Xerox 530, 550, & 560

MANAGEMENT SUMMARY

The two new medium-scale computer systems from Xerox, the Xerox 550 and 560, are the second and third models of a new product line that will eventually replace Xerox's older Sigma series of computer systems. The Xerox 550, designed for scientific, engineering, and real-time processing, replaces the Sigma 5, first delivered in 1969. The Xerox 560, aimed at the market for multi-purpose scientific and commercial processing, supersedes the older Sigma 6 computer system, first delivered in 1970. Initial deliveries of both the Xerox 550 and 560 are scheduled for the fourth quarter of 1974.

The current actively marketed Xerox computer product line now consists of the small-scale Xerox 530, the medium-scale Xerox 550 and 560 computer systems, and the larger Sigma 9 system (Report 70C-931-01), for which no replacement has yet been announced.

The Xerox 530, announced in January 1973, succeeded the Sigma 2 and Sigma 3 processors in the Xerox marketing line-up. A 16-bit processor, the Xerox 530 runs under its own version of the Real-Time Batch Monitor and offers as language processors ANS COBOL, FORTRAN IV, RPG II, and assembly language. With monthly rentals for an entry-level system beginning at approximately $1,000 per month, the Xerox 530 competes in price and performance with scientific and general-purpose systems in the minicomputer class. The ▷

The current Xerox family of computers includes the Xerox 530, a 16-bit minicomputer with general-purpose processing capabilities, and two new medium-scale computers. The Xerox 550 is aimed at scientific and real-time applications, and the Xerox 560 features multi-purpose computing capabilities under the Control Program-Five operating system.

CHARACTERISTICS

MANUFACTURER: Xerox Corporation, 701 South Aviation Boulevard, El Segundo, California 90245. Telephone (213) 679-4511.

MODELS: Xerox 530, Xerox 550, and Xerox 560.

DATA FORMATS

BASIC UNIT: The Xerox 530 operates with a 16-bit word (two 8-bit bytes) plus 1 parity bit per byte. The Xerox 550 and Xerox 560 use a 32-bit word (four 8-bit bytes) plus 1 parity bit per byte.

FIXED-POINT OPERANDS: The Xerox 530 uses a 16-bit word, with optional double-precision (32-bit doubleword) arithmetic operations. The Xerox 550 and Xerox 560 use 32-bit words, with operations performed upon 8-bit bytes, 16-bit halfwords, 64-bit doublewords, and/or immediate operands contained in the instruction words.

FLOATING-POINT OPERANDS: The Xerox 530 uses an extended-precision 48-bit (3-word) operand with a 32-bit signed fraction and a 16-bit signed exponent. The Xerox ▶

The Xerox 560 computer system is designed to handle a broad range of applications including real-time, time-sharing, communications, and business data processing. It offers up to 262K 32-bit words of core storage with a 645-nanosecond cycle time.

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unusually thorough communications software support available with the 530, including the Xerox Satellite Processor system and the Interactive Data Entry Network (INDEN) package, both delivered in 1974, also allows the Xerox 530 to perform data entry, validation, and inquiry activities from remote terminals, and to act as an intelligent remote batch entry system to Sigma 9 and Xerox 560 central processors operating under the Control Program-Five or to IBM System/360 and System/370 processors that operate under the HASP Binary Synchronous Multileaving Protocol.

Xerox states that the 560 computer system, running under the multi-mode Control Program-Five operating system, will achieve its highest level of performance in mixed-mode environments that combine concurrent batch and communications-oriented processing. In these installations (as opposed to strictly batch-processing shops), Xerox claims that the 560 can better the performance of the IBM System/370 Model 145 at prices equivalent to or slightly less than those of the System/370 Model 135. Xerox hasn't revealed any intention of taking a more aggressive stance vis-a-vis IBM's installed customer base. No emulation capabilities for competitive equipment have been announced for the new Xerox systems, although the Xerox-supplied FORTRAN, ANS COBOL, and RPG compilers offer source-language compatibility with other popular computer systems. In addition, the services of a special conversion group are available to assist users in converting from other vendors' computer systems.

Both the Xerox 550 and 560 incorporate many of the excellent hardware features developed by Xerox in the earlier Sigma series product line. Both systems utilize a 32-bit word (or four 8-bit bytes), and incorporate the same complement of 65 general-purpose registers offered in the Sigma 5 and Sigma 6 central processors. Direct, indirect, and indexed addressing are available, and stack operations are provided to facilitate re-entrant programming. For real-time applications, the new Xerox processors incorporate a somewhat reduced but still extensive interrupt system composed of up to 48 optional external interrupts for each central processor. Watchdog timers are available to assure that special real-time sensors or asynchronous devices which do not respond within a reasonable period will not hang up the entire system, and four real-time clocks are standard to provide timing information and signals for critical time-dependent processes in real-time environments.

The Xerox 550 and 560 processors include the hardware memory map feature that provided virtual memory addressing capabilities for the earlier Sigma 6 and Sigma 9 computer systems. The automatic relocation of program segments into noncontiguous 512-word blocks of main memory is software-supported on both computer system models, although highly time-critical real-time applications can be made non-pageable in both systems.

550 and Xerox 560 use either a short form, consisting of one word with a 24-bit-plus-sign fraction and a 7-bit exponent; or a long form, consisting of two words with a 56-bit-plus-sign fraction and a 7-bit exponent.

INSTRUCTIONS: The Xerox 530 uses one- or two-word instructions. Most of the instructions are one-word types consisting of a 4-bit operation code, a 4-bit address-control field, and an 8-bit address field. The Xerox 550 and Xerox 560 use one 32-bit word consisting of a 1-bit code for immediate and direct addressing, a 7-bit operation code, a 4-bit general register address field, and either a 20-bit field containing the immediate operand (for immediate instructions) or a 3-bit index register and a 17-bit field containing the reference address of the instruction operand.

INTERNAL CODE: Either 8-bit EBCDIC or 7-bit ASCII is used for internal data representation. No two printable EBCDIC character codes have their seven low-order bits identical to one another.

MAIN STORAGE

STORAGE TYPE: Magnetic core.

Capacity: From 8K to 64K words in 8K-word increments in the Xerox 530. In the Xerox 550 and 560, 16,384 words (65,536 bytes), expandable to 262,114 words (1,088,476 bytes). Main memory in the 550 and 560 is divided into from 1 to 8 units of 16,384 or 32,768 words, each of which can be accessed independently and simultaneously. A memory driver in each memory unit performs memory access, parity generation and checking, and write protect functions, and resolves conflicting memory access requests on the basis of memory port priority and other priority status information. Accesses to memory units can be interleaved on a two-way basis to increase the occurrence of overlapping access to memory units.

CYCLE TIME: Xerox 530: 800 nanoseconds per 16-bit word. Xerox 550 and 560: 645 nanoseconds per word.

CHECKING: Xerox 530: Standard parity bit per 8-bit byte is stored with each write and checked with each access. Xerox 550 and 560: A parity bit is generated for each 32-bit data and address word during writing and checked during reading. Parity is generated and checked during data transmission between processors, memory units, controllers, and peripheral devices and for data stored in register blocks and control memories. Information on detected errors is stored in a status register associated with each processing and memory unit, for processing by diagnostic programs to facilitate error localization.

STORAGE PROTECTION: Storage protection on the Xerox 530 is provided by 16 full-word protection registers, with each bit in the registers associated with a specific block of 256 consecutive 16-bit words in main memory (up to 64K). In combination with a Protect Violation Interrupt Level, read/write protection is guaranteed for a master- or executive-mode (foreground) program with concurrent background program execution. The storage protection system operates under control of a key-operated switch on the processor control panel.

Two levels of storage protection are supported on the Xerox 550 and 560 systems. Programs executed with real

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CHARACTERISTICS OF THE XEROX 530, 550, & 560 SYSTEMS

	Xerox 530	Xerox 550	Xerox 560
SYSTEM CONFIGURATION			
Max. no. of I/O Processors (excluding CPU) supported by standard software	2	16	21
Max. no. of interactive terminals	64	64	128
Orientation of system	Process control, communications, scientific	Real-time, time-sharing, communications, scientific	Real-time, time-sharing, communications, general-purpose
Typical system rental (including maintenance)	$1,700	$7,500	$9,000
Date of first delivery	July 1973	4th qtr. 1974	4th qtr. 1974
MAIN STORAGE			
Word length, bits	16	32	32
Cycle time, microseconds	0.800	0.645	0.645
Words accessed per cycle	1	1	1
Minimum capacity, words	8,192	16,384	16,384
Maximum capacity, words	65,536	262,144	262,144
Increment size, words	8,192	16,384	16,384
Storage interleaving	None	2-way	2-way
Memory mapping	No	Standard	Standard
CENTRAL PROCESSOR			
No. of hardware instructions	67	97	117
Instruction look-ahead	No	1 instruction	1 instruction
Index registers	6	1x7 to 4x7	1x7 to 4x7
Double-precision floating-point	No	Standard	Standard
Decimal instructions	No	No	Standard
Interrupt service time, microseconds	15 (typical)	15 (typical)	15 (typical)
Max. no. of interrupts—external/internal	40/30	48/14	48/14
Watchdog timer	Standard	Standard	Standard
I/O CONTROL			
MIOP transfer rate, bytes/sec.	—	1,000,000	1,000,000
RMP transfer rate, bytes/sec.	—	806,000	806,000
IOP transfer rate, bytes/sec.	640,000	—	—
Direct Memory Processor, bytes/sec.	—	1,350,000	1,350,000

Both central processor models have microprogrammed arithmetic and logic units and make extensive use of MSI/LST technology for control circuitry, which should makd the systems more economical and inherently more reliable. The storage medium for main memory in the Xerox 550 and 560 is magnetic core, with a cycle time of 645 nanoseconds. The minimum main memory size is 16K words, expandable to a maximum of 256K words for both processor models.

With its scientific and real-time orientation, the Xerox 550 features an instruction repertoire with facilities for fixed-point and single- and double-precision floating point arithmetic. The general-purpose Xerox 560 provides the same fixed- and floating-point arithmetic facilities, and also includes standard decimal arithmetic and byte manipulation instructions for commercial applications.

memory addresses are protected by 2,048 four-bit write-locks to protect 512-word pages of real memory from unauthorized writing only. The memory locks apply to input/output operations as well as to basic processor operations. The keys to these locks can be set up only in the privileged or "master" mode of operation. In addition, the memory map feature has an associated array of 256 2-bit registers, each of which contains an access control code for a specific 512-word page of virtual addresses. Access protection codes provide write-only access, read-only access, or complete denial of access to 512-word pages of programs operating in the "slave" mode.

GENERAL PROCESSORS

CONFIGURATION RULES: A Xerox 530 configuration can include one central processor and a maximum of two I/O processors.

The Xerox 550 and Xerox 560 are designed to permit the attachment of multiple CPU's and independently functioning I/O clusters up to the number of ports

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The architecture of earlier Sigma series processors made extensive use of symbiont I/O processors that transferred data along independent memory access paths to permit computation to continue in the central processing unit concurrently with I/O operations. In the new Xerox processors, the concept of separate computational and I/O processing units has been expanded, and these functions are performed by Basic and I/O Processor Clusters, each with separate paths to main memory units. The Basic Cluster contains a Basic Processor to perform computational and logic functions and a Multiplexer I/O Processor (MIOP) that provides multiplexed I/O channels to and from standard peripheral devices. Additional I/O Clusters can each contain up to three additional MIOP's sharing a one-million-byte-per-second memory bus to the main memory units. A specialized I/O processor, the Rotating Memory Processor (RMP), is exclusive to the Xerox 560 system, and provides the I/O interface and control functions for the large-capacity 3275/3276 Removable Disk Storage System.

An expanded I/O structure, one of the major enhancements in the design of the new Xerox computer systems over the older Sigma series models, permits up to 16 MIOP's to be included in a Xerox 550 configuration and a maximum of 16 MIOP's and five RMP's on a fully expanded Xerox 560 configuration.

Another innovation in the new Xerox systems architecture is the division of the central processing unit into a Basic Processor that performs computational tasks and a System Control Processor that performs all centralized system control functions. A manual partitioning capability that can be exercised through the System Control Processor permits redundant configurations to be defined and allows malfunctioning processing units to be taken off-line in a limited "fail-soft" mode of operation. A true multiprocessing mode of operation, however, is not yet supported by the Xerox operating system software.

Xerox has placed strong emphasis on reliability, availability, and maintainability in the design of its new computer system. Reliability features include parity checking on data transfers between processing units, peripheral devices, and main memory units, and on data stored in register blocks and control memories. Each processor and memory unit contains a status register to store information on detected errors for subsequent analysis by diagnostic programs. Multiplexor I/O Processors have the capability to isolate errors in device controllers, adapters, and peripheral devices. The Basic Processor automatically attempts instruction retry whenever possible after detecting an error, and memory units include error detection circuitry that permits the identification of 13 different errors, including data, address, and protection errors and hardware malfunc-

available on the memory banks. Each memory bank contains two, four, or six ports which allow the memory unit to communicate with a processor or I/O cluster via a memory bus through a memory interface. A fixed priority order resolves access contention between memory ports on a single memory unit.

Each Xerox 550 or Xerox 560 configuration is composed of multiple memory units, Basic Clusters, and I/O Clusters. The Basic Cluster consists of a Basic Processor which performs arithmetic and computational tasks and a Multiplexer Input/Output Processor (MIOP) which controls the transfer of information between main memory and selected peripheral devices. Each Input/Output Cluster can include up to three additional MIOP's in the Xerox 550 and up to three additional MIOP's and one Rotating Memory Processor (RMP) in the Xerox 560. The RMP is a specialized input/output processor specifically designed to service large-capacity disk storage units with high transfer rates. A Xerox 550 configuration can include a maximum of 16 MIOP's and a Xerox 560 configuration can include up to 16 MIOP's plus 5 additional RMP's.

A System Control Processor in each Xerox 550 and 560 configuration provides centralized control functions such as management of interrupts, the system clock, the system control panel, the configuration control panel, the real-time clocks, the operator's control console, and the remote assist facilities. The System Control Processor communicates with the Basic Processor and I/O clusters over separate memory busses independently of main memory operation. The Central Configuration Panel allows an operator to manually partition a redundant configuration by removing malfunctioning processors or memory modules in order to continue operation with a reconfigured system. Also incorporated in the System Control Processor is a modem that permits the system to communicate directly with a Xerox Field Engineering Center. The Remote Assist facility provides on-line diagnostic services for both hardware and software by a Xerox regional office.

REGISTERS: The Xerox 530 contains six 16-bit general-purpose registers, a 32-bit register for rapid content switching between re-entrant routines in a multiprogramming environment, and 16 storage protection registers. A scratch pad floating-point accumulator contains three high-speed registers for floating-point operations.

The Xerox 550 and Xerox 560 processors have 96 32-bit general-purpose registers grouped in 4 blocks of 24 registers each. These fast integrated-circuit registers are activated in 16-register blocks by a 2-bit control field in the Program Status word called the register block pointer. The register block pointer can be altered only when the basic processor is in the master or master-protected mode. Only the first 16 general registers in each register block can be used by programs. The remaining eight registers are reserved. Any of the 16 available registers can be used as fixed-point accumulators, temporary storage, and for counters or pointers. Registers 1 through 7 in each block can also be used as index registers, and Registers 12 through 15 are used as accumulators for decimal arithmetic operations.

INDEXING: In the Xerox 530, the first two general-purpose registers are used in index registers. In the Xerox 550 and Xerox 560, operand addresses can be modified by the 32-bit contents of registers 1 through 7 in the

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The Xerox 550 is oriented toward engineering and scientific use in applications such as data acquisition and reduction, traffic control, factory automation, power utility control, and laboratory automation. The CP-R operating system allows concurrent processing of real-time, batch, and terminal programs.

tions. All system errors are automatically referred to the System Control Processor, which includes a communications modem that provides a remote trouble-shooting communications link to a Xerox regional service center. This Remote Assist feature permits a customer engineer in a regional office to take over control of the system and perform hardware and software diagnostics, interrogate the system error log, and aid in debugging programs.

Software support for the new Xerox processor models includes two operating systems previously released for Sigma series processors.

The Control Program for Real-Time (CP-R) is an enhanced version of the Real-Time Batch Monitor previously available for the Sigma 3, 5, 7, and 8.

CP-R was originally announced in mid-1973 for the Sigma 9 Model 3 processor system, a limited Sigma 9 configuration that provides an upgrade system for Sigma 5 and Sigma 8 users. CP-R includes facilities for utilizing the memory-mapping hardware previously unavailable on the older real-time-oriented systems, and provides three levels of processing: primary real-time, secondary real-time, and background batch. Language processors offered with the CP-R operating system are Extended FORTRAN IV and the Xerox Assembly Program.

Control Program-Five (CP-V), originally announced early in 1973 for the Sigma 6, 7, and 9 computer systems, is the current product of Xerox's long-term efforts to produce a multi-purpose operating system. CP-V is based primarily on the earlier Universal Time-sharing System (UTS), which supported time-sharing along with local and remote batch and real-time processing. Xerox has also committed itself to adding a transaction processing capability to the CP-V operating system by the end of

current register block. The resulting effective address is automatically scaled for operands of 1-byte, halfword, fullword, or doubleword length.

INDIRECT ADDRESSING: In the Xerox 530, one level of indirect addressing is allowed, which may also be indexed. The Xerox 550 and Xerox 560 permit indirect addressing to one level only for all instructions except those using immediate addressing. Indirect addressing may be combined with indexing. That is, the index displacement modifies the direct reference address obtained from the location pointed to by the indirect reference address, rather than modifying the indirect reference address itself. The 17 low-order bits of the references address effectively replace the 17-bit reference address field of the current instruction.

INSTRUCTION REPERTOIRE: The Xerox 530 has 67 standard instructions plus 7 optional floating-point instructions and 8 optional field-addressing (bit-string manipulation) instructions.

The Xerox 550 instruction set is a compatible superset of the Sigma 5 and Sigma 8 Model 3 instruction repertoires and includes single- and double-precision floating-point and facilities for testing, logical operations, and byte manipulation. Decimal arithmetic is not available.

The Xerox 560 instruction set includes facilities for fixed-point, floating-point, and decimal arithmetic. Extensive byte manipulation operations, including byte-string manipulation and editing, are provided.

INSTRUCTION TIMES: Execution times for the Xerox 530 are listed below. All times are for 16-bit operands and are expressed in microseconds.

Load:	1.92
Store:	2.20
Add:	1.92
Subtract:	1.92
Multiply:	8.00
Divide:	13.44
Compare and branch:	3.04

Instruction execution times for the Xerox 550 and 560 are not available at this writing.

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1974. Xerox claims that one of the major advantages of CP-V is its "integrated" design that allows user jobs executing in all five modes of operation to have access to shared random-access files, processing resources, and common operating system services. The CP-V operating system has replaced both UTS and the Xerox Operating System (XOS), a general-purpose operating system originally written in Frances, as the top-of-the-line multi-purpose operating system for the Xerox 560 and Sigma 9 computer systems. Language processors available under CP-V include FORTRAN, ANS COBOL, RPG, APL, BASIC, and the Meta Symbol assembly language.

Along with the continued evolution of the CP-V operating system toward the goal of a comprehensive multi-purpose operating system, Xerox has eliminated the extra charges for two important software packages, the Extended Data Management System and MANAGE, a generalized file management system, in order to make the Xerox 560 more attractive to commercially oriented data processing installations. With its original successes concentrated mainly in the areas of scientific and real-time usage, Xerox has, in fact, made a concerted effort to provide the products required to gain acceptance in a wider data processing marketplace.

The new line of peripherals announced with the Xerox 550 and 560 computer systems is aimed at providing potential Xerox customers with a more competitive selection of input/output devices than was previously available for Sigma-series configurations. New peripherals announced in February 1974 include 100-million-byte removable disk storage drives that can be used both for systems software residence and for storage of an on-line data base; magnetic tape drives with densities of 800 and 1600 bits per inch and transfer rates of up to 200,000 bytes per second; and three new medium-speed printers with speeds of 300, 700, and 1250 lines per minute. Card readers with speeds of 200 or 1500 cpm and card punches with speeds of 100 or 300 cpm are those previously released for the Sigma series processors. Xerox currently offers a rather limited selection of standard terminals to support the company's increasing activities in commercial communications applications, but hardware and software interfaces are supplied for the majority of terminals marketed by most other manufacturers.

For the future, Xerox is looking to specialized areas of information processing for expansion of its computer business, rather than attempting to compete across the board with other mainframe vendors who have established positions in the strictly commercial data processing marketplace.

As a result, Xerox is directing its computer marketing resources toward selected market segments where its strengths in real-time and communications processing plus its combination of scientific and commercial capa-

PROCESSOR MODES: The Xerox 550 and Xerox 560 operate in the master, slave, or master-protected modes and in the mapped or unmapped addressing modes. The operation mode is determined by the setting of 3 bits in the Program Status Words. Master mode allows the execution of all instructions in any part of memory except certain protected areas. Under master mode operation, an operating system (in master mode) controls and supports the operation of other programs which may be in master, slave, or master-protected modes. Most user applications or "problem-solving" programs run in slave mode, in which certain privileged operations such as I/O control and alteration of the Program Status Words are prohibited. A slave mode program can gain access to selected executive program operations under control of the operating system through the CALL instructions. The master-protected mode provides additional protection for programs operating in the master mode when the memory map is operating. The mapped and unmapped modes determine whether the basic processor is operating in the virtual or real addressing modes.

INTERRUPT STRUCTURE: The Xerox 530 has 16 standard interrupt levels, of which 6 are internal, expandable in 2 increments of 12 external interrupts each to a maximum of 40 levels, of which 30 are external. Each interrupt level is assigned a unique hardware priority.

The Xerox 550 and 560 processors have an extensive, prioritized interrupt structure of up to 62 interrupt levels well suited to on-line and real-time environments. Each system control processor is equipped with 14 internal interrupt levels and 4 optional groups of external interrupts. The internal interrupts are divided into three main groups: the counter group, the override group, and the I/O group. The counter group interrupts are each associated with override interrupts, and are triggered when the result of a modify and test instruction in the interrupt counter produces a zero result. Counter interrupts may be inhibited by programs operating in the master mode. Override interrupts have the highest priority in the central processor and are used for processor and memory parity errors, power on and off, clock pulse signals, etc. Override interrupt signals cannot be shut off. The internal I/O interrupt group handles standard I/O service interrupt signals and operator control panel interrupts, and may be inhibited by the Program Status Words, which are alterable in the master control mode.

The external interrupts are reserved for use by the application programmers and are configured into 4 groups of 16 interrupts of levels per group. The priority of each level within the group is fixed, but the priority of each group may be established by the user. External interrupts may be in four basic states—disarmed, armed, waiting, or active—in response to interrupt signals. The basic processor can stimulate any given external interrupt level, thus permitting the simulation of special service attachments for testing and debugging real-time or on-line configurations and allowing the modification of the hierarchy of responses. All internal interrupts are terminated in the system control processor, and external interrupts are input to the system control processor.

A trap system is available to permit automatic detection and recovery from most programming errors without requiring alteration of the current execution priority. Traps automatically cause a branch to a predesigned location when a trap condition is encountered. Unimplemented instruction traps are provided to cause program

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bilities should prove advantageous. These areas include educational institutions, where Xerox already has earned a loyal, albeit small, customer base, and other specialized markets such as utilities, hospitals, and industrial environments with scientific and commercial processing requirements.

Since the merger of its computer activities with the copier/duplicating operations in 1972, Xerox obviously has set its sights on the combination of computers and imaging products into more complex information systems. The availability of the high-speed Xerox 1200 Computer Printing System (Report 70D-931-01) as an on-line peripheral device for Xerox computer systems represents the first important step in this direction. And the future may well see Xerox computers playing a central role in new communications-oriented systems combining the company's computer and graphics processing capabilities. □

control to be transferred to user-written or Xerox-supplied routines for execution of certain instructions to aid software simulation. Other trap locations are provided for conditions such as fixed-point arithmetic overflow, a floating-point or decimal arithmetic error, memory protection and write lock violation, exceeding the limit of the push-down stack, watchdog timer runout, hardware error, and the four CALL instructions for requesting control software services.

VIRTUAL MEMORY: The Memory Map feature, standard on the Xerox 550 and 560, permits user programs up to 128K words in length to occupy up to 256 non-contiguous pages of 512 words each that are distributed throughout main memory. The entire user task being executed must fit into main memory at one time, but it need not occupy one large contiguous area. Memory mapping translates the 8 most significant bits of the effective virtual address (the page identifier portion) into an 11-bit page address. The 11-bit page address is concatenated with the low-order 11 bits of the effective virtual address to produce a 22-bit memory address.

WATCHDOG TIMER: The watchdog timer ensures that real-time operations will not be hung up because of an improperly functioning sensor or other attached device. The watchdog timer issues a trap instruction at user-specified maximum time intervals, and if the currently executing program has not had a normal level of activity by the time this interval has expired, it is aborted and the next user job is activated.

INPUT/OUTPUT CONTROL

INPUT/OUTPUT PROCESSORS: One 16-channel IOP-1 is standard on the 530, and a second IOP-2 with 12 channels is optional. The byte-oriented IOP's are attached to the Internal Direct I/O (DIO) bus to provide interconnection between the CPU, interrupt system, IOP's, and Direct Memory Adapter. (DIO transfer of a full 16-bit word without use of a channel is used to move data directly to a general-purpose register from a low-speed peripheral, sensor, or asynchronous device). The maximum data transfer rate of either IOP is 640,000 bytes/second for device controllers attached to the internal interface and 504,000 bytes/second for controllers attached to the optional 16-bit external interface (using the two-byte interface option). Each IOP operates independently of the other and of the CPU, and is supported by its own I/O control double word.

Two Direct Memory Adapters (DMS's) are also available on the 530 to provide direct data interchange between external (high-speed) devices and main memory with a transfer rate of 625,000 words per second.

Xerox also offers a number of programmable switches to transfer up to ten peripheral controllers from one channel or I/O processor to another on the same or different system(s). A wide variety of special System Interface Units is also available to accommodate analog devices, display drives, counters, frequency sources, etc.

The Xerox 550 and Xerox 560 use Multiplexer Input/Output Processors to perform selector and multiplexer data transfers between main memory and peripheral I/O devices independently of computation performed by the Basic Processor. The first MIOP is included as a standard component of the Basic Cluster, which also includes the Basic Processor. Although this MIOP shares a memory bus with the Basic Processor, the two processors function and access memory independently of each other. Additional MIOP's can be added to the configuration in groups of three MIOP's per I/O Cluster. Each MIOP can have up to 16 I/O subchannels, permitting 16 simultaneous I/O operations, and has a maximum nominal bandwidth of 1 million bytes/second.

The Xerox 560 configuration can also include multiple Rotating Memory Processors (RMP's) for servicing high-speed, large-capacity disk storage subsystems. One RMP can be attached to each Xerox 560 I/O Cluster, but it operates independently of the Basic Processor and other I/O processors. Each RMP has a nominal bandwidth of 806,000 bytes/second and can accommodate up to 15 disk units, although only one can be selected for a data transfer operation at a time. The device controller functions are performed by the RMP, eliminating the need for a disk controller.

A Xerox 550 configuration can include up to 16 MIOP's, while a Xerox 560 configuration can include up to 16 MIOP's plus 5 RMP's for a total of 21 I/O processors. Xerox Sigma series peripherals can be interfaced to either processor model configuration through the use of Sigma series adapters.

The Direct Input/Output Interface (DIO) permits 32-bit word transfers between the Basic Processor general registers and external devices, such as a seldom-activated or low-speed sensor or asynchronous device for data acquisition or control. DIO transfers are performed directly by programs through use of the Read Direct and Write Direct instructions. The DIO Interface option is located in the System Control Processor.

Direct Memory Processors are specialized interfaces that permit extremely high-speed data transfer operations between an I/O Cluster and a main memory port. A maximum of four multiplexed Direct Memory Processors is permitted per configuration, each with a maximum transfer rate of 1,350,000 words per second. They are supplied by the Xerox Custom Systems group.

SIMULTANEOUS OPERATIONS: Each I/O controller is capable of transferring data to or from only one of the devices connected to it at a time. The 7240, 7260, and

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7265 Disk Subsystems, however, can have two-way access, enabling two controllers on different RMP's to access a disk storage unit simultaneously. The I/O clusters in each Xerox configuration operate independently of one another through individual memory ports, with simultaneous computing. The MIOP's permit a maximum of 16 simultaneous operations.

Two-way memory interleaving is possible on the Xerox 530, 550, and 560. Consecutive addresses are stored in alternate physical banks, permitting overlapped memory accesses. Instruction look-ahead causes the next instruction to be fetched and decoded during execution of any given instruction. The Xerox 550 and 560 have 1-instruction look-ahead.

MASS STORAGE

3201/3231/3232/3233 CARTRIDGE DISK SYSTEM: Provides medium-capacity removable disk storage in a subsystem composed of one Model 3201 Rotary Storage Controller and from one to eight Cartridge Disk Drives for a maximum storage capacity of 73.5 million bytes. Three Cartridge Disk Drive models are available. The Model 3231 Cartridge Disk Drive consists of one removable spindle with a total sectored capacity of 2.4 million bytes recorded on only one surface of the removable disk. The Model 3232 Cartridge Disk Drive records on both surfaces of a removable disk and has a total sectored storage capacity of 4.9 million bytes. The Model 3233 Cartridge Disk Drive has a total sectored storage capacity of 9.8 million bytes, half of which is on a removable disk and half on a fixed disk; data is recorded on all four recording surfaces of the two platters.

Data is recorded in 24 sectors of 256 bytes each per track, on 400 tracks per disk surface (plus 8 alternate tracks). The average seek time is 38 miliseconds, and average rotational delay is 12.5 milliseconds. The transfer rate is 312,000 bytes/second for a single-sector transfer and 246,000 bytes/second for multiple-sector transfers. A Controller Expansion Option is required if five or more disks are attached to a single control unit, and a Dual Access feature is optionally available.

The Model 3201 also functions as the control unit for Model 3203/3204 RAD's, and cartridge disks and RAD's can be intermixed on a single controller to a maximum of eight units.

3211/3214 RAPID ACCESS DATA (RAD) STORAGE SYSTEM: Consists of a Model 3211 Rotating Storage Controller and from one- to eight head-per-track Model 3214 RAD storage units. A Controller Expansion Option is required if five or more RAD storage units are connected to a single controller. Each single-spindle RAD storage unit has a capacity of 2,883,584 bytes. Data is organized into 256 tracks; there are 11 sectors per track, each containing 1024 bytes. Average access time is 8.5 milliseconds, and the data transfer rate is 755,200 bytes/second when accessing a single sector and 662,500 for multiple-sector transfers. A Dual Access feature is optional. The control unit is housed in the host mainframe and contains four manually operated write-protect switches that can disable the write circuitry in blocks of 720,896 bytes.

3201/3203/3204/ RAPID ACCESS DATA (RAD) STORAGE SYSTEM: Consists of a 3201 RAD Controller and one- to eight head-per-track 3203 or 3204 RAD Storage Units in any combination. Each 3203 has a capacity of 1,310,720 bytes (128 tracks), and the 3204 stores up to 2,621,440 bytes (256 tracks). Each single-spindle RAD Storage Unit organizes data into tracks of 40 sectors each, with 256 bytes per sector. Average access time is 8.5 milliseconds, and data transfer rate is 755,200 bytes/second when accessing a single sector or 604,480 bytes/second for multiple-sector transfers. The Model 3201 Rotating Storage Controller also serves as the controller for the 3231/3232/3233 Cartridge Disk Drives, permitting from one to right RAD and cartridge disk storage units to be intermixed in any combination. The controller is housed in the host mainframe and includes write-protect switches for disabling write circuitry in blocks of 655,360 bytes. The 3201/3202/3204 RAD Storage System is available for the Xerox 530 computer system.

3275/3276 REMOVABLE DISK STORAGE SYSTEM: Provides large-capacity removable disk storage for Xerox 560 computer systems. A minimum 3275 Disk Storage Subsystem consists of a Controller/Processor and a two Model 3277 Disk Drives for an entry-level capacity of 200 million bytes of on-like disk storage. An entry-level 3276 Disk Storage Subsystem consists of a Controller/Processor and seven Model 3277 Disk Drives containing 700 million bytes of on-line removable disk storage. Both the 3275 and 3276 entry-level configurations can be expanded by the addition of 3277 Disk Drives to a maximum of 15 drives per subsystem and a total capacity of 1.5 billion bytes of on-line disk storage.

The 3277 Disk Drive uses the 3279 Disk Pack, which contains 11 disks and uses 19 recording surfaces. Data is organized in sectors of 1024 bytes each. Each recording surface contains 404 tracks plus 7 spares. Total unformatted storage capacity of each 3279 Disk Pack is 100 million bytes. The average seek time for the 3277 Disk Drive is 30 milliseconds, and average rotational delay is 8.3 milliseconds. The transfer rate is 806,000 bytes per second for a single-sector access. Dual access is optionally available by adding a second RMP Controller/Processor and a Dual Access option to each disk drive. The 3275 and 3276 Disk Storage Subsystems interface to the Rotating Memory Processor (RMP) in a Xerox 560 configuration. Each RMP contains circuitry to perform operations such as error detection and correction, command retry, angular position sensing, overlapped seek operations, and automatic alternate track seek.

INPUT/OUTPUT UNITS

3332/3335 MAGNETIC TAPE SYSTEM: Consists of a 3332 Controller combined with one tape drive and up to seven additional 3335 Magnetic Tape Drives. Two tape drives can be housed in a single cabinet. Each drive reads and writes in 9-channel industry-compatible format at densities of either 800 (NRZI) or 1600 (Phase Encoded) bits/inch. Tape speed is 45 inches/second, and data transfer rates are 36,000 bytes/second and 72,000 bytes/second for the 800 and 1600 bpi densities, respectively. The units feature a single-capstan drive, vacuum-column buffering, and power window.

3340/3345/3347 MAGNETIC TAPE SYSTEM: Consists of a Model 3340 Control Unit and from one to eight Model 3345 Magnetic Tape Units. The 3345 Magnetic Tape Units read and write on ½-inch industry-compatible tape at densities of 800 bits/inch (NRZI) or 1600 bits/inch (Phase Encoded). Tape speed is 75 inches/second, with transfer rates of 60,000 and 120,000

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bytes/second for the 800 and 1600 bpi recording densities, respectively. The 3347 Magnetic Tape Units have a recording density of 800 ot 1600 bits/inch, a tape speed of 125 inches/second, and data transfer rates of 100,000 or 200,000 bytes/second. Both 3345 and 3347 Magnetic Tape Units can be intermixed on one controller up to a maximum of eight units. A Dual Access feature is optional for the 3340 Controller.

7121/7122 CARD READERS: Read 80-column cards serially by column at the rate of 200 or 400 cards/minute for the 7121 or 7122, respectively. Both tabletop readers accept EBCDIC or binary code. Input hopper capacity for either reader is 1400 cards, and output stacker capacity is 1000 cards. The 7121 or 7122 includes a controller and connects directly to the Multiplexer I/O Processor.

7140 HIGH-SPEED CARD READER: Reads 80-column cards serially by column at the rate of 1500 cards/minute in either EBCDIC or binary code. The input stacker holds 2500 cards, and two output stackers hold a combined total of 2000 cards. The stackers are program-selectable to facilitate the separation of exception or error cords. The 7140 includes a controller and connects directly to the Multiplexer I/O Processor.

7160 CARD PUNCH: Punches 80-column cards in row-by-row fashion at 3000 cards/minute in either EBCDIC or binary code. Read-after-punch verification is provided. The input hopper holds 1000 cards, and two program-selectable output stackers hold 1000 cards each. The 7160 includes a controller and connects directly to the Multiplexer I/O Processor.

7165 LOW-SPEED CARD PUNCH: Punches 80-column cards in column-by-column fashion in either EBCDIC or binary code. With 80 columns punched, the speed is 100 cards/minute; maximum punch speed is 300 cards/minute with up to 20 columns punched. The input hopper and the output stacker each have a capacity of 1000 cards. Cards in the output stacker can be offset under program control to segregate error cards, etc. The 7165 includes a controller and connects directly to the Multiplexer I/O Processor.

7060 PAPER-TAPE INPUT/OUTPUT SYSTEM: Includes a 7061 Controller and Cabinet, a 7062 Paper-Tape Reader, a 7063 Paper-Tape Punch, and a 7064 Spooler. The 7062 reads paper tape at a speed of 300 characters/second, and is mounted with the 7064 Spooler and the 7061 Controller in a separate cabinet. The 7063 Punch operates at a rate of 120 characters/second. The punched tape may be 5-, 6-, 7-, or 8-level format, and is passed through the 7060 system at a rewind or fast forward rate of 2000 inches/second.

3461 LINE PRINTER: Provides full-line buffering of 132 print positions and a print speed of 300 lines/minute with a 64-character ASCII set. The 3461 prints 6 or 8 lines/inch under operator control and uses a 12-channel carriage control tape to handle forms control. It attaches directly to a Multiplexer I/O Processor. A built-in maintenance panel permits off-line printing of all test patterns for maintenance purposes.

3465 LINE PRINTER: Provides full-buffered printing of 132 print positions at 1250 lines/minute for the full 64-character drum or 1800 lines/minute using a subset consisting of the first 32 characters. A dual-speed drum makes possible the selection of higher print quality at a speed of 925 lines/minute with the full 64-character ASCII set. The 3465 prints 6 or 8 lines/inch under operator control and uses a 12-channel carriage control tape for forms control. A built-in maintenance panel permits off-line printing of all test patterns for maintenance purposes. The 3465 includes a controller and attaches directly to a Multiplexer I/O Processor.

3466 LINE PRINTER: Provides full-line buffering of 132 print positions and a print speed of 925 lines/minute using a full 95-character ASCII drum or 1200 lines/minute using a 67-character subset. A dual-speed drum is available for higher print quality at a reduced speed of 675 lines/minute using the full 95-character set. The 3466 prints 6 or 8 lines/inch under operator control and uses a 12-channel carriage control tape for forms control. A maintenance panel permits off-line printing of all test patterns for maintenance purposes. The 3466 includes a controller and attaches to a Multiplexer I/O Processor.

7012/7014 KEYBOARD/PRINTERS: Provide the required operator console interface through an I/O channel. The 7012 is a modified Model 35 KSR Teletypewriter and controller that sends or receives EBCDIC code at a rate of 10 characters/second. Print line width is 86 characters at a horizontal spacing of 12 characters/inch. Vertical spacing is 6 lines/inch. The 7014 is a spare print mechanism.

7015/7016/7017 AND 7025/7026/7027 REMOTE COMMUNICATION TELETYPEWRITERS: These units are modified Teletype Model 35's and are ASCII-compatible. Each teletypewriter can operate in a simplex (one-way only), half-duplex (two-way alternate), or full-duplex (two-way simultaneous) mode using Bell System 103 modems. Input/output printing speed is 10 characters/second, with horizontal spacing of 12 characters/inch and vertical spacing of 6 lines/inch. The 7015 (KSR-35), 7017 (ASR-35), 7025 (KSR-35), and 7027 (ASR-35) are keyboard/printers; and the 7016 (RO-35) and 7026 (RO-35) are printers only.

7018 REMOTE KEYBOARD PRINTER: This unit is a modified Teletype Model 37 and is ASCII-compatible.

7020/7021 KEYBOARD PRINTERS: The 7020 is a modified Teletype Model 35 ASR with a paper tape reader/punch and controller which provides the required operator console interface to a Xerox operating system through an I/O channel. The 7021 is a replacement print mechanism. Standard EBCDIC code can be sent or received via the keyboard, printer, and/or punch at 10 characters/second, and via the paper tape reader at 19 characters/second on-line and 10 characters/second off-line. Horizontal spacing of the 86-character line is 12 characters/inch, and vertical spacing is 6 lines/inch.

7530/7531 GRAPH PLOTTERS AND 7534 CONTROLLER: These modified Calcomp drum-type plotters produce X-Y plots under computer control on rolls of paper either 11 inches (7530) or 29.5 inches (7531) in width. Maximum plotting speeds are as follows:

Increment Size	7530 (Modified Calcomp 565)	7531 (Modified Calcomp 563)
0.010 in.	3 in./sec.	2in./sec.
0.005 in.	1.5 in./sec.	1.5 in./sec.
0.100 mm.	30 mm./sec.	30 mm./sec.

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COMMUNICATION CONTROLS

7601 DATA SET CONTROLLER: Enables half-duplex or full-duplex connection (optional feature 7602) of a Bell System 100, 200, or 300 Series modem for communication over common-carrier private lines or switched message networks. Message transmission is provided at rates of 45 to 230,400 bits/second in a variety of standard speeds and formats. Operating synchronously or asynchronously, the 7601 is code-independent. An Automatic Dialing Feature (7603) provides control for the Bell System 800 Series Automatic Calling Unit or its equivalent to perform automatic dialing on a common-carrier switched network under computer control. The 7601 connects to an MIOP channel. Full-duplex operations use two MIOP channels.

7604 LOCAL BATCH TERMINAL CONTROLLER: Provides full-duplex tie-in for either a local batch terminal or a 7670 Remote Batch Terminal. Operating speed is 2400 bits/second.

7605 PROCEDURE-ORIENTED DATA SET CONTROLLER: A variation of the 7601 for binary synchronous protocol. This procedure-oriented controller provides an interface to a Xerox computer system for a single device operating at up to 230,400 bits/second via a Bell System 100, 200, or 300 series modem.

7611 CHARACTER-ORIENTED COMMUNICATION (COC) SUBSYSTEM: Provides low-to-medium-speed asynchronous communications control for up to 64 remote terminals operating simultaneously at speeds up to 1800 bits/second each. Independent simplex, half-duplex, or full-duplex operations is provided for each line handled. Up to 16 COC Subsystems can be connected, each through an MIOP channel. Up to five 7612 Timing Modules can be added to each COC Subsystem to control line interfaces. For each group of 8 lines tied to the COC subsystem, a 7613 Line Interface Unit (LIU) is required. A variety of other interface features are available for special-purpose requirements, including commercial modems, DC interfaces, military device interfaces, etc.

7630/7631 COMMUNICATION SUBSYSTEM: Consists of a 7611 COC Subsystem packaged to handle 8 lines.

7650 CHANNEL INTERFACE UNIT: Enables transfer of data and control information between two Xerox computers. Transmission is in half-duplex mode at a rate of 900,000 8-bit bytes/second (at 1000-foot distances or less) or over 450,000 8-bit bytes/second (at distances up to 2000 feet) using private-wire communications systems. The 7650 connects to any multiplexer or selector I/O processor.

COMMUNICATIONS I/O PROCESSOR: The CIOP is available from Xerox as a special programmable subsystem on an RPQ basis. This subsystem is capable of handling up to 512 voice-grade lines with line speeds of 75 to 9600 bits/second, or multiple wide-band lines with line speeds ranging from 20,000 to 230,400 bits/second, for an aggregate line capacity of more than 500,000 characters per second. The CIOP has a sustained message-switching capacity greater than 50,000 fifty-character messages (or 25,000,000 characters) per hour. The CIOP can operate in three modes—message switching, transaction mode, or a combination of both—to provide most of the communications interface functions in a Xerox communications network, thereby minimizing the communications demand on the central processor.

SWITCHING EQUIPMENT AND SPECIAL INTERFACE UNITS: Xerox offers a number of programmable switches to transfer up to ten peripheral controllers from one channel or I/O processor to another on the same or different computer system(s). A wide variety of special System Interface Units is also available to accommodate analog devices, display drivers, counters, frequency sources, etc.

SOFTWARE

OPERATING SYSTEMS: Software support for the new Xerox computer systems is provided at three different levels. Operating systems for the Xerox 530 include the Basic Control Monitor (BCM), the Real-Time Batch Monitor (RBM), and the communications-oriented Xerox Satellite Processor. The Xerox 550 runs under control of the Control Program for Real-Time (CP-R), and the Xerox 560 executes under control of the multi-use Control Program-Five (CP-V).

BASIC CONTROL MONITOR: BCM is designed for Xerox 530 systems that do not require mass storage devices. BCM runs on a minimum 8K-word system and provides real-time foreground processing concurrently with general-purpose background batch processing. Availability of operator communication support to the background batch job streams and automatic I/O handling are two of the key features of BCM, along with a resident absolute program loader, relocatable loaders, an optional debug facility, an extensive library of mathematical routines, and a utility package of media copy routines and text editors. Program development support is provided under BCM for Symbol (assembler) and Basic FORTRAN.

REAL-TIME BATCH MONITOR: RBM was developed to utilize the real-time hardware features present on the Xerox 530 processor to run multiple real-time processing programs in the foreground concurrently with batch processing in the background. The following capabilities have been designed to RBM: priority scheduling, program re-entrancy, and memory protection. RBM uses RAD or disk files for swapping of non-resident user programs and segments of RBM itself. RBM is extensively segmented, permitting resident operating system memory requirements (4K to 6K words) to be much smaller than the overall RBM size. Minimum Xerox 530 RBM system configuration is 16K words, one mass storage device, a teletypewriter, and a suitable binary input device.

Up to 30 real-time tasks can be processed concurrently by RBM, with re-entrant monitor services, use of the public library, and selected dedicated peripheral devices available to the real-time users. Background batch users can take advantage of job accounting facility that records system utilization by name and account, and can also use a variety of language processors, including ANS COBOL, a macro assembly language (Extended Symbol—a three-pass system), several versions of FORTRAN IV, RPG II, and a multiphase sort processor. Foreground programs which require more memory than has been reserved for foreground use can temporarily seize all of the system resources by using a checkpoint capability to dump the background on direct-access storage for subsequent restoration to memory. To complement this variable, partitioning capability, the operator can reduce the size of the foregound area from his console if desires, thus making more memory available for background use. Other features of RBM include symbolic I/O device references, allowing specific hardware assignment to be deferred until execution time under program control, and a Real-Time

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Debug package to assist in debugging foreground or background programs.

XEROX SATELLITE PROCESSOR: Operates under BCM or RBM to support remote job submission from a Xerox 530 to a host Xerox CP-V and/or IBM OS-HASP-compatible installation. Communications compatibility is provided for IBM's HASP Binary Synchronous Multileaving Protocol, Version 3.1 With the Satellite Processor control program, the 530 can be made functionally equivalent to a standard IBM 360/30 HASP workstation. Terminal-to-terminal data interchange is supported for multiple 530's, HASP-compatible workstations, or CP-V sites. Features of the Xerox Satellite Processor include standard communications capability, concurrent processing as a foreground task on the 530, terminal data exchange, message spooling, automatic resource allocating, and transmission statistics. Line speeds of 2,000 bps to 9,600 bps over leased or dial-up lines, in full- or half-duplex modes, are supported. The minimum BCM configuration that can support a Satellite Processor control program is an 8K-word memory, keyboard printer, card reader, line printer, and a 7605 data set controller. For RBM, an additional 8K words and a mass storage device are required. A further 8K words are required for concurrent use of background processing.

INTERACTIVE DATA ENTRY NETWORK (IDEN): IDEN operates under RBM on a Xerox 530 system to provide the basic framework for on-line data entry, retrieval, and update applications. Facilities are provided for data entry and processing of multiple tasks by user applications programs written in RPG II, COBOL, FORTRAN, or assembly language. Terminal handlers are available for the Xerox BC 100/200 display stations and for certain Teletype-compatible terminals, including the Hazeltine Model 2000 and Lear Siegler Model ADM-1. IDEN supports three file organizations: random-access File Management System (FMS) files, sequential RBM files, and indexed-sequential files generated by RPG programs.

The IDEN software, in conjunction with the Xerox Satellite Processor, allows a Xerox 530 processor to interchange data with other Xerox 530 processors or any IBM HASP-compatible workstation. It also enables the Xerox 530 to perform as a HASP workstation, transmitting jobs to either a Xerox CP-V or IBM HASP-compatible host computer system for execution and receiving output from the host computer for printing, punching and storage. IDEN also provides a set of operator-initiated utility programs to convert IDEN files for transmission to other computer systems operating under the Xerox Satellite Processor.

CONTROL PROGRAM FOR REAL-TIME: CP-R is an upward extension of the Real-Time Batch Monitor that includes new facilities to use the Memory Map feature available in the Sigma 9, Sigma 9 Model 3, and Xerox 550 computer systems. As a result, CP–R provides both real- and virtual-memory management capabilities for processing both real-time and batch-oriented programs. Multiprogramming support is provided for up to 32 jobs (of which one is a background job). A job is defined as a set of user programs, called tasks, which is allocated peripheral and main memory resources. Multi-tasking support is provided for a maximum of 255 tasks.

CP-R divided main memory into four classes: the CP-R System Memory, the Foreground Private Memory, the Foreground Preferred Memory, and Secondary Task Memory. The CP-R System Memory contains resident and nonresident CP-R routines and job and task management data. Foreground Private Memory is used by highly time-critical programs that are not rolled out to disk storage and for other programs that require direct access to physical memory. User programs also can execute in foreground private areas as primary tasks. CP-R System Memory and the Foreground Private Memory operate in the real-memory addressing mode. Primary tasks occupying foreground private areas are scheduled by the hardware priority interrupt system and do not require software scheduling intervention.

The Foreground Preferred Memory areas are used for sharing data between primary tasks and secondary tasks, for data transfers involving peripheral devices with very high transfer rates, and for remote terminal operations. Tasks executing in the Foreground Preferred Memory areas can reside at real or virtual memory addresses.

Secondary real-time tasks, the background batch task, symbionts, media conversion routines, and secondary tasks initiated from terminals execute in the Secondary Task Memory in a virtual-memory addressing mode. Secondary tasks are scheduled by primary tasks or by the CP-R task management routines and are dispatched by software dispatchers. All secondary tasks, unless they request to be "locked" in memory, may be rolled out by CP-R to provide memory space for higher priority tasks.

The CP-R System Area occupies 24K words of main memory, and an additional 8K words of memory are reserved for a Task I/O Buffer Area and tables used by the DEBUG program. The remainder of memory is available for primary and secondary task execution. CP-R uses RAD or disk files for swapping non-resident portions of primary programs and of CP-R itself, and for rolling out portions of mapped secondary tasks. Memory protection for mapped programs is built into the Memory Map for each 512-word page, and provides for free access, read and execute access only, read access only, and denial of access. Programs operating with fixed-memory addresses are protected by a two-bit write lock key. Each secondary task has a unique virtual-addressing space of 128K words independent of the size of physical memory.

CP-R is heavily segmented, permitting resident operating system memory requirements to be much smaller than the overall CP-R size. The CP-R software segmentation facility also allows virtually addressed tasks to be logically divided into segments. Only the active segments of a task need to be loaded into physical memory for execution. Context switching for virtually addressed tasks is accomplished by reloading the portion of the Memory Map corresponding to the segments to be activated.

Up to 100 real-time tasks can be processed concurrently by CP-R, with re-entrant monitor services, use of the public library, and selected dedicated peripheral devices available to real-time users. Background batch users can take advantage of a job accounting facility that records system utilization by name and account, and can use FORTRAN, Xerox Assembly Program, and SL-1, a simulation language designed specifically for digital or hybrid simulation. CP-R permits the use of symbolic I/O device references, allowing specific hardware assignment to be deferred until execution time under program control and both shared or exclusive use of peripheral devices.

A Terminal Job Entry (TJE) Facility supports concurrent terminal operations, permitting file creation and editing,

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batch job entry, real-time job initiation, and real-time job debugging. Up to 16 concurrent users can be supported at local and remote terminals. The CP-R debug facility is available for debugging primary or secondary tasks from a terminal and for the background task and tasks initiated locally.

CP-R incorporates comprehensive reliability, maintainability and availability (RMA) features. An error log of all central processor memory and I/O errors is stored on a disk file and can be retrieved in chronological or sorted orders. An error analysis program provides information on the system status, including CP-R tables and hardware conditions at the time of the error, to aid in error diagnosis. Malfunctioning peripheral devices can be manually removed from the system and subjected to device verification routines for detecting recoverable and non-recoverable errors. Off-line diagnostic software also is provided. In the event of a system failure, CP-R will isolate the malfunctioning system and provide for an orderly shutdown of the affected components. A resident routine loaded by CP-R after the shutdown procedure can be used to terminate real-time tasks or initiate application-dependent recovery attempts.

CONTROL PROGRAM-FIVE (CP-V): CP-V is a comprehensive multi-purpose operating system for Sigma 6, Sigma 9, and Xerox 560 computer systems. An outgrowth of the Universal Time-Sharing System (UTS), CP-V provides upward capability for UTS language processors and application programs and supports any combination of the following five modes of operation: multiprogrammed batch, remote batch, conversational time-sharing, real-time, and transaction processing. Designed as an "integrated" operating system, CP-V makes extensive use of common system services such as schedulers, memory management and file management routines, and symbionts to ensure interchangeability of programs and sharing of data files among the five operating modes. CP-V uses the Memory Map feature to relocate programs into non-contiguous 512-word pages. CP-V, using the Memory Map, manages the swapping of programs between main memory and a high speed RAD and provides for context switching by loading and reloading the 256 Memory Map registers.

The batch processing mode permits multiprogrammed execution of batch jobs from up to 16 batch streams or "partitions." Partitions are described by a set of parameters that establish the minimum and maximum limits for the resources utilized by each partition (such as total job execution time, main memory size, and non-shareable peripherals), and are used for optimizing the job mix being executed by predetermining the mix of I/O and compute-bound jobs. Partition attributes are dynamically alterable to respond to changing job mixes. All batch jobs are queued in a single input queue in priority sequence and are initiated according to priority and resource requirements.

Batch jobs entered from remote batch terminals also are entered in the input queue and scheduled for execution in the batch "partitions." Jobs can be entered from a time-sharing terminal, from a remote batch terminal, from an intelligent remote batch terminal (such as a Xerox 530 or IBM 360/20 computer system), from another Xerox computer system, or from any other computer system operating under IBM HASP multileaving protocol for binary synchronous transmission. Output from remotely entered jobs can be returned to the originating terminal, to another specified terminal, to multiple terminals, or to the central site. Output from locally entered batch programs can also be dispersed to one or more remote terminals. CP-V permits users to control the total number of active batch partitions, to temporarily block execution of a specified partition, or to lock a partition in memory in order to ensure faster execution of these jobs.

Up to 128 on-line time-sharing users can be handled concurrently with local or remote batch processing and real time operations. A Terminal Execution Language (TEL) is available for submitting requests for time-sharing services by users. Each time-sharing user has the facilities for creation, modification, debugging and initiation of programs as well as for creation, modification, inquiry into, and deletion of files. In addition to the conversational mode of operation, time-sharing users can use a deferred batch operation to initiate a job through the terminal batch entry facility for execution as a local batch job. Debugging aids are available for assembly language, FORTRAN, and COBOL programs; in addition, programs created in other modes of operation can be debugged from time-sharing terminals. Time-sharing terminals supported by the CP–V Time-Sharing Mode include Teletype terminals and the IBM 2741.

CP-V supports two levels of real-time processing. Highly time-critical real-time programs are assigned to an unmapped area of foreground memory and operate under direct control of the interrupt system without requiring operating system intervention. Centrally connected real-time tasks can be resident in memory or can be assigned to mapped memory. A non-resident real-time program can request to be locked into memory to complete the processing of a task. Centrally connected real-time tasks are connected to the interrupt structure through a central CP-V routine and are processed as normal batch or on-line jobs. Centrally connected real-time programs have access to all normal CP-V facilities and can direct their output to specified remote terminals. Real-time programs operate in a time-slicing mode, with user-determined intervals selected for each task. A "wake-up" facility permits tasks to be activated at predetermined times.

The Transaction Processing Mode provides device-independent access from remote or local terminals through user application programs to shared CP-V-managed central files or a generalized data base organized under the Xerox EDMS data base management system. The Transaction Processing Mode multi-tasking capability permits concurrent processing of multiple tasks entered from remote terminals or originating from a single terminal entry. Individual terminals can also be limited to entering specific transaction types. An interactive data base processor permits users to query and update files concurrently with other users and batch programs and provides file protection to prevent simultaneous updating of records by two users. A report-generating capability is supported. All output generated by the system can be routed directly to the originating terminal, to alternate terminals, or to output devices at the central site.

In systems using EDMS, a common journal facility is used to provide a complete audit trail of the flow of transactions through the system, including queued transactions and output. In the event of a system malfunction, utilities are available to restore the data base, including all transactions processed to the point of failure. In case of transaction errors, the transaction can be aborted and the data base restored to its original

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content before processing of the transaction. User-oriented commands are provided to enable users at remote locations to examine, search, and modify the data base.

Standard CP-V system services that are available to all processing modes include the system scheduler, the file management system and file maintenance utilities, re-entrant language processors, spooling symbionts, resource management routines, and accounting routines. Files can be protected from unauthorized access either by passwords or by association with a list of users with authorization to read or to read and update. A performance monitoring system provides statistical summaries of performance data and enables the user to alter key parameters for "tuning" the system.

A system recovery function is automatically invoked by CP-V upon detection of an unrecoverable hardware or software error. The recovery routines examine all essential system tables for intactness and reload a new copy of CP-V to begin system re-initialization. Errors that can be isolated to a single user cause that user's program to be aborted while the remainder of the system continues processing. A manual entry point is also provided for use in the event of unrecoverable errors.

File recovery is also handled automatically by CP-V. File structures supported by CP-V are consecutive (sequential), keyed (indexed sequential), and random. Secondary storage for virtual storage swapping can be a high-speed RAD or removable disk storage system.

DIAGNOSTIC PROGRAMMING SYSTEM: Includes 14 hardware and software micro-diagnostic routines that can detect up to 6 levels of errors for functional units and 13 types of memory errors in Xerox 550 and 560 systems. The routines operate off-line under operator control and can be executed under remote control through the Remote Assist facility. The routines are embedded in a read-only memory for each functional unit and permit the basic processor, memory modules, and functional units to be exercised individually and simultaneously to validate system operation.

COBOL: Xerox offers an ANS COBOL compiler which is segmented for use with the Memory Map feature. Extended COBOL language features include implementation of the Table Handling module, sort/merge linkages, common data storage, for independently compiled programs, etc. ANS COBOL is available for the Xerox 530, Xerox 550, and Xerox 560 systems.

FORTRAN: Xerox offers FORTRAN in a number of different versions. For the Xerox 530, Basic FORTRAN, FORTRAN IV, and ANS FORTRAN IV are available, all of which are upward-compatible with their FORTRAN counterparts on the larger Xerox processors.

A FORTRAN Load and Go (FLAG) compiler is available for the Xerox 550 and 560. FLAD is designed for one-pass operation to compile and execute a small-to-medium-size program without leaving main memory.

Extended FORTRAN IV-H is another one-pass compiler for operation under CP-R or CP-V on the Xerox 550 and 560. This compiler produces re-entrant programs with a number of extensions beyond ANS FORTRAN. Among these are IMPLICIT statements, END and ERROR options on READ statements, an in-line assembly-language option, run-time path-of-flow tracing for debugging, etc. Extended FORTRAN IV-H is intended for use on smaller-configuration systems and provides a high degree of compatibility with the FORTRAN compilers of numerous other computer vendors.

Extended FORTRAN IV is another superset of ANS FORTRAN for the Xerox 550 and 560. This three-pass compiler requires more memory for compilation than Extended FORTRAN IV-H, but produces more efficient code along with extensive diagnostics to reduce debug time. Extended FORTRAN IV runs under CP-R or CP-V. In addition to producing re-entrant object code, this compiler offers mixed-mode expressions, punctuation flexibility, automatic double precision, generalized DO loops and subscripts, bit manipulation, etc.

ASSEMBLERS: Extended Symbol, available for the Xerox 530 only, is a three-pass assembler under RBM that is upward-compatible with Symbol on the larger Xerox systems. A concordance (cross-reference table that lists the data and/or statement names) and a macro capability are the primary enhancements over basic Symbol. Many of the features of Extended Symbol are found in Meta Symbol on higher-numbered versions of the Xerox processors.

Meta Symbol is the full-scale Xerox assembler used under CP-R and CP-V. It includes provisions for procedure-oriented statements, symbolic references, etc. This two-pass assembler allows parameter testing during assembly that can vary the generated code. Other features of Meta Symbol include self-defining constants, full use of lists and subscripted elements, automatic alignment of instructions on word boundaries, etc. Meta Symbol runs on the Xerox 550 and 560.

The Xerox Assembly Processor (AP) is a four-phase macro assembler that executes in the background area of CP-R. AP allows recursive procedures, conditional coding to control assembly, arithmetic and Boolean operators, and updating of source programs during assembly.

TEXT: Xerox offers a TEXT Publication Processor under CP-V that is functionally identical with IBM's AT/360.

UTILITY ROUTINES: Sort/merge programs are offered for both CP-R and CP-V systems. All are generalized programs which are controlled by user-supplied parameters, and all can accommodate either fixed- or variable-length records. Each software level also includes an appropriate number of data transcription, diagnostic, mathematical, and other utility routines.

RPG II: An RPG II compiler is available to execute as a background program on the Xerox 530 under RBM, and both RPG and RPG II are available on the Xerox 560 under the CP-V operating system. Additional features implemented include the ability to automatically include and selectively execute subroutines, the EXCEPT operation code to provide output during total or detail calculations; user control of report line spacing; AND/OR functions; chain operation code and specialized edit codes; and the capability to access indexed sequential files.

BASIC: An extended BASIC compiler is usable in either batch or on-line mode on Xerox 560 systems under CP-V.

APL: Full APL is available under CP-V and does not require that the system be dedicated to APL exclusively. A graphic interface to APL programs ia available.

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EXTENDED DATA BASE MANAGEMENT SYSTEM: EDMS is a generalized data base mangement system that conforms to the CODASYL Data Base Task Group recommendations. It provides various file organization schemes for data access and retrieval. EDMS is designed to be used with COBOL, FORTRAN, and Meta Symbol programs and runs on the Xerox 560 under CP-V.

INTERACTIVE DATA BASE PROCESSOR (IDP): IDP offers query and report generation capabilities for batch and on-line users accessing EDMS data bases. Capability is also provided for sorting data for reports and accumulation of counts and totals.

MANAGE/TERMINAL-ORIENTED MANAGE (TOM): This generalized file retrieval and update program enables non-technical personnel to manipulate files and generate reports from files. TOM facilitates file access from remote terminals.

APPLICATION PROGRAMS: A number of applications programs are available from Xerox on an unbundled (separately priced) basis.

General Purpose Discrete Simulator (GPDS) is a version of IBM's GPSS that runs on a Xerox processor under CP-V.

Functional Mathematical Programming System (FMPS) is a linear programming system developed jointly with Bonner and Moore Associates. FMPS operates on a Xerox 560.

GAMMA III is an adjunct to FMPS that formulates linear programming problems into specialized matrix notation to simplify FMPS input.

CIRC is a sophisticated circuit design and analysis tool for electrical engineers that runs under CP-V. Three versions are available: CIRC-DC (direct current), CIRC-AC (alternating current), and CIRC-TR (transient analysis).

Simulation Language (SL-1) provides digital or hybrid simulation through a superset of IBM's Continuous System Simulation Language (CSSL) under CP-R or CP-V. A version called CSS/3 is available for the Xerox 530.

In addition to the applications supported by Xerox, more than 1,000 programs are listed in the Xerox Users' Group Catalog of Programs.

USERS' GROUP: Xerox has a users' group composed of over 1200 active members. Semi-annual meetings are held, and a newsletter, *User News*, is published monthly. A number of Special Interest Groups have been formed, covering topics such as commercial applications, real-time operation, educational applications, etc. A comprehensive catalog of the Xerox Users' Group program is available from Xerox. For further information, contact: Secretary, Xerox Users' Group, Xerox Corporation, 701 South Aviation Blvd., El Segundo, California 90245.

PRICING

EQUIPMENT: All necessary control units, I/O processors, and adapters are included in the indicated prices for the following typical configurations, and the quoted one-year rental prices include equipment maintenance. Note that numerous special interface units and communications controllers for real-time and on-line use have not been included.

XEROX 530 CARD/TAPE SYSTEM: Consists of an 8K-word Central Processor, 7315 Magnetic Tape Controller and Tape Unit and one additional 7316 Magnetic Tape Unit (60KB), 7121 Card Reader (200 cpm), and 3451 Line Printer (350 lpm). Purchase price is $59,000, and monthly rental is $2,420 on a one-year lease. For purchased systems, monthly maintenance is $835.

XEROX 550 MEDIUM-SCALE SYSTEM: Consists of a 32K-word Central Processor, 3214 RAD Storage System (2.9 MB), 3243 Cartridge Disk Drive (11.4 MB), 3332 Magnetic Tape Controller and Tape Unit and additional 3335 Magnetic Tape Unit (36/72 KB), 7121 Card Reader (200 cpm), 7165 Card Punch (100 cpm), 3461 Line Printer (300 lpm), and 4591 Printer-Keyboard. Purchase price is $330,880, and monthly rental is $9,391 on a one-year lease. For purchased systems, monthly maintenance is $1,949.

XEROX 560 TAPE/DISK SYSTEM: Consists of an 80K-word Central Processor, two 3214 RAD Storage Systems (5.8 MB), four 3277 Disk Drives (400 MB), 3340 Magnetic Tape Control and four 3347 Magnetic Tape Units (100/200 KB), two 7140 Card Readers (1500 cpm), 7165 Card Punch (100 cpm), two 3465 Line Printers (1250 lpm), and a 4591 Printer-Keyboard. Purchase price is $880,300, and monthly rental is $22,924 on a one-year lease. For purchased systems, monthly maintenance is $4,765.

SOFTWARE: Xerox was among the first mainframe vendors to price applications software separately. This policy applies to the major applications systems developed by Xerox or by outside sources under contract to Xerox. Such software is currently limited to a handful of applications-oriented packages. Operating systems, utilities, and language processors are bundled at no additional cost to users. A number of the separately priced applications packages are provided at no charge to qualified educational institutions.

SUPPORT: Xerox has formed a Commercial Systems Integration Group to provide systems engineering and field support to customers. "Emergency" operating system software support is available from Field Engineers at $25/hour on weekdays and $28/hour on Sundays and holidays. On-site custom software assistance is provided by Systems Engineers at $25/hour for small Xerox 530 systems and $30/hour for more complex systems.

EDUCATION: Xerox maintains an Education Center in Los Angeles at which standard and special courses are taught. These courses cover all aspects of Xerox computer usage and range in length from 2 to 10 days, at costs ranging from $100 to $300. A training program consisting of a number of courses may be desired, depending upon customer requirements. On-site training can be arranged at negotiated charges.

CONTRACT TERMS: Xerox offers a purchase agreement for its computer systems, and 1, 4, or 6-year lease terms. A 9-hour weekday principal period of maintenance is included at no additional charge for leased systems. Additional maintenance support is available: Saturday or Sunday coverage is offered at a premium of 20% of the separate maintenance charge; 16-hour maintenance is available for 5, 6, or 7 days per week at premiums of 40%, 70%, or 90%, respectively, of the separate maintenance charge; and 24-hour maintenance is available for 5, 6, or 7 days per week at premiums of 110%, 125%, or 140%, respectively, of the separate maintenance charge. ■

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EQUIPMENT PRICES

		Purchase Price	Monthly Maint.	Rental (1-year lease)*	Rental (4-year lease)*	Rental (6-year lease)*
XEROX 530 PROCESSOR AND MAIN STORAGE						
4101	530 CPU with 8K words of core memory (includes first IOP with 16 channels, extended arithmetic including multiply/divide, six general registers, two real-time clocks, fault interrupts, memory protect, power monitor, six levels of external interrupt, and first keyboard/printer control	20,000	150	700	630	560
4151	8K Core Memory Module	5,500	45	300	270	240
4105	Two-byte interface for first IOP	1,500	15	50	45	40
4118	Floating Point Arithmetic	3,500	35	167	150	135
4119	Field Addressing Instructions	1,500	15	50	45	40
4125	Priority Interrupt, 12 levels	600	5	20	18	16
4170	External Interface Feature	400	5	14	13	12
4171	Second IOP with 12 I/O Channels	5,000	35	167	150	135
4175	Two-byte Interface for second IOP	1,500	15	50	45	40
4180	DMA	1,200	5	14	13	12
4185	Dual Processor Adapter	5,000	35	167	150	135
4190	Second Keyboard/Printer Control	400	5	14	13	12
4191	KSR-35 Keyboard/Printer	3,300	15	110	100	80
4192	ASR-35 Keyboard/Printer	5,000	15	165	150	130
4193	KSR-33 Keyboard/Printer	1,300	15	45	40	35
4194	ASR-33 Keyboard/Printer	1,700	15	60	55	50
SPECIAL PACKAGED XEROX 530 SYSTEMS						
41C1	Paper Tape System (consists of a 4101 processor and a 7060 paper tape reader/punch)	25,000	240	1,000	912	827
41C2	Paper Tape plus Punched Card system (consists of a 4101 processor, 7060 paper tape reader/punch, and 7121 card reader)	29,500	295	1,220	1,119	1,023
41C3	Paper Tape plus Punched Card Plus Line Printer System (consists of a 4101 processor, 7060 paper tape reader/punch, 7121 card reader, and 3451 Line Printer)	47,000	545	1,670	1,539	1,423
41C4	Card System (consists of a 4101 processor and 7121 card reader)	24,500	205	920	837	756
41C5	Card System plus Line Printer (consists of a 4101 processor, 7121 card reader, and 3451 line printer)	42,000	455	1,370	1,257	1,156
41C6	Card System plus Line Printer and one Magnetic Tape Drive (consists of a 4101 processor, 7121 card reader, 3451 line printer, and 7315 magnetic tape drive & controller)	52,000	655	1,970	1,807	1,656
41C7	Card system plus Line Printer and two Magnetic Tape Drives (consists of a 4101 processor, 7121 card reader, 3451 line printer, 7315 magnetic tape drive & controller, and 7316 magnetic tape drive)	59,000	835	2,420	2,229	2,056
XEROX 550 PROCESSOR AND MAIN STORAGE						
4501	Xerox 550 Basic System; includes Basic Processor and MIOP, System Control Processor, 16K words of 2-port memory, four blocks of 16 general-purpose registers, memory map and access protection, and extended arithmetic unit. The System Control Processor contains four real-time clocks, power fail-safe, watchdog timer, configuration control, 14 internal interrupts, external control subsystem, and remote assist facility	104,700	600	3,000	2,820	2,700
4525	External Interrupts, 12 levels	2,000	15	70	66	63
4561	16K Core Memory Unit with two ports	26,000	110	832	782	748
4562	16K Core Memory Increment	24,000	96	768	722	692
4566	Two-Port Expansion for Memory (2 per 4561)	8,000	60	270	254	243
4570	Direct I/O Interface	2,500	20	88	82	81
4580	I/O Cluster	8,000	60	250	235	225
4581	Additional MIOP	15,000	82	500	470	450
4582	I/O Adapter	10,000	60	350	330	310
4591	KSR 35 Keyboard Printer	3,300	15	110	100	80
XEROX 560 PROCESSOR AND MAIN STORAGE						
4601	Xerox 560 Basic System; includes Basic Processor and MIOP, System Control Processor, 16K words of 2-port memory, four blocks of 16 general-purpose registers, memory map and access protection, extended arithmetic unit, floating	162,700	774	3,400	3,196	2,960

*Rental prices include monthly maintenance charges.

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		Purchase Price	Monthly Maint.	Rental (1-year lease)*	Rental (4-year lease)*	Rental (6-year lease)*
XEROX 550 PROCESSOR AND MAIN STORAGE (Continued)						
	point, and byte string and decimal instructions. The System Control Processor contains four real-time clocks, power fail-safe, watchdog timer, configuration control, 14 internal interrupts, external control subsystem, and remote assist facility					
4625	External Interrupts, 12 levels	2,000	15	70	66	63
4661	16K Core Memory Unit with two ports	26,000	110	832	782	748
4662	16K Core Memory Increment	24,000	96	768	722	692
4666	Two-Port Expansion for Memory (2 per 4661)	8,000	60	270	254	243
4670	Direct I/O Interface	2,500	20	83	82	81
4680	I/O Cluster	8,000	60	250	235	225
4681	Additional MIOP	15,000	82	500	470	450
4682	I/O Adapter	10,000	60	350	330	310
4691	KSR 35 Keyboard Printer	3,300	15	110	100	80
MASS STORAGE						
3201	Rotating Storage Controller for up to eight 3203 or 3204 RAD Storage Units or 3231, 3232, or 333 Cartridge Disk Drives in any combination	6,000	50	200	190	180
3203	RAD Storage Unit; 1.31 MB, 755,200 bytes/sec.	17,000	120	565	530	500
3204	RAD Storage Unit; 2.62 MB, 755,200 bytes/sec.	30,000	175	1,000	940	890
3211	Rotating Storage Controller (for up to eight 3214 RAD Storage Units or 3242 or 3243 Cartridge Disk Drives in any combination)	8,000	65	200	190	180
3214	RAD Storage Unit; 2.4 MB, 755,200 bytes/sec.	32,000	185	800	750	715
3215	Two 2.88 MB RAD Storage Units; 5.76 MB, 755,200 bytes/sec	42,000	275	1,050	990	930
3231	Cartridge Disk Drive; 2.4 MB, 246,000 bytes/sec.	5,500	50	185	174	170
3232	Cartridge Disk Drive; 4.9 MB, 246,000 bytes/sec.	9,000	75	300	282	276
3233	Cartridge Disk Drive; 9.8 MB, 246,000 bytes/sec.	16,000	130	495	465	455
3242	Cartridge Disk Drive; 5.7 MB, 286,000 bytes/sec.	9,000	75	300	282	276
3243	Cartridge Disk Drive; 11.4 MB, 286,000 bytes/sec.	16,000	130	495	465	455
3246	Disk Cartridge	25	NC	NC	NC	NC
1049	Dual Access for 3201/3211 Rotating Storage Controllers	1,000	10	27	26	23
3275	Rotating Memory Processor (RMP) and two 100 MB Disk Driver	89,500	385	2,185	1,935	1,830
3276	RMP and seven 100 MB Disk Drives	181,000	950	4,360	4,100	3,800
3277	100 MB Disk Drive	22,500	155	645	535	510
3279	Disk Cartridge	800	NC	50	50	50
1051	Second RMP for Dual Access	45,000	180	1,125	1,055	1,000
1052	Dual Access for Disk Drive	4,380	20	110	100	85
7201	Rapid Access Data (RAD) Controller (for up to eight 7202, 7203, or 7204 RAD Storage Units in any combination)	8,000	36	200	188	178
7202	RAD Storage Unit; 0.75 MB, 188,000 bytes/sec.	13,000	95	325	305	290
7203	RAD Storage Unit; 1.5 MB, 188,000 bytes/sec.	24,000	127	600	564	534
7204	RAD Storage Unit; 3.0 MB, 188,000 bytes/sec.	35,000	186	875	823	774
7240	Disk Controller (connected to any I/O Channel for up to 8 spindles in 7242 and/or 7246 Disk Storage Units)	20,000	104	500	470	445
7242	Disk Storage Unit; Removable, Dual Spindle, 49.15 MB	25,000	281	800	752	712
7244	Disk Pack for 7242 or 7246 Disk Storage Units; 24.58 MB	600	NC		31	31
7246	Disk Storage Unit; Removable, Single Spindle, 24.58 MB	15,000	212	450	423	400
7247	Device Pooling Feature, Single Spindle (for 7246 to provide dual access by two 7240's)	5,000	42	125	118	111
7250	Controller for 7251/7251	8,000	35	200	188	178
7251	Cartridge drive, 2.3 MB	5,500	50	140	125	110
7252	Cartridge disc, 4.6 MB	9,000	75	225	200	180
7254	Cartridge disc pack	200	—	—		
MAGNETIC TAPE INPUT/OUTPUT						
3322	Magnetic Tape Controller and one Tape Unit; 36 KB	12,500	110	600	415	390
3325	Add-on Tape Unit; 36 KB	7,500	90	330	300	275
3332	Magnetic Tape Controller and one Tape Unit; 36/72 KB	32,280	145	750	705	670
3335	Add-on Tape Unit; 36/72 KB	13,500	90	360	340	325
1045	Expansion Adapter	1,500	6	50	47	45
1046	ASCII Translation Option	1,000	5	25	20	15
3340	Magnetic Tape Controller; 75/125 ips	24,000	95	563	529	497
3345	Tape Unit; 800/1600 bpi, 60/120 KB	16,685	100	437	411	386
3347	Tape Unit; 800/1600 bpi, 100/200 KB	21,050	115	545	512	481
1047	Second Controller for Dual Access	7,270	30	190	180	170

*Rental prices include monthly maintenance charges.

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		Purchase Price	Monthly Maint.	Rental (1-year lease)*	Rental (4-year lease)*	Rental (6-year lease)*
MAGNETIC TAPE INPUT/OUTPUT (Continued)						
7315	Magnetic Tape Controller and one Tape Unit	16,000	200	600	550	500
7316	Add-on Tape Drive; 60 KB	12,000	180	450	422	400
7322	Tape Unit; 60 KB	12,000	180	450	422	400
7330	Magnetic Tape Controller; 1600 bpi	28,400	114	710	667	632
1038	Magnetic Tape Controller; 800 bpi option for 7330	4,000	26	100	94	89
1039	Extended Width Interface for 1600 bpi Controller	2,500	16	63	60	56
7332	Tape Unit; 1600 bpi, 120 KB	18,500	159	435	409	387
7333	Tape Unit; 1600 bpi, 240 KB	25,850	196	610	573	543
7361	Magnetic Tape Controller; 556 bpi	6,000	42	150	141	134
7362	Tape Unit; 19.7 KB	19,000	133	475	447	423
7365	BCD Option	2,000	NC	50	47	46
7371	7-Channel Tape System Controller	22,000	104	550	517	490
7372	7-Channel Tape Unit; 200/556/800 bpi, 15/41.7/60 KB	27,000	196	675	635	601
7374	Binary Packing Option	3,200	NC	80	76	72
OTHER INPUT/OUTPUT UNITS						
7121	Card Reader (including control); 200 cpm	8,800	45	220	207	196
7122	Card Reader (including control); 400 cpm	16,000	120	400	376	356
7140	Card Reader (including control); 1500 cpm	24,000	180	600	564	534
7160	Card Punch (including control); 300 cpm	32,000	250	800	752	712
7165	Card Punch (including control); 100 cpm	19,600	125	490	461	437
3451	Buffered Line Printer; 350 lpm	22,000	250	450	420	400
3461	Buffered Line Printer; 300 lpm	17,000	150	485	460	400
3463	Buffered Line Printer; 700 lpm	33,500	225	880	827	783
3464	Buffered Line Printer; 500 lpm	36,500	245	960	902	855
3465	Buffered Line Printer; 1250 lpm	52,000	275	1,370	1,285	1,220
3466	Buffered Line Printer; 925 lpm	55,000	305	1,450	1,360	1,290
1050	Second Printer Control for Access Switching	2,500	20	83	80	77
7060	Paper Tape Reader (7062), Punch (7063), Spooler (7064), w/Controller & Rack (7061)	12,000	90	300	282	267
7061	Paper Tape Equipment Cabinet & Controller	7,000	32	175	165	156
7062	Paper Tape Reader; 300 cps	2,000	16	50	47	46
7063	Paper Tape Punch; 120 cps	2,500	27	63	60	57
7064	Paper Tape Spooler	1,500	11	38	36	34
7530	Incremental Graph Plotter (11-inch)	13,000	80	325	306	290
7531	Incremental Graph Plotter (30-inch)	22,000	106	550	517	490
7534	Graph Plotter Controller (For 7530 or 7531)	8,400	47	210	198	187
7580	Graphic Display Unit (including control)	45,000	300	1,124	1,058	1,002
COMMUNICATIONS CONTROLS						
7601	Data Set Controller	7,000	36	175	165	156
7602	Full Duplex Feature (for 7601)	800	0	20	19	18
7603	Automatic Dialing Feature (for 7601)	800	0	20	10	18
7604	Local Batch Terminal Controller	8,400	36	210	198	187
7605	Procedure-Oriented Data Set Controller	9,500	50	238	224	212
7611	Character-Oriented Communications Subsystem (for up to 64 simultaneous remote devices)	10,500	47	263	248	235
7612	Timing Module for 7615/7616 (a maximum of 5 may be connected to a 7611)	250	0	6	6	6
7613	Line Interface Unit (a maximum of 7 may be connected to a 7611 for up to 64 lines)	1,000	0	25	24	23
7615	Formatted Send Module (one per 7611 line)	250	2	6	6	6
7616	Formatted Receive Module (one per 7611 line)	250	2	6	6	6
7623	DC Power Supply (for 7611)	1,000	5	25	24	23
7618	Automatic Dialing Unit (controls 1 Bell System 800 Series Automatic Call Unit)	5,500	42	138	130	123
7619	Additional Dialing Position (up to 15 may be added to a 7618 for a total of 16 dialers)	500	0	13	13	12
7630	Communications Controller Plus 8 Lines	14,000	47	350	329	312
7631	8-Line Expansion Unit	5,800	31	145	137	130
7650	Channel Interface Unit for inter-processor data transmission	7500	52	188	177	168
7670	Remote Batch Terminal; includes control unit, operator's console, 250-lpm bar printer, 200-cpm card reader, and 75-to-200-cpm card punch	36,500	180	900	846	801

*Rental prices include monthly maintenance charges.

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SOFTWARE PRICES

Program Product	Monthly Use Fee	Prepaid Use Fee
SL-1	200	10,000
FMPS	Not avail.	15,000
GAMMA III	Not avail.	7,500
GPDS	72	3,600
CIRC-DC	78	3,900
CIRC-AC	24	1,200
CIRC-TR	59	2,950
ACES (Administrative and Classroom Education System):		
Control Program	30	1,500
Financial Accounting	17	850
Payroll and Personnel	33	1,650
Stores Inventory	17	850
Accounts Payable	33	1,650
Student Work Continuation Program	50	2,500
Attendance Accounting	16	800
Student Scheduling	16	800
Mark Reporting, Education Planning, and Guidance Reporting	26	1,300
Test Reporting	32	1,600