NO. 2 ELECTRONIC SWITCHING SYSTEM

NO. 2 ESS

GENERAL DESCRIPTION

The No. 2 ESS has been developed to provide the advantages of stored program control in the small to medium sized central office. This system complements the No. 1 ESS by being economically competitive with the No. 5 Crossbar while offering electronic service and features in nonmetropolitan areas.

No. 2 ESS is intended for use in areas serving from 1000 up to about 16,000 main stations with an originating plus incoming calling rate up to 19,000 average busy-season busy-hour calls which are dependent upon the call mix of the traffic.

A typical initial order for a No. 2 ESS system would provide for:

4500 Lines

4640 Main Stations

3.12 Originating and Terminating CCS/MS

620 Trunks

304 Junctors

490 Service Circuits

68 Frames

Some of the custom calling services currently available are:

(1) Speed Calling

(2) Call Forwarding

(3) Call Waiting

(4) Three-way Calling.

SYSTEM OPERATION

Equipment Components

The No. 2 ESS is a common control switching system which utilizes high speed electronic circuitry and functions under the control of a stored program. The system is composed of two primary equipment groups as shown in the block diagram (Fig. 1). These groups are the control complex and the switching network.

A. Control Complex

The control complex consists of duplicated control units with a common maintenance center. Each control unit has been designed as a single switchable entity consisting of a central processor, program store, call store, central pulse distributor, and input-output control.

Central Processor

Each central processor frame consists of call store, input-output control, and program control equipment. Both central processors are normally running synchronously but only one is actually generating the commands to the peripheral units. In the meantime, the other unit is being used for comparison and is ready to assume the active functions immediately in case the on-line central processor fails.

The central processor is a systematic, logic performing device that gets its direction, or "intelligence," from the generic program retained in the program store. Call processing data, which provides the ability to be aware of the immediate situation, are retained in the call store. This is, in effect, the "scratch pad" where information is stored, used, and destroyed.

This ability to function in a logical manner is applied to call processing by scanning lines, trunks, junctors, and service circuits; recognizing and interpreting inputs; and generating outputs to appropriately control the network, trunks, junctors, and service circuits in response to the inputs received.

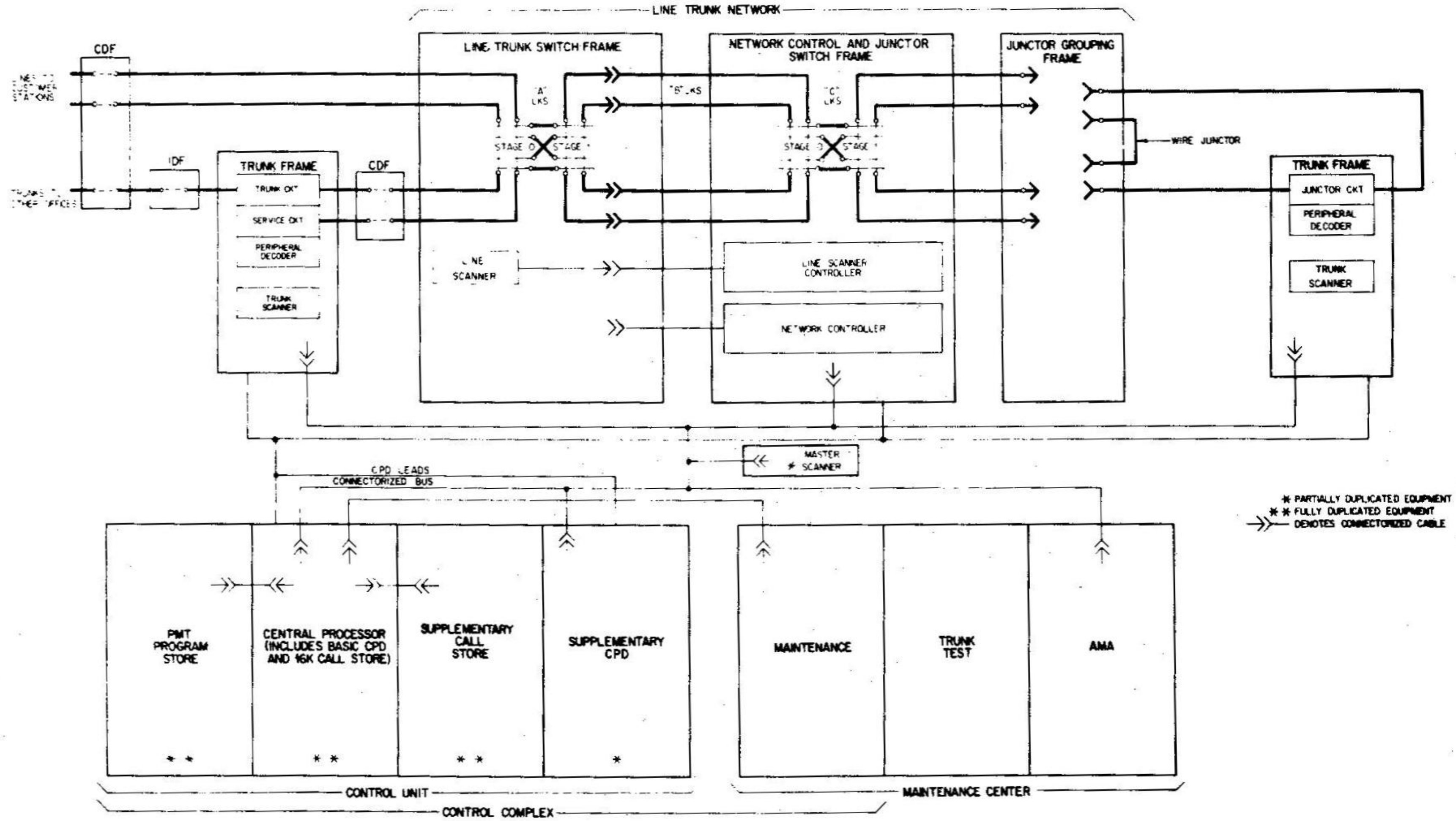


Fig. 1—No. 2 ESS Block Diagram

NO. 2 ELECTRONIC SWITCHING SYSTEM NO. 2 ESS

Program Store

The program store is the larger of the two memory units used in the No. 2 ESS. It is a semipermanent read-only memory; that is, it contains information that is used by, but is unchanged by, the normal functioning of the system as it processes calls.

Two types of information are stored in the program store memory: the generic program and translations. The generic program is information that details the sequences of instructions that the central processor must follow. The instructions have been developed so that the processor always knows exactly what it will do next and continues to cycle itself through sequences of related instructions either recognizing inputs, interpreting them, or generating outputs, as required. A common generic program called Local Office 1 (LO-1) is used for all No. 2 ESS offices.

Centrex

Centrex is one of the features to be provided with the Extended Features (EF-1) generic program. When fully developed, the EF-1 generic will include all Centrex I and Centrex II package features plus many additional Centrex and non-Centrex features such as ROTL, TOMUS, AIOD, improved AMA capabilities, carrier group alarm, charging on call forwarding, and full transient call trace.

The first No. 2 ESS EF-1 office was placed in service at Naperville, Illinois, on February 3, 1974. The standard EF-1 generic will be available for offices with a service date of March 1, 1975 or later.

Translations make up the other portion of the program store. Information such as line assignments, classes of service, features and options, as well as trunk assignments, routing, and charging information is included. Also included are the parameters for the specific office, identifying the limits in terms of size, quantities, equipment, and features. The translation area of the program store is affected by day-to-day office changes and, consequently, means are available via service order and recent change teletypewriter messages to update portions of this information on a regular basis.

Program store information is arranged in words of 22 binary digits (bits) stored in twistor magnet modules of 16,384 words each. One program store frame contains four of the modules. Up to 16 plug-in program store modules may be provided containing 262,144 words, as required. The LO-1 generic program occupies 5 modules allowing a maximum of 11 modules for translations.

Call Store

The call store is the other major memory unit and provides temporary memory for information primarily associated with either call processing or the status of the system. Because this information tends to change frequently, the call store is a read-write type of memory; that is, the central processor may put information into a call store memory location for later use and then retrieve it when needed. It is this ability to store information and return to it that permits the processor to give the appearance of handling many calls at a time.

The call store is composed of 16-bit words arranged in 4096 word modules. Up to four modules are located on each central processor frame and an additional four modules may be added on supplementary call store frames to each control unit. A minimum of two call store modules must be provided with each processor.

A unique feature of No. 2 ESS is the preallocation of the functional areas of the call store modules. This allows the Traffic Engineer to determine the quantity of the various traffic sensitive units required per functional area, relate the requirements per area to module capacity, and provide call store traffic requirements in modular units.

Maintenance Center

The maintenance center has access to both control units. It contains the necessary facilities for maintenance, operational communication, and management of the system. The maintenance frame contains system control keys, a maintenance teletypewriter, as well as alarms and indications showing the status of major equipment units for maintenance personnel.

Management of the system, including service order changes and requests for translation verification as well as traffic administrative and engineering information, is transmitted over teletypewriter channels associated with the maintenance center.

Automatic message accounting and trunk test equipment are provided on separate frames and are located in the maintenance center area. The single card writer is used to update the translation information stored on the twistor magnet memory cards in the program store and is part of the maintenance center frame. The automatic message accounting frame contains two 9-track incremental tape recorders used to assemble triple-entry billing information under stored program control. The operational and transmission testing of customer lines, trunks, and service circuits is accomplished from the trunk test frame facilities.

Input-Output

The input-output control performs the interface function between the peripheral units and the central processing unit. It provides and controls the special circuitry required to communicate with the peripheral units under control of program instructions. Also included in the input-output portion of the control complex are wired-logic circuits for autonomously performing a portion of the digit receiving, digit sending, line scanning, and data sending tasks independent of specific program instructions from the central processor. Peripheral units are equipment units directly associated with but not inherently part of the central processor.

Peripheral Buses

Communication between the central processor and the peripheral units is accomplished by peripheral unit address buses, enable pairs, and scan answer buses as shown in Fig. 1. Buses are nothing more than groups of electrically balanced twisted pairs of wires which are transformer coupled to the communication circuits. The address buses and enable pairs are used to send instructions to the peripheral units while the answer buses receive the status from the peripheral units.

Central Pulse Distributor

The first central pulse distributor, which is an integral part of the central processor frame, is directly controlled by the input-output circuitry.

It is used to select and enable (turn on) a peripheral unit to receive information on a peripheral unit address bus. It is also used to send information to the network controllers and peripheral decoders in serial form over a dedicated pair of wires.

Each central pulse distributor has a capacity for a maximum of 512 outputs. Up to 7 supplementary central pulse distributor frames, equipped with a maximum of 512 outputs each, may be provided as they are needed. Each supplementary central pulse distributor frame may be controlled by either control unit. A supplementary central pulse distributor frame contains duplicated central pulse distributor equipment.

Scanners

The ferrod scanners of the No. 2 ESS are used to provide information to the central processor about the state of the units being monitored. There are three types of scanners in this system:

(1) ***Line Scanner***—The line scanner is used for scanning customer lines for service requests. There are 2 line scanners in each line trunk network providing for up to 2048 line scan points.

(2) ***Master Scanner***—The master scanner is used for scanning items such as dial pulses, fuse alarms, teletypewriter inputs, miscellaneous trunks, etc. There are 1024 scan points mounted on the master scanner frame.

(3) ***Universal Trunk Scanner***—The universal trunk scanner monitors the trunks and circuit junctors mounted on the universal trunk and junctor frames. A maximum of 1024 scan points is available per universal trunk and junctor frame. The first 512 scan points are always associated with the universal trunk and junctor frame in which they are installed. The remaining 512 scan points may be associated with an additional universal trunk and junctor frame or may be for miscellaneous trunks, service circuits, etc.

B. Switching Network

The switching network provides the means for connecting the lines, trunks, and service circuits, as required, to process calls. The combined line trunk switching network has the lines, trunks, and service circuits assigned to terminals on one side of the 4-stage array. Junctors interconnect the switches on the opposite side to form a folded 8-stage network. The talking path is 2-wire with the metallic connections being established through ferreed switches.

The switching network is composed of from 1 to 15 line trunk networks (LTNs), each being made up of from 1 to 4 line trunk switch frames (LTSs) and a single network control and junctor switch frame (NCJS).

Two concentration ratios are available as 2:1 or 4:1. The selection of which concentration ratio to provide depends on the office traffic characteristics. The concentration ratio represents the number of terminals on the LTN that will have access to 512 junctors. Each LTS frame has 512 terminals; therefore, a 2:1 concentration ratio consists of two LTSs providing 1024 terminals with access to 512 junctors. The 4:1 concentration ratio uses four LTSs and 512 terminals each, thereby, giving 2048 terminals access to 512 junctors.

The choice of concentration ratio is dependent upon the average usage per network terminal since each LTN has the capacity to serve a maximum of 7372 CCS at objective levels of service.

The physical maximum network capacity, with all 15 LTNs installed, would be 30,720 terminals and 110,580 CCS. These capacities will normally never be utilized due to the maximum call processing capacity of the central processor which will govern maximum network size.

Typical Call Sequence

Figure 2 shows the sequence of connections for the intraoffice call.

Prior to initiation of our call, a process known as line supervision or line scanning is continually taking place. Every 100 milliseconds, a network order is issued which causes the line scanner ferrod assigned to our customer to be interrogated. The results of this interrogation are transmitted to the central processor via the answer bus and compared with the results of the previous scan which is stored in the call store. If the results of both scans indicate an on-hook condition, no action is required. If the last look indicates a change to off-hook, the central processor realizes that a call is being initiated.

When the subscriber goes off-hook to initiate a call, several steps must be taken immediately, each requiring a separate order from the central processor. First, the line scanner on the LTS frame is isolated from the line by the operation of a cutoff switch. Next, an idle digit receiver is selected and a network path between the calling line and the digit receiver is selected and a network path between the calling line and the digit receiver is computed. A network order is issued which will connect the calling line to the digit receiver. A peripheral decoder order is issued to apply dial tone to the calling line. The digit receiver is scanned by the trunk scanner every 10 milliseconds to detect dial pulses. This faster scan rate is necessary to detect the difference between the interpulse interval and the interdigital interval. When the first dial pulse is recognized by the trunk scanner, it is transmitted to a digit register in call store. As each additional pulse of a digit is received, it is added to the digit register. This process continues until the entire called number is recorded in call store.

The central processor now tests the called line for busy or idle and, if idle, selects an idle junctor circuit and an idle ringing circuit. It then computes a network path from the calling line to the junctor circuit and another network path from the called line to the ringing circuit. At this time, it also computes and reserves a network path between the called line and the junctor circuit. The ringing circuit now applies ringing current forward to the called line and the junctor circuit applies audible ringing tone backward to the calling line.

When the called party answers, ringing is tripped and the ringing circuit is now released. The called party is connected to the junctor circuit via the reserved network path, audible ring is shut off, and the junctor circuit is placed in the talking state. The call is now in a stable talking state and requires only a periodic monitoring by the trunk scanner until a disconnect occurs.

When the call is terminated, a new set of orders is issued which releases the junctor circuit and permits the line scanners to monitor both lines in preparation for another call.

PERFORMANCE

The design of the 2-wire No. 2 ESS was derived from experience with both the No. 1 ESS and No. 101 ESS. The system uses a switching network and peripheral units similar to the No. 1 ESS while

NO. 2 ELECTRONIC SWITCHING SYSTEM NO. 2 ESS

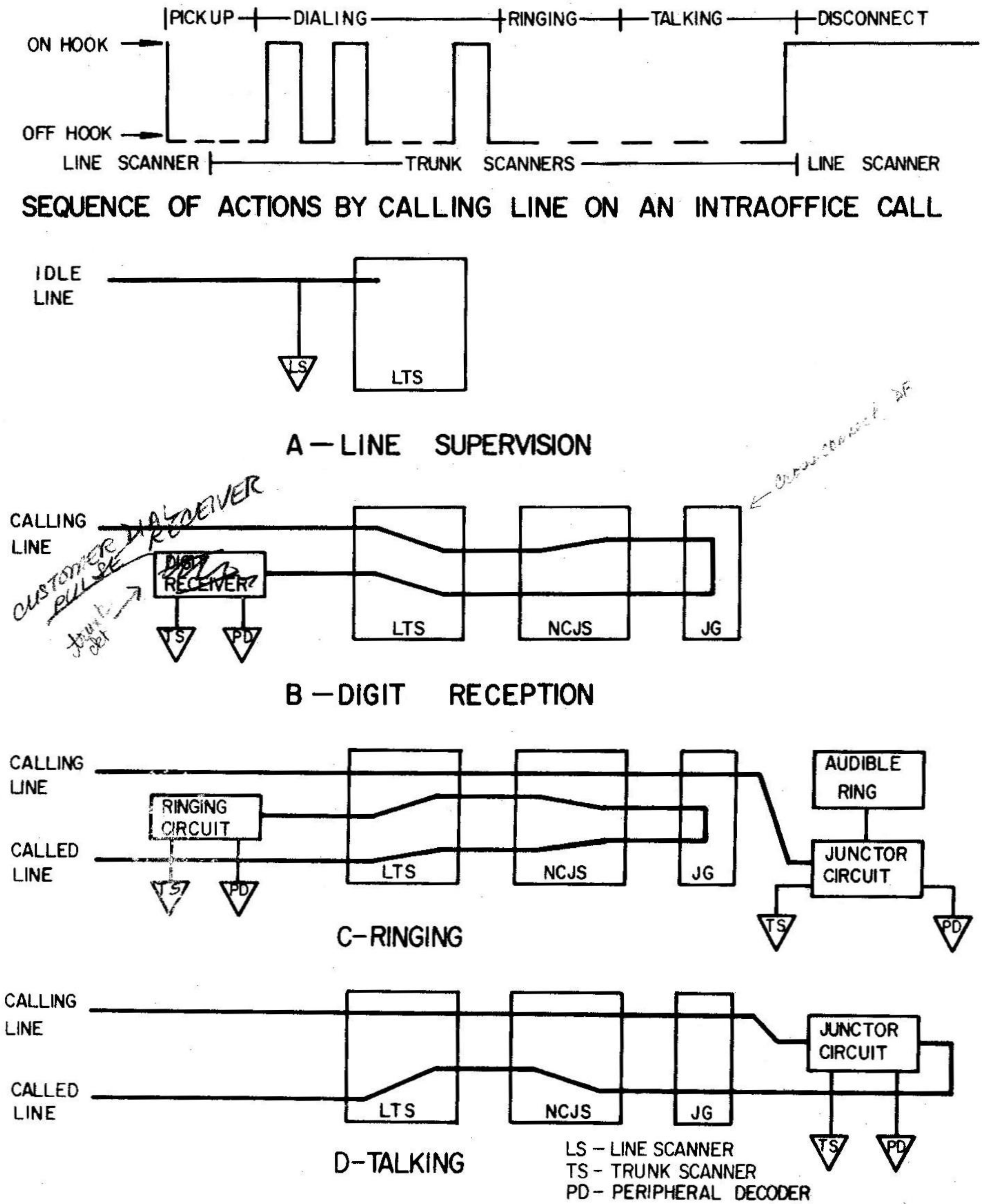


Fig. 2—Connections for an Intraoffice Call

the control is a new design based on the No. 101 ESS.

By virtue of design and the use of modern electronic components, the system is highly dependable, easily maintained, and operationally efficient. Installation and testing effort are greatly reduced by the extensive use of frame and unit connectorization. Connectorization also allows factory testing of major subsystems prior to shipment and simplified growth since many of the basic growth units are pluggable.

The present configuration of No. 2 ESS is call limited by the 19,000 busy-hour call capacity of the central processor. A new system controller, the 3A CC, is being introduced into the No. 2 ESS to increase the calling capacity to 38,000 busy-hour calls. With the new processor, the full network configuration can then be utilized, thus increasing the system capacity to approximately 25,000 lines. General availability of the new processor is presently planned for the first quarter of 1977.

EQUIPMENT DESCRIPTION

ESS Equipment

The No. 2 ESS system contains a limited number of frames to be used as office building blocks. Their design has been significantly simplified by replacing apparatus and wiring options with program options wherever possible. Further economics have been gained by using No. 1 ESS frameworks, end guards, and cable racks. See Fig. 3.

Power Plants

The No. 2 ESS uses separate 800-ampere 111A Power Plants for +24 volt and -48 volt supply. These potentials are distributed to the ESS frames through No. 1 ESS type Power Distributing Frames. A one-half ampere Ring and Tone plant is available for either AC-DC or superimposed ringing. A 523A plant is provided as a source of emergency AC power. A pair of 200-ampere DC-to-DC converters is located in the Control Complex to provide a source for the +6 volts required by the central processor.

INSTALLATION

Installation of the No. 2 ESS has been greatly reduced due to the complete factory test of the Control Complex and selected use of connectorized cabling. The factory test of the Control Complex uses the same X-Ray and diagnostic tests which the installer uses in the field. This technique has greatly improved the product quality.

Connectorization has been designed into the system at those points which will significantly affect installation, growth, or maintenance of the system. The three areas which have been connectorized are:

(1) ***Control Complex***—The Control Complex is approximately 95 percent connectorized which greatly enhances factory testing, reduces installation effort, and simplifies both growth and maintenance of the program and call stores.

FRAME	ABB.	NUMBER REQUIRED
AUTOMATIC MESSAGE ACCOUNTING	AMA	0 OR 1 PER OFFICE
CENTRAL PROCESSOR	CP	2 PER OFFICE, INCLUDES 8K WORDS OF CALL STORE AND 512 CPD POINTS
COMBINED DISTRIBUTING	CDF	AS REQ
INTERMEDIATE DISTRIBUTING FR	IDF	AS REQUIRED
JUNCTOR GROUPING	JG	1 TO 3 PER OFFICE
LINE/TRUNK SWITCHING	LTS	1 TO 4 PER LTN
MAINTENANCE CENTER	MC	1 PER CONTROL COMPLEX MAY INCLUDE SINGLE CARD WRITER
MASTER SCANNER	MS	1 MINIMUM PER OFFICE
MISCELLANEOUS	M	AS REQUIRED
MISCELLANEOUS POWER	MP	1 PER OFFICE
MISCELLANEOUS TRUNK	MT	AS REQUIRED
NETWORK CONTROL JUNCTOR SWITCHING	NCJS	1 PER LINE TRUNK NETWORK (LTN)

FRAME	ABB.	NUMBER REQUIRED
POWER DISTRIBUTING	PD	2 OR 4 PER OFFICE
6.7V 200 AMP POWER PLANT	PWR	2 PER CONTROL COMPLEX
PROGRAM STORE	PS	4 TO 8 PER CONTROL COMPLEX
PROTECTOR	PROT	AS REQ
RANGE EXTENSION	RE	AS REQUIRED IN PAIRS
RECORDED ANNOUNCEMENT	RA	1 OR 2 PER OFFICE
RINGING AND TONE POWER PLANT	RT	1 PER OFFICE
SUPPLEMENTARY CALL STORE	SCS	0 OR 2 PER CONTROL COMPLEX SUPPLEMENTS CS IN CP
SUPPLEMENTARY CENTRAL PULSE DISTRIBUTOR	SCPD	0 TO 7 PER OFFICE, SUPPLEMENTS CPD IN CP
SUPPLEMENTARY RINGING AND TONE	SRT	AS REQUIRED
TRUNK TEST	TT	1 PER OFFICE
UNIVERSAL TRUNK AND JUNCTOR (H,M OR HMS)	UTJ	AS REQUIRED

Fig. 3—No. 2 ESS Frame Types

(2) ***Line Trunk Network***—All interframe leads within a Line Trunk Network are connectorized to facilitate factory testing, initial installation and, most importantly, simplify the growth from a partial to a full network. The cabling between the CDF and the LTS frames is connectorized on the LTS end, reducing the field wiring effort.

(3) ***Communications Bus***—The entire communications bus, including the terminating resistors, has been connectorized in the No. 2 ESS. While connectorizing the bus simplifies installation, it assumes major significance during office growth by reducing transition time of this important circuit.

TECHNICAL DATA

Basic System Characteristics

A. SYSTEM	
Engineered Call Capacity	19,000 Calls/Hr
New Start Range	≈ 1000-5000 Lines
Growth to	≈ 10,000-20,000 Lines
B. PERIPHERY	
Network (Folded 4 Stage Ferreed)	1-15 Networks with 1024 Terminals @ 2/1 CONC Each 2048 Terminals @ 4/1 CONC Each 7372 CCS Per Network MAX TOTALS: 30,720 Terminals, 110,580 CCS
Service Circuits	≈ 1000 MAX.
Trunk and Circuit Junctors	≈ 5000 MAX.
C. PROCESSOR	
Program and Translation Store (Permanent Magnet Twistor)	256K 22 Bit Words Growable in 4K Word Blocks 6 μsec cycle
Call Store	32K 16 Bit Words Growable in 16K Word Blocks 6 μsec cycle
Instructions	3, 6, 9 and 12 μsec Execution Times
Interrupts	8 Priority Levels (3 Assigned)

Ranges For Line Originations

The normal subscribers line limit is 1300 ohms; however, this may be extended by using the unigauge range extension plan as described in BSP 820-610-153. As reference data, the following ranges are given for line originations:

Type of Line	Max. Ext Ckt Loop Res Office Min Normal −49.75	(OHMS) Battery Min Emerg −42.75	Earth Pot. Diff (± Volts)
Loop Start	3500	2800	—
Ground Start (Note 1)	3200	2500	3

Note 1: For ground start lines, the value given is that of a single conductor.

NO. 2 ELECTRONIC SWITCHING SYSTEM NO. 2 ESS

Recommended Environment

The No. 2 ESS is designed to operate over a wide range of temperature and humidity conditions. The recommended atmospheric conditions are as follows:

Room Ambient Temps

Type of Equipment	Min	Max.	Recommended Operating Range
Central Office Equipment Using Solid State Circuits	35	120	40-100
Power Equipment	35	115	40-100
Batteries	35	110	65-80
Common Systems and Traffic Systems	35	120	40-100

Relative Humidities

Type of Equipment	*Short-Term Min	*Short-Term Max.	Recommended Operating Range
Central Office Equipment Using Solid State Circuits	20	80	20-55
Power Equipment	15	80	15-55
Batteries	15	80	15-55
Common Systems and Traffic Systems	15	80	15-55

* "Short-term" is hereby defined, for this use only, as a period of time not to exceed approximately 3 days at a time and 15 days per year.

Relative Humidity Control

Where control is necessary, it is recommended that relative humidity be maintained between 45 percent and 55 percent in the warm months and 30 percent and 35 percent in the cold months.

Maximum inside relative humidities allowable without the appearance of moisture on single-glazed windows with inside air temperature at 70° F are as follows:

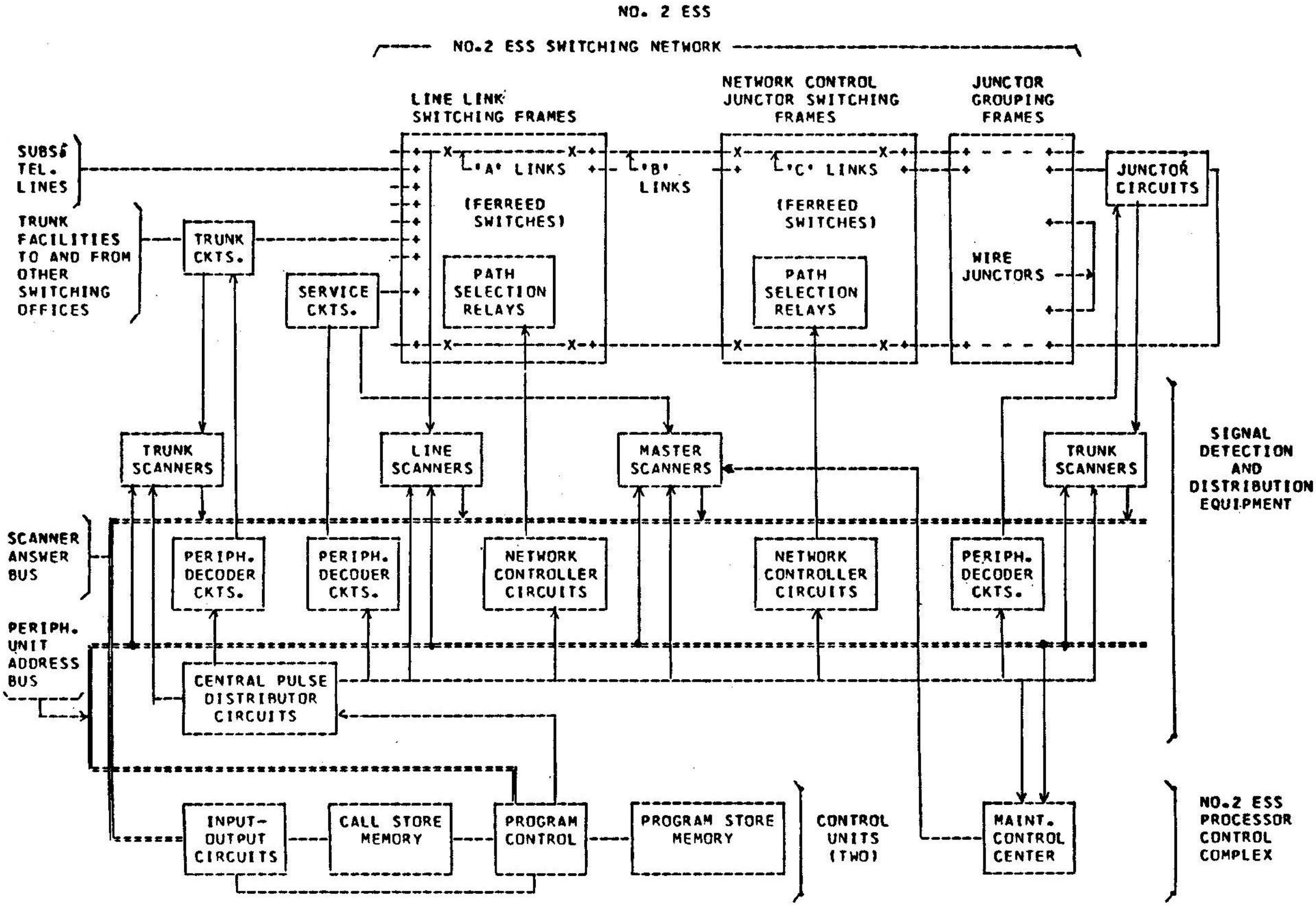
OA Temp (°F)	RH (%)	OA Temp (°F)	RH (%)
40	48	0	15
30	37	−10	11
20	28	−20	7
10	21	−30	5

The maximum line capacity of the No. 2 ESS is a function of the number of terminations, the usage (in terms of CCS per Main Station), and the calling rate (in terms of calls per busy hour). Until the introduction of the 3ACC, the system capacity will probably be dependant upon the calling rate. With the 3ACC, the three factors will carry a more equal consideration.

SELECTED REFERENCES:

BSP 232-000-000 — No. 2 ESS Plant Series
BSP 820-600-180 — No. 2 ESS Performance Requirements
BSP 966-200-100 — General Description
BSP 966-202-100 — General Description, No. 2 ESS with Centrex Features
No. 2 ESS EL 600, August 16, 1970 (GL 70-08-158)
No. 2 ESS Pricing and Economic Analysis (GL 72-111-113)
No. 2 ESS Translations Guide, TG-2H
No. 2 Equipment Questionnaire, E-8071
No. 2 ESS General Installation Circular, GIC 11:06
No. 2 ESS Programs and Features — GL 73-03-043, GL 71-02-181

Western Electric


NO. 2 ESS
NO.2 ESS SWITCHING NETWORK
LINE LINK SWITCHING FRAMES
NETWORK CONTROL JUNCTOR SWITCHING FRAMES
JUNCTOR GROUPING FRAMES
SUBS. TEL. LINES
'A' LINKS
'B' LINKS
'C' LINKS
JUNCTOR CIRCUITS
(FERREED SWITCHES)
(FERREED SWITCHES)
TRUNK FACILITIES TO AND FROM OTHER SWITCHING OFFICES
TRUNK CKTS.
SERVICE CKTS.
PATH SELECTION RELAYS
PATH SELECTION RELAYS
WIRE JUNCTORS
TRUNK SCANNERS
LINE SCANNERS
MASTER SCANNERS
TRUNK SCANNERS
SIGNAL DETECTION AND DISTRIBUTION EQUIPMENT
SCANNER ANSWER BUS
PERIPH. DECODER CKTS.
PERIPH. DECODER CKTS.
NETWORK CONTROLLER CIRCUITS
NETWORK CONTROLLER CIRCUITS
PERIPH. DECODER CKTS.
PERIPH. UNIT ADDRESS BUS
CENTRAL PULSE DISTRIBUTOR CIRCUITS
INPUT-OUTPUT CIRCUITS
CALL STORE MEMORY
PROGRAM CONTROL
PROGRAM STORE MEMORY
CONTROL UNITS (TWO)
MAINT. CONTROL CENTER
NO.2 ESS PROCESSOR CONTROL COMPLEX

NO. 2B ELECTRONIC SWITCHING SYSTEM
NO. 2C ELECTRONIC SWITCHING SYSTEM

GENERAL DESCRIPTION

A new processor for No. 2 ESS has been developed which will ultimately double the call processing capacity of No. 2 ESS. The new processor is designated the 2B Processor. When the processor is used with No. 2 ESS peripheral equipment, the system will be referred to as No. 2B ESS. If installed in No. 2A ESS modular buildings, it will be referred to as No. 2C ESS.

The 2B Processor will be compatible with all No. 2 ESS peripheral equipment including remreed and ferreed networks, scanners, AMA, and supplementary CPD. The existing No. 2 ESS call processing programs will be directly usable with the 2B Processor. This represents approximately 75 percent of the total No. 2 ESS program words. Some programs which are processor dependent will be rewritten, such as processor diagnostics, TTY interface, memory update procedures, and some peripheral unit diagnostics.

SYSTEM OPERATION

The 2B Processor design is based on the 3A Central Control (3A CC) which is a small general purpose processing unit designed for electronic switching systems. Though designed for use in smaller switching systems, the 3A CC offers sufficient flexibility and capacity to permit call processing improvement in the No. 2 ESS. The 3A CC is a low-cost, 16-bit general purpose control unit. Sufficient flexibility and capacity have been provided in the 3A CC to meet the needs of varied applications. Due to the use of the standard high-speed 1A ESS integrated logic, the 3A CC is small in size and can perform its functions at a very high speed. The 3A CC uses self-detection circuits to give an immediate indication of faults. These circuits eliminate the process of synchronous operation, match comparison between two control units, and enable diagnostics to locate troubles more easily. The internal sequencing is controlled by a microprogram structure which results in a highly flexible means of implementing the instruction set and the basic control functions. Additional flexibility is allowed by the asynchronous nature of both the 3A CC-to-memory and 3A CC-to-periphery communication. A modular loosely coupled I/O structure provides the capability of handling a wide variety of I/O devices. This I/O facility is growable by increments of 20 subchannels up to a maximum of 400 high-speed 6.7-MHz serial subchannels. General registers are provided in the 3A CC to provide flexibility in data handling and processing.

PERFORMANCE

Design Objectives

The design objective of the 2B/2C ESS is to provide a call processing capacity of 38,000 calls per busy hour (engineered load) for basic telephone service with a peak busy-hour capacity of 52,000 calls. Provision of custom calling services and centrex services will reduce the maximum call processing capacity. At this time, it is not possible to precisely estimate the peak calling capacity for all traffic mixes. For planning purposes, a call processing capacity for No. 2B/2C ESS of twice the equivalent No. 2 ESS capacity for a particular traffic mix seems appropriate.

Initial Limitations

No. 2B/2C ESS offices, which ship in 1975 and 1976, will be restricted to the 19,000 busy-hour call capacity limit of No. 2 ESS. The restriction will be removed by 1977 when a new generic will permit increases in software parameters to allow a capacity of 38,000 busy-hour calls.

EQUIPMENT DESCRIPTION

Equipment Arrangement

The 2B Processor will consist of a maximum of seven 18-inch deep, 2-foot 2-inch wide equipment bays arranged in a single equipment lineup. One double bay processor frame will contain in each bay a 3A CC, an I/O control circuit, CPD matrix, a memory controller, space for 256K of program, translation, and call store memory, and a power unit. Supplemental memory frames will allow the main store to grow to one million words of memory

NO. 2B ELECTRONIC SWITCHING SYSTEM—NO. 2C ELECTRONIC SWITCHING SYSTEM

if needed in the future. Frame space should be reserved to allow for the eventual use of the supplementary memory frames. A maintenance frame will contain the maintenance TTY, TTY control circuitry, tape cartridge units for memory backup, and a system status panel.

To put the size of the 2B Processor in perspective, the present No. 2 ESS control complex consists of a maximum of 26 equipment bays (excluding TTP or AMA) arranged in two equipment lineups. The present No. 2 ESS also has a maximum memory capacity of 256K words of program and translation and 32K words of call store. Thus the 2B Processor will provide twice the call handling capacity in less than one third the space.

Software

The 2B Processor will only be available with the generic equivalent of the Extended Feature (EF-1) generic. This generic provides for full basic telephone service features, updated custom calling services, and centrex-CO capability. There are no plans for making the Local Office (LO-1) generic program available on the No. 2B/2C ESS.

Some operations and features will be improved in the 2B/2C ESS which are not contained in the EF-1 generic for No. 2 ESS. For instance, since the 2B Processor uses semiconductor memory for program and translation data, program and translation update procedures will be significantly simplified over current magnetic card writing procedures.

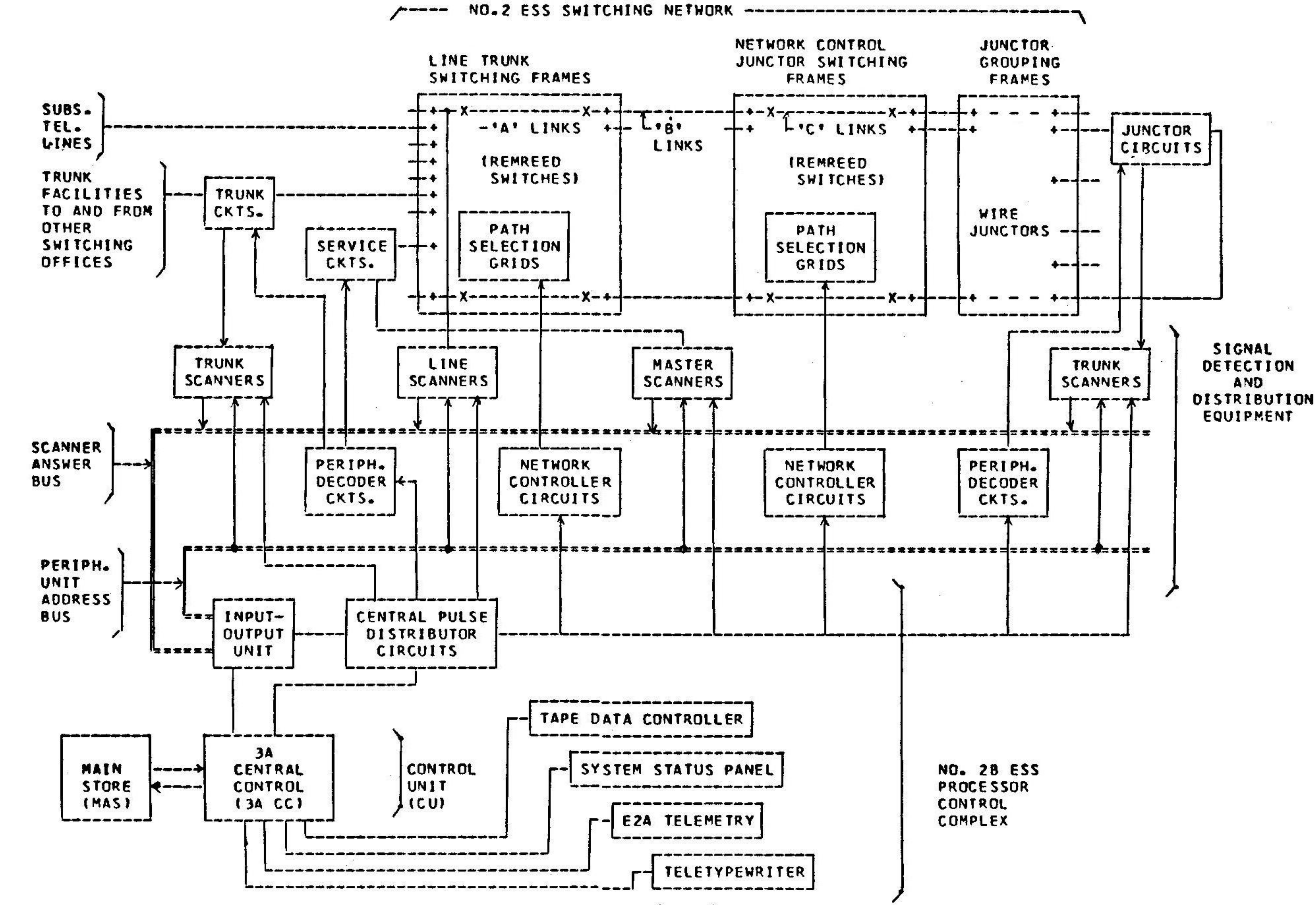
AVAILABILITY OF NO. 2B/2C ESS

The first application of the 2B Processor was in Acworth, Georgia. The office was a No. 2C ESS and was cut into service in February 1976. A second office, No. 2B ESS, in Elgin, Illinois, is scheduled to cut into service on June 19, 1976. General availability for shipment of the 2B Processor is January 1977.

SELECTED REFERENCE:

GL 74-01-056—Features, Capacity, Availability, Retrofit

NO. 2B ESS



ESS SYSTEMS CHART NO. 10 ISSUE 1

NO. 3 ELECTRONIC SWITCHING SYSTEM

NO. 3 ESS

GENERAL DESCRIPTION

The No. 3 ESS is a small stored program controlled switching machine designed to provide modern telephone switching service for the rural and suburban market up to 4500 lines. This switching system provides the modern telephone services listed in Table A.

The No. 3 ESS System has maintenance and administration features that provide considerable remote control capability and is therefore particularly suited to an unattended office environment.

SYSTEM OPERATION

Figure 1 provides a block diagram of the system. The following is a description of the No. 3 ESS circuits.

Central Processor

The Central Processor controls the setting of switch paths through the network and coordinates the actions of other parts of the system. The processor complex is duplicated. Each processor is capable of detecting faults within itself so that, in the event of a failure, control is transferred to the standby unit. Due to the relatively low number of calls generated in a small switching system and the high speed of the processor, design strategy has minimized the autonomy of peripheral hardware by having the processor exercise extensive control over simple peripheral circuits at the expense of available real time.

Switching Network

The Switching Network is a five (5) stage folded design with a fixed concentration ratio of six to one. Lines, trunks, test, and service circuits are intermixed on the terminals of the network. All connections including interoffice and intraoffice talking connections, as well as digit receiving, ringing and signaling, are made through the remreed network. A circuit junctor, located electrically between the second and third stages, is used in every connection.

As shown in Fig. 2, the network is constructed of modules called concentrator groups, each of which includes two stages of switching and will terminate up to 384 lines, trunks, test, and service circuits. These terminals are concentrated by the first two stages of switching to 64 links, half of which are equipped with junctor circuits. The 64 links from each concentrator group are spread uniformly across the 32 third-stage switches on a fixed assignment. Thus, any switch connection requires passage through the first and second stages of one concentrator group, a third-stage switch, and the second and first stages of another (or the same) concentrator group.

Peripheral Control

Control of the entire periphery is accomplished over 6.7 megabit serial I/Ø channels between the Central Control and peripheral control circuits which convert the information between serial and parallel forms and gate the data to and from the network, scanner, and distributor controllers, tape data controllers, and teletypewriter controllers.

The network controller, which steers current pulses to the selected crosspoints via an electronic path of PNPNs and diodes, receives its address information from the Frame I/Ø Controller (FIOC) in parallel form. Verification of proper access pulsing is then returned to the Central Control via the FIOC and the I/Ø channel.

The scanner permits the processor to monitor the status of the system. Information is read by the scanner from a ferrod matrix which is then passed back to the Central Control via the FIOC and associated I/Ø channel. The peripheral circuit relays are controlled by an electronic distributor.

Trunks, Junctors, and Service Circuits

Trunk circuits maintain supervision only toward external facilities since the line supervision is accomplished at the circuit junctor during call stable states. The junctor circuit is located electrically between the second and third stages of the network and provides loop supervision in both directions on

NO. 3 ELECTRONIC SWITCHING SYSTEM NO. 3 ESS

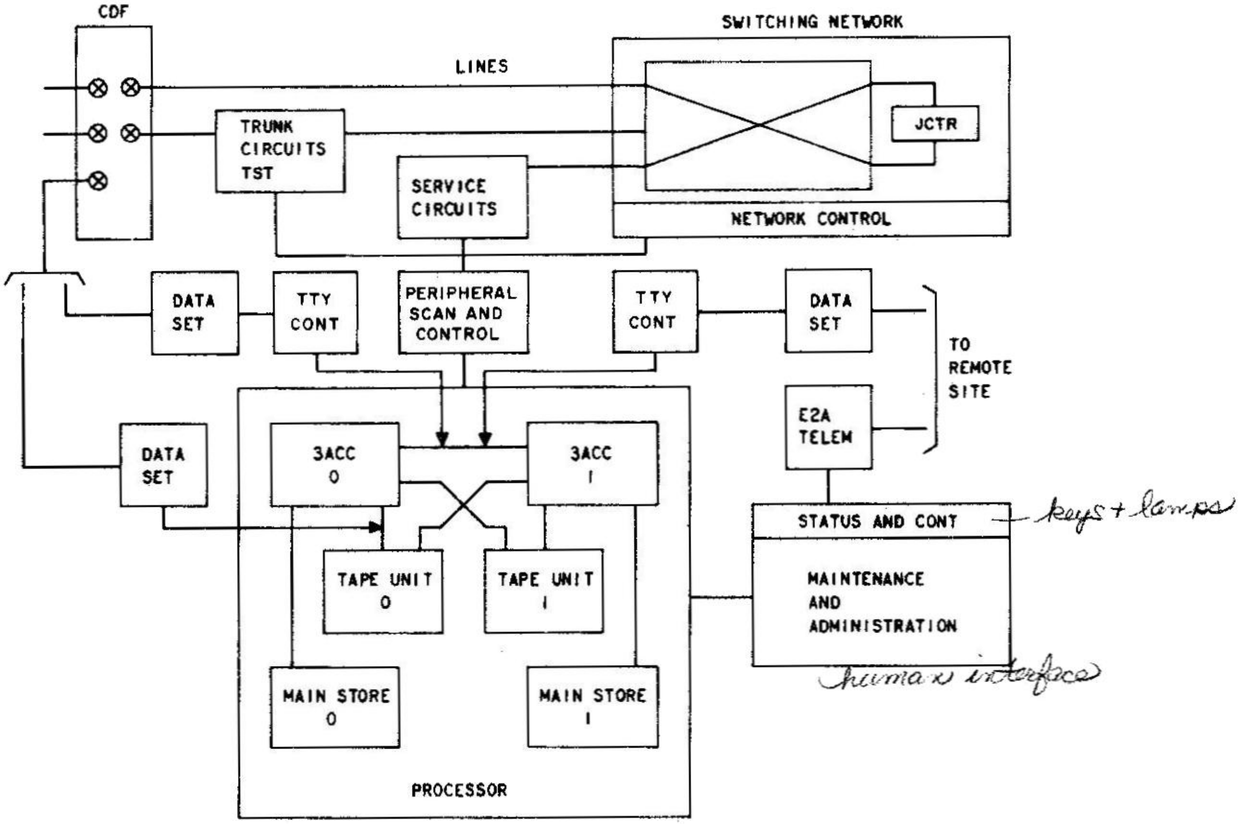


Fig. 1—System Block Diagram

intraoffice calls and toward the lines on outgoing and incoming calls. Also, a junctor opens or cuts through the network tip and ring leads between the switched terminals.

Test and Maintenance Circuits

Test and maintenance circuits are provided to test trunk and service circuits. Provision is made in the office for a dedicated teletypewriter. Also, additional circuits are provided for remote maintenance.

PHYSICAL DESIGN AND EQUIPMENT CAPABILITIES

Five switching frame designs, 7 feet high and either 12 or 18 inches in depth, are required for No. 3 ESS offices. Three frames, a Processor, Test, and Maintenance Frame are required on a one-per-office basis. Also, for a given office, 1 to 15 Network Frames and either 1 or 2 Control Frames are required.

Each Network Frame accommodates the network, trunk and service circuits, and the associated control equipment in a single package. This concept, as opposed to that of separate entities for different functional types of equipment, will reduce the material, engineering, and installation costs for No. 3 ESS. Since the Network Frame is the growth frame, office growth is simplified. Cabling between frames is connectorized to facilitate office testing and growth.

Processor Frame

Figure 3 shows a Processor Frame with two 3A Central Controls and the main store memories and store controllers.

The 3A Central Control Unit uses large scale integrated ceramic technology extensively. The semiconductor main store memory serves as program, translation, and call store. A duplicate copy of program and translation is stored in the tape

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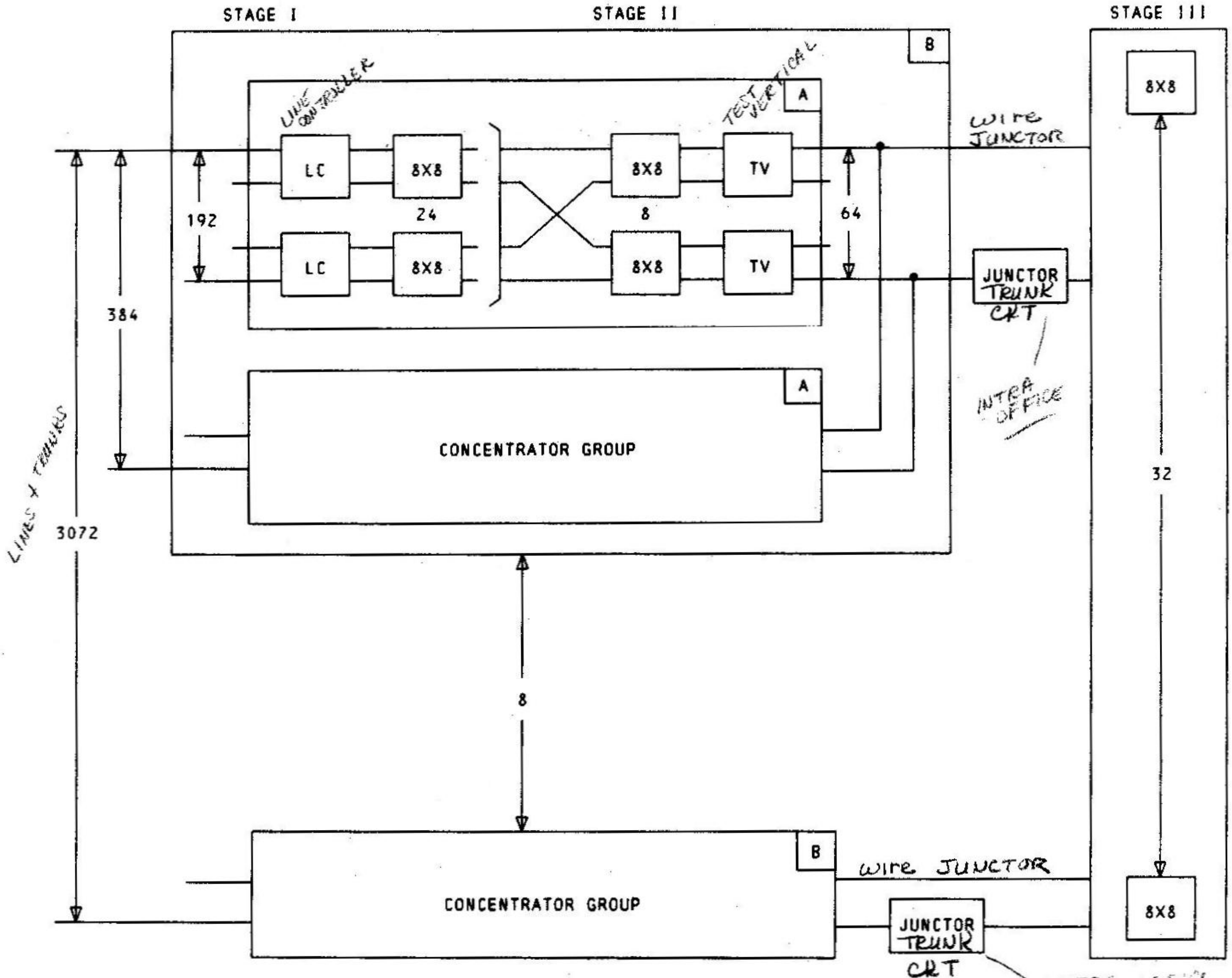


Fig. 2—No. 3 ESS Network Topology—2688 Terminals or Less—For 8 or More Concentrator Groups, the Third-Stage Switch is Built Out Into a 16 by 16 Matrix

cartridge along with infrequently used administrative and diagnostic routines.

The processor control panel provides a means of communication between the craftspersons and the 3A Central Control. Due to the No. 3 ESS serial bussing arrangement, the processor requires very little cabling between it and the frame I/Ø circuits on the control and maintenance frames.

Network Frame

Each Network Frame provides the first and second stage remreed switches for 384 terminals, associated junctors, trunks, service circuits, and associated control equipment.

The first and second stage network units are connectorized to facilitate repair and are organized to minimize interruption of service during repair. There are six stage 1 units and two stage 2 units for a concentrator group. Traffic handling capability of a concentrator group is about 1400 CCS. The fixed concentration ratio of 6 to 1 permits optimum fill of the network with lines offering approximately 3 CCS (originating and terminating) per line with 65 percent intraoffice traffic.

NO. 3 ELECTRONIC SWITCHING SYSTEM NO. 3 ESS

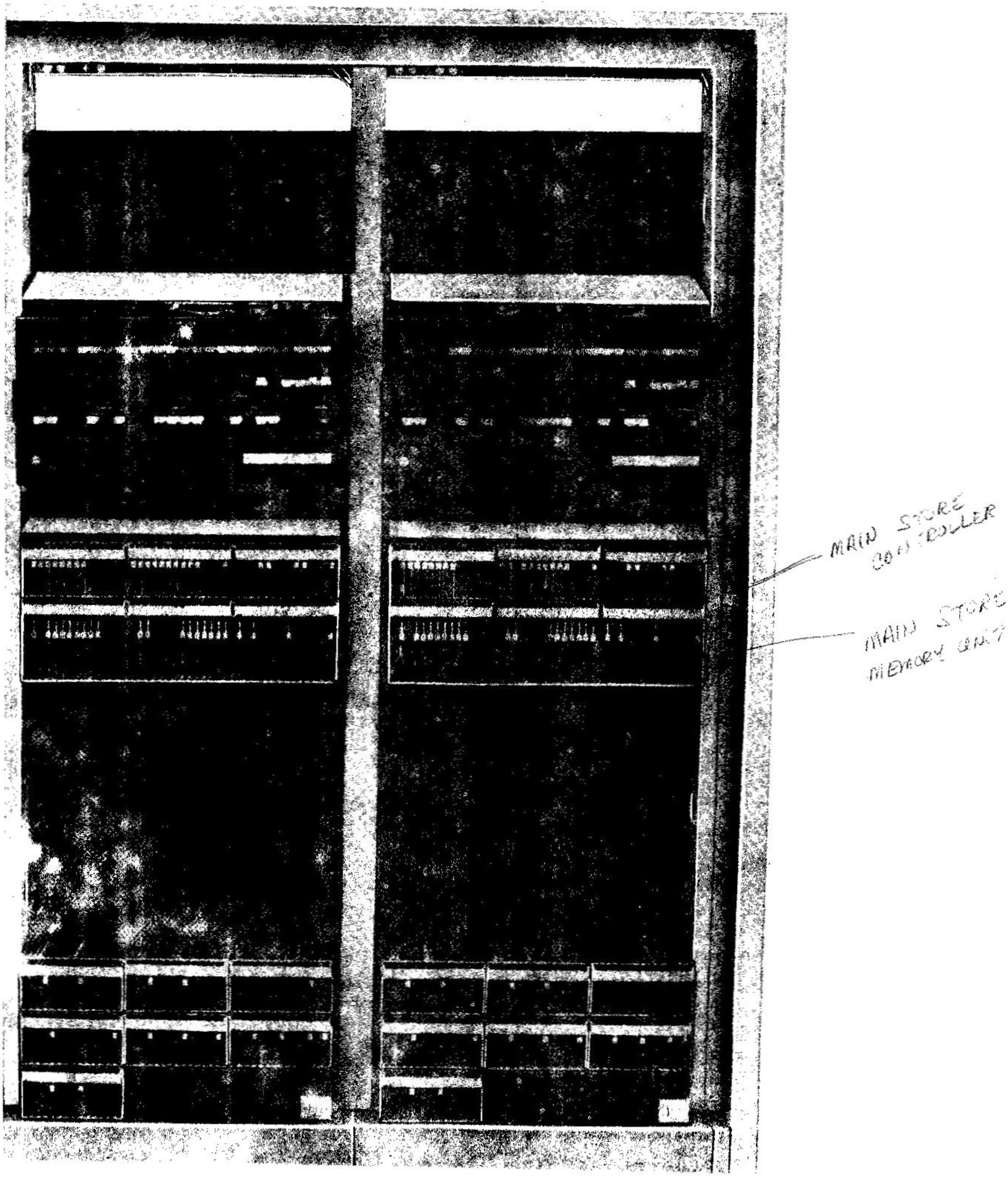


Fig. 3—No. 3 ESS Processor Frame

During network growth over the life of the office, concentrator groups and their associated junctors are added without rearrangement of the existing junctors. With 8 by 8 switches in the third stage, the network may accommodate up to 3072 terminals. The maximum number of network terminals can be raised to 5760.

The unit for trunk and service circuits is universally wired to accept the most commonly used trunk circuits and has dedicated positions for the service circuits. The junctors, trunks, and service circuits are mounted on the circuit packs and use miniature components, such as low profile inductors, inductor reed relays, and wire spring relays. Since neither optional units nor optional wiring is required on the Network Frame, the only variation between Network Frames is the quantity and types of circuit packs for trunk and service circuits.

Control Frame

The Control Frame provides duplicated peripheral FIOC network, scanner, and distributor controllers in addition to the associated +3V power converters and the network third stage. The remaining space on the frame is used for trunk, service, and miscellaneous circuit equipment which does not grow with any network and additional equipment required due to small groups of circuits or high traffic.

The peripheral controllers are provided on high scale integrated ceramic packs and discrete circuit packs. The third stage network units are connectorized to facilitate repair.

Maintenance Frame and Test Frame

The Maintenance Frame provides a system maintenance control circuit and system status. Provision is also made for a dedicated teletypewriter. The frame also houses the teletypewriter controllers, tape data controllers, and tape cartridges. The Test Frame houses the equipment for testing trunks, line, and service circuits as well as facilities for manual testing by the craftsperson.

This local maintenance center, which provides for the normal administration and maintenance of the system, may be augmented by connection to a Switching Control Center which gives status reporting and control capabilities at a remote point. Local and remote capability, therefore, exists for accessing, testing, and exercising parts of the system, removing equipment from service, and making class of service and directory number assignments.

ENGINEERING ECONOMICS

The No. 3 ESS designs use new integrated ceramic technology, new remreed switches, new semiconductor memory, and circuit pack mounted trunks, junctors, and service circuits. Use of these new devices and hardware not only makes No. 3 ESS economically attractive, but also reduces the size of the No. 3 ESS office. As shown in Fig. 4, an area of 22 feet by 41 feet can accommodate a full 4500-line No. 3 ESS office as well as 2 lineups of toll terminal gear.

The circuit packs and units are connectorized for easy growth and repair. Also, the cabling between frames is connectorized. Due to the physical design of frames, the only variation between frames is the quantity and type of circuit packs for trunk and service circuits. All these design features, plus the small size of the switching system, make it possible to test the complete switching system in the factory utilizing its own unique office data. This approach reduces the installation cost and interval.

No. 3 ESS comes as a single unitized equipment arrangement that has all the switching equipment required for an office. The system is completely assembled and tested at the factory and shipped intact as a single unit. At the installation site, it is lifted from the truck and rolled into the building. The physical design of the No. 3 ESS permits it to be installed in a conventional or preengineered building. It can also be shipped in a modular building, although this has not yet been engineered.

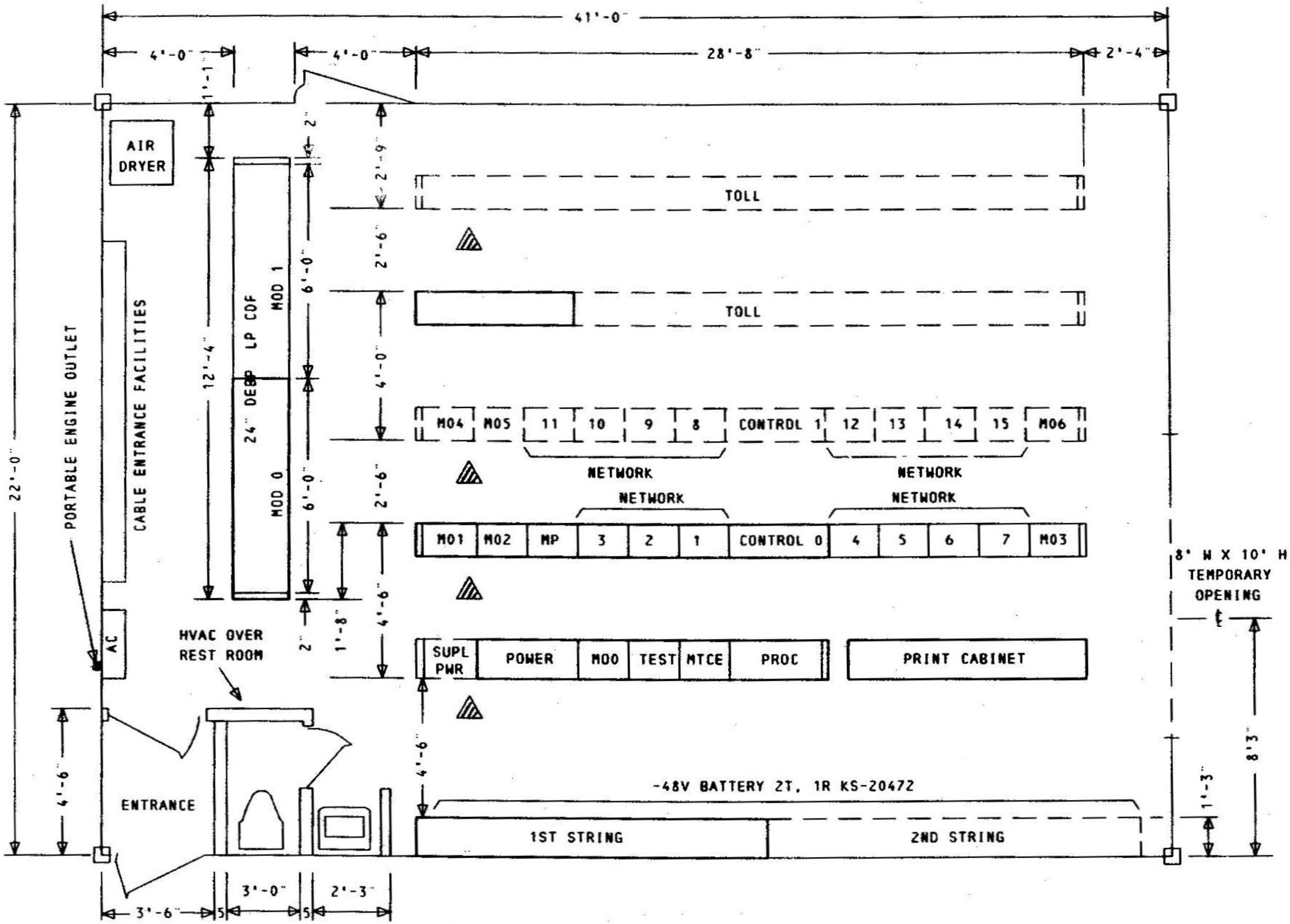


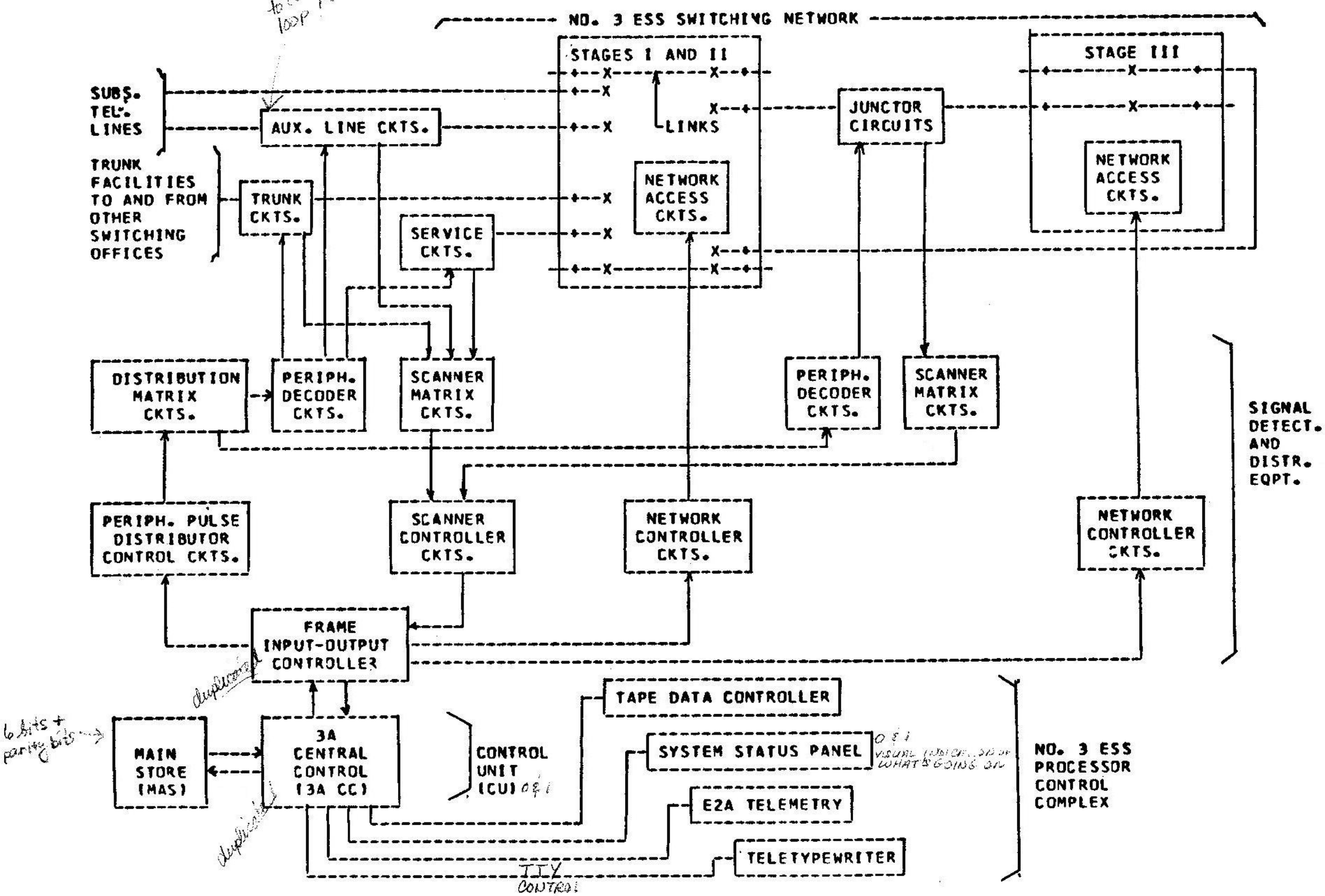
Fig. 4—No. 3 ESS—2100 Line Office Shown Solid—Full Growth (4500 Lines) Shown Dotted

NO. 3 ELECTRONIC SWITCHING SYSTEM NO. 3 ESS

NO. 3 ESS FEATURES

	INITIAL	FUTURE	UNDETERMINED
MISCELLANEOUS			
CUSTOM CALLING SERVICES	X		
TOUCH-TONE	X		
CENTREX			X
PBX	X		
HOTEL-MOTEL	X		
BISCUS	X		
LOCAL TANDEM		X	
TSPS	X		
EAS	X		
ACCOUNTING			
LAMA —		X	
ANI	X		
MESSAGE RATE	X		
MINI-WATS			X
TTY			
COMMON WITH SHARED CHANNEL	X		
DEDICATED SHARED BY TRAFFIC & MAINTENANCE	X		
ALARM REPORTING	X		
REMOTE READ-OUT OF TRAFFIC DATA	X		
REMOTE REMOVAL OF EQPT FROM SERVICE	X		
TRUNKS			
PLUG-IN	X		
MF SIGNALING ON INC FROM LTD	X		
COMBINED TRUNK FOR:			
1) OG - 411, 611, ETC & INTERCEPT			X
2) INC - VERIFICATION & LTD			X
BY-LINK	X		
DISTRIBUTED ANNOUNCEMENT FACILITIES	X		
LOOP CHARACTERISTICS			
1600	X		
SWITCHED			X
COIN	X		
SLM	X		
SXS LEAKAGE RQMT	X		
DISTRIBUTING FRAME			
PRE-ASSIGNMENT	X		
SIMPLIFIED	X		
ELIMINATE CABLE VAULT	X		
TAC	X		
STATION TESTING			
REMOTE	X		
INEXPENSIVE LIT	X		
INSTALLER DIAL UP	X		

NO. 3 ESS



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