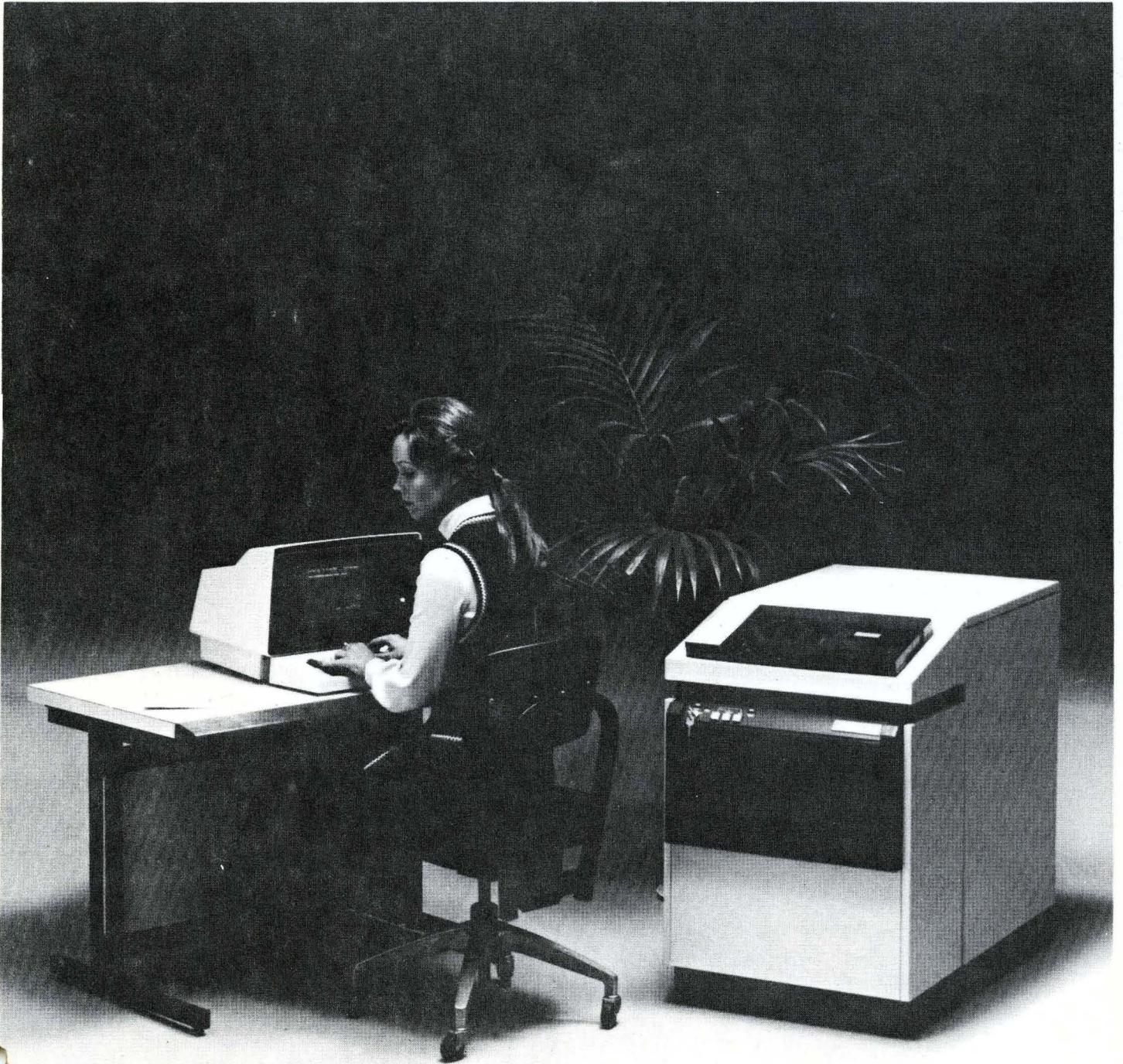


## General Information





# XL Distributed Processing Systems

## General Information

August 1980

This document contains the latest information available at the time of publication. However, Pertec Computer Corporation reserves the right to modify or revise its contents. To ensure that you have the most recent information, contact your local sales representative.

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## I. INTRODUCTION

XL Distributed Processing Systems are advanced, microprocessor-based multi-terminal systems that perform a mix of data retrieval, data entry and data management in addition to background processing tasks. These systems bring to small installations, and to individual user departments in large organizations, powerful data processing capabilities that significantly reduce the cost and turnaround time to produce error-free, computer-ready data. Both systems enable user departments to prepare accurate data with source department personnel, to access and update local data bases for better information control, and to generate needed reports and documents on demand.

The larger of the two systems, the XL40, is a powerful, multi-microprocessor-based system capable of concurrent data retrieval, applications processing, batch data entry, source data capture, data communications, file inquiry and Host Interactivity. The smaller XL20 is designed for high-volume, high-flexibility locations which need local intelligence or have diskette media interchange requirements. An on-line/off-line switch permits XL20 CRT terminals interactive access to an XL40 data base and, via the XL40, Host Interactivity.

The XL Systems combine multiple microprocessor architecture with a sophisticated multi-tasking operating system, XL/OS, to bring flexibility, high performance and efficient use of resources to the user at a low cost. Two user programming capabilities are provided: a simple-to-use checkbox specification format, and easy-to-program, yet powerful COBOL procedures for increased editing, data validation and report generation.

Data Communications provides remote sites with the ability to communicate with other XL Systems or with mainframes and terminals using industry-compatible binary synchronous protocols over leased or switched telephone lines. Data communications functions concurrently with all other system activities.

The primary design objectives of the XL Systems are to offer immediate distributed processing cost savings today while providing a growth potential as local processing needs change. All features required to meet current and future applications are provided in the basic system software. Through memory and peripheral expansion, the user easily grows into more sophisticated application areas, employs more system capabilities, and performs generalized processing tasks that need not be done on a mainframe computer.



## II. SYSTEM DESCRIPTION

The XL20 and XL40 incorporate a versatile combination of hardware and software to provide extremely efficient transaction-oriented distributed processing. Hardware components of the XL20 include the Micro Control Unit, which contains the diskette drives; printer; card reader; and CRT terminals. The XL40 hardware components include the Micro Control Unit, which contains the first disk drive and optionally, up to two diskette drives and magnetic tape unit; printer; card readers; and CRT terminals. Additional XL40 disk drives and tape units may be housed in an expansion cabinet.

With the XL20, the general flow of information is from the keyboard through memory to a self-contained magnetic diskette. Complete diskette files may be stored, transferred to another diskette, transported to another XL20, output to a line printer, or communicated via telephone lines to an XL40 or a mainframe computer. Data files may also be received via data communications and stored on a diskette.

The general flow of data through the XL40 System is from the keyboard through memory to a disk drive where it is collected into a data file. When a file is completed, it is transferred from the disk to a diskette or magnetic tape unit that can be transported to a large-scale computing system to be read as input for mainframe processing. As an alternative, data files may be communicated over telephone lines to an XL20 or a mainframe computer. Data files may also be entered into the system from magnetic tape, diskette, or data communications and stored on a disk drive for subsequent processing and output.

This section provides detail on XL hardware, software and system operation. Those features and functions available only on the XL40 are so indicated in the text or by an asterisk as appropriate. A summary of capabilities and features precedes the detailed descriptions.

### CAPABILITIES/FEATURES SUMMARY

#### MAJOR CAPABILITIES

Information update and retrieval—Data retrieval software provides rapid multiple access to large data files; fast, flexible very large table lookup; full-screen file inquiry/update applications; \* high-speed search/modify; sorting.

Comprehensive system software—Includes XL/OS operating system programs, SYSGEN utility program, a series of diagnostic programs for hardware testing, a user's program library and the ability to create user formats, tables, label programs and subprograms.

Dynamic memory allocation—Memory is assigned to each task as needed. No artificial limits due to fixed memory partitions.

Direct memory accessing—A universal bus design allows any peripheral controller to access memory directly without interrupting the executive processor.

*\*XL40 only. (XL20 file inquiry software is scheduled for release during 1980.)*

Multi-task operating system — Provides concurrent foreground and background processing. Supervisor can disengage from background tasks after initiation.

System generation (SYSGEN) — Customizes software and resident memory for each installation. Capable of being generated on user equipment.

Data Communications — Binary synchronous, half-duplex to 9600 bps, emulating IBM 2770, 2780, 3741, 3780, or HASP 360/20 Multileaving Workstation; half-duplex to 4800 bps emulating SDLC;\* 3270 Host Interactivity.\* Operates concurrently with other system activities as a background task.

Remote On-Line Subsystem (ROLS) — Allows 480- and 2000-character CRTs and 120 character-per-second station printers to operate under XL40 program control via dial-up or leased telephone lines. Up to 12 active locations, with a total of 24 active devices (of which up to 15 may be remote CRT terminals and up to 16 may be remote station printers), may be configured per XL40 System.

User programmability — English language COBOL procedures provide powerful application programs for data entry, validation, retrieval, and full application processing.

Extensive data editing and validation at all levels: character, field, record, and batch. Ensures clean, accurate, computer-ready data. Protects mainframe files, reduces mainframe edit runs.

Easy to understand prompts and messages which guide and assist the operator. Especially useful for operators in training. Programmable prompts allow full-screen “fill-in-the-blanks” data entry.

System security and data protection — System password required to enter Supervisor and Command Manager modes. Data batches protected by job name, format and individual field restrictions.

Operator Statistics — All operator statistics automatically recorded on disk (XL40) or diskette (XL20). Sorted reports by operator or job are available. Improves management control, greatly reduces supervisor clerical activity.

Auto Save,\* Auto Log — Automatic saving to tape of batches when closed, providing immediate file backup.\* Automatic logging of user-selected data with time and terminal ID, including all supervisor activity and batch open/close activity for complete audit trails.

Auto Prompt — Permits automatic execution of user-created prestored Supervisor command prompts and responses defining the parameters of an initiated task or series of tasks. Pauses to allow operator intervention if necessary.

Spooling\* — a background function which intercepts data when received via data communications or when created locally, and records it on disk for immediate or later output. Provides a large, high-speed buffer on disk.

\*XL40 only.

## **DATA RETRIEVAL FEATURES\***

- Full-screen business forms display.
- Automatic processing of files under format control with or without keyboard entry.
- Data security preserved through passwords at the system and individual program levels.
- Disk table lookup for validation and auto insertion of data.
- Sequential device support for I/O operations under format control in a mode other than supervisor.
- Real-time file inquiry and update with audit trail.
- Multiple operators can simultaneously share files, with controls established by the user.
- Indexed Direct Access Method (IDAM) is used for fast efficient data retrieval.
- Multiple operators can update files while other operators access and use same files.
- Files may be accessed by primary and up to nine alternate keys without having multiple copies of the data file in different SORT sequences.
- Duplicate keys are permitted in both primary and alternate keys.
- File management and recovery utilities are provided with the system to enable the supervisor to easily handle indexed files.
- SORT/MERGE has been implemented with a generalized design so that it can be used to create indexed files or to externally sort sequential files.
- Up to 60 indexed files can be accessed by single or multiple operators.

*\*XL40 only. (XL20 Data retrieval/transaction processing features are scheduled during 1980.)*

## DATA ENTRY FEATURES

- File creation can be accomplished by three methods: Supervisor creation from ordinary batches, input from magnetic tape,\* or operator real-time creation from keyed data.
- Number of format programs, tables, check digits, subprograms and tape label\* programs limited only by disk or diskette storage capacity.
- Up to 32 levels per format program.
- Mid-record level changes.
- Up to 999 characters per record.
- Up to 333 fields per record.
- Up to 50,000 batches per job.
- Up to 99 arithmetic registers (13 digits) per job.
- Up to 99 balance registers (13 digits) per job.
- Up to 99 character registers (542 characters) per job.
- Up to 99 auxiliary duplication registers (542 characters) per job.
- Output reformatting to printer or industry-compatible diskette; output tape reformatting on the XL40.
- Multiple output files.
- Standard diskette labeling; standard and user-defined tape labeling on the XL40.
- Audible tone on record release.
- SYSGEN throughput enhancement options.
- Enter Continue and Verify Continue modes.
- Enter and Verify interrupt.
- Concurrent Enter and Verify modes on same batch.
- File Inquiry mode.\*\*

\*XL40 only.

\*\*XL20 file inquiry software is scheduled for release during 1980.

- Multiple search modes (record number, content, content/level, invalid fields).
- Batch replay after field modification when registers or procedures affected.
- Update mode.
- Freeform input.
- Operator-selectable displays (register content, record content, time, terminal number, total batch time, keystrokes).
- Operator messages.
- Record insertion and deletion.
- Automatic correction of all duplicated data in a dup chain.
- Field insertion from auxiliary duplication registers.
- Field tabbing, skipping, bypassing.
- Auto-off key to disable and override programmed skip, dup or procedure.
- Continuous job status display.
- Operator-adjustable alarm tone, key click and CRT display intensity.
- Output tape translation \* (EBCDIC, ASCII, BCD, packed hexadecimal, IBM 360 packed decimal, binary, user-defined).
- Output record blocking and padding.\*

## **PROGRAMMING FEATURES**

- Checkbox programming.
- Data type character validation including upper and lower case alphabetic, numeric, signed numeric, blank, punctuation, hexadecimal, COBOL character set, and up to eight user-defined character sets.
- Must-key fields.
- Must-release fields.
- Selectable field display on CRT (display or suppress).

\*XL40 only.

- Multiple verification options (key, sight, to balance).
- Right- or left-justification.
- Selectable fill characters.
- COBOL procedure programming.
- Range checking on any field, inclusive or exclusive.
- Character and field concatenation.
- Single- and double-entried table lookup.
- Field/record/batch invalid flags set on programmed condition tests or field bypass.
- Job constant and computational insertions. Real-time and date insertions.
- Inner-record cross-footing, extensions, field duplication.
- Numeric and non-numeric literals.

#### **SUPERVISOR FEATURES AND UTILITIES**

- Continuous Supervisor status display including percentage of disk or diskette available.
- Any Supervisor function concurrent with data entry.
- Any terminal can be Supervisor.
- Close any terminal from Supervisor terminal.
- Delete batches, jobs, directories, or programs from disk or diskette.
- Obtain status of any job, program, or directory on the system.
- Disk (XL40)/diskette (XL20) volume table of contents purge on power-off.
- Restore jobs or programs to disk from save tapes.\*
- Write batches/jobs under control of a format to magnetic tape or printer on the XL40; to printer or another diskette on the XL20.
- Write valid or invalid records only.

\*XL40 only.

- Monitor activity at any other terminal.
- Compile formats, subprograms, tape\* or diskette labeling programs, tables.
- Creation, control and deletion of indexed files.
- Compiler diagnostics.
- Assign values to system variables (I/O logical devices, Auto Save options,\* communication options, password, etc.).
- Prestore Supervisor command prompts and responses (Auto Prompt).
- Rename/renumber and copy jobs disk-to-disk (XL40) or diskette-to-diskette (XL20).
- Batch recovery of unreadable records.
- Save jobs, programs or directories from disk or diskette to an output tape\* or diskette.
- Input jobs from magnetic tape\* or punched cards to disk (XL40) or diskette (XL20) under control of a format.
- Transfer data between peripherals (media conversion).
- On-line hardware diagnostics.
- Search/Modify magnetic tape records (tape edit).\*
- Control of operator statistics files, including generation of sorted reports.
- Control of checkpoint positions for data communications (also spool files on XL40).
- Build Directories (batch lists) for data communications (also spooling or indexed files on the XL40).
- Control of spooling functions.\*
- Background message routing.

\*XL40 only.

## **HARDWARE**

### **MICRO CONTROL UNIT**

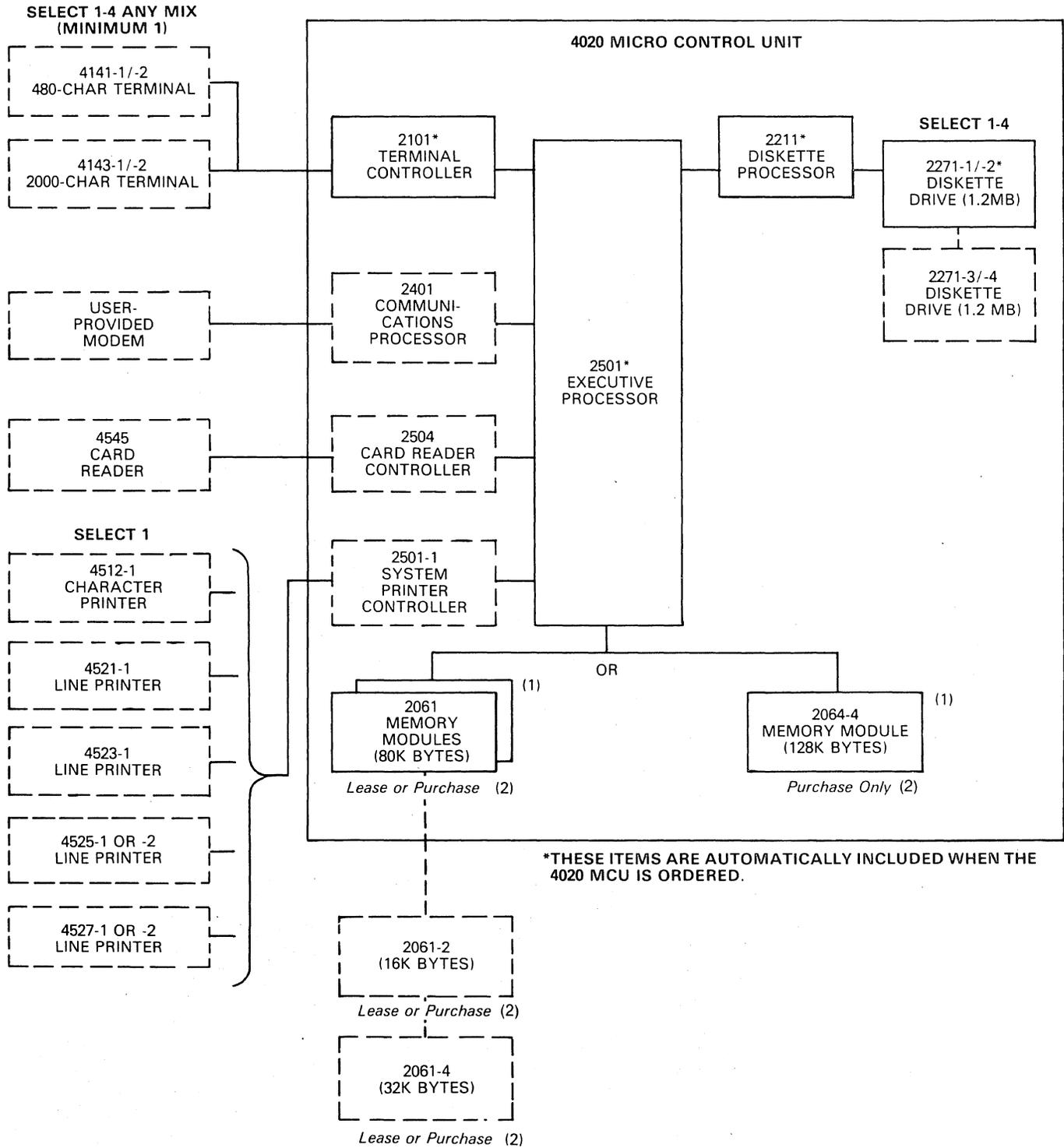
The executive processor, system memory, and peripheral processors are integrated within a single cabinet designated as the Micro Control Unit (MCU). The XL40 MCU also includes the first disk drive, an optional tape unit and one or two optional diskette drives; the XL20 MCU includes two diskette drives. The MCU, as the primary hardware component of the system, is a small, desk-high unit which is compatible with most office decor.

The MCU features an executive processor and solid state MOS memory circuits which form a complete general-purpose, stored-program digital computer. Also included in the MCU are a universal addressing and data bus system, the DC power supply and the system control panel. The universal bus is bidirectional and synchronous, allowing the transfer of data and control signals. The peripheral controllers, under control of the executive processor, use Direct Memory Access with main memory via the universal bus. For enhanced performance, most peripheral controllers employ microprocessors in their design.

### **EXECUTIVE PROCESSOR**

The executive processor consists of a single printed circuit board installed within the MCU cabinet, and is designed around a 16-bit, programmable, high-speed micro-processor with a micro-instruction cycle time of 200 nanoseconds. Its circuits provide the arithmetic and data manipulative capabilities used in performing system operations. The executive processor interprets and executes the system operating programs to perform the functions indicated. The executive processor connects to the remainder of the system, including the main memory circuits, via the universal bus logic. This extremely fast processor guarantees high data throughput rates, enhanced operator efficiency, and minimal contention between concurrent system activities. A diagnostic self-test function is designed into the executive processor, and is performed each time the MCU is powered on.

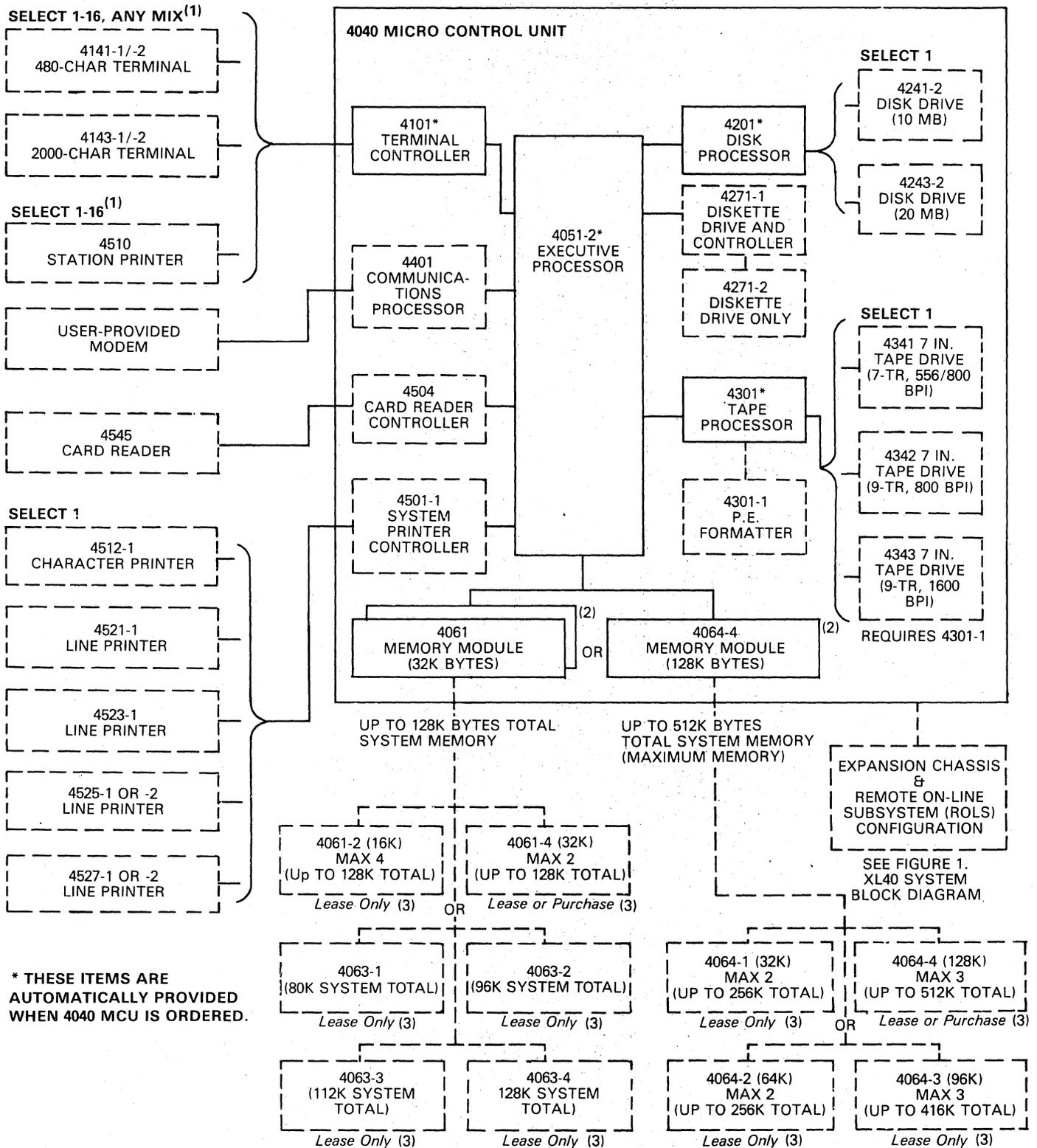
# XL20 CONFIGURATOR



**NOTES:**

1. Memory may be configured in two ways. If the MCU is configured with 80K bytes, memory may be expanded up to 128K bytes, as indicated. If the MCU is configured with 128K bytes, no expansion is necessary.
2. Lease options apply to domestic (U.S.A. and Canada) markets only.

# XL40 CONFIGURATOR



\* THESE ITEMS ARE  
AUTOMATICALLY PROVIDED  
WHEN 4040 MCU IS ORDERED.

**NOTES:**

1. One terminal is required per system. A mix of 480- and 2000-character CRT terminals and station printers may be configured for either local or remote installation, or both, up to system totals of 16 terminals and 16 station printers. One terminal must be local.
2. For a total system memory requirement of 128K, two 32K-byte memory modules are automatically provided when the MCU is ordered. For a total requirement of 512K, one 128K-byte memory module is automatically provided with the MCU.
3. Lease options apply to domestic (U.S.A. and Canada) markets only.

## **SYSTEM MEMORY**

The main memory within the Micro Control Unit is a random access read/write storage facility capable of storing the system operating programs and the temporary data required by the executive processor. This memory also acts as a high-speed buffer between all system input/output devices including disk and/or diskette drives, magnetic tape units and operator terminals. Main memory consists of 16-bit words (8-bit bytes). The minimum XL20 system configuration requires 80K bytes, expandable to 128K bytes; on the XL40, the minimum system configuration requires 128K bytes, expandable to 512K bytes.

## **TERMINALS**

The terminal is the primary means through which the operator or Supervisor communicates with the system. Each terminal consists of a CRT (Cathode Ray Tube) video display screen and a detached alphanumeric keyboard. The video displays are available with either a 480-character or 2000-character screen.

The 9-inch CRT video unit displays 480 characters in 12 lines of 40 characters each. The top two lines of the screen are reserved for current job or Supervisor status information, which is displayed continuously. The third line is for informational or error messages generated either by the system or by user-written application programs.

The 15-inch CRT displays 2000 characters in 25 lines of 80 characters each. The top line of the screen is reserved for current job or Supervisor status information, the second line is for informational or error messages generated either by the system or by user-written application programs.

The remaining nine lines on the 480-character screen and the remaining 23 lines on the 2000-character screen are for the display of data being input through the keyboard or generated by the format program. The CRT is capable of displaying a maximum of 128 type-font characters, including upper and lower case alpha, numeric, punctuation, and special characters. A character generator RAM within each terminal forms characters by a 5 x 7 dot pattern displayed within an 8 x 13 cell (480-character screen) or a 7 x 9 dot pattern displayed within a 10 x 15 cell (2000-character screen). This "down-line" loading of font requirements. The appropriate character set is selected at SYSGEN time. The cursor, a blinking solid rectangle, indicates where the next character will appear on the screen. Tone volume, key click, and CRT character intensity controls are available for operator adjustment. Audible alarms and screen-flash functions bring input errors to the attention of the operator.

The keyboard contains both alphanumeric and control function keys for the keypunch or typewriter/numeric pad configurations. If desired, different keyboard configurations can be simultaneously used on the same system since separate translation tables in the MCU main memory can appropriately translate input from each keyboard.

Local terminals are daisy-chained to either or both of two interface ports on the MCU by coaxial cable, and may be up to 2000 feet from the MCU. Each terminal is assigned a unique, but changeable, address code by the installing customer engineer.

The XL20 System supports up to four terminals per processor while the XL40 System supports up to 16 terminals per processor. XL20 terminals may only be installed locally. On the XL40, the 16 terminals are supported in any mix: local, remote, or a combination of the two (one terminal must be local). The XL40 remote terminals are interfaced to the processor through a ROLS (Remote On-Line Subsystem) and a dial-up or leased telecommunications facility.

Either 480-character CRTs or 2000-character CRTs are available in any mix. The MCU sequentially polls (addresses) all connected terminals to sense when information (data or control signals) is being entered through a terminal. As information is entered, it is processed by the MCU and, when applicable, messages or data are formatted and sent back to the terminal for display on the video screen. CRT refresh memory is contained within each terminal.

Terminals are designed to be failsafe. If a station is turned off, removed from its coaxial connection or disabled by a hardware failure, the remainder of the system is unaffected.

#### **EXPANSION CABINETS (XL40)**

Up to three optional, three-partition, freestanding expansion cabinets are available, each of which houses up to three additional disk drives, an additional disk drive and one 10.5-inch reel maxi tape drive or two additional disk drives and two seven-inch reel mini tape drives. Each expansion cabinet contains its own power distribution module.

#### **MAGNETIC TAPE DRIVES (XL40)**

The optional mini tape drive installed within the MCU is a dual-gap head, read-after-write unit with industry-compatible half-inch tape and a 600-foot capacity on seven-inch reels. Seven- or nine-track NRZI (556 or 800 bits per inch), or phase encoded (1600 bits per inch) drives are available. Tape transport speed is 18.75 inches per second. Industry-standard error checks are featured, including read-after-write checking. Up to three auxiliary mini tape drives may be added in expansion cabinets.

An optional maxi tape drive is available which has a reel capacity of 2400 feet on 10.5-inch reels. Tape transport speed is 37.5 inches per second. Available with the same densities, formats and industry-standard features as the smaller tape drive, this optional unit may only be housed in an expansion cabinet. Up to two 10.5-inch reel maxi tape drives can be added per system, each housed in a separate expansion cabinet.

#### **DISK DRIVES (XL40)**

The first disk drive is integrated within the MCU and may contain two or four platters. Each platter stores 5 Mbytes (4.4 Mbytes sectored) of information. Up to three additional two-platter 10 Mbyte disk drives or three four-platter 20 Mbyte disk drives yielding a maximum of 80 Mbytes may be housed in an expansion cabinet. Average seek time on the 10 Mbyte drive is 70 milliseconds; 40 milliseconds on the 20 Mbyte drive. Average latency time is 12.5 milliseconds. Track density is 200 tracks per inch, bit density is 2200 bits per inch.

## **DISKETTE DRIVES**

On the XL20, up to four double-sided, double-density diskette drives may be integrated within the MCU. Each diskette stores 1.2 Mbytes of information yielding a system maximum of 4.8 Mbytes. Average seek time is three milliseconds track-to-track; average rotational latency is 83.3 milliseconds. Track density is 48 tracks per inch; maximum bit density is 6816 bits per inch, depending on recording format.

On the XL40, a diskette subsystem may be integrated within the MCU to provide one or two double-sided, double-density diskette drives for read or write operations. For user convenience, the subsystem uses IBM-standard diskettes written in Basic Data Exchange (BDE) format to provide interchange compatibility between XL40 and XL20 Systems and between the XL40 and any BDE-compatible systems.

Each diskette stores 240K bytes of data in BDE format, yielding a maximum of 480K bytes if two drives are used in the subsystem. Average seek time is three milliseconds track-to-track; average rotational latency is 83.3 milliseconds. Track density is 48 tracks per inch.

## **SYSTEM PRINTERS**

An optional line printer or serial character printer is supported which allows the system to produce hard copy reports. Formatted reports containing header and detail information are easily implemented through the use of COBOL procedures within the user's format programs. The printer may also be employed as a log device to provide audit trails of all Supervisor, batch open and close activity, and background messages. User program compile listings may also be output to the printer.

Print speeds up to 900 lines per minute are available with a line printer; 160 characters per second with the serial printer. Line length is 132 positions. A 96 character set is available, with both upper and lower case characters.

Horizontal spacing is 10 characters per inch; vertical is six or eight lines per inch. Paper widths from four inches to 15 inches may be used, printing an original plus up to five copies.

## **STATION PRINTERS (XL40)**

Optional software-driven station printers may be configured at either remote or local sites. The printers can provide CRT-display hard copy or hard copy for keyed data combined with stored disk file information, or they can be controlled as a separate addressable device by the application program.

Print speed is rated at 120 characters per second. Line length is 132 positions. a 96 character set is provided, with both upper and lower case characters.

A maximum of 16 stations printers are supported per XL40 System. These 16 may be installed in any mix: local, remote, or a combination of the two. The remote station printers are interfaced to the processor through a ROLS, using either a dial-up or leased telecommunications facility.

## **CARD READER**

An optional card reader is supported which permits cards to be input directly to disk or input to a mainframe via communications. Standard 12-row, 80-column punched cards are read serially at a speed of 600 cards per minute.

## **STATION LINE SWITCH (ON-LINE/OFF-LINE)**

An optional station line switch is available which permits cross-connection of terminals between local or remote XL Systems to provide interactivity in a network configuration as well as system backup capability at a multi-system site. At least one terminal must be available to each MCU. The unit is a small switch box cable-connected to the terminal on one side and the MCU or modem on the other. It may be freestanding, mounted to the underside of a terminal desk, or wall mounted.

## **PRINTER SWITCH**

An optional line printer switch is provided which permits two co-located MCUs access to one line printer.

## **DATA COMMUNICATIONS**

The Data Communications function for both systems is provided by an optional communications processor printed circuit board which interfaces with the executive processor and main memory via the universal bus, and which interfaces with the communications line via the EIA standard, RS-232-C. The communications control hardware is designed using processor architecture and contains a RAM memory capable of being loaded with communications software instructions. Binary synchronous protocols are supported in half-duplex mode up to 9600 bps in point-to-point or multipoint (slave only) networks. IBM 2770, 2780, 3741, 3780 and 360/20 HASP Workstation protocols are provided.

The XL40 System also supports SDLC/SNA functions in half-duplex mode up to 4800 bps. Terminals appear as IBM 3776-1, 3776-2 and 3777-1.

For access to non-resident data bases, the XL40 System supports 3270 Host Interactivity. Host Interactivity uses IBM BSC EBCDIC transmission operating in a half-duplex mode using either half- or full-duplex facilities. Data rate clocking is provided by the modem.

## **SYSTEM CONTROL PANEL**

The system control panel provides means for the user to power on and off the MCU and to initiate program loading procedures. The panel consists of controls for power on/off (key switch), restart (disk load), and load (tape\* or diskette load\*\*). In addition, indicators signify the power-on condition and system diagnostic status. Optional provision is available for a data set ready indicator.

\*XL40 only.

\*\*XL20 only.

## SYSTEM BLOCK DIAGRAMS

The following diagrams show all major hardware elements of the XL Systems.

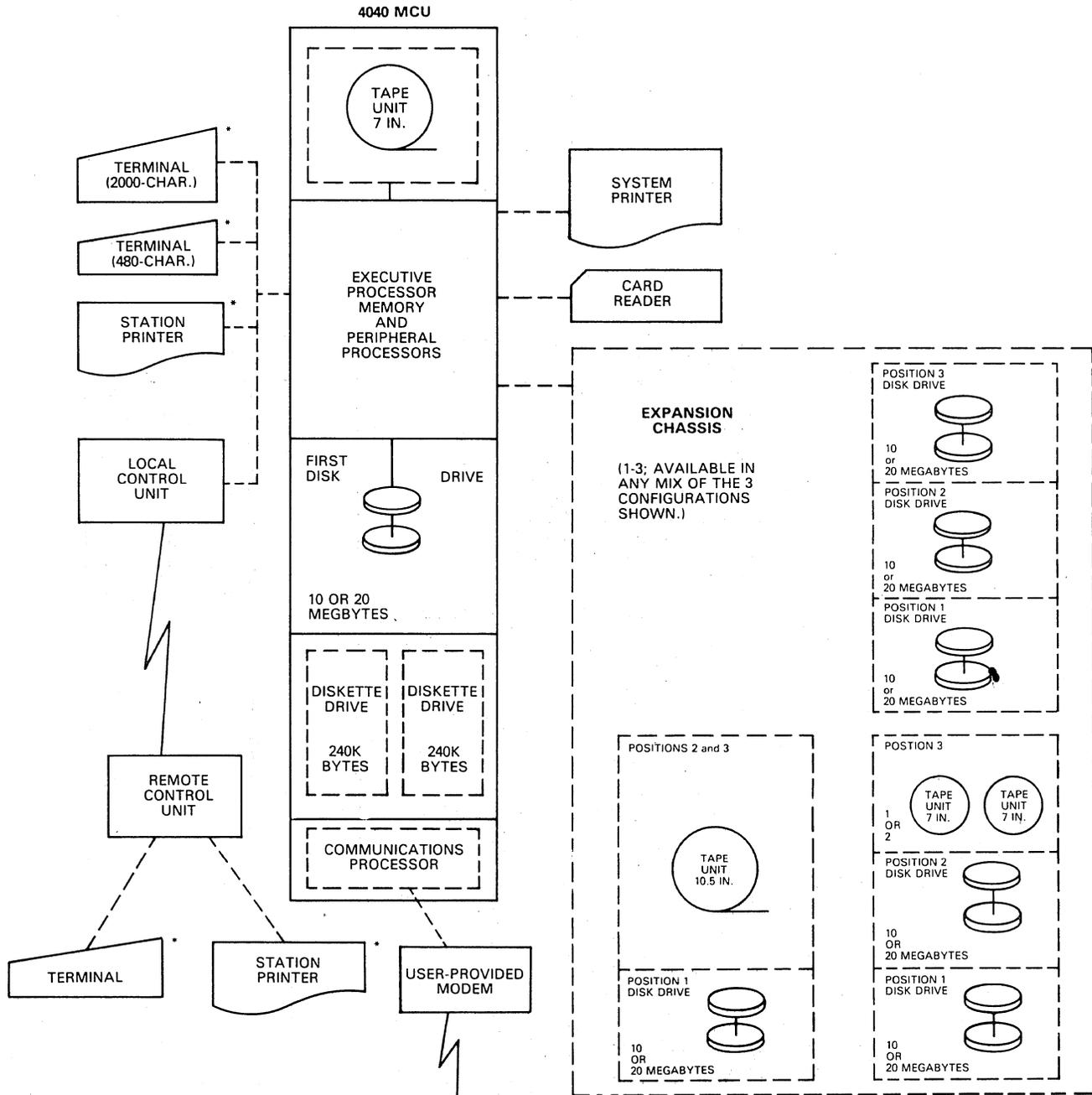


Figure 1. XL40 System Block Diagram

\*A mix of 480- and 2000-character CRT terminals and station printers may be configured for either local or remote installation, or both, up to system totals of 16 terminals and 16 station printers. One terminal must be local.

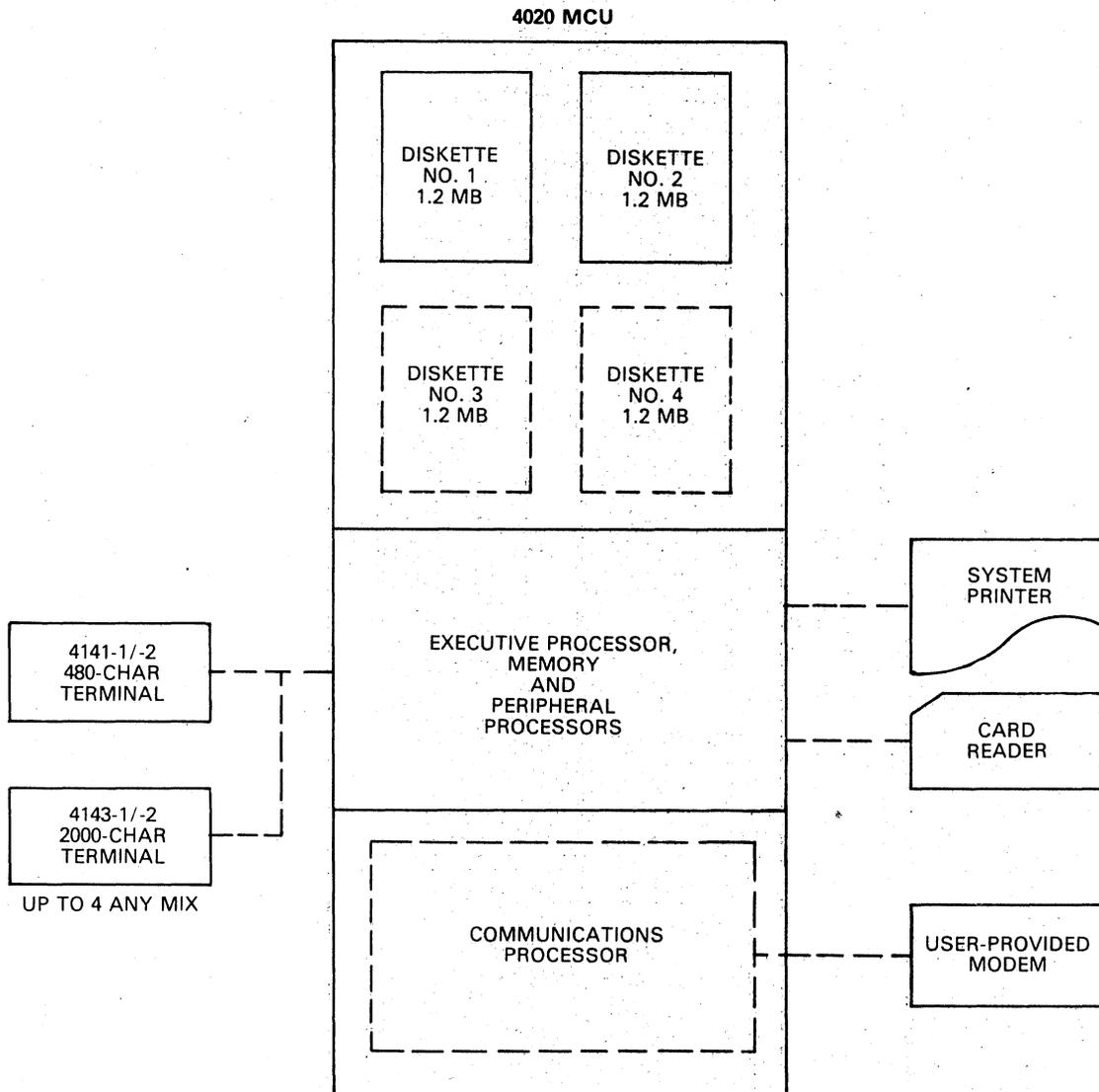


Figure 2. XL20 System Block Diagram

## SOFTWARE

The software included with the system contains the XL/OS operating system and associated support software. The operating system contains the functional elements required for system resources management, data management, file processing, program compilation, and input/output operations. The support software includes the SYSGEN utility program necessary to generate, load and maintain operational software systems, a series of diagnostic programs for testing the various input/output devices and the central system, and the user's program library. The following diagram (Figure 3) details the types of software used by the system.

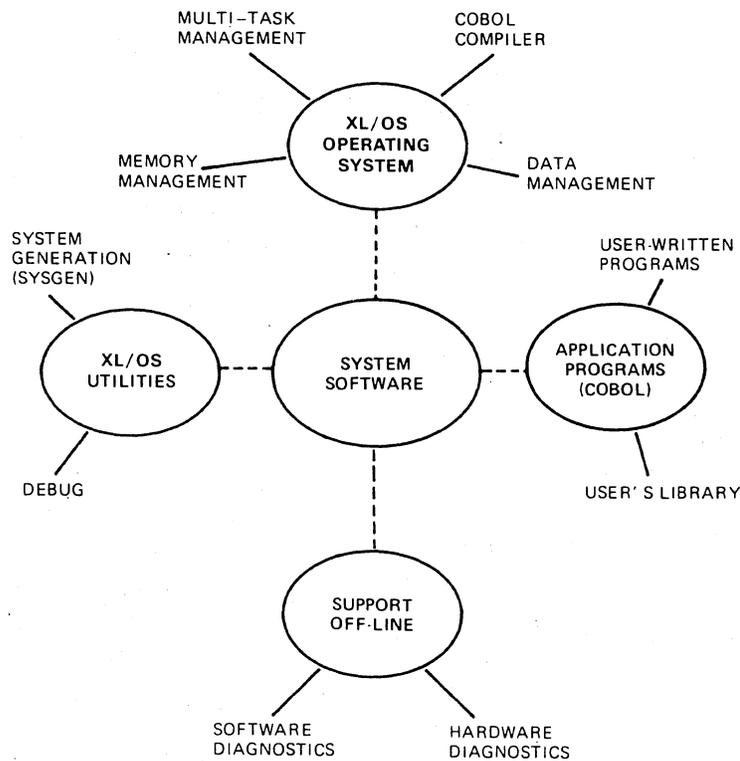


Figure 3. System Software

### XL/OS OPERATING SYSTEM

The XL/OS operating system consists of seven major elements: Executive, Editor, Input/Output (I/O), System Subroutines, Runtime, Supervisor Task Manager, and Background Task Manager.

## **Executive**

The Executive is the primary controlling program for the entire system. It is divided into four sections: scheduler, save and restore stack, enqueue and dequeue, and memory allocation. The scheduler allocates use among the active terminals of serial reusable routines (those routines that may be used by another terminal after a preceding terminal has exited). The save and restore stack routines are responsible for the memory management tasks associated with the save pushdown stack that stores items for terminals awaiting input/output operations. The enqueue and dequeue routines are responsible for managing the first-in/first-out queue employed for input/output requests. The memory allocation routine is responsible for all dynamic memory allocation for such items as overlays, save stack, terminal work areas and format programs.

## **Editor**

The Editor routine, under control of the Executive scheduler, handles data management and validation within the system software. The Editor processes input data in the sequence described below.

Under interrupt control, the I/O routines acquire data from the various terminals and store this information in the appropriate data buffers. The Editor sequentially empties these buffers and converts the data into EBCDIC characters for processing. Each converted input character is validated according to the appropriate format table. If the character is valid, it is stored in the terminal's record buffer. As necessary, field-end, record-end and special processing is performed. If the format designates execution of a COBOL procedure, the Editor calls the Runtime routine to perform the interpretation.

The Editor routine also calls the I/O routines to display the acquired data by updating the appropriate CRT display. At record end, the Editor calls the write routines to store the information on disk. In addition, the Editor also handles verify, update, search/modify and the operations necessary for work initiation and batch close.

## **Input/Output (I/O)**

The I/O routines are divided into four major software modules: file control, index files, logical I/O and physical I/O. The file control module is the highest level I/O module, interfacing with the index files and logical I/O modules. Index files is a higher level module than logical I/O, both interfacing with physical I/O, the lowest level I/O module.

All calls for I/O from other modules are routed through the file control module. The index files module and logical I/O module perform such services as loading a format program, loading overlays, and reading, writing and updating data records. The index file module handles the volume table of contents on disk and the indexing structure used for all disk operations.

The logical I/O module interfaces between file control and physical I/O to maintain the status and operations necessary to perform I/O functions. The physical I/O module is responsible for posting of the interrupt-complete routines under control of the Executive scheduler.

## **System Subroutines**

The system subroutines contain all of the general routines needed by the remainder of the system software. These include the binary-to-decimal and decimal-to-binary conversion modules, the get-time and convert-time modules, and the move byte string module.

## **Runtime**

The COBOL compiler produces interpretive code that is included in the format program. When the Editor detects such code, it calls the Runtime routine to execute the interpretive code. Examples of such interpretive code include add, subtract, multiply, divide, subroutine calls, alarm, display, etc.

## **Supervisor Task Manager**

Supervisor functions are handled by one or more independent overlay programs. These programs permit the system supervisory operator to establish system operating parameters, check on system status, monitor system operation and perform other supervisory tasks.

## **Background Task Manager**

The Background Task Manager provides an alternate method of control, in addition to the Supervisor, for data communications, spooling and the other background functions. This task manager calls the appropriate background function overlays as required.

## **SUPPORT SOFTWARE**

### **System Generation (SYSGEN)**

The SYSGEN program provides field personnel with a means of generating, loading and maintaining the operating system software. The XL40 SYSGEN process uses a master program tape for input; the XL20, a master diskette. The master tape/diskette, which is identical for all installations, contains SYSGEN and all other system software programs. From a terminal, using a simple series of directive commands and responses to prompting messages issued by the SYSGEN program, field personnel can select system options, set parameters, define table values and specify the hardware elements that are to be available in the system.

### **Diagnostic Programs**

A set of off-line and on-line diagnostic programs are provided to functionally test the operation of the CPU, main memory, disk drives, diskette drives, magnetic tape units, terminals, station printers, communications controller and line printer. These tests are run from a terminal and begin with the simpler system functions and sequentially progress toward more complex functions to determine the logic area of the system in which a fault may exist. When a fault is detected, an error message is displayed at the control terminal. When properly interpreted, these messages assist in localizing faults to a replaceable module so that the system may be rapidly repaired and returned to full

operation. If no faults are detected by the diagnostic test programs, the operator may reasonably assume that the system is operating properly and that no equipment malfunctions exist. An automatic diagnostic self-test function is also performed each time the system is powered-up. Any faults found during this self-test are reported via the system status indicator on the MCU system control panel.

In addition, an off-line Software Diagnostic utility program is provided to diagnose and back up the XL40 operating system software. This utility allows the user to save all disk information to tape (a disk dump), restore a diagnostic save tape to disk, recover all batches on disk and transfer them to tape in the absence of a disk table of contents, and copy files from an input to an output tape. On the XL20, an off-line diagnostic diskette stores programs used for system test.

### **User's Program Library**

The user's program library contains common formats, subprograms, tables and label programs that have general applicability. The formats allow the entering of tables, label programs, subprograms, and additional formats. Tables provide for data validation and insertion. The subprograms perform COBOL procedures outside the main format program. The label programs allow creation and processing of IBM label formats, as well as other standard label formats.

## **SOFTWARE ARCHITECTURE**

### **Main Memory Allocation**

The system's main memory is divided into two sections: a portion reserved for fixed resident information and programs and a portion that is dynamically allocated. The resident programs include those that handle data acquisition and processing, disk/diskette storage, and the programs necessary to manage the dynamically allocated memory. The dynamically allocated memory includes all supervisory overlays, special overlays, a work area for each terminal and task and a common format area. Common overlays used by several tasks and common formats used by multiple operators appear in memory only once. All programs are dynamically allocated.

### **XL40 Disk Allocation and Access**

The disk is divided into logical segments called allocation units (AU's). Each AU spans a quarter of one track and contains a fixed number of 16 sectors (88 bytes each), with the first sector containing the AU header that identifies the file and both the backward and forward pointers that enable AU linkage. A volume table of contents correlates file names with absolute disk addresses and contains other information necessary for the control of such files.

To conserve disk space, data records written on the disk are packed together independent of sector boundaries. Entered data is accumulated in main memory and not written to disk until the data constitutes at least one complete record and is enough to fill at least one sector. Such information is then written to disk with a single disk access, followed by a read-after-write check. An additional access is required at the end of an AU to assign the next AU and establish the required linkage. Figure 4 provides a graphical representation of the disk organization.

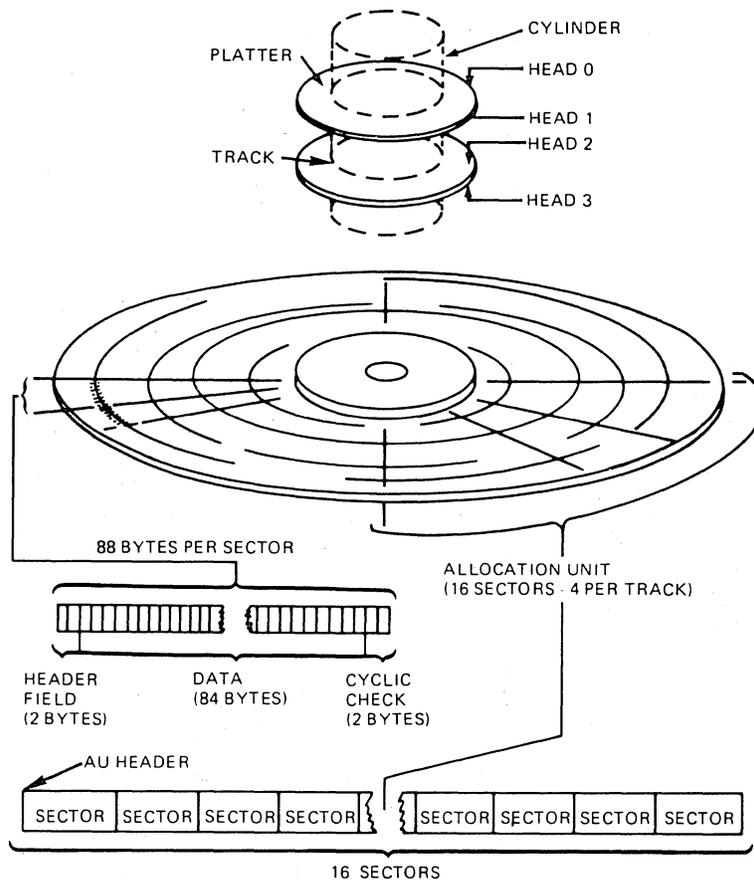


Figure 4. Disk Organization

### XL40 Disk Structure

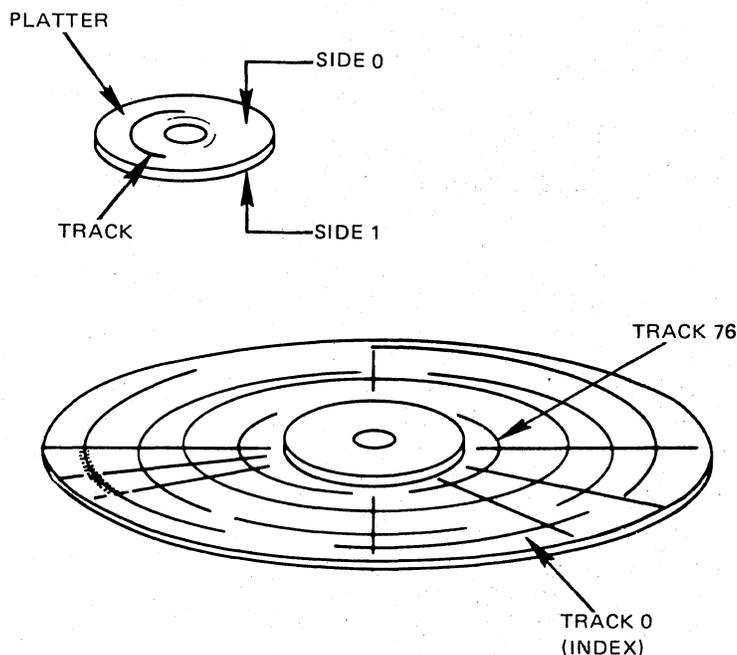
The disk structure for storing the system software is established at SYSGEN time. The physical location of all files (except the bootstrap and the volume label) is arbitrary and varies from system to system depending on the sequence in which the modules appear on the SYSGEN tape and the locations of possible unusable recording tracks on the disk. The bootstrap module always appears in sector 0 and the volume label is always at disk address HEX 6570 or the preceding AU. If neither location is good, the disk is unusable. After the bootstrap and volume label have been written to disk, all other modules are assigned to good AU's as available.

During operation of the system, each user-generated file is automatically assigned to an AU without requiring any action by the Supervisor. When multiple platters are installed, newly opened files are assigned to the least-filled platter. Data sets do not span multiple platters except in an indexed file mode.

### XL20 Diskette Allocation and Access

The diskette is divided into logical segments called sectors. In IBM compatible format there are 128 bytes per sector, 26 sectors per track and 77 tracks per side, of which 73 are used. In XL extended format there are 1344 bytes per sector and six sectors per track. A sector in XL extended format is equivalent to a disk AU and is used in the same manner by the XL20 System.

The diskette controller allows as many as four units to be seeking simultaneously, or three units seeking and one unit performing a data transfer operation simultaneously.



FORMAT	SECTORS PER TRACK	BYTES PER SECTOR
IBM-BDE	26	128
XL	6	1344

Figure 5. Diskette Organization

## XL20 Diskette Structure

At SYSGEN time the diskette structure is established to support the installed hardware and the software options desired. The first drive must contain the system diskette. The remaining drive(s) may contain extended diskettes or basic diskettes and these may be interchanged freely by the supervisor. For ease of operation, the format programs related to the work being done may reside on the extended diskette.

The XL20 System facilitates operations by allowing the batch data and format programs to be directed to specific diskettes. Data status and utilization of individual diskettes is available to the operator via the STATUS command.

Diskette organization and track allocation is shown in the following Table 1. Physical layout of the diskette and the contents of the volume and data set labels are IBM Basic Data Exchange standard, which is used by both the XL20 System and the XL40 diskette subsystem.

Table 1. Diskette Organization

DESCRIPTION	IBM BDE FORMAT	XL EXTENDED FORMAT
<ul style="list-style-type: none"> <li>• • Organization —</li> <li>• Density</li> <li>• Bytes per sector</li> <li>• Sector per track</li> <li>• Tracks per diskette               <ul style="list-style-type: none"> <li>— Used for data</li> </ul> </li> <li>• User records per diskette</li>   <li>• Data area bytes per diskette</li>   <li>• Total bytes per diskette</li>   <li>• Tracks are allocated as follows —               <ul style="list-style-type: none"> <li>• Index track number</li> <li>• Data tracks (number) available to user</li> <li>• Unused track number</li> <li>• Alternate track numbers reserved for assignment</li> </ul> </li> <li>• Layout of the Index Track               <ul style="list-style-type: none"> <li>• Sectors 1 - 4</li> <li>• Sector 5</li> <li>• Sector 6</li> <li>• Sector 7</li> <li>• Sector 8 - 26</li> </ul> </li> </ul>	Single 128 26 77 73 1898  242,944  246,272  0 1 - 73 74  75, 76  Reserved Error map Reserved Volume Label Up to 19 dataset labels	Double 1344 6 77 74 Varies with <sup>(1)</sup> record length and number of fields per record 1,193,472 (2 sides) 1,200,128 (2 sides)  0 1 - 74 —  75, 76  Reserved Error map Reserved Volume Label Special labels used for internal processing

<sup>(1)</sup>Up to 7900 80-column, 20-field records.

## Multi-task Data Management

The scheduler portion of the Executive module coordinates a maximum of 255 tasks which can be concurrently processed. The general philosophy is to maximize overlapped I/O activity by minimizing interrupt level processing. This complements the hardware architecture containing direct memory access I/O controllers and fast, solid-state MOS memory. This minimizes executive processor idle time and optimizes concurrent I/O use.

In a multi-task environment, many tasks can compete for executive processor time. Order is maintained by priority tasking. This ensures that high priority foreground tasks obtain the necessary executive processor and I/O time for completion. If none of the higher priority tasks, such as operator data activity, can do useful work, the software subsequently moves the lower priority tasks to give them executive processor time slices.

Table 2 lists the software priority scheme.

**Table 2. Software Priorities**

LEVEL	ACTIVITIES
Highest 4	Disk/diskette volume table of contents update. Disk/diskette overlays brought into memory. I/O activity.
3	Operator error messages. Operator 40 keystroke buffer full — Priority processing of keystrokes. Format program loading. Operator stopped entering for 1/2 second — Priority display of current position and data in record.
2	Normal operator entry, field and COBOL procedure processing.
1	Supervisor functions. Operator replay and search functions. Build terminal work areas, memory moves or rearrangements. Background tasks (Auto Save,* Auto Log, Data Communications, Spooling*).
Lowest 0	Normal operator terminal display character updates — one character displayed for each character entered.

\*XL40 only.

## INDEXED FILE ORGANIZATION

The Indexed Direct Access Method (IDAM) of file organization is used. This allows data to be directly accessed by a primary key or up to nine alternate keys without maintaining duplicate copies of the data file in different sort sequences. Each indexed file consists of three components: the indexed file header, the index key trees and the data records. These structures reside on disk (XL40) or diskette (XL20) as elements of the indexed file name, as shown in Figure 6.

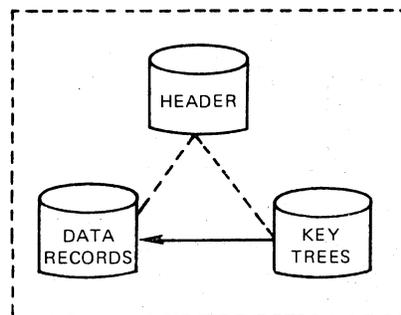


Figure 6. Indexed File Components

File index keys are used to access specific records. A key value consists of a user-specified set of character positions within the record, taken always from the same contiguous character positions of every record in the file. Each index key is linked to a specific disk/diskette address which provides a direct path to access the entire record. An index tree is generated for each index key specified. Figure 7 illustrates an indexed file with two index trees. Since as many as ten keys may be specified, data can be referenced in many different ways. Each index tree contains keys arranged in ascending sequence so that data may be accessed both randomly and sequentially. When records are added, deleted or modified all index keys are automatically updated in real-time.

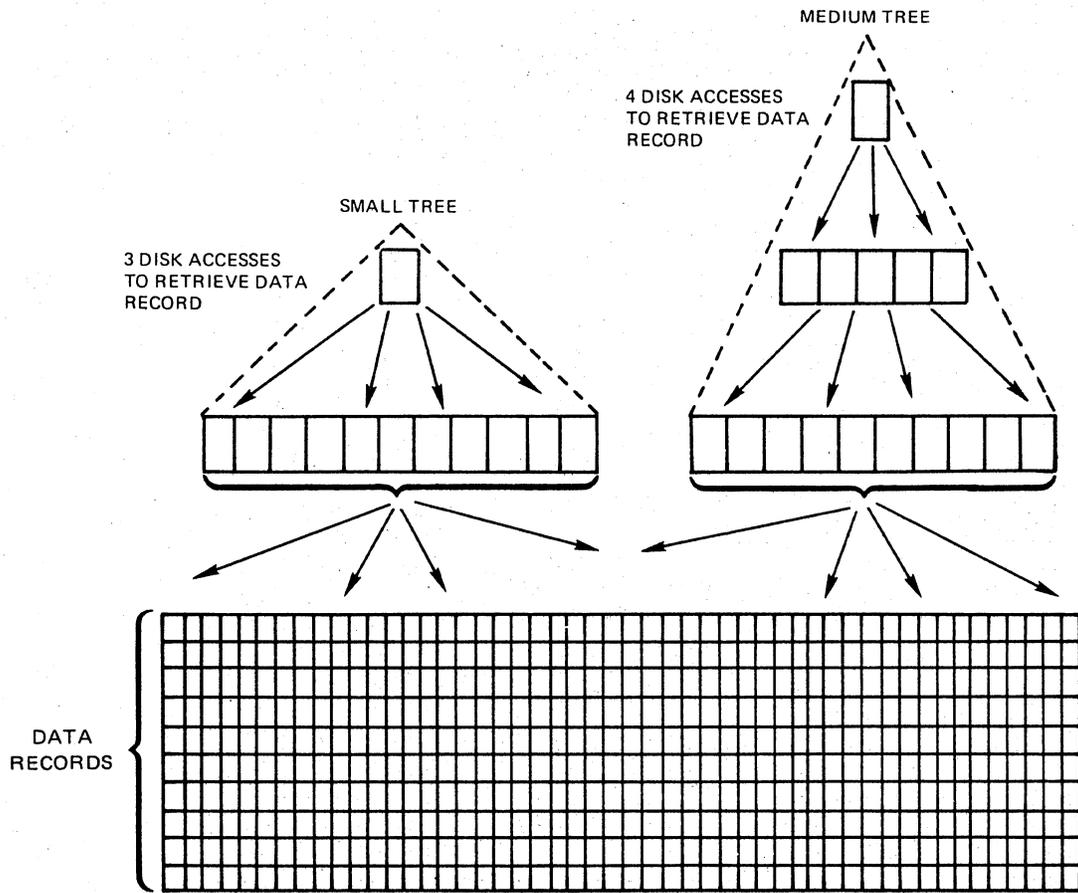


Figure 7. Two-key Index Tree Structure

## SYSTEM OPERATION

### TERMINALS

The terminal consists of an electronic keyboard and a video display screen (CRT). Two standard keyboard configurations are available: keypunch and typewriter/numeric pad. The keyboard is detached from the display unit.

Two display units are available: a 480-character screen display or a 2000-character screen display. The 9-inch video screen is formatted into 12 lines of 40 characters each; the 15-inch screen is formatted into 25 lines of 80 characters each.

The current status of work at the terminal is displayed on the top two lines of the 480-character screen, the top line only of the 2000-character screen. This information is formatted for easy reference and includes: position in record, last character entered, field number, position in field, field name, program level, record number, page number, keyboard shift, data type, auto-off indication, mode, operator initials, job name and batch number.

The third line of the 480-character video screen and the second line of the 2000-character screen are used to display messages to the operator. Messages are generated by the system or may be programmed within the COBOL procedures of the user's application format programs.

The bottom nine lines of the 480-character screen and the remaining 23 lines of the 2000-character screen comprise the data area. The data area may be programmed to display blanks for blind entering, display the entire record with fields separated for clarity, or display non-entered prompting messages for fill-in-the-blanks-type entering.

The operator need not monitor the video screen as work progresses. When a condition requiring the operator's attention occurs, the operator is signaled visually and audibly. Visual attention is attracted by a bright checkerboard pattern which appears on the video screen for one-half second.

The keyboard contains control keys, positioning keys, shift keys and data keys. The control keys are: CTRL, RESET, REPEAT, DISPLAY, PROG, CMND, AUTO OFF, FIELD REL, -SKIP, DUP, X DUP, ATTN, V COR, PASS, REL, INS, and DELETE. The positioning keys are: character backspace, character forward, field backspace, field forward, record backspace, and record forward. The shift keys are: ALPHA, NUMERIC, and LCA (Lower Case Alphabetic). A shift lock is provided on the typewriter keyboard which overrides the programmed shifts. The data keys include alphabetic, numeric, punctuation and special characters.

### ENTER MODE

The Enter mode is used to create records in a data file under control of a format program. It is the primary means of defining and creating a data file or adding records to a file

which is already created. Upon mode initiation, the character index (cursor) is positioned at the first field to be entered. As the operator enters data, the format program in control ensures that all entered data meets the specified validity requirements. Any invalid characters or fields will be reported to the operator.

## **VERIFY MODE**

In the Verify mode, previously entered data (from Enter mode) is compared (verified) with that on the source documents and corrected as required. Fields may be key- or sight-verified. The only fields presented to the operator in Verify mode are those programmed for verification or invalid fields. All other fields may be displayed, but are automatically skipped. All fields contributing to an out-of-balance condition may also be programmed to require key verification.

These fields are presented to the operator as long as the batch is not in balance. If a correction is made to a balance field resulting in the batch being in balance, that field in subsequent records no longer requires verification. Records may be inserted or deleted in Verify mode.

Concurrent entry and verification may be accomplished on the same batch to speed completion of high priority jobs. The enter operator and the verify operator must maintain a separation of at least one record between their respective operations. Also, the enter operator cannot backspace behind the point of verification. Error messages protect against an overrun.

## **SEARCH/MODIFY MODE**

In the Search/Modify mode, a batch may be searched and any selected field within any record may be modified under format program control.

If the operator wishes to search for a particular record number within the batch, the system asks for the record number and then moves forward through the batch and displays the requested record.

Specifying a search for records containing invalid fields causes the system to scan the batch sequentially from the start until any record containing an invalid field is found. When such a record is found, the search is suspended and the record is displayed with the cursor positioned at the start of the invalid field. If no invalid fields are found, the search is terminated at the end of the batch.

Searching a batch for a particular data configuration is accomplished by entering, under free-form control, the desired search mask. The system then searches the batch sequentially for any record matching the mask.

When the record is found, it is displayed with the cursor positioned at the start of the first manually keyed field. If no such record is found, the search is terminated at the end of the batch. It is also possible to search for a particular data configuration keyed under a specific program level. In this case, both the search mask and level must be specified.

In all cases, the displayed record may then be modified or deleted, or a record inserted before it. The operator may also move forward or backward through the record or batch using the character, field or record positioning keys. Where appropriate, the search may be continued to locate other records satisfying the search condition.

## **UPDATE MODE**

In the Update mode, the operator may enter additional data into each of the records of an existing batch. The cursor is automatically positioned at the beginning of each field designated for update in the controlling format program. All fields not designated for update are skipped. Operation of the Update mode is dependent upon the appropriate use of entries in the "update" column of the format program coding form.

## **FILE MANAGEMENT MODE**

The File Management mode is a modified version of Enter mode which permits the operator to enter, retrieve or change indexed file data under format control. Work initiation and data entry are the same as in Enter mode.

To protect the indexed file from changes due to operator error, including possible replay or reexecution of COBOL procedures, several control and positioning keys as well as operator-initiated procedures are inhibited in File Management mode. These are batch interrupt, level selection, AUTO OFF, record insertion or deletion, record forward or backward, field backward, and field forward (except in current field). The CONTINUE prompt is also inhibited.

## **SUPERVISOR FUNCTIONS**

The three main functions of the Supervisor mode are system management, data and file management and on-line diagnostics.

The system management commands are used to monitor system activities and to control the physical operation of the system. These commands are:

<b>AUTOPROMPT</b>	Permits prestored Supervisor command prompts.
<b>CLOSE</b>	Closes any terminal on the system.
<b>DISK LOAD</b>	Allows mounting and dismounting of auxilliary disk platters or diskettes.
<b>MONITOR</b>	Monitors activity at any terminal.
<b>OP-STAT</b>	Generates detailed operator statistics reports.
<b>POWEROFF</b>	Performs disk or diskette volume table of contents purge prior to system power-down.
<b>SET</b>	Assigns values to system variables.
<b>STATUS</b>	Obtains the status of any job or program in the system.

The data management commands allow the Supervisor to control all data within the system. The data management commands are:

BUILD DIR	Creates permanent batch lists for data communications, spooling* or indexed or sequential files.
CHKPT CNTL	Controls restart of transmission function during data communications (also spool-off on XL40).
COMPILE	Translates program source code into executable code.
DCOM CNTL	Specifies controls for data communications.
DELETE	Deletes jobs, batches and directories (except indexed files) and compiled programs on disk/diskette.
DK UTILITY	On the XL20, this command provides initialization, copying and labeling utility operations for the diskette.
FILE MGMT	Creates, controls and deletes indexed files; loads file management module.
INPUT	Inputs data from tape, card reader or IBM-compatible diskette to disk under control of a format program on the XL40; on the XL20, inputs data from a card reader or IBM-compatible diskette to file storage on an Extended Format diskette.
NEW NAME	Renames or renumbers jobs on disk/diskette.
PRINT	Outputs formatted data to a printer.
RESTORE*	Restores jobs or programs from a save tape to disk.
SAVE*	Outputs jobs or programs from disk to tape in disk format.
SM TAPE*	Permits selectable, in-place editing of tape records.
SORT	Sorts indexed file keys or sequential files.
SPOOL CNTL*	Controls all spooling functions.
TRANSFER	Transfers data between peripherals.
WRITE	Outputs data to a peripheral device under control of a format program

The on-line diagnostics allow the Supervisor to check out the functional performance of all hardware elements of the system. The diagnostics are accessed through the TEST command.

## COMMAND MANAGER MODE

The Command Manager mode is an alternate way, in addition to the Supervisor mode, to communicate with background tasks (data communications, AUTOPROMPT, and Auto Log on the XL20; data communications, AUTOPROMPT, Auto Save, Auto Log, and spooling on the XL40). The Command Manager uses a subset of the Supervisor commands. These commands are: CHKPT CNTL, BUILD DIR, AUTOPROMPT, DCOM CNTL, SPOOL CNTL and SET. The system password is required to enter the Command Manager mode. Multiple terminals can be in the Command Manager mode simultaneously. Up to eight Command Manager terminals may be active concurrently with the Supervisor mode. Some commands may not be used by more than one terminal at a time.

\*XL40 only.

## DATA COMMUNICATIONS

Data Communications tasks are implemented by the Supervisor or Background Command Manager through the use of video display (CRT) prompts. To initiate a transmission, the Supervisor first builds a batchlist of those job names and batch numbers that are to be transmitted. This batchlist is called a Directory. The creation of a Directory is identical to the building of a batchlist for certain other Supervisor functions (SAVE, STATUS, WRITE, etc.). The Supervisor then establishes a communication linkage with the remote station, selects the DCOM CNTL command, enters TR for transmit, ST for start, selects the desired Directory, selects one of four possible sets of protocol options, and specifies AUTO ANS yes or no and LONG RECORD yes or no. Both the transmitting and receiving stations must be observing the identical protocol and options.

In the event of an unrecoverable line error (line noise, loss of connection, etc.), the software will automatically store the number of the last good record transmitted, together with its job name and batch identifiers. This action is called Checkpointing. An appropriate error message is displayed on the CRT. After an acceptable reconnection with the receiving station has been made, the Supervisor again selects the DCOM CNTL command and enters the same responses to the prompts described above. Communications resume automatically at the checkpoint position (the record following the last good record transmitted).

Initiating the receive function requires less Supervisor action than that needed for transmit. Because a batchlist (Directory) does not have to be created for receive, the Supervisor first establishes a communication channel, selects the DCOM CNTL command, enters RE for receive, ST for start, selects the protocol desired, and specifies AUTO ANS yes or no and LONG RECORD yes or no. A restart after unrecoverable line errors in the receive mode opens a new file for the appropriate device. The remote transmitting station should have taken a checkpoint and may use that on restart.

Binary synchronous protocols are supported in half-duplex mode up to 9600 bps, in point-to-point or multipoint leased or switched telephone networks. IBM 2770, 2780, 3741, 3780 and 360/20 HASP Workstation protocols are provided. SDLC\* protocol is supported in half-duplex mode up to 4800 bps.

Transmission may be made between two XL Systems, an XL System and any Pertec-manufactured System, or between an XL System and any mainframe computers using the IBM protocols mentioned above.

Features supported within the 2770, 2780, 3741, 3780 and 360/20 HASP Workstation protocols are: EBCDIC or ASCII code transmission, EBCDIC transparency, auto-answer, reverse interrupt, internal synchronous clock, trailing blank truncation, space compression/expansion, vertical forms control, print control suppression, horizontal tabbing, output device selection, buffer expansion, multirecord and long record options, automatic checkpointing on line errors, checkpoint restarts, transmission of field marks/formats, auto turnaround, and multipoint.

\*XL40 only.

SDLC\* protocol is EBCDIC only, and appears as an IBM 3776-1, 3776-2 or 3777-1. The feature provides data compression and packing/unpacking.

Host Interactivity\* allows access to a remote IBM 360/370-resident data base via a data communications software subsystem. The subsystem uses IBM BSC EBCDIC transmission operating in a half-duplex mode using either half- or full-duplex facilities with data rate clocking provided by the modem.

### **SPOOLING (XL40)**

Spooling provides the ability to intercept data at the time it is received or created, record it on disk and, at a later time, output the data to a designated peripheral device. It can be used in conjunction with, or independent of, data communications.

Spooling allows incoming data, when in data communications receive mode, to be written directly to disk at a high transfer rate. The spooled data can then be routed to the line printer or video display. Spooling allows the disk to be used as a large buffer for incoming data communications, avoiding the slowing down of a highspeed data link with a relatively slow data output device.

Spooling may also be employed independently of data communications. Any function which creates an output such as WRITE, PRINT, SAVE, COMPILE, TRANSFER, LOG, etc. can be spooled to disk and later output to a designated peripheral device. A spool file may be output to selected devices as many times as necessary.

Spooling also enables peripheral devices to be shared between background and foreground activities. Data spooled-on to disk for intermediate storage may be spooled-off to a hardware device under Supervisor control when the device is available. Spool-off operations may also be interrupted at any time to allow for higher priority tasks. A checkpoint restart is automatically provided.

### **INDEXED FILE MANAGEMENT**

Indexed file organization allows faster data entry and widens the data processing role of the XL System by providing instantaneous access to any record contained in very large data files. Supervisor commands are used to create, maintain and manipulate indexed files without support of a mainframe computer. Guided by application programming, such tasks as fast, flexible, disk\*/diskette\*\* table lookup; full-screen file inquiry and update; high-speed search and modify; and sorting can be performed. Data can be automatically generated from tables, registers or as the result of arithmetic computations, and preprocessing can be performed to reformat and validate data.

Up to 60 active indexed files may be accessed by operators. Each file contains a primary index key and may contain up to nine alternate index keys. Duplicate key values are permitted in all indexes. Index structures are automatically updated in real-time whenever

\*XL40 only.

\*\*XL20 only.

data is inserted, deleted or modified, so that the indexed file is always current. Indexed files may be accessed simultaneously by different users for concurrent data entry, verification and file inquiry.

Indexed files may be created under format program control or using Supervisor commands. The file may be created from existing ordinary batches, magnetic tape\* input or operator real-time entry of keyed data. File management and recovery utilities are provided to enable the supervisor to easily handle indexed files. Indexed files may be removed to tape\* or data storage diskette\*\* when not in use to allow more space for other activities. A special password is required to delete indexed files.

### **I/O DEVICE CONTROL\***

I/O Devices such as printers, tape drives, disk or diskettes may be accessed and controlled either by the system Supervisor or by an XL40 application program using sequential device support.

*\*XL40 only.*

*\*\*XL20 only.*



### III. USER PROGRAMMING

The XL20 and XL40 Systems provide the user with the ability to easily code application programs customized to specific requirements. Four types of programs are available: formats, subprograms, tables and label programs. Program source code is entered as a data batch under control of special system formats. Source code is then converted into executable code through the use of the Supervisor COMPILE command. User programs are shared in memory by multiple terminals (i.e., if two or more terminals are using the same format, it resides in memory only once).

#### CODING FORM

A single coding form is used to code the four types of user programs. The coding form (Figure 8) is divided into two areas: a header area at the top and a field description area. The header is used to identify overall program characteristics. The field description area consists of a checkbox section where field characteristics are specified and a procedure section where COBOL procedure statements are entered.

#### FORMATS (APPLICATION PROGRAMS)

Formats provide a communications link between the terminals and the system by controlling entering operations, performing COBOL procedures in a batch processing mode or data entry mode, and governing data output. Formats are the primary programs employed by the user. The other three types of user programs are subordinate to, and called by, formats.

A header record is required for each format level. The header for the first level defines overall program parameters. The header entries are: program name, level identifier, level selectability, output translation code, output record fill and pad, required padding, blocking factor, label program name, data and comment.

All of the fields that comprise an application format are described, one field at a time, in the field description area of the coding form. Field input and output parameters are coded by filling in the appropriate checkboxes. The field descriptor checkboxes are: field name, field size, keyboard shift, data type, key control, update field, must release field, display field, verify type, balance field, tab or continue field, auto field, aux dup field, reformatting output position, justification, fill character and output conversion.

The procedure section of the coding form is used to write COBOL statements. Any number of COBOL statements on continuation lines may follow a given field description. This group of statements is defined as a COBOL procedure. A COBOL procedure is associated with a single field. The appearance of the next field description terminates the previous procedure.



COBOL, a subset of ANSI COBOL with extensions, employs English language statements, and is readily learned by personnel. Each statement begins with a verb, and describes some action to be taken. The verbs available for use in format programs are listed below.

ADD	DUP	NO-DISK
ALARM	END	NOTE
ALLOW	END LEVEL	PROMPT
ASSIGN	FIELD BKSP	READ
CALL	FIND	REL
CHECKPOINT	GO TO	SELECT
COMPUTE	HOLD	SET
CONNECT	IF	SHOW RECORD
DECLARE	INITIALIZE	SUBTRACT
DISALLOW	MOVE	TAB
DISPLAY	MULTIPLY	WRITE
DIVIDE	NEXT SENTENCE	

Additional verbs available for File Management mode are:

ACCESS	SAME RECORD AREA
ALTERNATE RECORD KEY	SELECT
ASSIGN	SHARE-I
CLOSE	SHARE-IO
DELETE	SHARE-O
OPEN	START
REWRITE	

Verbs available for Host Interactivity are:

DISABLE	RECEIVE
ENABLE	SEND

A "RELEASE" verb is available for sequential files/printer\* mode.

### **SEQUENTIAL DEVICE SUPPORT (XL40)**

The Sequential Device Support capability allows operations on files under control of format programs. This capability enables format programs to perform input and output operations directly to a selectable set of devices including magnetic tape, line printer, station printer and disk.

Sequential Device Support should run under File Management mode to ensure that field backspacing is suppressed when accessing files.

Communication is established by defining a sequential file in the Environment and Data Definition levels of the format program.

\*XL40 only.

## SUBPROGRAMS

A subprogram is a COBOL language subroutine that is used to perform a procedure outside of the main format program. A subprogram is typically used where a procedure relates to more than one field in a format program or is used by two or more formats. A CALL statement in the format program passes control to the subprogram. Arguments in the CALL statement and in the subprogram ENTRY statement pass data and computed results between the format and the subprogram.

Since a subprogram relates to a single field or procedure in the calling format program, individual field descriptions (field name, field size, etc.) are not employed in subprograms. Only the procedure section of the field description area is used for the coding of the subprogram statements.

Not all COBOL verbs are permissible entries when coding a subprogram. Those which may be used are:

ADD	END	MULTIPLY
ALARM	ENTRY	NEXT SENTENCE
COMPUTE	GO TO	NOTE
CONNECT	GOBACK	SUBTRACT
DISPLAY	IF	USING
DIVIDE	MOVE	

## TABLES

A table consists of a series of items arranged in tabular order. It may be called upon at any time during the execution of a format to provide pertinent information to the format. For example, a table may be used to validate an account number, or to automatically retrieve a customer's name and insert it in a field, based on a previously keyed account number.

A table may be either single- or double-entried, depending on its intended use (data validation or automatic data retrieval, respectively). If a table consists of only a list of items (called arguments), it is a single-entried table. Single-entried tables may be used only for searching (data validation) operations.

If a table consists of a list of items (arguments) and their associated values (functions), it is a double-entried table. Double-entried tables may be used for validation or accessing operations. The accessed information may be used by the format and automatically inserted into a field or register.

The arguments and functions in a table may be either numeric or non-numeric. Although the data type of arguments within a table need not be the same as the data type of the functions, all arguments must be of the same data type, as must all functions. If the data types of either the argument or the functions in a table are a mix of alpha and numeric, they must be set up as non-numeric character strings.

Single-entried tables are searched using the IF statement in the format. Double-entried tables are searched using the IF statement, and are accessed using the FIND statement.

## **LABEL PROGRAMS**

Label programs are used to process labeled or unlabeled magnetic tape\* or diskette volumes. The processing functions of label programs include: creating new labels, checking existing labels and positioning the tape past existing labels.

Label programs are used in conjunction with format programs. The Supervisor WRITE function is used to create labeled tapes\* or diskettes. The label program is first executed to process the header label; the format program is executed to write the data batch; then the label program is executed again to generate the trailer label. Label programs are also used with the Supervisor INPUT function to position the tape past existing labels.

Additional COBOL I/O and control verbs are available in label programs to provide for the tape read, write and control functions. These additional verbs are:

READ RECORD	REWIND
RESTORE RECORD	SAVE RECORD
RETURN	WRITE EOF
RETURN ERROR	WRITE RECORD

\*XL40 only.



The logo for Pertec, consisting of the word "PERTEC" in a bold, white, sans-serif font, centered within a solid black square.

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