to "pump up" the Main Store in case of a prolonged power outage. Non-resident programs, such as those that control administrative tasks, are also stored only on the tape cartridge and brought into main memory when required.



Top: No. 3A Central Control and Maintenance Center
Bottom left: Tape Cartridge
Bottom right: Main Store



SYSTEM INSTALLATION

Factory assembled equipment groups are pretested and shipped as:

- A complete switching system
- Equipment lineups, or
- Connector-ended frames

REDUCED ENGINEERING

Equipment features offer fewer engineering choices and reduced "order-to-ship" intervals. The fixed floor plan with standard cabling eliminates engineering of frame locations, cable racks and cabling.

QUICK EXPANSION

Modular plug-in units or frames serve additional subscriber lines and trunks.

COMPACT DESIGN

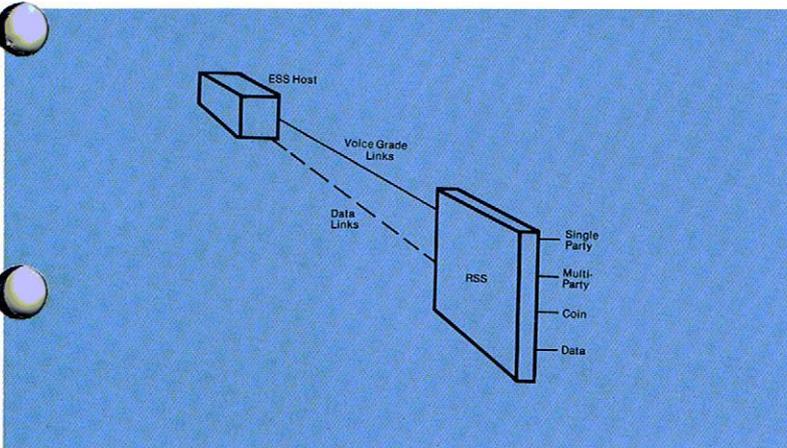
No. 3 ESS requires less than half the space needed for an equivalent electromechanical system.

Remote Switching System (RSS)

A new satellite switcher, operating from a host central office, is planned for availability in 1979. It will serve small communities, within a 50-mile range of the host office, with available ESS features.

RSS will accommodate 100 to 1,000 lines initially, with a maximum capacity of 2,000 lines.

The remote unattended switcher will fill a need for a small CDO replacement. In addition, it will reduce or eliminate cable growth from central office to subscribers and expand the capacity of electromechanical machines.



Top: Typical Floor Plan, No. 3 ESS Central Office
 Center: No. 3 ESS Unit Installation
 Bottom: Remote Switching System

Improvements in Electronic Switching Systems

1A Technology is a broad and flexible technology applied to a new generation of telephone switching equipment.

CIRCUIT PACKS

Silicon integrated circuit elements are used for both digital and analog circuits. Standardized circuit characteristics permit maximum use of computer-aided design, manufacturing and testing.

Connections between IC chips are physically smaller and more densely packed. Although increasing the number of interconnections, circuit packs keep down manufacturing and installation costs.

Three IC pack designs:

- Ceramic substrate with build up of IC chips for logic circuits.
- Epoxy-glass printed-wiring boards with combinations of IC's and large numbers of discrete components.
- Dual In-Line Packaging (DIP). Small standard enclosure with connecting leads aligned along the long sides; well suited to automatic assembly.

CIRCUIT PACK CONNECTORS

Connectors maintain a low and stable contact resistance to satisfy low signal levels and high pulse rates.

Connectors	Circuit Packs
80-pair	ceramic
40-pair	epoxy-glass
160-pair	DIP

BACKPLANES

Although the front of a typical equipment shelf is open to accommodate plug-in circuit packs, the rear contains from two to eight double-sided, multilayer circuit boards, stacked and laminated together. The multilayer boards hold circuit pack connectors. Connector terminals, spaced on vertical and horizontal 1/8-inch centers, are grouped into a dense field connected by wires. Multilayer boards are used for power and ground conductors, while most signal inter-connections are made through the wires.

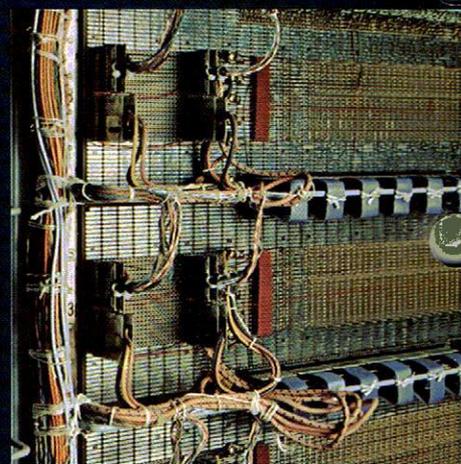
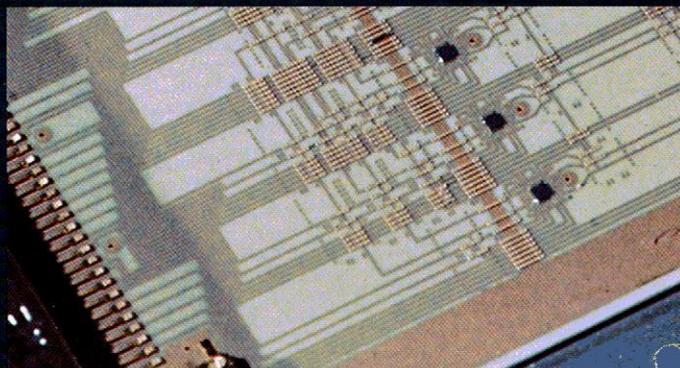
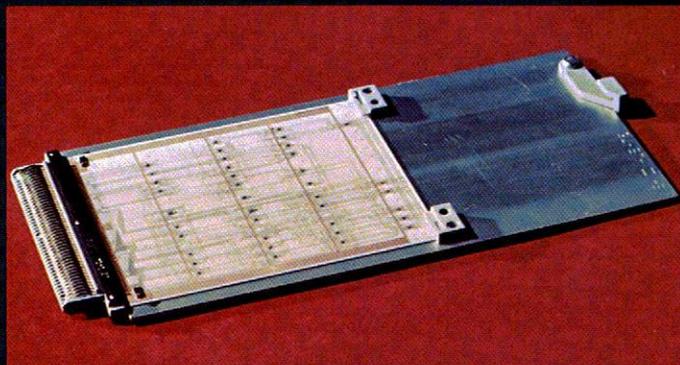
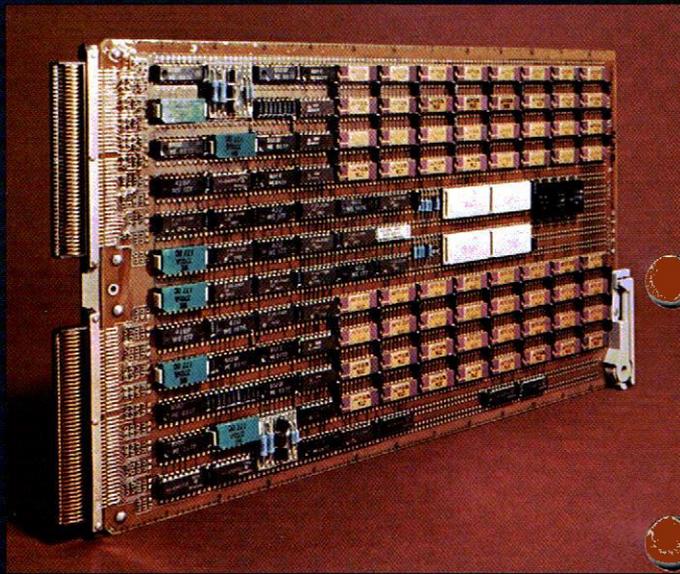
CABLE CONNECTIONS

Flat and round cables link both equipment units and frames. Connector-ended cables between units clear the way for rapid frame assembly. System expansion and repairs are easier.

Advantages of 1A Technology

Some of the more important advantages of 1A technology include:

- Greater reliability
- High speed electrical performance
- Low cost computer-aided design, manufacturing and assembly
- Rapid maintenance and frame assembly



Top: Memory Circuit Pack - Intergrated Circuits
Second from Top: Ceramic Circuit Packs
Third from Top: Batch Bonded Crossovers
Bottom: Back Plane and Connectors

Local Electronic Switching Systems

Application — Area	NO. 1A	NO. 2B	NO. 3
	Metropolitan	Suburban	Rural
Maximum Subscriber Lines:			
LLN Concentration ratio — 2:1	57,344	—	—
3:1	86,016	—	—
4:1	114,688	—	—
6:1	129,024	—	—
LTN Concentration ratio — 2:1	—	10,000	—
4:1	—	20,000	—
LTLN Concentration ratio — 6:1	—	—	4,500
Remreed Network	8-stage	8-stage, folded	5-stage, folded
Network CCS — Local traffic	210,000	—	—
Network CCS — Local, Trunk, and Service	—	110,580	20,300
Future Extended Network — CCS — 0+1	366,000	—	—
Average Peak Busy Hour Calls	240,000	38,000	11,000
Generic Program	CTX-7	EF-2	SO-2
Tandem Switching — 2W	Yes	No	No
Tandem Switching — 4W	Yes	No	No
Trunk Link Network — Concentration ratio	1:1 & 1.5:1	—	—
(1024 junctor term./TLN)	1024	—	—
Concentration ratio	1:1	—	—
(2048 junctor term./TLN)	2048	—	—
Primary Store — Program store	Writable (write protected)	Writable (write protected)	Writable (write protected)
bits/word	24+2 parity	24+2 parity	16+2 parity
word capacity — Max	10 ⁶ (approx)	10 ⁶ (approx)	10 ⁶ (approx)
Call store	Writable	—	—
word capacity — Max	10 ⁶ (approx)	—	—
Program/Call store word capacity — Max	—	10 ⁶ (approx)	10 ⁶ (approx)
Secondary Store	Disk File	Tape Cartridge	Tape Cartridge
Secondary Store Capacity	1280K words/File	1064K words	1064K words
Tape Store speed	—	48K-bits/second	48K-bits/second

For additional information and technical assistance, please contact the Western Electric Account Manager serving your telephone company.

Reference

EL 4113 No. 1A ESS Retrofit Planning
EL 4942 No. 1A ESS General Description
EL 5080 Call/Program Store Frame
EL 5187 No. 2B ESS System Description
EL 3000 No. 3 ESS General Description



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