

IBM System/360 Models 22-195

MANAGEMENT SUMMARY

When IBM announced the System/360 in April 1964, it introduced what was to become during its heyday the most widely used line of computer equipment in the world. Because of its extensive use, the System/360's impact on data processing has been enormous. It became the de facto standard of comparison for general-purpose computer systems and, for better or worse, many of its characteristics and facilities have become virtual (no pun intended) industry standards. Enhancements and new architectural features, introduced one by one in the succeeding processor models which joined the System/360 family, also revealed many of the advancements in the state of the art which eventually became consolidated in IBM's evolutionary System/370. Not that IBM invented them; rather, as in the case of virtual memory — one feature which clearly distinguishes the System/370 from the System/360 — IBM put them to widespread use.

When it was announced, IBM proclaimed that "the System/360 marks the achievement of a truly all-purpose computer that can solve any type of data-handling problem with greater speed and efficiency than ever before." In exchange for enjoying the advantages of a common machine for performing both scientific and commercial tasks, IBM asked users of its incompatible 7000 and 1400 Series computers to undergo a massive conversion — in ➤

The System/360 product line, which dominated the computer marketplace from 1964 through 1970, encompasses 12 central processors, over 50 peripheral devices, and a vast array of software. This detailed report describes the System/360's characteristics and analyzes its present and future status.

CHARACTERISTICS

MANUFACTURER: International Business Machines Corporation, 1133 Westchester Avenue, White Plains, New York 10604.

MODELS: System/360 Models 22, 25, 30, 40, 44, 50, 65, 67, 75, 85, and 195.

DATA FORMATS

BASIC UNIT: 8-bit byte. Each byte can represent 1 alphanumeric character, 2 BCD digits, or 8 binary bits. Two consecutive bytes form a "halfword" of 16 bits, while four consecutive bytes form a 32-bit "word."

FIXED-POINT OPERANDS: Can range from 1 to 16 bytes (1 to 31 digits plus sign) in decimal mode; 1 halfword (16 bits) or 1 word (32 bits) in binary mode.

FLOATING-POINT OPERANDS: 1 word, consisting of 24-bit fraction and 7-bit hexadecimal exponent, in "short" ➤



Model 65, shown at left, was the most widely used of the large-scale System/360 computers and is still delivering cost-effective performance in many installations.

REFERENCE EDITION. This is a mature product line, and no significant further developments are anticipated. Because of its importance, coverage is being continued, but no future update is planned.

IBM System/360 Models 22-195

▷ effect, to “reset to zero.” Several years later, beleaguered users were making wry remarks about the “slaughter of innocents in the 1964 battle of System/360.” Nevertheless, the System/360 prospered and IBM with it. Industry sources estimate that IBM shipped over 33,000 360's, and nearly a decade after the product line's emergence, enough systems remain in operation to provide a profitable *raison d'être* for a substantial number of third-party leasing companies, independent software houses, and suppliers of compatible main memories and peripheral devices.

The System/360 was conceived as a single, all-purpose line of compatible equipment to handle workloads of widely varying types over a large range of sizes. Capabilities for manipulating both variable-length decimal and fixed-length binary data fields were provided. However, the attempt to create a truly general-purpose computer system necessitated certain design compromises that made it less than ideally suitable for any one environment — large or small, business or scientific, batch or on-line. Despite these limitations, the System/360 has been successfully employed in almost every conceivable type of application.

Announcement of the System/370 in June 1970, with significant price/performance improvements, marked the end of the System/360's active marketing life, at least from IBM's point of view. Later announcements of a virtual storage capability for the System/370 (in August of 1972) and the functional stabilization of the Disk Operating System (DOS), OS/360-MFT (Multiprogramming With a Fixed Number of Tasks), and OS/360-MVT (Multiprogramming with a Variable Number of Tasks) gave System/360 users fair warning that IBM expects them to migrate into the System/370 fold in order to be eligible for operating system enhancements and support for newer, more attractive peripheral devices.

The intervening years since the announcement of the System/370 have seen a steady diminution of the installed System/360 customer base. By the end of 1973, the value of the installed base of System/370 users exceeded that of System/360 users. The remaining pool of loyal System/360 users has begun to represent an “opportunity” for persevering IBM salesmen, for competing mainframe manufacturers that offer a high degree of System/360 compatibility, and for the myriad companies that can provide attractively priced third-party leasing arrangements, enhanced software packages, much-needed additional main memory, and compatible peripheral devices.

PROCESSOR MODELS

The System/360 line now consists of 12 different central processors, ranging from the most recent, the 360/22, to the “super-computer” Model 195. (The smallest processor, the Model 20, differs from the rest of the family in ▷

▶ format; or 2 words, consisting of 56-bit fraction and 7-bit hexadecimal exponent, in “long” format. (Extended-precision floating point, using 4-word operands, can also be performed in Models 85 and 195.)

INSTRUCTIONS: 2, 4, or 6 bytes in length, specifying 0, 1, or 2 memory addresses, respectively.

INTERNAL CODE: EBCDIC (Extended Binary-Coded Decimal Interchange Code). The System/360 processors can alternatively use 8-bit ASCII, but no software support is provided for this code.

MAIN STORAGE

STORAGE TYPE: Magnetic core.

CAPACITY: See table.

CYCLE TIME: See table.

CHECKING: Parity bit with each byte is generated during writing and checked during reading.

STORAGE PROTECTION: The Storage Protection feature, which guards against inadvertent overwriting of data in specified 2048-byte blocks of storage, is standard in Model 50 and optional in Models 22, 25, 30, and 40.

The Fetch Protection feature, which provides protection against unauthorized reading as well as writing, is standard in Models 65, 67, 75, 85, and 195 and optional in Model 44.

CENTRAL PROCESSORS

INDEX REGISTERS: All models have sixteen 32-bit general registers, used for indexing, base addressing, and as accumulators, plus four 64-bit floating-point registers.

INDIRECT ADDRESSING: None.

INSTRUCTION REPERTOIRE: The “Standard Instruction Set” contains 86 instructions and is standard in all processors except Model 44. These instructions handle fixed-point binary arithmetic, loading, storing, comparing, shifting, branching, radix conversion, code translation, logical operations, packing, and unpacking.

Decimal Arithmetic is optional in Models 30 and 40 and standard in Model 22, Model 25, and Models 50 thru 195. It consists of 8 additional instructions that handle arithmetic, comparison, and editing operations on variable-length decimal operands.

Floating-Point Arithmetic is optional in Models 22, 25, 30, and 40 and standard in Models 50 thru 195. It consists of 44 additional instructions that perform arithmetic and comparison operations on floating-point operands expressed in both the “short” (1-word) and “long” (2-word) formats.

Models 44's basic instruction repertoire is a subset of the Standard Instruction Set, but various options now make it possible to equip the Model 44 with the full System/360 instruction set.

INSTRUCTION TIMES: See table; the times shown are for 1-address binary addition of 32-bit fields and for 2-address decimal addition of signed 5-digit (3-byte) fields. ▶

IBM System/360 Models 22-195

Characteristics of the System/360 Processor Models

	Model 22	Model 25	Model 30	Model 40	Model 44	Model 50	Model 65*	Model 67*	Model 75	Model 85	Model 195
MAIN STORAGE											
Cycle time, microseconds	1.5	0.9	1.5	2.5	1.0	2.0	0.75	0.75	0.75	0.96 or 1.04	0.756
Bytes fetched per cycle	1	2	1	2	4	4	8	8	8	16	8
Storage interleaving, max.	none	none	none	none	none	none	2-way	2-way	4-way	4-way	16-way
Minimum capacity, bytes	24,576	16,384	16,384	32,768	32,768	131,072	262,144	262,144	262,144	524,288	1,048,576
Maximum capacity, bytes	32,768	49,152	65,536†	262,144	262,144	524,288	1,048,576	1,048,576	1,048,576	4,194,304	4,194,304
PROCESSOR											
Machine cycle, nanoseconds	750	900	750	625	250	500	200	200	195	80	54
Add time, microseconds (32-bit binary fields)	30	47	30	12	2.3	4	1.4	1.6	0.7	0.16	0.054
Add time, microseconds (5-digit decimal fields)	57	100	57	40	—	20	5.2	5.7	4.8	1.5	?
CHANNELS											
No. of selector channels	1	0-1	0-2	0-2	none	0-3	0-6	0-12	0-6	0-6	0-6
No. of multiplexer channels	1	0-1	1	1	1-3	1	0-1	0-2	0-1	0-2	0-2
Maximum no. of multiplexer subchannels	96	32	224	128	72	256	192	384	192	384	384
COMPATIBILITY FEATURES											
IBM 1401/1440/1460	no	yes	yes	yes	no	no	no	no	no	no	no
IBM 1410/7010	no	no	no	yes	no	yes	no	no	no	no	no
IBM 1620	no	no	yes	no	no	no	no	no	no	no	no
IBM 7070/7074	no	no	no	no	no	yes	yes	no	no	no	no
IBM 7080	no	no	no	no	no	no	yes	no	no	no	no
IBM 7040/7090 Series	no	no	no	no	no	no	yes	yes	no	yes	no
IBM S/360 Model 20	no	yes	no	no	no	no	no	no	no	no	no

* A Model 65 or 67 system may include two processors; dual-processor systems can have up to 2,097,152 bytes of storage.

†98,304 bytes available as an RPQ feature.

➤ many significant respects and is fully described in the preceding report).

Models 30, 40, 50, 65, and 75 are the basic, long-established members of the System/360 line and span roughly a 40-fold range of processing speeds. All five were designed as general-purpose computers suitable for a wide range of applications, and all five are fully upward-compatible at the hardware level. Models 30, 40, and 50 were part of the original System/360 announcement in April 1964. Models 65 and 75 were added a year later, replacing the originally announced Models 60, 62, and 70. Models 30 through 65 accounted for the vast majority of the System/360 customer base. Model 75, however, found considerably less acceptance than the other four because it offered only a modest speed advantage over the Model 65 and lacked the read-only storage that enables the Model 65 to emulate the earlier IBM 7040/7090 Series scientific computers. Two Model 65 Processing Units can share up to 2 million bytes of core storage to form a multiprocessor system.

Model 22, the cheapest fully compatible System/360 processor, was also the last to be announced. After IBM introduced the System/370 Model 135 in March 1971, there was considerable speculation as to whether the company would plug the remaining performance gap between

➤ **OPTIONAL FEATURES:** The Decimal Arithmetic, Floating-Point Arithmetic, Storage Protection, and Fetch Protection features, which are standard in some processor models and optional in others, have been described above.

Direct Control (standard in Models 75 and up, optional in Models 25 thru 67) provides six external interrupt lines which are independent of the normal data channels.

Interval Timer (optional in Models 22, 25, and 30, standard in the rest) provides the facility to generate program interrupts at specified time intervals.

Channel-to-Channel Adapter (optional for all except Models 22 and 44) permits direct communication between two System/360 processors via their standard multiplexer or selector channels.

Shared Storage (available for Model 50 only) permits two interconnected Model 50 Processors to share their main storage units, while increasing the effective core cycle time by 0.5 microsecond.

COMPATIBILITY FEATURES: Certain models of the System/360 can be equipped with extra-cost compatibility features or "emulators" that enable them to execute programs written for earlier IBM computers, as listed in the table. These features are combinations of specialized hardware and software. In general, their use requires a System/360 with I/O devices equivalent to those of the system to be emulated, and with more core storage capacity and processing power. Only the more common peripheral devices (such as tape units, card readers, punches, and

IBM System/360 Models 22-195

➤ the small-scale System/3 and the larger System/370 computers by extending the System/3 upward or the System/370 downward. As it turned out, IBM did neither. The "missing link" between the System/3 and the System/370, for an 18-month period, turned out to be the System/360 Model 22.

Introduced in April 1971, the Model 22 was a reworked, bargain-priced version of the Model 30 Processor which has long been the workhorse of the System/360 line. The Model 22 Processor offered the internal performance of the Model 30, and 1.4 to 1.5 times that of the Model 25, at less than half the price of either of the earlier models. To help justify the huge price reduction, IBM restricted the input/output capabilities of the Model 22 to one multiplexer channel and only one selector channel with a maximum data rate of 170,000 bytes per second, compared to the two 333KB selector channels available with the Model 30 Processor. Thus, IBM ruled out the use of the popular 2314 and 2319 Disk Drives on the Model 22 and limited users of the system to the older, smaller, and slower 2311 Disk Drives.

No emulation or compatibility features were provided with the Model 22. The lack of emulation, the unavailability of the 2314/2319 Disk Drives and other newer peripheral devices, and the restricted main memory capacities of 24K and 32K bytes were designed to dissuade most Model 25 and 30 users from switching to a Model 22 to reduce their equipment costs.

Model 25, announced in January 1968, spurred System/360 sales by offering performance only slightly below that of the Model 30 at a substantially reduced price (although it later was outclassed in price/performance by the Model 22). The Model 25 maintained complete program compatibility with the larger general-purpose processors and filled a performance gap that previously existed between the Models 20 and 30, an area where several competitors were enjoying some success. The Model 25 also introduced new hardware features that were to reappear in later systems in the IBM product line. A 16K-byte writeable control storage was provided to hold microprograms that enable the Model 25 to execute programs in the standard System/360 mode, in the Model 20 mode, or in 1400 Series emulator mode. Integrated input-output attachments were also included in the Model 25 to directly connect a 1403 Printer, 2540 Card Read Punch, 1052 Printer Keyboard, and up to four 2314 Disk Storage Drives. As a result, only one I/O channel (either a multiplexer or a selector) could be installed on the system.

Model 44, announced in August 1965, was specifically oriented toward medium-scale scientific computing, data acquisition, and process control — areas in which the earlier System/360 models had turned out to be overpriced. Model 44 was designed to deliver high computational speeds on fixed-point and (optionally) floating-point binary arithmetic applications that did not require ➤

printers) can be emulated, and exact compatibility may not be maintained in the execution of time-dependent programs or the handling of error conditions. Despite their limitations, these compatibility features have been found to be quite effective and are in widespread, everyday use.

INPUT/OUTPUT CONTROL

I/O CHANNELS: A multiplexer channel, which can accommodate a number of simultaneous low-speed I/O operations, is standard in Models 22, 30, 40, and 50 and optional in all other models. Selector channels, which can handle one I/O operation at a time, can be used with all models except Model 44. The table lists the maximum number of selector channels and multiplexer subchannels each processor can accommodate.

Models 85 and 195 can also utilize the 2880 Block Multiplexer Channels, introduced in February 1970. Each of these channels provides a single data path that can be shared by up to 64 high-speed peripheral devices which transfer data alternately in burst-mode fashion. While the channel is interleaving blocks of data to and from various devices, it can also control non-data-transfer functions on other devices. A maximum of 12 or 13 block multiplexer channels can be used in a Model 85 or 195 system, respectively.

CONFIGURATION RULES: In general, each multiplexer or selector channel can accommodate up to eight peripheral control units. Most System/360 peripheral devices can be connected to either a multiplexer or selector channel. Exceptions are the data communications controllers and character readers, most of which require a multiplexer channel, and the high-speed mass storage units, which require a selector channel.

The Model 25 CPU, unlike the larger models, offers low-cost "integrated attachment" features that enable a 2540 Card Read Punch, a 1403 Printer (Model 2, 7, or N1), up to four 2311 Disk Storage Drives, and a variety of communications devices to be connected directly to the CPU without their normal control units. Other I/O devices can be connected to a Model 25 CPU via a single channel (either multiplexer or selector) and the usual control units.

SIMULTANEOUS I/O OPERATIONS: Concurrently with computing, a System/360 can control a maximum of one high-speed I/O operation per selector channel and one low-speed I/O operation per multiplexer subchannel. Alternatively, the multiplexer channel can operate in the "burst" mode and handle a single high-speed operation.

I/O INTERFERENCE: Selector channel operations generally require only one core storage cycle for each unit of I/O data read or written, so the interference they impose is quite low. (The "unit" size ranges from 1 byte per cycle in Model 22 to 8 bytes in Models 65 and above). The control of multiplexer channel operations in the smaller System/360 models, however, can impose substantial demands upon the processors.

MASS STORAGE

2301 DRUM STORAGE: Provides high-speed random-access data storage for Models 65 and above. Stores up to 4.09 million bytes in 200 addressable tracks with a maximum data capacity of 20,843 bytes each. Record lengths are variable. Average access time is 8.6 milliseconds, and data transfer rate is 1,200,000 bytes/sec. Four bits at a time are transferred between the 2301 and the associated ➤

IBM System/360 Models 22-195

➤ the input/output power and decimal processing capabilities of the general-purpose models. The Model 44 Processor included a built-in disk storage drive that accommodated a removable single-disk cartridge and held the specialized software which Model 44 required. The Model 44 provided higher computational speeds than Model 50 at a substantially lower cost, making it a "best buy" among IBM computers for many scientific users. IBM reduced the purchase (but not the rental) prices of the then six-year-old Model 44 Processor by 25 percent in January 1971, thus encouraging outright purchase of the systems.

Model 67, introduced in April 1965, was designed specifically for large-scale time-sharing applications. The Model 67 Processor was essentially a Model 65 equipped with additional hardware features to facilitate operation in "time-slicing" fashion: a virtual addressing capability that permits dynamic storage allocation, an 8-register associative memory that provided rapid translation from virtual to physical addresses, a high-resolution interval timer, and a group of specialized instructions to control these facilities. IBM thus made its first attempt at implementing a virtual storage environment in the System/360 family, although the company encountered serious problems and delays in developing the Model 67 hardware and the associated Time-Sharing System (TSS) software.

Model 85, announced in January 1968, extended the System/360 family upward by providing roughly three times the internal processing power of Model 75, while maintaining full compatibility. The Model 85 introduced IBM's first attempt at implementing a small, fast buffer memory integrated into the central processor unit, often called a "cache." The Model 85 featured an 80-nanosecond buffer memory that held 16K, 24K, or 32K bytes and greatly reduced the effective main storage access time. The cache was not addressable by a program and was completely "transparent" to the program. The concept was successful and became a key hardware element of the System/360 Model 195 and the System/370 Models 155 through 195. (In fact, the System 370 Model 165 offers nearly the same performance as the Model 85 at a far lower price.)

Model 195 was added to the System/360 family in July 1968 and provided IBM with a product in the "super-computer" arena. It superseded the earlier System/360 Models 91 and 95, which were considered developmental models and were built in very limited quantities. The Model 195 was billed as a full-fledged member of the System/360 family and is program-compatible with the smaller general-purpose models. Its internal processing power ranges from about 1.5 to 3 times that of the Model 85, depending upon the application. Like the Model 85, it utilizes a buffer memory, which in Model 195 has a 54-nanosecond cycle and a 32K-byte capacity. Other throughput-boosting features include an instruction stack, ➤

➤ **2820 Storage Control**, which can accommodate up to four 2301 Drums.

2302 DISK STORAGE: Provides large-capacity random-access storage for Models 30, 40, 50, 65, 67, and 75. Uses comb-type access mechanisms and non-interchangeable disks. Records can be variable-length, with a maximum length of 4984 bytes. Model 3 has two independent access mechanisms and stores up to 112.8 million bytes. Model 4 has four access mechanisms and stores up to 225.6 million bytes. In both models, average head movement time is 165 milliseconds, average rotational delay is 17 milliseconds, and data transfer rate is 156,000 bytes/sec. Requires a 2841 Storage Control, which can accommodate up to eight 2302 access mechanisms. The 2302 has been largely superseded in IBM's product line by the 2314 Direct Access Storage Facility, which uses interchangeable disk packs.

2303 DRUM STORAGE: Provides moderately fast random-access storage for Models 40, 50, 65, and above. Stores up to 3.91 million bytes in 800 addressable tracks with a maximum data capacity of 4892 bytes each. Record lengths are variable. Average access time is 8.6 milliseconds, and data transfer rate is 303,800 bytes/sec. Requires a 2841 Storage Control, which can accommodate up to two 2303 Drums.

2305 FIXED-HEAD STORAGE: Provides very fast access to moderate quantities of information. Usable only with Models 85 and 195. Each drive unit contains 6 non-removable disks with 12 recording surfaces. A fixed read/write head serves each track. One or two 2305 drive units can be connected to a 2835 Storage Control. A Two-Channel Switch can optionally be added to the 2835.

The 2305 Model 1 stores up to 5.4 million bytes of data. Each of the 384 addressable tracks can hold up to 14,136 bytes. Average access time is 2.5 milliseconds, and data transfer rate is 3.0 million bytes per second.

The 2305 Model 2 stores up to 11.2 million bytes of data. Each of the 768 addressable tracks can hold up to 14,660 bytes. Average access time is 5.0 milliseconds, and data transfer rate is 1.5 million bytes per second.

Two standard features help the 2305 take advantage of the capabilities of the Block Multiplexer Channels in the System/360 Models 85 and 195 and in the newer System/370 processors. Rotational Position Sensing lets the drive unit disconnect from the channel during most of the rotational delay period, leaving the channel free for other operations. Multiple Requesting permits queuing of multiple requests for access to data stored on a 2305 drive; after each request is logged, the channel disconnects until the desired record position is reached and the channel is free.

2311 DISK STORAGE DRIVE, MODEL 1: Provides interchangeable disk pack storage for Models 22 thru 195. Each 1316 Disk Pack has 6 disks, weighs 10 pounds, and can hold up to 7.25 million bytes of data. One read/write head serves each of the 10 recording surfaces. Up to 36,250 bytes (10 tracks) can be read or written at each position of the comb-type access mechanism. Average head movement time is 75 milliseconds, average rotational delay is 12.5 milliseconds, and data transfer rate is 156,000 bytes/sec. Record lengths are variable.

Up to four 2311 Drives can be connected directly to a Model 25 Processing Unit equipped with an Integrated 2311 Attachment. All other processors require a 2841 Storage Control, which can handle up to eight 2311 Drives. ➤

IBM System/360 Models 22-195

▷ operand stacks, and extensive overlapping of operations in the instruction unit and six execution units. Emphasis is placed upon floating-point arithmetic speeds; a floating-point addition takes only 108 nanoseconds.

HARDWARE FEATURES

All of the System/360 processors (Models 22 through 195) share a number of significant characteristics. Reflecting their "all-purpose" design philosophy, they have a large, complex instruction repertoire. They can perform fixed-point arithmetic in either fixed-length binary or variable-length decimal modes, and floating-point arithmetic on operands of two or three different sizes. In addition, they can perform radix conversions, code translations, and conversions between the packed (2 digits per byte) and unpacked (1 digit per byte) data formats. They have a comprehensive interrupt system that enables them to respond to a variety of special conditions, both internal and external. They have sixteen 32-bit general registers that can serve as accumulators, index registers, or base address registers, as well as four 64-bit floating-point registers. And finally, they use a base-plus-displacement addressing scheme that permits direct addressing of up to 16 million bytes of core storage.

The circuitry used in the initial System/360 models was IBM's Solid Logic Technology (SLT), a "hybrid" approach that represented a reasonable state-of-the-art compromise between discrete components and monolithic integrated circuits. Since then, IBM has progressed to increasingly high circuit densities; the Monolithic Systems Technology (MST) logic used in Model 195 packs approximately 53,000 circuit components per square inch. Conventional magnetic core main memories are used in all of the System/360 processors, and all except Model 75 make use of read-only control memories.

SOFTWARE

Accompanying the announcement of a family of radically new computer systems was IBM's commitment to provide an automatic, integrated operating system. The original goal was that the family of compatible hardware systems would function under various levels of the Operating System/360 (OS/360) or the rudimentary Special Support Systems Programs. But it didn't work out that way. Nearly ten years later, there are five major levels of support for the general-purpose processors, of which the most widely-used are the Disk Operating System (DOS) and the two larger versions of OS/360. In addition, specially-tailored software was provided to support the scientific Model 44 and the time-sharing Model 67. At each level, there are supervisory programs, language translators, service programs, and utility routines.

Because of the System/360's complex internal architecture, programming the system was unusually difficult. The ▷

▶ **2314 DIRECT ACCESS STORAGE FACILITY, MODEL 1:** Provides large-capacity random-access storage for Models 30, 40, 50, 65, and above. Consists of a controller and eight independent modules, each capable of storing up to 29.17 million bytes in a removable 2316 Disk Pack. A ninth drive module is provided as a spare. Total on-line storage capacity is 233.4 million bytes. Each module has a comb-type access mechanism that can read or write up to 145,880 bytes (20 tracks) at each of its 200 positions. Average head movement time is 75 milliseconds, average rotational delay is 12.5 milliseconds, and data transfer rate is 312,000 bytes/sec. Record lengths are variable. The 2314 Direct Access Storage Facility, Model 1, is no longer available from IBM.

2314 DIRECT ACCESS STORAGE FACILITY, SERIES A: A modular, faster-access version of the 2314 Model 1 described above. Usable with Models 30, 40, 50, 65, and above. Each unit is composed of a 2314 Storage Control, Model A1, and from 1 to 9 disk storage modules (8 active plus 1 spare). Each module stores up to 29.17 million bytes in a removable 2316 Disk Pack. Each module has a comb-type access mechanism that can read or write up to 145,880 bytes (20 tracks) in each of its 200 positions. Average head movement time is 60 milliseconds, average rotational delay is 12.5 milliseconds, and data transfer rate is 312,000 bytes/sec. Record lengths are variable.

2314/2319 DIRECT ACCESS STORAGE SUBSYSTEM: Provides the same storage capacity and performance as the 2314 Series A units, described above, at much lower prices. A 2314/2319 subsystem consists of a 2314 Model B1 Storage Control and from one to three 2319 Disk Storage units. Each 2319 unit contains three functionally independent disk drives, and each drive holds a removable 2316 Disk Pack that stores up to 29.17 million bytes. As in the 2314 Series A drives, average head movement time is 60 milliseconds, average rotational delay is 12.5 milliseconds, and data transfer rate is 312,000 bytes/sec. The 2314/2319 subsystem is usable with Models 30, 40, 50, 65, and above. It was introduced in December 1970, with customer shipments beginning in April 1971.

2321 DATA CELL DRIVE: Provides extremely large-capacity storage, at the expense of slow access times and mechanical complexity, for Models 30, 40, 50, 65, and above. Stores up to 400 million bytes of data on magnetic strips 13 inches long by 2.25 inches wide. The 2321 Drive accommodates up to 10 removable Data Cells, and each Data Cell contains 200 strips. Each strip has 100 tracks capable of holding up to 2000 bytes each. Record lengths are variable. Average access times for selection of a particular strip range from 175 to 600 milliseconds. Once the strip is on the read/write drum, average rotational delay is 25 milliseconds. Data transfer rate is 55,000 bytes/sec. Up to eight 2321 Drives can be connected to a 2841 Storage Control.

2361 CORE STORAGE (LCS): Serves as an extension of the main core storage for a System/360 Model 50, 65, or 75. Cycle time is 8 microseconds, and read access time is 3 microseconds. Addressing is a direct extension of the system's main storage. Storage protection is a standard feature. Model 1 stores 1,048,576 bytes, and Model 2 stores 2,097,152 bytes. Up to two Model 1 units or four Model 2 units can be used in a system. When two or four units are used, addresses can be two-way interleaved for faster effective access time. The 2361 units can be shared by two processors.

3330 DISK STORAGE: Provides fairly rapid access to extremely large quantities of data stored in interchangeable ▶

IBM System/360 Models 22-195

▷ development of this huge array of software, thus, was a formidable task that severely taxed even IBM's vast resources. There were many slippages in the software delivery schedule, and a number of the promised facilities were "decommitted," never to be heard of again. The goal of compatibility throughout the software product line had to be abandoned when it became evident that the large OS/360 simply could not be extended downward throughout the entire family of processors. Possibly one of the most serious weaknesses of the entire System/360 product line thus developed — the relatively high degree of incompatibility between the small-to-medium-scale Disk Operating System and the large-scale Operating System/360. Nevertheless, operating systems for all of the processor models were eventually delivered, and many of the initial limitations were removed with the continuing release of enhancements — although there have been well-founded complaints about the complexity and inefficient performance of many of the key software facilities.

Users also found that programming the System/360 at the assembly-language level is unusually difficult and error-prone. For this reason, coupled with the other increasingly evident advantages of higher-level languages, most System/360 users did the bulk of their programming in COBOL, FORTRAN, PL/I, or RPG. PL/I, a multi-purpose language suitable for both business and scientific applications, has received only limited user acceptance despite strong IBM emphasis upon its many claimed virtues. The majority of System/360 users have elected to continue to use FORTRAN for their scientific work and COBOL and/or RPG for their business applications.

With the announcement of the System/370 in 1970, and, in particular, the virtual storage versions of System/370 software in 1972, it became obvious that IBM would shift its programming resources to the development and support of software for the System/370. DOS users were notified of the "functional stabilization" of DOS for the System/360 with the distribution of Release 26 in December 1971. Final enhancements to System/360 DOS included support for the 3270 Display System, the 3735 Programmable Buffered Terminal, and the 2596 Card Read/Punch. Release 27 and all subsequent releases of DOS will be available for the System/370 only. In addition, System/360 users of DOS were put on notice that by April 1973, all Class A support for DOS and its components would cease, and that IBM would reserve the right to charge regular hourly rates for systems engineering support of System/360 DOS. Thus, System/360 DOS users who managed to resist IBM's earlier efforts to upgrade them into OS/360 must now migrate into the System/370 to be eligible for enhancement and continued free support of DOS.

All three versions of OS/360 for the System/360 were "functionally stabilized" in August 1972—PCP (the Primary Control Program) at Release 19, and MFT (Multi-programming With a Fixed Number of Tasks) and MVT ▷

▶ 3336 Disk Packs. Usable only with Models 85 and 195. Each 3336 Disk Storage Module contains two independent disk drives, each mounted in a powered drawer for operating convenience. Up to four 3336 modules (eight drives) can be connected to a 3830 Storage Control, which occupies one control unit position on a Block Multiplexer Channel. Rotational Position Sensing and Multiple Requesting, as described under the 2305 above, are standard features.

Each 3336 Disk Pack contains 12 disks. Nineteen disk surfaces are used for data recording, and a 20th surface holds prerecorded data that controls seeking, position sensing, and clocking. Each disk pack holds up to 100,018,000 bytes of data, so an 8-drive 3336 subsystem can store over 800 million bytes on-line. Each data track has a capacity of 13,030 bytes, and each of the 404 data cylinders holds up to 247,570 bytes (19 tracks). Head movement time ranges from 10 to 55 milliseconds and averages 30 for random accesses. Average rotational delay is 8.4 milliseconds, and data transfer rate is 806,000 bytes per second. The 3336 was announced along with the IBM System/370 in June 1970. Deliveries began in August 1971.

INPUT/OUTPUT UNITS

2401 MAGNETIC TAPE UNIT, MODELS 1—6: These units have the following basic characteristics:

Model 1: 800 bpi; 30,000 bytes/sec at 37.5 in/sec.
 Model 2: 800 bpi; 60,000 bytes/sec at 75.0 in/sec.
 Model 3: 800 bpi; 90,000 bytes/sec at 112.5 in/sec.
 Model 4: 1600 bpi; 60,000 bytes/sec at 37.5 in/sec.
 Model 5: 1600 bpi; 120,000 bytes/sec at 75.0 in/sec.
 Model 6: 1600 bpi; 180,000 bytes/sec at 112.5 in/sec.

All models use standard 1/2-inch, 9-track tape, have 0.6-inch inter-record gaps, and can read backward as well as forward. Models 1, 2, and 3 can alternatively be equipped with a 7-track head, making them compatible with the second-generation IBM 729 tape units. Models 4, 5, and 6 can be equipped with a Dual Density feature that enables them to operate at 800 bpi as well as 1600 bpi.

All models perform read-after-write checking of the data they record. Models 1, 2, and 3 perform vertical, longitudinal, and diagonal parity checks. Models 4, 5 and 6 perform vertical parity checking only, but can automatically correct single-track read errors without rereading.

Up to eight 2401 units can be connected to a 2803 (single-channel) or 2804 (dual-channel) Tape Control of the appropriate model. These tape drives are usable with all processor models. With a System/360 Model 25, however, only 2401 Models 1, 2, or 4, connected to the selector channel via a 2803 Control, can be used. The 2401 Model 6 drives cannot be used in a Model 22 system.

The 2816 Switching Unit permits individual tape drives to be switched between two or more control units. One 2816 can accommodate a maximum of eight 2401 or 2420 Magnetic Tape Units and four 2803 Tape Controls.

2401 MAGNETIC TAPE UNIT, MODEL 8: Introduced in November 1970, this model is designed specifically for 7-track tape users; 9-track capability is not available. Standard 1/2-inch tape is read and written at 200, 556, or 800 bpi, with associated data transfer rates of 15,000, 41,700, or 60,000 characters/second. Up to eight 2401 Model 8 drives can be connected to a 2803 Model 3 (single-channel) or 2804 Model 3 (dual-channel) Tape ▶

IBM System/360 Models 22-195

▷ (Multiprogramming With a Variable Number of Tasks) with Release 21. Support for most of the recently announced and forthcoming peripheral devices will clearly be limited to the virtual storage operating systems for the System/370. At this writing, System/360 users of OS/360 still have Class A support, which includes central programming support and free on-site field maintenance. IBM has not yet announced a date for the end of free support of Release 21, but it is not likely to continue beyond 1974.

COMPATIBILITY

Within the System/360 family, IBM achieved a high degree of data and program compatibility at the hardware level. Among the general-purpose models, any two systems equipped with equivalent storage, features, and peripheral devices can execute the same programs and produce the same results (provided only that the programs are valid ones and do not depend on any fixed relationships between internal processing and input/output times). The degree of compatibility between the specialized Models 44 and 67 and the rest of the family is not as high, but the incompatibilities that exist are clearly defined and reasonably easy to overcome.

Unfortunately, the high degree of hardware compatibility was not fully maintained in the System/360 software. The several levels of each programming language are generally upward-compatible, but there are numerous incompatibilities between the various operating systems. Three of them, BOS, TOS, and DOS, had a common origin and are therefore generally compatible. But a user who wanted to move up from any of these to the top-level Operating System/360 had, at the very least, to recompile all his programs and change all the "job control cards" that give the operating system its instructions—and the latter task can be a formidable one.

IBM's newer System/370 product line features a high degree of program and data compatibility with the System/360. Nearly all of the new hardware facilities of the System/370 represent extensions, rather than modifications, of the System/360 hardware. As a result, most programs written for a System/360 can be executed on an equivalent or larger System/370 configuration with few, if any, changes.

The System/360 architecture is totally different from that of earlier IBM computers. To bridge the compatibility gap and obviate the need for reprogramming, IBM provided a broad array of compatibility features or "emulators" that enable various models of the System/360 to execute machine-language programs written for various second-generation IBM computers (see table). Intended mainly as "crutches" that would let former users of the IBM 1400 and 7000 Series machines spread out their reprogramming tasks over a period of time, the emulators worked so well that most users who adopted them have never gotten

▶ Control on System/360 Models 22 through 195. The Data Conversion Feature is standard on these tape controls, but the 2816 Switching Unit cannot be used.

2415 MAGNETIC TAPE UNIT AND CONTROL: Consists of 2, 4, or 6 tape drives and an integral controller. Usable with Models 20, 22, 25, 30, 40, 50, 65, 67, and 75. All 6 models of the 2415 use standard 1/2-inch, 9-track tape, have 0.6-inch inter-record gaps, and can read backward as well as forward. Optional features permit reading and writing of 7-track tape by all models, and of 800-bpi tape by the 1600-bpi models. The following models are available:

Model 1: 2 drives; 800 bpi; 15,000 bytes/sec.
 Model 2: 4 drives; 800 bpi; 15,000 bytes/sec.
 Model 3: 6 drives; 800 bpi; 15,000 bytes/sec.
 Model 4: 2 drives; 1600 bpi; 30,000 bytes/sec.
 Model 5: 4 drives; 1600 bpi; 30,000 bytes/sec.
 Model 6: 6 drives; 1600 bpi; 30,000 bytes/sec.

2420 MAGNETIC TAPE UNIT: A high-performance tape drive with automatic threading and a single-capstan vacuum drive. Uses standard 1/2-inch, 9-track tape, recorded at 1600 bpi. Model 5 transfers 160,000 bytes/sec and Model 7 transfers 320,000 bytes/sec. Up to 8 drives can be connected to a 2803 Tape Control. Model 7 can be used only with System/360 Models 50 and above, while Model 5 can be used with System/360 Models 30 and above.

3410/3411 MAGNETIC TAPE SUBSYSTEM: These compact, low-cost tape units, designed primarily to bring magnetic tape capabilities to the small-scale IBM System/3 Model 10, are also available for use with System/360 Models 22, 25, 30, 40, and 50. The 3410 is a tape unit only, while the 3411 contains both a tape unit and the subsystem control unit. The compact, waist-high cabinets are cable-connected to one another at the front corners, making it possible to place them side by side or at any angle up to 90 degrees to one another. The 3410 and 3411 are available in three models, whose principal characteristics are as follows:

	Model 1	Model 2	Model 3
Tape speed, inches/sec	12.5	25	50
Recording density, bpi	1600	1600/800*	1600/800*
Date rate, bytes/sec:			
At 1600 bpi			
(phase-encoded)	20,000	40,000	80,000
At 800 bpi (NRZI)	Not avail.	20,000	40,000*
Inter-block gap, inches	0.6	0.6	0.6
Rewind time, minutes/2400' reel	3	3	2

*Requires Dual Density feature.

All three models use half-inch tape recorded in the standard IBM 9-track formats. On a System/360 or a System/370, a 3411 Model 1 Magnetic Tape Unit and Control can accommodate up to three additional 3410 Model 1 Magnetic Tape Units for a maximum subsystem capacity of four tape drives. A 3411 Model 2 can control up to five additional 3410 Model 2 units, and a 3411 Model 3 can control up to five additional 3411 Model 3 units. Models cannot be intermixed within a subsystem. Every 3410 and 3411 tape unit must be equipped with either the Single Density (1600 bpi) or Dual Density (1600 or 800 bpi) feature; the Dual Density capability is not available for the Model 1 units. A System/360/370 Attachment is required on the 3411 Control Unit.

IBM System/360 Models 22-195

➤ around to reprogramming. As a result, they are still "locked in" to the second-generation languages and are using their System/360 hardware at considerably less than peak efficiency, while continuing to pay for the optional features and additional core storage required for emulation.

WHITHER THE SYSTEM/360 USER?

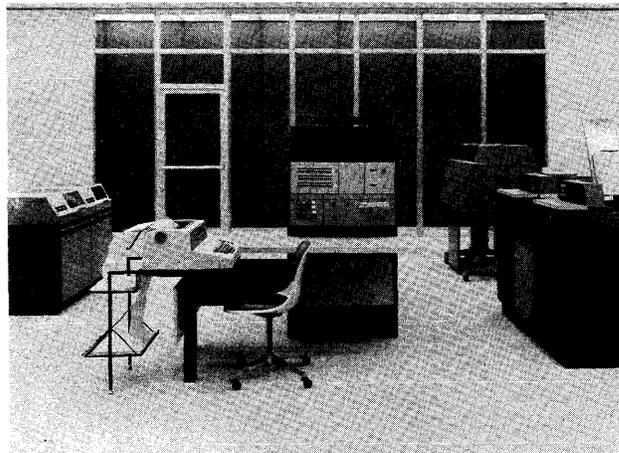
Throughout the active marketing life of the System/360, and more intensively since the introduction of the System/370, IBM's migration strategies have successfully translated users' requirements for additional main memory and increased software capabilities into the need to upgrade to larger, more expensive computer systems. A Model 40 user, for example, whose memory requirements exceeded the IBM-established limit of 256K bytes was forced to upgrade to a Model 50 Processor. Similar memory restrictions throughout the lower end of the System/360 product line supported IBM's marketing efforts to upgrade its customers into larger systems, even though the need for additional main memory was not necessarily accompanied by requirements for the additional processing power of the larger systems. With the announcement of the System/370, the main memory limitations of the System/360 processors continued to supply incentive for System/360 users to migrate into the System/370 product line, where memory allocations for comparable processor models are more generous.

Systems software supplied with the System/360 also played a role in IBM marketing campaigns. Multi-programming capabilities and more advanced operating system facilities beyond those supported in DOS were made available only under OS/360, which in turn required even more memory. Word got around, however, of the enormity of the conversion from DOS to OS/360, and many users elected to stay with DOS. IBM's announcement of the cessation of enhancement and free support for System/360 DOS put these users on notice that they will have to move at least "sideways" into the newer System/370 product line in order to continue to utilize fully supported IBM systems software.

With the stabilization of all versions of OS/360 and the threat of eventual loss of free support for that operating system, users of larger System/360's will feel more and more compelled to move in IBM's "direction of the future," to the virtual storage operating systems and processors of the System/370 family.

Concurrently with the end of further development of System/360 software, IBM has introduced a succession of new and more attractive peripheral products which are earmarked for System/370 users only. A partial list follows:

- The 3330 Disk Storage unit (available only for the System/360 Models 85 and 195), which provides over ➤



A disk-oriented System/360 Model 25 configuration.

➤ Features of the 3410/3411 subsystem include single-capstan drive, linear rewind, simplified tape threading, and a push-pull quick-release latch. As in the high-performance IBM 3803/3420 subsystem, the tape units are connected to the control unit in radial rather than series fashion to facilitate maintenance. Only digital signals are transmitted across the interface to reduce the sensitivity to noise. Programming support for the 3410/3411 subsystem is provided under OS (MFT and MVT), DOS, and TOS. Programs written for the IBM 2400 Series tape drives can use the 3410/3411 units with little or no charge. Deliveries of 3410/3411 subsystems began in January 1973.

3420 MAGNETIC TAPE UNIT: An economical, high-performance tape drive introduced in November 1970. Incorporates the features of the earlier 2420 drives together with several worthwhile improvements. Air bearings and a single-capstan drive are used to reduce tape wear, and the tape's oxide surface touches only the read/write head and tape cleaner. Wraparound cartridge loading and automatic tape threading are standard features, and a new automatic reel latch makes it unnecessary for the operator to lock the tape reel in place. Additional tachometers control the reel motors' speeds for smoother winding. Read access times are considerably faster than those of the corresponding 2420 drives. A new "radial interface" connects each tape drive directly to the control unit, making it possible to switch individual drives off-line without cable changing. Principal characteristics of the three models are as follows:

Model 3: 75 inches/sec; 120,000 bytes/sec at 1600 bpi.
Model 5: 125 inches/sec; 200,000 bytes/sec at 1600 bpi.
Model 7: 200 inches/sec; 320,000 bytes/sec at 1600 bpi.

Operation in the basic 9-track mode, at 1600 bpi only, requires use of the Single-Density Feature on both the tape drives and the control unit. The Dual-Density Feature permits 9-track operation at either 1600 bpi (phase-encoded) or 800 bpi (NRZI). The 7-Track Feature (for Models 3 and 5 only) permits 7-track operation in NRZI mode at either 556 or 800 bpi. One of these three optional features is required on every tape drive and every control unit.

The 3420 tape drives can be used with Models 30, 40, 50, 65, and above, except that the 3420 Model 7 cannot be connected to a Model 30 or 40 CPU. The 3420 Model 5 can be used in a Model 22 system, but only at the 800 and 556 ➤

IBM System/360 Models 22-195

- three times the storage capacity of the 2314 and 2319 disk drives at a far lower cost per byte stored.
- The double-density 3330 Disk Storage Unit (Model 11), which doubled the capacity of the original 3330 for about 40% more cost.
 - The 3340 Direct Access Storage Facility, which stores data at a density nearly eight times that of the 2314 at a much lower cost per byte stored.
 - The 3420 Magnetic Tape Unit, Models 4, 6, and 8, which record data at 6250 bits per inch on standard 1/2-inch tape and transfer data at up to 1,250,000 bytes per second.
 - The 3504 and 3505 Card Readers, which perform at speeds of either 800 or 1200 cards per minute and offer several attractive new features.
 - The 3525 Card Punch, which shares a micro-programmed control unit with the 3505 Card Reader and punches at speeds of 100, 200, or 300 cards per minute.
 - The 3704 and 3705 Communications Controllers, which operate with the System/360 only in the 2701/2/3 Emulation Mode and are therefore unable to deliver the full benefits of "front end" communications processors.
 - The 5425 Multi-Function Card Unit, which combines the functions of a 96-column card reader/punch, collator, and interpreter, and is functionally similar to the 5424 MFCU used with the System/3.
 - The 3203 Printer, an improved version of the 1403 Model N1 Printer with rated printing speeds of 600 or 1200 lines per minute.
 - The 3881 Optical Mark Reader, Model 1, which operates on-line to a System/370 at a speed of 4000 to 6000 documents per hour.
 - The 3886 Optical Character Reader, Model 1, which operates on-line to a System/370 and serves as a slower but less expensive alternative to the IBM 1287 Optical Reader.
 - The 3890 Document Processor, a high-speed MICR unit that can operate at twice the throughput rate of the IBM 1419 Magnetic Character Reader.
 - The 3540 Diskette Input/Output Unit, an on-line device that can read the "floppy disks" recorded by IBM's new 3740 Data Entry System directly into a System/370 computer—but not a System/360.

Just to prove that most IBM users can take a non-too-subtle hint, industry sources have documented a steady attrition of the IBM customer base of rented 360/30's, ➤

➤ bpi densities. Up to eight 3420 drives can be connected to a 3803 Tape Control. The control unit uses monolithic circuits and features "microdiagnostic programs" which facilitate maintenance. Optional Tape Switching Features permit two, three, or four control units to jointly access up to 16 tape drives. The Two-Channel Switch Feature permits a control unit to be accessed via either of two I/O channels. Deliveries of the 9-track 3420 Tape Units began in October 1971, with the 7-track units following in early 1972.

2495 TAPE CARTRIDGE READER: Reads 16-millimeter sprocketed magnetic tape cartridges recorded by an IBM 50 Magnetic Data Inscrber or Magnetic Tape Selectric Typewriter (MTST). Recording density is 20 bpi, and rated speed is 900 bytes/sec. Feed hopper holds up to 12 cartridges, and successive cartridges are loaded and read automatically at the rate of about 1 cartridge per minute. Usable with Models 22, 25, 30, 40, 50, 65, 67, and 75.

1442 CARD READ PUNCH, MODEL N1: Reads 80-column cards at 400 cpm and punches them at 160 columns per second. Usable with Models 22 thru 195.

1442 CARD PUNCH MODEL N2: Punches 80-column cards in column-by-column fashion at 160 columns per second (or 91 cpm when all 80 columns are punched). Usable with Models 22 thru 75.

2501 CARD READER: Reads 80-column cards serially by column at either 600 cpm (Model B1) or 1000 cpm (Model B2). Usable with Models 22 thru 195.

2520 CARD READ PUNCH, MODEL B1: Can read cards in column-by-column fashion, punch cards in row-by-row fashion, or read and punch simultaneously, at the rate of 500 cpm. Usable with Models 22 thru 195.

2520 CARD PUNCH, MODELS B2 AND B3: Punches 80-column cards in row-by-row fashion at either 500 cpm (Model B2) or 300 cpm (Model B3). Usable with Models 22 thru 75.

2540 CARD READ PUNCH: Consists of two functionally separate units, a 1000-cpm reader and a 300-cpm punch, in a single cabinet. Usable with Models 22 thru 195. The 2821 Control Unit, optional with Model 25 and required with all the larger processors, provides fully buffered card reading and punching.

2560 MULTI-FUNCTION CARD MACHINE (MFCM): Combines the functions of a card reader-punch, collator, and interpreter in one unit. Reads at 500 cpm, punches at 160 columns per second, and (with Card Print feature) prints on the cards at 140 print positions per second. Usable only with the System/360 Model 20 or with a Model 25 Processor equipped with the Model 20 Mode feature.

2596 CARD READ PUNCH: Equips a System/360 or System/370 computer to read, punch, and interpret IBM's new 96-column "minicards". Thus, the 2596 makes it possible to interchange 96-column card data between an IBM System/3 and the larger IBM computers. The 2596 has essentially the same mechanical specifications as the 5424 Model A2 Multi-Function Card Unit for the System/3 Model 10. It consists of two 2000-card input hoppers, a read station, a punch station, an optional print station, and four 600-card stackers. On the 2596 (unlike the 5424 MFCU), one input hopper and two stackers are used for reading and the other input hopper and two stackers are used for punching. The 2596 cannot read and punch the same card during a single pass. Rated speeds are 500 cpm ➤

IBM System/360 Models 22-195

▷ 40's, 50's, and 65's. It is estimated that at the end of 1973, just over 1,000 *rented* System/360 Models 30 through 65 remained on the IBM rolls. Most users of rented systems have given in to the IBM migration policies and the blandishments of the IBM marketing representatives.

WILL THE REAL SYSTEM/360 PLEASE STAND UP?

System/360 users, however, have been provided with a number of ways to extend the economic life of their systems, and enough System/360's remain installed to support the conclusion that they will be around for some years to come. Most of these systems have either been purchased by their users or leased from third-party leasing companies, whose "bargain" prices can provide price/performance ratios far more attractive than the IBM leasing provisions for the System/360. In addition, to help increase the power and extend the lives of the System/360 computers, leasing firms, independent memory and peripheral suppliers, and software vendors can supply a number of enhancements which IBM offers only on the System/370. For example, it is possible to acquire a Model 30 equipped with the ability to execute the additional System/370 instructions, greatly increased main memory capacity (up to half a million bytes is offered for the Model 30 by one supplier), a complement of lower-cost plug-compatible peripheral devices, an accelerator to boost its internal performance, and an operating system that offers many of the important features of OS/360.

Probably the most widely used method of enhancing System/360 price/performance is the use of add-on main memory. Core and/or semiconductor memory is available for most System/360 processors that can provide at least twice the maximum IBM storage capacities for these systems. In addition, plug-compatible replacements for IBM disk storage units and tape drives can in many cases offer improved performance at a lower cost. A number of front-end communications processors are on the market that will interface with the System/360 and provide capabilities equivalent to those of the IBM 3704 and 3705 Communications Controllers as used with the System/370.

Numerous software packages are available that provide services neglected by or not efficiently performed by equivalent IBM software. These include spooling programs, library cataloging facilities, and data base management packages. Indeed, the resourceful System/360 user can substitute an entire new operating system for DOS and get additional multiprogramming and enhanced system throughput without incurring the additional expense of acquiring more expensive hardware.

WHAT HAPPENS TO THE OLD SECURITY BLANKET?

Computer users who are considering the possibility of purchasing a used System/360 or renting one from a ▷

▶ for reading and 120 cpm for punching. The optional Card Print feature permits interpretive printing of the data being punched. The printing is in a fixed format of three 32-character lines across the top of each card. Printing is performed simultaneously with punching at 120 cpm. The 2596 contains a built-in control unit and connects to a multiplexer or selector channel of a System/360 Model 22 through 195. Programming support is provided under both OS and DOS, but in both cases the 2596 is supported only as an auxiliary input/output device for Assembler-language programs. Thus, 80-column card equipment still is required for systems input/output functions.

1017 PAPER TAPE READER: Reads 5- to 8-track punched tape at up to 120 char/sec. Model 1 reads strips of tape, while Model 2 includes supply and take-up reels. Usable with System/360 Models 22, 25, 30, 40, and 50. Requires 2826 Paper Tape Control.

1018 PAPER TAPE PUNCH: Punches 5- to 8-track tape at up to 120 char/sec. Usable with Models 22, 25, 30, 40, and 50. Requires 2826 Paper Tape Control.

2671 PAPER TAPE READER: Reads 5- to 8-track punched tape in strip form at up to 1000 char/sec. Optional facilities permit center-roll or reel feeding and reel take-up, at 500 char/sec. or more. Usable with Models 22, 25, 30, 40, 44, 50, and 67. Requires 2822 Paper Tape Reader Control.

1403 PRINTER: Provides high-quality printed output by means of a horizontal chain or train mechanism. Standard character set contains 48 characters, expandable to up to 240 with the optional Universal Character Set feature (not available for Model 7). Standard skipping speed is 33 inches per second; dual-speed carriage in Models 2, 3, and N1 permits speed of 75 inches per second on skips of more than 8 lines. Model N1 has a motor-operated acoustical cover to reduce the noise level.

Models 2, 7, and N1 of the 1403 Printer are usable with System/360 Models 22 thru 195; Model 3 is usable with Models 30 thru 75. The 2821 Control Unit is optional with Model 25 and required with all the larger processors. Characteristics of the four models are as follows:

Model 2: 600 lpm; 132 print positions.
Model 3: 1100 lpm; 132 print positions.
Model 7: 600 lpm; 120 print positions.
Model N1: 1100 lpm; 132 print positions.

1404 PRINTER: Performs the same printing functions on continuous forms as the 1403 Printer, and can also print on individual 51- to 80-column cards, fed one or two at a time. Peak speed is 800 cards per minute when printing 1 line per card on cards fed in "two-up" fashion. Usable only with Models 25, 30, 40, and 50; requires 2821 Control Unit, Model 4.

1443 PRINTER, MODEL N1: Uses a horizontally oscillating typebar. Rated speed is 240 lpm with standard 52-character set. Standard model has 120 print positions, with 24 more positions available as an option. Selective Character Set Feature permits the use of other interchangeable typebars; speeds range from 200 lpm for 63-character set to 600 lpm for 13-character set. Usable with Models 22 thru 195; controller is built into the 1443.

1445 PRINTER, MODEL N1: Provides printed output in either conventional or MICR form, using a horizontally oscillating typebar. Standard character set includes the 14 Font E-13B MICR symbols; rated speed is 190 lpm. Has ▶

IBM System/360 Models 22-195

➤ third-party leasing company will have some justifiable anxieties about the availability of IBM systems software and maintenance.

If the system is a standard configuration and has not been altered by installation of non-IBM memory or enhancement features, the user can simply get a standard IBM maintenance contract. In the case of systems that have been modified or include non-IBM equipment, the solution can be a little more complex. Prospective users of non-IBM memory, for example, should make sure that the memory supplier has obtained IBM approval for the alterations and additions required for his product, and that the equipment will be eligible for continued IBM maintenance. Basically, IBM limits its obligations to servicing and maintaining the unaltered portions of the processing unit in a best-efforts manner. However, IBM, in its latest policy statement on multiple-supplier systems, has indicated that it will charge regular Field Engineering hourly rates to inspect and certify equipment that has been altered or refurbished by another company. In addition, IBM reserves the right to make additional charges in the case of equipment which has been significantly altered and, as a result, incurs a higher number of equipment failures. Since standard IBM maintenance agreements make it clear that IBM can hold the user liable for any damage to its equipment, users should demand that their independent memory supplier assume all liability for any damage to the IBM equipment and should negotiate agreements to protect themselves against any excessive IBM maintenance charges.

IBM system software and supporting documentation is supplied by IBM for IBM computer systems regardless of their ownership. In addition, operating-system and other free IBM software is often traded along with its parent hardware configuration. Some lessors will tailor an operating system to meet lessee specifications and will provide technical support until the system is operational. Practices vary, and much depends upon what services the potential lessee demands.

Datapro queried a number of System/360 users about their plans for their currently installed System/360's. Not unexpectedly, most System/360 users who were still renting from IBM were planning to upgrade their installations to System/370's, although two users were planning to switch to other mainframe vendors. The upgrades usually coincided with the implementation of new applications, and the upgrading users cited the additional processing power, larger and faster direct-access storage devices, and improved software capabilities offered by IBM only with the System/370 as important factors in their decisions.

Almost all of the interviewed users who were planning to keep their System/360's for another year or longer had either purchased the systems or had acquired them through third-party leasing arrangements that had not yet ➤

➤ 113 print positions. Usable only with Models 25 and 30; controller is built into the 1445.

3211 PRINTER: Provides high-speed printed output by means of an endless "train" of 432 type characters that move horizontally in front of the printer hammers. The standard character set, consisting of 48 graphic characters in 9 identical arrays, yields a single-spaced printing speed of 2000 lines per minute. Speeds of up to 2500 lpm can be obtained with smaller character sets, and a 120-character Text Printing Set yields an expected printing speed of 906 lpm. The Universal Character Set feature is standard, permitting the use of character arrangements which are optimized for specific applications. Up to 254 different graphic characters can be used on a print train, and the train cartridges can be interchanged by an operator.

The 3211 Printer has a standard 132-character line that can be expanded to 150 print positions. Horizontal spacing is 10 characters/inch, and vertical spacing is 6 or 8 lines/inch. A 180-position forms control buffer, loadable from main storage, defines vertical format control operations, eliminating the need for a carriage control tape. Skipping speed is at least 30 inches per second, with acceleration to a maximum speed of 90 inches per second after 7 lines have passed. Forms ranging from 3.5 to 18.75 inches in width and from 3 to 24 inches in length can be handled. A powered forms stacker automatically compensates for the height of the paper stack, and a self-positioning platen adjusts itself to the thickness of the forms being used.

Announced along with the IBM System/370 in June 1970, the 3211 Printer and its associated 3811 Control Unit can also be used with System/360 Models 30, 40, 50, 65, 67, 75, 85, 91, and 195. Deliveries began in December 1971.

1255 MAGNETIC CHARACTER READER: Reads and sorts MICR-encoded documents from 5.75 to 8.875 inches in length, 2.5 to 4.25 inches in width, and 0.003 to 0.007 inch in thickness. Three models are available. Model 1 reads up to 500 six-inch documents per minute, while Models 2 and 3 read up to 750 six-inch documents per minute. Models 1 and 2 have six horizontal stackers arranged in a single vertical bay and require one and one-half sort passes for each digit position. Model 3 has twelve horizontal stackers in two vertical bays. All three models can also be used for off-line sorting. The optional Self-Checking Number, 51-Column Card Sorting, and Dash Symbol Transmission features are available for all three models. Model 3 can also be equipped with the High-Order Zero and Blank Selection feature, which reduces off-line sorting times. One 1255 can be connected to a Model 22, 25, 30, 40, or 50 via a System/360/370 Adapter.

1259 MAGNETIC CHARACTER READER, MODEL 2: Reads and sorts MICR-encoded documents at up to 600 per minute. Has 11 pockets. Usable only with Models 22, 25, 30, and 40. Also usable for off-line sorting.

1412 MAGNETIC CHARACTER READER: Reads and sorts MICR-encoded documents at up to 950 per minute. Has 13 pockets. Usable only with Models 22, 25, and 30. Also usable for off-line sorting.

1419 MAGNETIC CHARACTER READER: Reads and sorts MICR-encoded documents at up to 1600 per minute. Has 13 pockets. Usable only with Models 22, 25, 30, 40, 50, and 65. Also usable for off line sorting.

1231 OPTICAL MARK PAGE READER, MODEL N1: Reads pencil-marked data from 8.5-by-11-inch sheets at a ➤

IBM System/360 Models 22-195

▷ expired. The majority of these systems were equipped with additional main memory, and many were operating with peripheral devices obtained from independent suppliers. Their users responded that the System/360's were still doing journeyman work, and some intended to keep them installed indefinitely so long as attractive prices were available.

Several votes of confidence were registered for the System/360 Model 65 as a computer that can still be highly cost-effective, particularly in applications of the "number-crunching" type. One user reported that his installation is now converting its Model 65's from DOS to OS/360. Not unexpectedly, the prospect of the loss of free support for OS/360 is viewed with displeasure by many users of large System/360's, who see the promised economies in memory utilization eaten away by the high residence requirements of the virtual storage versions of OS. A user of a purchased Model 67, running under non-IBM software, felt that the performance of his system was adequate to enable him to "sit out" the System/370 generation entirely, with the expectation that IBM's next product announcement will prove more interesting to sophisticated users to whom the concept of a virtual machine has long been a reality.

During the next few years, System/360 computers will be available at steadily lower prices as the leasing companies scheme to keep them installed in spite of IBM's continuing efforts to displace them with System/370's. Computer users who are not inclined to be dazzled by the latest technological advances, and who are willing to do some serious shopping around, can expect to get a lot of processing power for their EDP dollar from these work-horse Sytem/360 computers.

It is clear that the System/360 will continue to be used for years to come. And the System/360 hardware and software concepts will live on even longer, in the System/370 and in competitive computer lines as well. Thus, despite its imperfections, the System/360 must be judged a major technical and marketing triumph. It kept IBM firmly entrenched in its accustomed position of overwhelming market dominance throughout the 1960's, despite the aggressive efforts of numerous competitors. And it has had a profound influence on much of the computer equipment and software currently on the market. □

▶ maximum speed of 2000 sheets per hour. Each sheet can have up to 1000 mark positions printed on a side. Usable only with Models 22, 25, 30, 40, and 50.

1285 OPTICAL READER: Reads the digits 0 thru 9 and the letters C, N, S, T, X, and Z from journal tapes printed by adding machines, cash registers, etc. Printing must be in IBM 1428 font or NCR Optical Font. Up to 32 characters can be read from each line. Speed varies with line spacing, number of characters per line, and other factors. Usable only with Models 22, 25, 30, 40, and 50.

1287 OPTICAL READER: Optically reads printed characters into a System/360 at speeds ranging from less than 100

to about 665 documents per minute, depending on document size, number of characters per document, etc. Can also be equipped to read pencil-marked data and/or the handprinted digits 0 thru 9 and letters C, S, T, X, and Z; shapes and sizes of handprinted characters must conform with specified rules. Usable only with Models 22, 25, 30, 40, and 50. Four models of the 1287 are available:

Model 1: Reads multiple lines of numeric data from individual paper or card documents up to 5.91 by 9 inches in size.

Model 2: can read data from continuous journal tapes as well as individual paper or card documents.

Model 3: Same as Model 1, with added capability of reading the alphanumeric USASCSOCR Size A font.

Model 4: Same as Model 2, with added capability of reading the alphanumeric USASCSOCR Size A font.

1288 OPTICAL PAGE READER: Reads alphanumeric data printed in the USASCSOCR Size A font from page-size documents up to 9 by 14 inches. Can also be equipped to read pencil-marked data and/or the hand-printed digits 0 thru 9 and letters C, S, T, X, and Z. Speed varies with document size, number of characters and fields to be read, etc. (e.g., 14 documents per minute for 8.5-by-11-inch documents with 65 characters on each of 50 lines). Usable only with Models 22, 25, 30, 40, and 50.

1418 OPTICAL CHARACTER READER: Reads numeric digits 0 thru 9 and three special symbols from paper or card documents. Speed ranges from about 300 to 420 documents per minute, depending upon document length. Reads one or two lines of characters printed by an IBM electric typewriter, 1403 Printer, 407 Accounting Machine, or credit card imprinter. Models 1 and 3 have three stackers; Model 2 has 13 stackers and can also be used for document sorting. Usable only with System/360 Models 22, 25, 30, 40, and 50.

1428 ALPHANUMERIC OPTICAL READER: Reads upper-case letters, digits, and seven special symbols from paper or card documents. Peak speed is 400 documents per minute. Reads one or two lines of characters printed in 1428 font by a 1403 Printer or certain electric typewriters. Models 1 and 3 have three stackers; Model 2 has 13 stackers and can also be used for document sorting. Usable only with System/360 Models 22, 25, 30, 40, and 50.

1052 PRINTER-KEYBOARD: Provides keyboard input and character-at-a-time printed output for all System/360 processors (a similar console printer-keyboard is standard in Model 44). Uses IBM Selectric printing mechanism with a rated speed of 15.5 char/sec.

2150 CONSOLE: Serves as a free-standing console for Models 50 and above. Can include a 1052 Printer-Keyboard and one or two remote operator control panels which duplicate the operator controls on one or two System/360 processors.

2250 DISPLAY UNIT: Displays data in both alphanumeric and graphic (line drawing) form in a 12-by-12-inch area on the face of a CRT. Displays up to 52 lines of 74 characters each, and provides format flexibility to position characters, points, and vector end-points anywhere on a 1024-by-1024-position grid. Optional light pen allows program detection of specific displayed points or characters indicated by the operator. Optional keyboard permits entry ▶

IBM System/360 Models 22-195

► of alphanumeric data. Model 1 has a built-in control unit and 4K or 8K bytes of buffer storage. Model 3 requires a 2840 Display control, which has a 32K buffer and can control up to four display units. Both models are designed for direct connection to System/360 Models 22 thru 195.

2260 DISPLAY STATION: Displays alphanumeric data in a 4-by-9-inch area on the face of a CRT. Can display from 240 to 960 characters at a time, depending upon the model of the associated 2848 Display Control. Character set includes 64 symbols. Optional alphanumeric or numeric keyboard permits data entry. Usable with System/360 Models 22 thru 195; can be connected either directly, via an I/O channel, or remotely, via leased communication lines. The 2848 Display Control can accommodate up to 24 display stations, which may be located up to 2,000 feet from the control.

2285 DISPLAY COPIER: Produces photographic copies of images displayed on a 2250 Display Unit. Consists of an internal CRT, lens system, paper transport, and developer. Picture area is 7.25 inches square, on 8.5-by-11-inch paper. Each copy takes 15 to 38 seconds to produce, depending on exposure. Connects to a 2250 equipped with appropriate special features.

COMMUNICATION CONTROL

2701 DATA ADAPTER UNIT: Enables System/360 Models 22 thru 195 to communicate, via appropriate transmission facilities, with a broad range of terminal equipment or with other computers. Accommodates up to four half-duplex start/stop lines with speeds of up to 600 bps; or up to four half-duplex synchronous lines (only two of which can operate simultaneously) with speeds of up to 230,400 bps; or up to four parallel data acquisition devices with word widths of 16 to 48 bits. The 2701 is highly modular; various adapters and special features equip it to transmit via switched or leased telephone lines, the TWX network, Western Union Type A, B, C, D, E, or F Channels, common-carrier broadband services, and privately-owned communication facilities.

2702 TRANSMISSION CONTROL: Permits connection of multiple low-speed terminals to a System/360 Model 30, 40, 44, 50, 65, 67, or 75. Handles a maximum of 31 half-duplex lines with speeds of up to 200 bps, or up to 15 half-duplex lines with speeds of up to 600 bps, all of which can operate simultaneously. Transmission is serial by bit, in start/stop mode. Various adapters and special features equip the 2702 to transmit via switched or leased telephone lines, the TWX network, Western Union Type A, B, C, D, or E Channels, and suitable private communication facilities.

2703 TRANSMISSION CONTROL: Permits connection of multiple low-speed and medium-speed terminals to a System/360 Model 22, 30, 40, 50, 65, or above. Operates in half-duplex fashion, in either start/stop or synchronous mode. In start/stop mode, a 2703 handles up to 176 lines with speeds of up to 180 bps or up to 72 lines with speeds of up to 600 bps. In synchronous mode, a 2703 handles up to 48 lines with speeds of up to 2400 bps, in either EBCDIC or USASCII code; if 6-bit Transcode is used, the maximum number of lines is 32. Various adapters and special features equip the 2703 to transmit via switched or leased telephone lines, the TWX network, Western Union Type A, B, C, D, E, or F Channels, and suitable private communication facilities.

2711 LINE ADAPTER UNIT: Accommodates up to 32 IBM Line Adapters, which permit an associated 2702 or

2703 Transmission Control or Model 25 Processing Unit to communicate with various IBM Terminals over leased telephone lines or privately-owned facilities. Common-carrier data sets are not required when IBM Line Adapters are used.

3704 AND 3705 COMMUNICATIONS CONTROLLERS: On March 1, 1972, IBM unveiled its long-awaited programmable communications processor for the System/360 and System/370 computers. Designed as IBM's evolutionary replacement for the hard-wired 2701, 2702, and 2703 transmission controls, the 3705 Communications Controller is a mini-computer-based front-end processor that can have from 16K to 240K bytes of core storage and control up to 352 communications lines. The 3705 is available in 20 models with varying storage sizes and line capacities, as listed in the price list. Customer shipments began in July 1972.

On February 1, 1973, IBM announced a smaller version of the 3705 called the 3704. The 3704 is available in only four models with a main memory capacity of 16K to 64K bytes. It can accommodate a maximum of 32 lines, just one-half the capacity of the basic 3705 configuration. The 3704 uses the same software as the 3705, ensuring upward compatibility for economic expansion of a small network into a large one. Customer shipments began in May 1973.

When connected to a System/370 computer, a 370X can use either the Network Control Program (NCP) or the 2701/2/3 Emulation Program. When the NCP is used, a 370X functions as a true "front-end" communications processor and relieves the central processor of many routine tasks such as line control, character and block checking, character buffering, polling, and error recovery.

But when the 3705 is connected to a System/360 computer, it can function *only* in the 2701/2/3 Emulation mode. Thus, the 3705 will not enable System/360 users to obtain the increased central processor throughput that represents the biggest single benefit of front-end communications processing.

The 3705 consists of a Basic Module and up to three Expansion Modules. The Basic Module houses the Central Control Unit and Control Panel. Also contained in these modules are the core storage, Channel Adapters, Communications Scanners, Line Interface Bases, and Line Sets required to accommodate up to 352 communication lines. Configuration rules for the 3705, which are quite complex, are summarized in the price list. The maximum number of lines that can be connected is a function of the 3705 model, the line speeds and types, and the mode of operation. In the 2701/2/3 Emulation mode, a maximum of 255 lines can be controlled. Line speeds can range from 45.5 to 50,000 bits per second. In the NCP mode, data is transferred between the 3705 and the host computer via a single subchannel interface—a significant difference from the 2701/2/3 controls, which require separate multiplexer subchannel for each communications line.

Software support for the 3705 in the Network Control Program mode will be provided only under System/370 OS/TCAM (MFT or MVT). For the System/360, it is supported under OS, DOS, and TSO/TCAM, but only in a 2701/2/3 Emulation mode. A set of System Support Programs for the 3705 run on the host CPU under either OS or DOS; these include an Assembler, Load Program, Dump Program, and Generation Procedures for the 2701/2/3

IBM System/360 Models 22-195

- Emulation Program and for the NCP. Support for the 2701/2/3 Emulation mode was provided with first customer delivery of the 3705 in July 1972.

Configuration rules for the 3704 follow the same general pattern as for the 3705, but are much more straightforward.

Detailed reports on both the 3704 and 3705 are contained in the Peripherals section; see Reports 70D-491-31 and 70D-491-32.

1800 DATA ACQUISITION AND CONTROL SYSTEM: Modular facilities enable this system to handle a broad range of process control and data acquisition requirements, including both analog and digital inputs and outputs. The 1801 and 1802 Processor-Controllers are the central components. They offer from 4096 to 65,536 18-bit words of core storage with a cycle time of 2, 2.25, or 4 microseconds. Three data channels and 12 interrupt levels are standard, expandable to a maximum of 15 channels and 24 interrupt levels. Disk storage, magnetic tape, punched card, paper tape, printer, plotter, and typewriter I/O units are available. An 1800 system can be directly connected to a Model 22, 25, 30, 40, 44, or 50 I/O channel. Alternatively, an 1827 Data Control Unit permits direct connection of various 1800 Series process I/O units and features to a Model 22, 25, 30, 40, 44, or 50 without the need for an 1801 or 1802 Processor-Controller.

7770 AUDIO RESPONSE UNIT: Provides audio responses, in recorded human-voice form, to digital inquiries from pushbutton telephones or other inquiry-type terminals. Usable with Models 22, 25, 30, 40, 50, 65, 75, and 85. Handles a maximum of 48 lines, any or all of which can be active simultaneously. Has a 32-word basic vocabulary, expandable in 16-word increments to a maximum of 128 words. Receives inquiry messages and forwards them to the processing unit, which processes each message and composes an appropriate reply. The 7770 then converts the reply into a sequence of English words which are read from its magnetic drum and transmitted to the inquirer.

7772 AUDIO RESPONSE UNIT: Provides audio responses, in recorded human-voice form, to digital inquiries from pushbutton telephones or other inquiry-type terminals. Usable with Models 22, 25, 30, 40, 50, 65, 75, and 85. Handles a maximum of 8 lines. Vocabulary size is limited only by the user's requirements. The vocabulary is stored on an external random-access storage device (e.g., a 2311 Disk Drive) in digitally-coded voice form. Thus, the 7772 controls fewer lines but accommodates a larger, more flexible vocabulary than the 7770.

SOFTWARE

OPERATING SYSTEMS: Software support for System/360 Models 22 through 195 is provided at five major levels. Their designations, in order of increasing power and complexity, are: Basic Programming Support (BPS), Basic Operating System (BOS), Tape Operating System (TOS), Disk Operating System (DOS), and Operating System/360 (OS). Both DOS and OS, the most widely used operating systems, have been "stabilized" for System/360 users (meaning that no further improvements are planned), and free central support for the systems software for the System/360 is gradually being withdrawn.

In addition, specialized software support is provided for the scientific Model 44 and the time-sharing Model 67 systems.

The facilities provided at each of these support levels are summarized in the following paragraphs.

BASIC PROGRAMMING SUPPORT: BPS consists of a group of independent programs designed to support minimum card and tape configurations with 8K or 16K bytes of core storage.

For card systems, the available programs include a Basic Assembler, FORTRAN compiler, RPG translator, I/O subroutines, loaders, dump routines, and data transcription routines.

Magnetic tape systems can use all the above BPS facilities plus a macro-type Input/Output Control System (IOCS), a tape sort/merge program, an Autotest routine that facilitates debugging of object programs, control routines for optical and magnetic character readers, and a series of "control programs." The control programs perform basic supervisory functions such as job transition control, scheduling and control of I/O operations, handling of interrupts and error conditions, control of program overlays, etc. Most BPS programs can be used in 8K systems, but the FORTRAN compiler and Autotest require 16K.

BASIC OPERATING SYSTEM: BOS is a disk-resident operating system for installations with at least 8K bytes of core storage and one 2311 Disk Storage Drive. Like the other System/360 operating systems, BOS consists of both "control programs" and "processing programs."

The BOS control programs are designed to supervise stacked-job processing of one program at a time. A Supervisor routine resides in core storage (a minimum of 4K bytes) and handles I/O scheduling, interrupts, operator communication, etc. A Job Control routine, which the Supervisor calls into core storage between jobs, handles job-to-job transitions and I/O device assignments. A group of Librarian programs create and maintain disk libraries of core-image programs, relocatable program sections, and/or macro routines. A Linkage Editor routine combines program sections from the relocatable library and/or a system input unit and prepares them for execution. An Input/Output Control System (IOCS) provides macros to handle the following types of I/O: consecutive processing, indexed sequential, direct access method (for randomly organized disk files), and telecommunications in either the STR or BSC mode.

"Processing programs," in IBM terminology, include language translators, service and utility programs, and the user's own application programs. The only language translators available under BOS are Assembler and RPG. Service routines include a disk sort/merge program, Autotest (which requires 16K), and a group of card, disk, and tape utilities.

TAPE OPERATING SYSTEM: TOS is a tape-resident operating system designed for System/360 installations that have at least 16K bytes of core storage but lack disk storage facilities. It is less efficient and far less widely used than the Disk Operating System described below. Four magnetic tape drives are required for full utilization of the TOS facilities.

The TOS control programs coordinate stacked-job processing in a 16K system or limited multiprogramming in a system with at least 32K bytes. A Supervisor routine resides in core storage (occupying from 6K to 10K bytes) and handles I/O scheduling, interrupts, operator communication, and control of multiprogrammed operations in a ►

IBM System/360 Models 22-195

▶ maximum of three partitions: one "background" partition in which programs are executed sequentially in stacked-job fashion, and two "foreground" partitions in which each program must be explicitly initiated by the operator. A Job Control routine handles job-to-job transitions and I/O device assignments. A Librarian routine creates and maintains a core image library, a relocatable library, and a source statement library on magnetic tape. A Linkage Editor routine combines program sections from the relocatable library and/or a system input unit and prepares them for execution. An IOCS provides macros to handle sequential I/O operations; no data communications or random-access I/O control facilities are available under TOS.

TOS provides language translators for Assembler, RPG, COBOL, FORTRAN, and PL/I. (A 32K system is recommended for COBOL.) Service routines include a tape sort/merge program, Autotest, and utility programs.

DISK OPERATING SYSTEM: DOS is a disk-oriented operating system for installations with at least 16K bytes of core storage and one 2311 Disk Storage Drive or 2314 Direct Access Storage Facility. It is the most widely used of the System/360 operating systems. Multiprogramming, data communications, MICR processing, or COBOL compilation under DOS requires a minimum of 24K bytes. The Storage Protection feature is also required for multiprogramming.

DOS can control concurrent processing of one "background" program and one or two "foreground" programs, each in a fixed "partition" or program area within core storage. Partition sizes can be varied by the operator, in 2K increments. Programs in the background partition are executed sequentially, in automatic stacked-job fashion. Programs in one or both of the foreground partitions can be loaded and executed in similar stacked-job fashion if sufficient storage and I/O facilities are available; if not, each foreground program must be explicitly initiated by the operator. Foreground programs always have priority over the background program.

The principal DOS control program is the Supervisor, which handles I/O scheduling, interrupts, operator communications, multiprogramming control, etc. It occupies from 6K to over 12K bytes of core storage, depending upon the facilities required in a specific installation. A Job Control routine handles job-to-job transitions and I/O device assignments. A Librarian routine creates and maintains a core image library, a relocatable library, a source statement library, and optional private libraries, all on disk files. A Linkage Editor routine combines program sections from the relocatable libraries and/or a system input unit and prepares them for execution.

Several Input/Output Control Systems are available with DOS, providing macros to handle the following types of I/O: consecutive processing of tape or disk files, indexed sequential (for either random or sequential processing of sequentially organized disk files), direct access method (for randomly organized disk files), MICR or OCR input, and telecommunications. DOS provides two distinct types of communications support: the Basic Telecommunications Access Method (BTAM), which performs basic line and message control functions, and the Queued Telecommunications Access Method (QTAM), which extends the techniques of IBM's logical Input/Output Control Systems into the communications environment. BTAM requires a minimum of 24K bytes of core storage, while QTAM requires at least 65K bytes.

POWER is a DOS enhancement that adds input reader and output writer capabilities similar to those of the full Oper-

ating System/360. By overlapping I/O data transcriptions with disk-oriented processing, POWER can increase the throughput of some DOS installations by up to 40 percent. Operating in a dedicated foreground partition, POWER transcribes all input data from card readers and other low-speed input devices to disk storage and transcribes all output data from disk storage to printers and other output devices. Thus, the user's application programs can operate on a disk-to-disk basis for maximum processing efficiency. No recording of the application programs is required. POWER can support one or two independent batch job streams and up to 26 I/O devices. A special version called POWER RJE supports remote job entry through up to five batch terminals.

DOS provides language translators for Assembler, RPG, COBOL, FORTRAN, and PL/I. Service routines include both disk and tape sort/merge programs, Autotest, and a wide variety of utility programs.

Compatibility Support routines (CS/30 for Models 25 and 30, and CS/40 for Model 40) enable System/360 processors equipped with the appropriate compatibility features to run IBM 1401/1440/1460 programs under DOS control. In a multiprogramming environment, the 1400 Series programs can be executed in any one partition that is initiated in batch mode. Moreover, they can be intermixed with regular System/360-mode programs in stacked-job fashion.

OPERATING SYSTEM/360: OS/360 is the most comprehensive and complex general-purpose operating system available for System/360 users. It is designed for installations with disk and/or drum storage facilities and at least 65K bytes of core storage. The system is highly modular and offers a broad range of control program options, language translators, data management techniques, and service programs. In large, multiprogrammed systems, the OS/360 resident control programs alone may require as much as 200K bytes of core storage.

Three basic versions of OS/360 are now available: Primary Control Program (PCP), Multiprogramming with a Fixed Number of Tasks (MFT), and Multiprogramming with a Variable Number of Tasks (MVT). They differ primarily in the amount and flexibility of the multiprogramming operations they can control. In all three versions, the control programs perform the supervisory functions of job scheduling, resource allocation, I/O scheduling, interrupt control, error handling, and storage and retrieval of data.

The Primary Control Program (PCP), delivered in April 1966, controls the sequential execution of one program at a time and permits inclusion of all the OS/360 facilities that are appropriate for this type of operation. No multiprogramming is possible under PCP.

Multiprogramming with a Fixed Number of Tasks (MFT) was delivered in December 1966, and a greatly improved "Version II" became available in July 1968. MFT provides all the facilities of PCP, plus the ability to control multiprogramming in up to 15 fixed partitions as small as 8K bytes in size. Automatic job-to-job transitions can be effected in any or all of the partitions. MFT requires at least 131K bytes of core storage. Partition sizes can be varied by the operator.

Multiprogramming with a Variable Number of Tasks (MVT), delivered in October 1967, controls multiprogrammed operation of up to 15 simultaneous tasks. The amount of storage allocated to each task and the number of tasks being processed at any time are dynamically variable. Core storage is allocated in 2048-byte blocks, and the

IBM System/360 Models 22-195

► blocks assigned to a given program may be non-contiguous. Task dispatching is performed on the basis of priorities, which may be altered by the tasks themselves during execution. A "roll-out/roll-in" facility enables one task to obtain more core storage by displacing one or more lower-priority tasks. MVT requires at least 262K bytes of core storage.

Model 65 Multiprocessing is an extension of MVT that enables two Model 65 Processing Units to share a single core storage facility and operate under the control of a single supervisory program.

I/O control under OS/360 is accomplished by an extensive array of "data management" facilities. OS/360, like earlier IBM input/output control systems, supports two fundamental types of data access techniques: basic and queued. The queued access technique deals with individual logical records, provides automatic blocking and buffering facilities, and applies only to sequentially organized files. The basic access technique deals with blocks of I/O data rather than logical records, provides direct programmer control of blocking, buffering, and I/O device functions, and is usable with both direct (random) and sequential file organizations.

IBM defines the combination of a specific data access technique and a specific type of file organization as a "data access method." Nine data access methods are available under OS/360: Basic Sequential Access Method (BSAM), Queued Sequential Access Method (QSAM), Basic Indexed Sequential Access Method (BISAM), Queued Indexed Sequential Access Method (QISAM), Basic Direct Access Method (BDAM), Basic Partitioned Access Method (BPAM), Telecommunications Access Method (TCAM), Basic Telecommunications Access Method (BTAM), and Queued Telecommunications Access Method (QTAM). TCAM, BTAM, and QTAM, however, are not available with the Primary Control Program.

OS/360 provides language translators for all of the System/360 programming languages: Assembler, RPG, COBOL, FORTRAN, PL/I, and ALGOL. Users of the Assembler, COBOL, or FORTRAN language, in fact, are offered a choice of two or more translators. OS/360 service routines include a sort/merge program for either tape or disk, a TESTRAN package that facilitates program debugging, a Graphic Job Processor that permits jobs to be initiated and controlled from a 2250 Display Unit, a Remote Job Entry system that permits jobs to be submitted to a System/360 from a remote communications terminal, Linkage Editors that combine separately-compiled object modules into programs in a format suitable for loading and execution, and a comprehensive package of utility routines.

The Attached Support Processor (ASP) is a related application program that works in conjunction with OS/360 to control a multiprocessing system. Under ASP, the "support processor" (Model 40 or larger) handles all support functions (such as card reading, punching, and printing) while one or two "main processors" (usually Model 50, 65, or 75) process the computational workload. The processors are interconnected by means of the Channel-to-Channel Adapter.

TSO (TIME-SHARING OPTION): This extension of OS/360 MVT, announced in November 1969, permits interactive time-sharing operations to be run concurrently with teleprocessing and batch processing on a 524K Model 50 or larger system. Up to 14 regions can be devoted to time-sharing. Programmers at remote terminals can develop, execute, store, and modify programs written in any OS/360-supported language. COBOL, FORTRAN, and As-

sembler "prompters" permit the associated compilers to be used in a conversational mode, and dynamic debugging facilities aid in program testing. TSO also offers three compilers designed specifically for use by nonprogrammers: Code and Go FORTRAN, ITF-BASIC, and ITF-PL/I. TSO uses the OS/360 Telecommunications Access Method (TCAM) to handle all remote-terminal I/O operations. TSO-supported terminals include the IBM 2741, 1050, 2260, and 2265, and the Teletype Models 33 and 35. Most of the TSO functions are provided by separately priced IBM Program Products, as listed under "Software Prices."

ITF (INTERACTIVE TERMINAL FACILITY): This separately priced IBM Program Product, announced in November 1969, permits interactive problem-solving on up to 31 terminals in either a dedicated or multiprogramming environment. The terminal users can program in either ITF-BASIC or ITF-PL/I, a subset of PL/I. Each user has access to both a common program library and a private library in which his own programs and data files are stored. ITF will support 10 to 12 terminals on either a 49K DOS system or a 65K OS/360 system. Additional core storage permits the use of up to 31 terminals, as well as concurrent batch processing. IBM 2741 and Teletype Model 33 and 35 terminals are supported.

MODEL 44 PROGRAMMING SYSTEM: This software support package is tailored for the system/360 Model 44 and the medium-scale scientific users for whom the Model 44 was designed. It consists of a Supervisor, an Assembler, a FORTRAN IV compiler, and a group of system support programs. FORTRAN and/or Assembler-language programs can be compiled and executed in a stacked-job environment, with automatic job-to-job transition, I/O control, and interrupt handling. The system requires at least 65K bytes of core storage and offers no facilities for multiprogramming or data communications.

The Model 44 FORTRAN IV language is compatible with OS/360 FORTRAN IV G and H. Programs written in the Model 44 Assembler language can be translated by the DOS, TOS, or OS/360 Assemblers if certain incompatibilities are avoided or resolved.

TIME-SHARING SYSTEM/360 (MODEL 67): TSS is a specialized operating system designed to support the time-sharing System/360 Model 67. Its purpose is to provide many simultaneous users with conversational-mode access to a large computing facility while controlling "background" processing of non-conversational batch programs. The TSS Supervisor and a group of associated service programs control the overall operation of a Model 67 system in "time-slicing" fashion, enabling multiple users at remote terminals to compile and execute programs, manipulate files, and perform other useful functions. A Command System serves as the interface between the user and the computer, providing commands that control job execution in both conversational and nonconversational modes.

TSS provides language translators for FORTRAN IV and Assembler. Both can operate in either conversational mode, in which the user can correct errors as they are detected by the translator, or batch mode. Moreover, both translators use source languages which are compatible with their OS/360 counterparts except for minor differences due to Model 67's unique facilities. A PL/I F compiler is also available.

TSS can be used in a Model 67 system with either one or two processing units and at least five 2311 Disk Drives or five modules of a 2314 Direct Access Storage Facility. At ►

IBM System/360 Models 22-195

► least 524K bytes of core storage are required in a one-processor system, and 786K bytes are recommended in a two-processor configuration.

In June 1973 IBM announced that on December 15, 1973, the support for TSS/360 would be reclassified from Class A to Class B. Class B support provides continuation of free central programming support but imposes hourly rates for Field Engineer programming services.

COBOL: IBM offers COBOL compilers only under DOS, TOS, and OS/360. DOS COBOL, TOS COBOL, and OS/360 COBOL E all use essentially the same source language, which includes many of the facilities of ANS COBOL but also has numerous incompatibilities and restrictions with respect to the standard language. OS/360 COBOL F, which requires at least 80K bytes of core storage for compilation, offers all the language facilities of COBOL E plus useful extensions such as the Sort and Report Writer facilities.

In 1968 IBM announced ANS (formerly USASI) COBOL compilers for operation under both DOS and OS. These two compilers implement the full American National Standard COBOL language as well as certain IBM extensions; the extensions are primarily in the areas of source-language debugging and mass-storage file accessing. IBM offers Language Conversion Programs to aid users in resolving the numerous detail differences between ANS COBOL and the earlier IBM COBOL languages. In October 1971, IBM withdrew support of the OS/360 COBOL F compiler in favor of ANS COBOL. The latest and most powerful versions of both the DOS and OS ANS COBOL compilers are classified as separately priced Program Products.

The ANS Subset COBOL Compiler is another IBM Program Product, for use in DOS installations with as little as 32K bytes of storage and one disk drive. (Full ANS COBOL under DOS requires at least 65K bytes.) The Subset COBOL language includes the following modules of ANS COBOL: Nucleus (Level 2), Sequential Access (Level 2), Random Access (Level 2), Library (Level 1), Table Handling (Level 2), and Segmentation (Level 1). The ANS Report Writer and Sort modules are not implemented.

FORTRAN: IBM offers FORTRAN compilers for operation under most levels of System/360 software support. With respect to the language facilities they offer, these compilers fall into two basic categories.

BPS FORTRAN, TOS FORTRAN, DOS Basic FORTRAN, and OS/360 FORTRAN E all use a source language which is essentially USASI Basic FORTRAN with a number of useful extensions (mixed-mode and double-precision arithmetic, arrays of up to three dimensions, etc.).

DOS FORTRAN IV, OS/360 FORTRAN G and H, TSS FORTRAN (for Model 67), and Model 44 FORTRAN all use a source language that encompasses and is compatible with American National Standard FORTRAN IV. Significant extensions beyond the standard language include direct-access I/O statements and arrays of up to seven dimensions. FORTRAN G (which requires 131K bytes for compilation) and FORTRAN H (which requires 262K) have essentially the same language facilities, but the H-level compiler provides improved object-program optimization.

Three other FORTRAN compilers are offered as separately priced Program Products. Code and Go FORTRAN and OS/360 FORTRAN IV (G1) are compile-and-go batch-mode compilers, respectively, that use the same language level as FORTRAN G and operate under the OS/360

Time-Sharing Option (TSO). The FORTRAN IV (H Extended) compiler operates under OS/360 and provides all the facilities of FORTRAN H plus extended-precision arithmetic, asynchronous I/O, list-directed I/O, and other extensions.

PL/I: IBM currently offers compilers for PL/I, its multi-purpose programming language, under DOS, TOS, OS/360, TSS, and ITF. PL/I includes a broad range of language facilities suitable for both business and scientific programming, enabling it to handle applications beyond the scope of either COBOL or FORTRAN. Despite its power, PL/I has not yet found widespread acceptance among users.

The OS/360 PL/I F compiler requires at least 44K bytes of core storage and handles most—but by no means all—of the language facilities defined by PL/I's co-developers, IBM and the SHARE user group. It provides facilities for handling numerous data types and arithmetic modes, dynamic storage allocation, source-language debugging, data communications, sorting, program segmentation, etc. Moreover, it accommodates six different data access modes: BSAM, QSAM, BISAM, QISAM, BDAM, and QTAM.

The DOS and TOS PL/I compilers accommodate a "Basic PL/I" language whose facilities are a proper subset of, but considerably less extensive than, those of OS/360 PL/I. Both compilers can be used in 16K-byte systems.

Several other PL/I compilers are offered as separately priced Program Products. PL/I Optimizing Compilers, available in both DOS and OS versions, offer improvements in compilation speed, object program efficiency, and language facilities. The OS PL/I Checkout Compiler is an interpretive processor for the PL/I F language that features high translation speeds and effective diagnostic and debugging capabilities; it can be used in batch mode under MFT or MVT, or in conversational mode under TSO. ITF-PL/I uses a subset of the PL/I language and is designed specifically for time-sharing operation under ITF, in either a DOS or OS environment.

BASIC: The BASIC language, which is gaining widespread popularity for problem-solving applications because of its simplicity and ease of use, is supported for time-sharing use under either ITF or TSO. The BASIC compilers are separately priced Program Products. The language features extensive matrix handling facilities and a variety of built-in mathematical functions, but arrays are limited to two dimensions.

APL: Conceived in the early 1960's by Dr. Kenneth E. Iverson of IBM, the APL language is designed to permit clear, concise expression of computational algorithms. Its facilities for handling vectors and arrays are especially powerful. The APL/360 system is a separately priced Program Product, available for time-shared operation under either DOS or OS. The system requires a minimum partition of 170K bytes and supports IBM 2740, 2741, and 1050 terminals.

ALGOL: As a reluctant concession to current ALGOL users, IBM offers a single ALGOL compiler, which operates under OS/360 on a system with at least 65K bytes of core storage. The OS/360 ALGOL language is a proper subset of ALGOL 60 that encompasses the ECMA and IFIP subsets and provides the IFIP Input/Output Procedures and other useful additions. IBM has stated that it plans no further ALGOL compiler development work and is encouraging ALGOL users to switch to PL/I. ►

IBM System/360 Models 22-195

► **REPORT PROGRAM GENERATORS:** IBM offers RPG's at all five software levels for the general-purpose System/360 models: BPS, BOS, TOS, DOS, and OS/360. While the versions for the higher-powered operating systems provide extended capabilities, a fairly high degree of upward language compatibility is preserved.

All of the System/360 RPG's use data from five types of user-prepared specification sheets to generate object programs to perform common business data processing functions. If desired, the generated programs can be executed immediately. In addition to their basic report-writing functions, RPG programs can handle various types of calculations, update files, perform table look-up operations, accept data from multiple input files, and accommodate user-coded routines to handle functions that cannot be programmed in the RPG language.

RPG II: Early in 1971, IBM announced a DOS compiler for RPG II, the principal programming language for the small-scale IBM System/3 computers. RPG II is an improved Report Program Generator language that offers the facilities of System/360 RPG plus at least 20 useful extensions. Among the extensions are the ability to define and execute closed subroutines, to use dual input/output areas, and to debug programs at the source-language level. The System/360 DOS compiler supports all the facilities of System/3 RPG II except the telecommunications and automatic program overlay functions. Thus, its availability represents a significant step toward improved compatibility between the System/3 and the larger IBM computers.

ASSEMBLERS: The Assembler language, often called BAL (Basic Assembly Language) or ALP (Assembly Language Programming), is the standard symbolic assembly language used to write machine-oriented programs for all models of the System/360. Assemblers are therefore furnished at all levels of System/360 software support. Facilities for handling macro-instructions and literals are provided at all levels except the BPS Card Assembler. Though the Assembler language is essentially the same at all the other levels, there are certain differences in the handling of literals, constants, and macros that preclude complete freedom to transfer Assembler-coded programs between the various operating systems.

DOS and OS/360 users are offered a choice of two Assemblers. The two DOS Assemblers require 10K and 44K bytes of core storage. OS/360 Assemblers E and F require a minimum of 18K and 44K bytes, respectively. In both cases, the larger version provides considerably faster assembly.

OS/360 Assembler H is a separately priced Program Product that requires at least 200K bytes. It is upward-compatible with the other System/360 assemblers and features improved assembly speed, macro language extensions, improved diagnostics, batched assemblies within a single job step, and support of the new machine instructions in the System/370 processors.

UTILITY ROUTINES: Sort/merge programs are offered at all five levels of software support for the general-purpose System/360 models. All are generalized programs which are controlled by user-supplied parameters, and all can accommodate either fixed or variable-length records. Improved sort/merge programs for both DOS and OS are offered as separately priced Program Products.

Each software level also includes an appropriate complement of data transcription, diagnostic, and other utility routines.

APPLICATION PROGRAMS: A fairly wide range of "packaged" application programs is now available for the general-purpose System/360 models. The principal programs which are currently available to System/360 users at no additional charge are listed below, together with the operating systems under which they are designed to run.

Administrative Terminal System—OS, DOS
Advanced Life Information System—DOS
Attached Support Processor System—OS
Automated Chemistry—DOS
Bill of Material Processor—BOS/DOS
Communication Control Application Program—BPS
Continuous System Modeling—OS
Coursewriter III
Decision Logic Translator—DOS
Demand Deposit Accounting—BOS
Document Processing System—OS
FLOWCHART—DOS
1400 Autocoder to COBOL Conversion Aid—OS
General-Purpose Simulation System—OS, DOS
Inventory Control—DOS
Linear Programming System—DOS
Mathematical Programming System—OS
Matrix Language—OS
Mechanism Design System; Kinematics—OS, DOS
Medical Information System Programs—DOS
Mortgage Loan—BOS
Numerical Control Processors—OS, DOS
On-Line Teller—BOS
Optimum Bond Bidding—BOS
Problem Language Analyzer—OS, DOS
Product Structure Retrieval—BOS/DOS
Program for Optical System Design/II—OS, DOS
Project Control System—DOS
Project Management System—OS
Property and Liability Information System—DOS
Remote Access Computing—BPS



The IBM 3420 Magnetic Tape Units, introduced in November 1970, provide high performance (up to 320,000 bytes per second) at far lower prices than previous IBM tape drives.

IBM System/360 Models 22-195

► Requirements Planning—DOS
Retail IMPACT (inventory management)—OS, DOS
Scientific Subroutine Package—OS
Shared Hospital Accounting System—DOS
Student Scheduling—BOS
Synchronous Transmit-Receive Access Method—OS,
DOS
Test Processor—DOS
1287 Input Conversion—DOS
Vehicle Scheduling—DOS
Wholesale IMPACT (inventory management)—BOS/
DOS/OS

In addition, more than 40 application programs for the System/360 and System/370 are now offered as separately priced Program Products. These products are listed under "Software Prices" at the end of this report, and functional descriptions of most of them can be found in Report 70E-491-21.

PRICING

On November 26, 1973, IBM announced an across-the-board price increase of approximately 2 percent on equipment rental and purchase prices and charges for maintenance, education, and Program Products. A 10 percent increase was levied for systems engineering services and field engineering hourly (per call) services. The new purchase prices and new rates for systems engineering services and hourly maintenance services became effective immediately upon announcement. The increases in equipment rentals, monthly maintenance charges, educational services, and Program Products will become effective March 1, 1974.

Users with IBM Extended-Term Plan or Fixed-Term Plan leases that were in effect before November 26, 1973, will not be affected, but any new FTP or ETP leases or extensions signed after November 26, 1973, will incorporate the 2 percent increase. Any equipment scheduled for shipment on or after March 1, 1974, will be subject to the new prices.

The new hourly rates for Field Engineering equipment and programming services outside the scope of an IBM agreement rose by \$3.00 to \$3.75 per hour. The new rates that apply to Class 1 equipment, which includes key entry and most terminal equipment, are \$28.25 per hour for service during normal IBM working hours and \$36.50 per hour for service at other times. For Class 2 equipment, which includes unit record and accounting machines and most components of the 1130, 1620, 1800, and System/3, System/7, and System/360 Model 20 systems, the new hourly rates are \$33.00 and \$43.00. For Class 3 equipment, which includes most components of the System/360 (Models 22 and above), System/370, 1400 Series, and 7000 Series systems, the new hourly rates are \$37.75 and \$49.00.

IBM attributed these November 1973 price increases to the increased costs of doing business. Only certain recently announced new products were excluded, few of which are available for the System/360.

EQUIPMENT: The following systems are representative of the types of System/360 configurations that have been widely installed and are supported by standard IBM software. Obviously, they comprise only a small sampling of the myriad configuration possibilities within the System/360 line. All necessary control units and adapters are included in the indicated prices. Prices for peripheral devices are for the standard IBM short-term lease. Users should note that much of this equipment is now available

from other sources at prices far below the IBM list prices shown here.

MODEL 25 DISK SYSTEM: Consists of 16K Model 25 Processor, two 2311 Disk Storage Drives, 2540 Card Read Punch, 1403 Model 2 Printer (600 lpm), and 1052 Printer-Keyboard. Monthly rental and purchase prices are approximately \$5,104 and \$231,870, respectively.

MODEL 30 DISK SYSTEM: Consists of 32K Model 30 processor with Decimal Arithmetic and one Selector Channel, four 2311 Disk Storage Drives, 2540 Card Read Punch, 1403 Model N1 Printer (1100 lpm), and 1052 Printer-Keyboard. Monthly rental and purchase prices are approximately \$8,844 and \$358,200, respectively.

MODEL 22 DISK SYSTEM: Same configuration as Model 30 Disk System, above, with 32K Model 22 Processor in place of Model 30. Monthly rental and purchase prices are approximately \$6,650 and \$293,000, respectively.

MODEL 40 TAPE/DISK SYSTEM: Consists of 65K Model 40 Processor with Decimal Arithmetic and two Selector Channels, two 2311 Disk Storage Drives, six 2401 Model 2 Magnetic Tape Units (60KB), 2540 Card Read Punch, 1403 Model N1 Printer, and 1052 Printer-Keyboard. Monthly rental and purchase prices are approximately \$14,209 and \$587,850, respectively.

MODEL 44 SCIENTIFIC SYSTEM: Consists of 131K Model 44 Processor with Floating-Point Arithmetic and High-Speed Registers, one Multiplexer Channel, four 2401 Model 1 Magnetic Tape Units (30KB), 1442 Model N1 Card Read Punch, and 1443 Model N1 Printer. Monthly rental and purchase prices are approximately \$11,143 and \$356,910, respectively.

MODEL 50 TAPE/DISK SYSTEM: Consists of 262K Model 50 Processor with two Selector Channels, four 2311 Disk Storage Drives, eight 2401 Model 5 Magnetic Tape Units (120KB) and dual-channel tape control, 2540 Card Read Punch, 1403 Model N1 Printer, and 1052 Printer-Keyboard. Monthly rental and purchase prices are approximately \$27,412 and \$1,140,026 respectively.

MODEL 65 TAPE/DISK SYSTEM: Consists of 524K Model 65 Processor, Multiplexer Channel, three Selector Channels, 2314 Model 1 Direct Access Storage Facility, twelve 2401 Model 6 Magnetic Tape Units (180KB) and two dual-channel tape controls, 2540 Card Read Punch, 1403 Model N1 Printer, and 1052 Printer-Keyboard. Monthly rental and purchase prices are approximately \$60,151 and \$2,422,174, respectively.

MODEL 67 TIME-SHARING SYSTEM (Single-Processor): Consists of one Model 67 Processor, 524K bytes of core storage, Multiplexer Channel, two Selector Channels, 2301 Drum Storage, 2314 Model 1 Direct Access Storage Facility, four 2401 Model 2 Magnetic Tape Units (60KB), 2540 Card Read Punch, 1403 Model N1 Printer, and 1052 Printer-Keyboard. Monthly rental and purchase prices (exclusive of the data communications and remote terminal equipment normally used in a system of this type) are approximately \$57,597 and \$2,313,330, respectively.

MODEL 75 TAPE/DISK SYSTEM: Consists of 524K Model 75 Processor and the same peripheral equipment as in the "Model 65 Tape/Disk System" above. Monthly rental and purchase prices are approximately \$70,251 and \$2,737,714, respectively. ►

IBM System/360 Models 22-195

► **MODEL 85 TAPE/DISK/DRUM SYSTEM:** Consists of 2097K Model 85 Processor, Multiplexer Channel, four Selector Channels, two 2301 Drums, 2314 Direct Access Storage Facility, twelve 2420 Model 7 Magnetic Tape Units (320KB) and two single-channel tape controls, 2540 Card Read Punch, 1403 Model N1 Printer, and 1052 Printer-Keyboard. Monthly rental and purchase prices are approximately \$141,445 and \$7,075,040, respectively.

MODEL 195 SYSTEMS: According to IBM, monthly rentals range from about \$165,000 to \$300,000, with purchase prices ranging from about \$7 to 12 million.

SOFTWARE: Most of the existing System/360 software, like all programs which were being distributed by the IBM Program Library as of June 23, 1969, is available at no additional charge. All new IBM programming announcements (except for certain modifications and improvements of existing IBM programs) are designated as either System Control Programming or Program Products.

System Control Programming provides functions which are fundamental to the operation and maintenance of a system (e.g. loading, scheduling, supervising, and data management) and is available without charge.

Program Products are related to the application of a system to user tasks (e.g., compilers, utility programs, and application programs). These are offered on an individual-charge basis, as listed under "Software Prices."

SUPPORT: IBM Systems Engineering assistance is available to System/360 users at a basic rate of \$30 per hour for Models 25 through 50 and \$37.75 per hour for Models 65 and up. (The \$37.75-per-hour rate also applies to smaller models used in environments such as full multi-

programming, time-sharing, complex telecommunications, or real-time.)

EDUCATION: IBM "Professional Courses" are now individually priced. System Features Instruction is offered to users of IBM data processing equipment at no charge. Customer Executive Seminars, Industry Seminars, and promotional sessions are still offered at no charge by IBM invitation.

CONTRACT TERMS: The standard IBM rental contract includes equipment maintenance and entitles the customer to up to 176 hours of billable time per month. Time used in excess of that amount is charged for, on all machines equipped with meters, at an extra-use rate. This rate, for most System/360 components, is 10% of the basic hourly rate (i.e., 10% of 1/176 of the monthly rental for each hour of extra use).

IBM's Fixed-Term Lease Plan, introduced on June 1, 1971, offers price reductions of 8 or 16 percent from the short-term monthly rates to users willing to sign a 12-month or 24-month contract, respectively. The Fixed-Term Leases apply to nearly all of the magnetic tape, disk, drum, and printer units and their associated control units and features, and to the Models 3704 and 3705 Communications Controllers, but not to the mainframes or other types of peripheral devices. Extra-use charges are eliminated under these leases, and up to two years of purchase option accruals are available. The user has the option to extend his lease for an indefinite number of additional 12-month or 24-month periods and for one shorter period under the same terms. Users who elect to cancel a Fixed-Term Lease (even for a model upgrade) will be assessed a penalty of 2.5 times the monthly rental on a 12-month contract or 5 times the monthly rental on a 24-month contract (or the remaining rental due, whichever is less). ■

IBM System/360 Models 22-195

EQUIPMENT PRICES

		<u>Purchase Price</u>	<u>Monthly Maint.</u>	<u>Rental (short-term lease)*</u>
PROCESSORS AND MAIN STORAGE				
2022	Processing Unit (for Model 22 systems)			
	DC; 24,576 bytes	32,600	137.00	867
	E; 32,768 bytes	44,800	147.00	1,170
2025	Processing Unit (for Model 25 systems)			
	D; 16,384 bytes	69,500	198.00	1,410
	DC; 24,576 bytes	100,000	224.00	1,980
	E; 32,768 bytes	130,000	234.00	2,530
	ED; 49, 152 bytes	177,800	244.00	3,370
2030	Processing Unit (for Model 30 systems)			
	D; 16,384 bytes	81,700	110.00	1,880
	DC; 24,576 bytes	104,000	120.00	2,400
	E; 32,768 bytes	121,800	126.00	2,830
	F; 65,536 bytes	175,800	147.00	4,110
2040	Processing Unit (for Model 40 systems)			
	E; 32,768 bytes	173,800	131.00	3,810
	F; 65,536 bytes	227,600	154.00	5,070
	G; 131,072 bytes	302,400	186.00	6,780
	GF; 196,608 bytes	376,400	275.00	9,000
	H; 262,144 bytes	478,400	296.00	10,800
2044	Processing Unit (for Model 44 systems)			
	E; 32,768 bytes	88,900	204.00	3,530
	F; 65,536 bytes	129,000	224.00	4,750
	G; 131,072 bytes	185,000	255.00	6,380
	H; 262,144 bytes	317,000	357.00	10,250
2050	Processing Unit (for Model 50 systems)			
	G; 131,072 bytes	478,800	319.00	10,500
	H; 262,144 bytes	654,800	429.00	14,550
	HG; 393,216 bytes	747,500	605.00	18,150
	I; 524,288 bytes	937,800	627.00	21,100
2065	Processing Unit (for Model 65 systems; requires 2365 Mod. 1 or 2 Processor Storage)			
	H; for 262, 144 byte system	556,000	450.00	14,300
	I; for 524,288 byte system	558,000	450.00	14,350
	IH; for 786,432 byte system	575,700	473.00	14,800
	j; for 1,048,576 byte system	577,000	473.00	14,850
	MP; for dual-processor systems	683,000	627.00	17,100
2067	Processing Unit (for Model 67 systems)			
	Mod. 1; for single-processor system without switching capabilities; requires 2365 Mod. 2 Processor Storage	703,000	578.00	18,050
	Mod. 2; for single- or dual-processor systems with switching capabilities; requires 2365 Mod. 12 Processor Storage	712,000	599.00	18,300
2075	Processing Unit (for Model 75 systems; requires 2365 Mod. 3 Processor storage)			
	H; for 262,144 byte system	863,000	743.00	23,800
	I; for 524,288 byte system	865,000	743.00	23,850
	IH; for 786,432 byte system	887,000	776.00	24,450
	J; for 1,048,576 byte system	896,600	776.00	24,650
2085	Processing Unit (for Model 85 systems; requires 2365 Mod. 5 or 2385 Processor Storage)			
	I; for 524,288 byte system	2,260,000	3,870.00	43,500
	J; for 1,048,576 byte system	2,260,000	3,870.00	43,500
	K; for 2,097,152 byte system	2,260,000	3,870.00	43,500
	L; for 4,194,304 byte system	2,260,000	3,870.00	43,500
2365	Processor Storage			
	Mod. 1; 131,072 bytes; for 2065	273,000	275.00	6,310
	Mod. 2; 262,144 bytes; for 2065 & 2067-1	393,000	418.00	9,420
	Mod. 3; 262,144 bytes; for 2075	393,000	418.00	9,420
	Mod. 5; 262,144 bytes; for 2085	442,000	438.00	9,970
	Mod. 12; 262, 144 bytes; for 2067-2	401,000	428.00	9,600
	Mod. 13; 262,144 bytes; for dual 2065's	412,000	459.00	9,820
3195	Processing Unit (for Model 195 systems)			
	J; 1,048,576 bytes	4,350,000	12,900.00	98,700
	K; 2,097,152 bytes	5,880,000	13,700.00	130,350
	L; 4,194,304 bytes	7,910,000	15,200.00	171,150
3060	System Console (required in Model 195 system)	314,000	459.00	7,340
3080	Power Units (three required in Model 195 system)	38,100	15.25	867
3085	Power Distribution Unit (required in Model 195 system)	31,400	10.00	714
3086	Coolant Distribution Unit (required in Model 195 system)	33,600	10.00	765

* Rental prices include equipment maintenance.

IBM System/360 Models 22-195

EQUIPMENT PRICES

		<u>Purchase Price</u>	<u>Monthly Maint.</u>	<u>Rental (short-term lease) *</u>
PROCESSORS AND MAIN STORAGE (cont)				
9442	208/230-volt Motor Generator Set (for Model 195)	14,500	Time & mat'ls.	Purchase only
9443	440-volt Motor Generator Set (for Model 195)	14,500	Time & mat'ls.	Purchase only
PROCESSING UNIT FEATURES AND CHANNELS				
For 2022 Processing Unit (Model 22):				
3895	External Interrupt	800	0.25	20
4427	Floating Point Arithmetic	1,910	1.50	51
4690	Integrated 1052 Attachment	2,070	10.50	56
4760	Interval Timer	1,910	2.75	51
7520	Storage Protection	5,750	1.50	153
For 2025 Processing Unit (Model 25):				
1580	Card Print Control (for 2560 MF CM)	1,180	2.50	25
3274	Direct Control	3,840	1.25	102
3895	External Interrupt	816	0.25	20
4427	Floating-Point Arithmetic	No charge	No charge	No charge
4440	IBM 1400 Series Compatibility	5,020	6.00	98
4580	Integrated Communications Attachment	13,600	16.25	272
4590	Integrated 1403 Printer Attachment	22,600	45.75	443
4595	Integrated 2540 Card Read Punch Attachment	13,800	16.25	272
4596	Integrated 2560 MF CM Punch Attachment	12,500	15.25	246
4598	Integrated 3211 Disk Storage Attachment	18,500	35.50	267
4760	Interval Timer	1,910	2.75	51
5100	Multiple Character Set Adapter	734	3.50	15
5248	Multiplexer Channel (not with 6960)	7,530	10.00	147
6960	Selector Channel (not with 5248)	7,530	10.00	147
7520	Storage Protection	5,750	1.50	153
7600	System/360 Model 20 Mode	5,020	6.00	98
For 2030 Processing Unit (Model 30):				
1850	Channel-to-Channel Adapter	9,640	3.75	239
1990	1401/1440/1460 Compatibility; Column Binary	1,430	1.75	31
3237	Decimal Arithmetic	989	0.75	25
3274	Direct Control	3,840	1.25	106
3895	External Interrupt	816	0.25	20
4427	Floating-Point Arithmetic	1,910	1.50	53
4456	1401/1440/1460 Compatibility—Basic	9,110	8.00	239
4463	1402/1403 Compatibility Attachment	1,910	1.50	42
4464	1442/1443 Compatibility Attachment	1,910	1.50	42
4465	Console Inquiry Station Attachment	765	0.75	15
4466	Disk Storage Compatibility Attachment	2,390	0.75	53
4467	Magnetic Tape Compatibility Attachment (Multiplexer)	2,640	0.75	53
4468	Magnetic Tape Compatibility Attachment (Selector)	2,390	0.75	53
4760	Interval Timer	1,910	2.75	53
5856	Programmed Mode Switch	816	0.50	20
6960	Selector Channel—First	8,200	17.25	227
6961	Selector Channel—Second	7,570	14.25	195
7190	IBM 1620 Compatibility (not with 4456)	10,600	9.50	281
7520	Storage Protection	5,750	1.50	159
7915	Attachment for 1051	3,960	8.00	79
For 2040 Processing Unit (Model 40):				
1850	Channel-to-Channel Adapter	9,640	3.75	239
3237	Decimal Arithmetic	4,740	1.75	121
3274	Direct Control	6,140	2.00	159
4427	Floating-Point Arithmetic	4,120	2.50	106
4457	IBM 1401/1460 Compatibility	21,800	17.25	530
4460	IBM 1401/1440/1460 DOS Compatibility	5,040	No charge	153
4462	IBM 1401/1440/1460 Relocatable DOS Compatibility	5,040	No charge	153
4478	IBM 1410/7010 Compatibility	27,800	18.25	688
6980	Selector Channel—First	14,800	18.25	372
6981	Selector Channel—Second	13,700	15.25	346
7520	Storage Protection	5,750	1.50	159
7920	1052 Adapter	10,400	9.00	239
For 2044 Processing Unit (Model 44):				
3275	Direct Data Channel	24,100	30.50	816
3288	Direct Word	8,310	3.00	280
3895	External Interrupt	907	1.00	30
4427	Floating-Point Arithmetic	8,310	11.00	280
4555	High Resolution Interval Timer	3,020	2.00	102
4560	High-Speed Multiplexer Subchannel	3,770	6.00	127
4583	High-Speed General Registers	21,100	28.50	714
4598	High-Speed Multiplexer Channel—First	19,600	29.75	663
4599	High-Speed Multiplexer Channel—Second	10,800	18.25	367
5248	Multiplexer Channel	10,500	18.00	357

* Rental prices include equipment maintenance.

IBM System/360 Models 22-195

EQUIPMENT PRICES

	Purchase Price	Monthly Maint.	Rental (short-term lease)*
PROCESSING UNIT FEATURES AND CHANNELS (cont)			
5625	Priority Interrupt	12,000	10.00
6415	Second Single-Disk Storage Drive	7,030	40.75
7531	Store & Fetch Protect; Model E	6,800	4.00
7532	Store & Fetch Protect; Model F	1,510	0.75
7533	Store & Fetch Protect; Model G	1,510	0.75
7534	Store & Fetch Protect; Model H	2,270	1.50
8501	Commercial Feature	14,500	5.00
For 2050 Processing Unit (Model 50):			
1850	Channel-to-Channel Adapter	9,640	3.75
3274	Direct Control	8,250	2.50
4478	IBM 1410/7010 Compatibility	25,500	39.75
6980	Selector Channel—First	30,300	28.50
6981	Selector Channel—Second	30,300	28.50
6982	Selector Channel—Third	30,300	28.50
7117	IBM 7070/7074 Compatibility	25,500	39.75
7920	1052 Adapter	10,400	9.00
8080	2361 Attachment	2,970	2.00
For 2065 Processing Unit (Model 65):			
1505	Configuration Control Panel (for 2-processor system)	17,100	10.00
3274	Direct Control	8,920	3.00
7117	IBM 7070/7074 Compatibility	28,200	30.50
7118	IBM 7080 Compatibility	29,200	25.50
7119	IBM 709/7040/7044/7090/7094/7094 II Compatibility	23,900	20.25
7920	1052 Adapter—Second	10,400	9.00
7921	1052 Adapter/Second	10,400	9.00
8080	2361 Attachment	3,880	3.00
For 2067 Processing Unit (Model 67):			
1102	Additional 2846 Attachment	5,770	5.00
3274	Direct Control	8,920	3.00
3800	Extended Direct Control	13,500	4.00
3862	Extended Dynamic Address Translation	133,000	110.00
4434	Floating Storage Addressing	1,080	No charge
5495	Partitioning Sensing	3,470	2.00
6310	Second Wall Section Attachment	25,300	12.00
7119	IBM 709/7040/7044/7090/7094/7094 II Compatibility	23,900	20.25
7920	1052 Adapter	10,400	9.00
For 2075 Processing Unit (Model 75):			
7920	1052 Adapter—First	16,300	24.25
7921	1052 Adapter—Second	10,400	19.25
8080	2361 Attachment	14,400	10.00
For 2085 Processing Unit (Model 85):			
1431	Buffer Expansion—First	154,000	300.00
1432	Buffer Expansion—Second	154,000	300.00
4520	High-Speed Multiply	142,000	255.00
5450	Operator's Console	39,800	51.00
7119	IBM 709/7090/7094/7094 II Compatibility	154,000	255.00
2860	Selector Channel		
	Mod. 1; one channel	99,800	56.00
	Mod. 2; two channels	142,000	91.00
	Mod. 3; three channels	184,000	127.00
1850	Channel-to-Channel Adapter (for 2860)	9,640	3.75
2870	Multiplexer Channel	105,000	98.00
6990	Selector Subchannel—First (for 2870)	17,700	15.25
6991	Selector Subchannel—Second (for 2870)	10,700	10.00
6992	Selector Subchannel—Third (for 2870)	10,700	10.00
6993	Selector Subchannel—Fourth (for 2870)	10,700	10.00
2880	Block Multiplexer Channel		
	Mod. 1; one channel	155,000	346.00
	Mod. 2; two channels	222,000	459.00
7850	Two-Byte Interface (for 2880)	18,100	6.00
2846	Channel Controller (for 2067 Mod. 2 only)	76,700	95.00
2167	Configuration Unit (required with 2067 Mod. 2)		
	Mod. 1; for up to 2 Processor Storage modules	54,900	75.00
	Mod. 2; for up to 3 Processor Storage modules	54,900	75.00
	Mod. 3; for up to 4 Processor Storage modules	54,900	75.00
	Mod. 4; for up to 8 Processor Storage modules	62,300	83.00
CONSOLE I/O			
1052	Printer-Keyboard		
	Mod. 7 (for Model 25, 40, 50, 65, 67, 75, 85, or 195 system; requires either 1052 Adapter on CPU or 2150 Console)	2,690	18.25
	Mod. 8 (for Model 30; requires 1051 Control Unit)	2,690	18.25

* Rental prices include equipment maintenance.

IBM System/360 Models 22-195

EQUIPMENT PRICES

		Purchase Price	Monthly Maint.	Rental (short-term lease)*	Rental (12-month lease)*	Rental (24-month lease)*
CONSOLE I/O (Continued)						
1051	Control Unit, Model N1 (for Model 30; requires Feature 7915 on CPU)	3,010	10.50	59		
2150	Console (optional for Model 50, 65, 67, 75, 85, or 195 systems)	24,100	15.25	525		
5475	Operator Control Panel—First (for 2150)	1,480	No charge	35		
5476	Operator Control Panel—Second (for 2150)	1,480	No charge	35		
MASS STORAGE						
2841	Storage Control (basic unit handles up to eight 2311 Disk Drives)	22,200	57.00	535	492	449
7950	3202 Attachment (for 2841; handles up to eight 2302 access mechanisms)	8,160	2.75	254	234	213
8077	2303 Attachment (for 2841; handles up to two 2303 Drums)	15,400	7.00	407	374	342
8079	2321 Attachment (for 2841; handles up to eight 2321 Data Cell Drives)	5,710	1.50	177	163	149
1024	Additional Storage (for 2841)	6,520	1.00	203	187	171
4385	File Scan (for 2841)	1,140	1.00	35	32	29
6118	Record Overflow (for 2841)	346	0.50	10	9	8
8100	Two-Channel Switch (for 2841)	3,460	4.00	101	93	85
2302	Disk Storage					
	Mod. 3; two access mechanisms	241,000	295.00	5,700		
	Mod. 4; four access mechanisms	341,000	428.00	8,040		
2303	Drum Storage	89,700	357.00	2,550	2,346	2,142
2311	Disk Storage Drive, Model 1	21,390	56.00	580	534	487
2321	Data Cell Drive	111,000	484.00	2,850	2,622	2,394
1316	Disk Pack (for 2311)	360	Time & Mat'ls.	15		
2314	Direct Access Storage Facility, Model 1 (9 Drives)	181,000	627.00	5,350	4,922	4,494
2314	Storage Control, Model A1	57,900	61.00	1,500	1,380	1,260
2312	Disk Storage, Model A1 (1 disk drive)	20,800	76.00	544	500	457
2313	Disk Storage, Model A1 (4 disk drives)	68,300	244.00	1,770	1,628	1,487
2318	Disk Storage, Model A1 (2 disk drives)	36,000	137.00	937	862	787
2314	Storage Control, Model B1	57,900	61.00	1,500	1,380	1,260
2319	Disk Storage, Model B1 (1st 3-drive unit on 2314-B1)	39,000	214.00	1,019	937	856
2319	Disk Storage, Model B2 (2nd & 3rd 3-drive units on 2314-B1)	39,000	214.00	1,019	937	856
2844	Auxiliary Storage Control (optional second control unit for 2314)	103,000	42.75	2,700	2,484	2,268
8170	Two-Channel Switch (for 2314)	4,850	2.50	142	131	119
8171	Two-Channel Switch (for 2844)	4,850	2.50	142	131	119
2316	Disk Pack (for 2314 drives)	525	Time & mat'ls.			
2301	Drum Storage	80,700	367.00	2,220	2,042	1,865
2820	Storage Control (for up to four 2301's)	91,600	61.00	2,340	2,153	1,966
8170	Two-Channel Switch (for 2820)	3,950	2.00	101	93	85
2305	Fixed-Head Storage Facility					
	Mod. 1; 5.4 million bytes	199,000	504.00	4,990	4,591	4,192
	Mod. 2; 11.2 million bytes	158,000	479.00	3,970	3,652	3,335
2835	Storage Control					
	Mod. 1; for 2305 Mod. 1	122,000	453.00	3,060	2,815	2,570
	Mod. 2; for 2305 Mod. 2	101,000	387.00	2,550	2,346	2,142
2361	Large Capacity Core Storage (LCS)					
	Mod. 1; 1,045,576 bytes	181,000	382.00	6,620		
	Mod. 2; 2,097,152 bytes	302,000	586.00	11,200		
7131	Shared Storage Feature (for 2361)	3,970	2.00	153		
3330	Disk Storage; 2-drive module; 200 million bytes	52,900	173.00	1,320	1,214	1,109
3333	Disk Storage and Control; 2 drives, 200 million bytes (up to three 3330 modules can be attached)	66,300	204.00	1,647	—	1,402
3830	Storage Control, Model 2 (controls up to four 3333's and twelve 3330's)	82,600	117.00	2,060	1,895	1,730
2150	Control Store Extension (for 3830; prerequisite for 9845)	19,100	10.00	478	440	402
8151	3333 String Switch Attachment (for 3830)	No charge	No charge	No charge	—	—
9845	32-Drive Expansion (for 3830)	No charge	No charge	No charge	—	—
8170	Two-Channel Switch (for 3830)	8,140	10.00	203	187	171
8171	Two-Channel Switch, Additional (for 3830)	8,140	10.00	203	187	171
3336	Disk Pack (for 3330)	1,000	Time & mat'ls.	Purchase only		
MAGNETIC TAPE INPUT/OUTPUT						
2415	Magnetic Tape Unit and Control					
	Mod. 1; 2 tape drives; 800 bpi	29,900	110.00	764	703	642
	Mod. 2; 4 tape drives; 800 bpi	47,800	197.00	1,220	1,122	1,025

* Rental prices include equipment maintenance; 12-month and 24-month fixed-term leases permit unlimited usage at no additional cost.

IBM System/360 Models 22-195

EQUIPMENT PRICES

	<u>Purchase Price</u>	<u>Monthly Maint.</u>	<u>Rental (short-term lease)*</u>	<u>Rental (12-month lease)*</u>	<u>Rental (24-month lease)*</u>
MAGNETIC TAPE INPUT/OUTPUT (Continued)					
2415	Magnetic Tape Unit and Controller				
	Mod. 3; 6 tape drives; 800 bpi	65,700	285.00	1,680	1,546
	Mod. 4; 2 tape drives; 800/1600 bpi	36,300	126.00	923	849
	Mod. 5; 4 tape drives; 800/1600 bpi	58,300	225.00	1,480	1,362
	Mod. 6; 6 tape drives, 800/1600 bpi	80,300	324.00	2,040	1,877
3228	Data Conversion Feature (for 2415; either 7125, 7127, or 7135 is a prerequisite)	1,760	1.00	45	41
5320	Nine-Track Compatibility (for 2415 Mod. 4, 5, or 6)	5,290	10.00	137	126
7125	Seven-Track Compatibility (for 2415 Mod. 1, 2, or 3)	1,950	1.25	50	46
7127	Seven-Track Compatibility (for 2415 Mod. 4, 5, or 6)	3,710	3.50	96	88
7135	Seven- and Nine-Track Compatibility (for Mod. 4, 5, or 6)	6,060	13.25	157	144
2803	Tape Control (single-channel; for 2401 or 2420)				
	Mod. 1; for 800 bpi drives	26,500	20.25	662	609
	Mod. 2; for 1600 bpi drives	32,700	25.50	815	750
	Mod. 3; for 7-track 2401 Model 8 drives	15,600	30.50	458	421
5320	Nine-Track Compatibility (for 2803 Mod. 2)	9,010	28.50	233	214
7135	Seven- and Nine-Track Compatibility (for 2803 Mod. 2)	14,600	47.75	382	351
7185	16-Drive Addressing (for 2803 Mod. 1 or 2)	1,000	0.75	25	23
7900	2420 Model 5/7 Attachment (for 2803 Mod. 2)	13,800	10.00	346	318
8100	Two-Channel Switch (for 2803 Mod. 1)	3,420	4.00	101	93
2804	Tape Control (two-channel; for 2401)				
	Mod. 1; for 800 bpi drives	38,000	35.50	948	872
	Mod. 2; for 1600 bpi drives	44,200	40.75	1,100	1,012
	Mod. 3; for 7-Track 2401 Model 8 drives	21,600	45.75	637	586
5321	Nine-Track Compatibility (for 2804 Mod. 2)	10,900	22.25	283	260
7136	Seven- and Nine-Track Compatibility (for 2804 Mod. 2)	17,600	43.75	458	421
2401	Magnetic Tape Unit				
	Mod. 1; 30,000 bytes/sec; 800 bpi	13,100	67.00	341	314
	Mod. 2; 60,000 bytes/sec; 800 bpi	19,000	76.00	494	454
	Mod. 3; 90,000 bytes/sec; 800 bpi	30,800	93.00	800	736
	Mod. 4; 60,000 bytes/sec; 1600 bpi	15,000	80.00	392	361
	Mod. 5; 120,000 bytes/sec; 1600 bpi	21,000	89.00	545	501
	Mod. 6; 180,000 bytes/sec; 1600 bpi	32,800	107.00	851	783
	Mod. 8; 15,000/41,700/60,000 char/sec; 7-track	13,800	92.00	407	374
3471	Dual Density (for 2401 Mod. 4, 5, or 6)	1,000	1.75	25	23
5121	Mode Compatibility (for 2401 Mod. 1, 2, or 3)	387	No charge	10	9
7160	Simultaneous Read-While-Write (for any 2401)	387	No charge	10	9
2420	Magnetic Tape Unit				
	Mod. 5; 160,000 bytes/sec; 1600 bpi	25,300	112.00	576	530
	Mod. 7; 320,000 bytes/sec; 1600 bpi	45,900	122.00	1,039	956
2816	Magnetic Tape Switching Unit	21,600	4.00	561	516
3803	Tape Control	26,300	96.00	688	633
9570	Single Density Feature (for 3803)	No charge	No charge	No charge	No charge
3551	Dual Density Feature (for 3803)	2,920	3.00	76	70
6408	7-Track Feature (for 3803)	2,920	3.00	76	70
8100	Two-Channel Switch (for 3803)	5,850	5.00	152	140
1792	2 x 16 Switching Feature	7,800	10.00	203	187
1793	3 x 16 Switching Feature	9,950	15.25	260	239
1794	4 x 16 Switching Feature	11,700	15.25	305	281
3410	Magnetic Tape Unit:				
	Model 1; 20 KB	7,850	45.75	188	173
	Model 2; 40/20 KB	10,500	51.00	249	229
	Model 3; 80/40 KB	13,000	56.00	311	286
3411	Magnetic Tape Unit and Control:				
	Model 1; 20KB	17,300	71.00	412	379
	Model 2; 40/20 KB	21,900	76.00	525	483
	Model 3; 80/40 KB	26,700	81.00	637	586
3211	Single Density Feature (for 3410 & 3411)	2,550	7.50	55	51
3221	Dual Density Feature (for 3410 & 3411, Models 2 & 3 only)	3,670	27.50	81	75
7360	System/360/370 Attachment (required on 3411)	6,420	15.25	152	140
3420	Magnetic Tape Units:				
	Mod. 3; 120,000 bytes/sec at 1600 bpi	13,800	51.00	361	332
	Mod. 5; 200,000 bytes/sec at 1600 bpi	18,500	56.00	484	445
	Mod. 7; 320,000 bytes/sec at 1600 bpi	22,800	66.00	595	547
6631	Single Density Feature (for 3420)	3,320	15.25	86	79

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IBM System/360 Models 22-195

EQUIPMENT PRICES

		Purchase Price	Monthly Maint.	Rental (short-term lease)*	Rental (12-month lease)*	Rental (24-month lease)*
MAGNETIC TAPE INPUT/OUTPUT (Continued)						
3550	Dual Density Feature (3420)	4,290	25.50	111	102	93
6407	7-Track Feature (for 3420)	3,320	25.50	86	79	72
2495	Tape Cartridge Reader	19,000	158.00	346		
PUNCHED CARD I/O AND PRINTERS						
1442	Card Read Punch (with control), Mod. N1	25,900	82.00	520		
1442	Card Punch (with control), Mod. N2	18,500	72.00	372		
1443	Printer (with control), Mod. N1	37,200	89.00	866	797	727
1445	MICR Printer (with control), Mod. N1	61,300	121.00	1,400		
2501	Card Reader (with control)					
	Mod. B1; 600 cpm	14,800	52.00	265		
	Mod. B2; 1000 cpm	15,040	56.00	326		
2520	Card Read Punch (with control), Mod. B1	40,300	154.00	933		
2520	Card Punch (with control)					
	Mod. B2; 500 cpm	35,709	144.00	826		
	Mod. B3; 300 cpm	35,400	116.00	637		
2560	Multi-Function Card Machine (with control), Mod. A1; usable only with Model 25	27,500	98.00	627		
2596	Card Read Punch	30,100	336.00	861		
1510	Card Print Feature (for 2596)	5,350	53.00	153		
2821	Control Unit					
	Mod. 1; for one 2540 & one 1403	37,900	44.75	988	909	830
	Mod. 2; for one 1403	23,500	34.50	612	563	514
	Mod. 3; for two 1403's	46,900	70.00	1,220	1,122	1,025
	Mod. 4; for one 2540 & one 1404	41,100	47.25	1,070	984	899
	Mod. 5; for one 2540 & two 1403's	61,400	79.00	1,590	1,463	1,336
	Mod. 6; for one 2540 only	12,900	98.00	448	412	376
3615	1100 lpm Printer Adapter (for 2821; required for 1403 Mod. 3 or N1)	2,440	1.00	76	70	64
7945	Third Printer Control (for 2821 Mod. 3 or 5)	19,500	6.50	510	469	429
8100	Two-Channel Switch (for 2821)	8,550	8.00	203	187	171
8637	Universal Character Set Adapter (for 2821)	622	3.50	15	14	13
1403	Printer					
	Mod. 2; 600 lpm; 132 print positions	28,500	174.00	764	703	642
	Mod. 3; 1100 lpm; 132 print positions	34,600	200.00	892	821	749
	Mod. 7; 600 lpm; 120 print positions	27,400	135.00	672	591	539
	Mod. N1; 1100 lpm; 132 print positions	34,600	200.00	892	821	749
1416	Interchangeable Train Cartridge (required for 1403 Mod. 3 or N1)	2,960	Time & mat'ls.	98		
4740	Interchangeable Chain Cartridge Adapter (for 1403 Mod. 2 or 7)	2,630	No charge	74	68	62
8640	Universal Character Set Feature (for 1403 Mod. 3 or N1)	387	1.75	10	9	8
8641	Universal Character Set Feature (for 1403 Mod. 2)	387	1.75	10	9	8
1404	Printer (for card and paper documents)	74,200	379.00	1,530		
2540	Card Read Punch	33,500	126.00	724		
3211	Printer; 2000 lpm	70,700	372.00	1,730	1,592	1,453
3216	Interchangeable Train Cartridge (for 3211)	11,700	173.00	257		
5554	18 Additional Print Positions (for 3211)	2,280	8.00	55	51	46
3811	Control Unit (for 3211 Printer)	31,200	117.00	764	703	642
5553	18 Additional Print Positions (for 3811)	836	5.00	20	18	17
PAPER TAPE INPUT/OUTPUT						
2826	Paper Tape Control					
	Mod. 1; for up to two 1017's and/or 1018's	14,600	35.50	280		
	Mod. 2; for up to eight 1017's and/or 1018's	35,000	76.00	673		
5801	Punch Adapter; for first 1018 on 2826 Mod. 1	5,040	9.00	98		
5802	Punch Adapter; for second 1018 on 2826 Mod. 1	4,300	5.00	83		
6101	Reader Adapter; for first 1017 on 2826 Mod. 1	4,300	8.00	83		
6102	Reader Adapter; for second 1017 on 2826 Mod. 1	3,530	5.00	69		
5852 thru 5858	Punch/Reader Adapters (for connecting second)	3,040	3.00	59		
1017	Paper Tape Reader (120 char/sec)					
	Mod. 1; reads strips only	2,370	14.25	49		
	Mod. 2; reads strips or reels	3,630	17.25	74		
1018	Paper Tape Punch (120 char/sec)	5,500	40.75	123		
2822	Paper Tape Reader Control (for one 2671)	9,590	8.25	214		
2671	Paper Tape Reader (100 char/sec)	6,430	21.25	142		
OPTICAL AND MAGNETIC READERS						
1231	Optical Mark Page Reader	26,400	42.25	499		
1285	Optical Reader	83,100	373.00	1,970		

* Rental prices include equipment maintenance.

IBM System/360 Models 22-195

EQUIPMENT PRICES

		Purchase Price	Monthly Maint.	Rental (short-term lease)*
OPTICAL AND MAGNETIC READERS (cont)				
1287	Optical Reader			
	Mod. 1; reads documents only	124,000	816.00	2,760
	Mod. 2; reads documents and journal tape	142,000	918.00	3,160
	Mod. 3; reads documents only	187,000	1,170.00	4,250
	Mod. 4; reads documents and journal tape	209,000	1,220.00	4,650
3945	Farrington 7B Font (for 1287)	1,110	1.00	25
4470	1428 & USASCOCR Font (for 1287)	1,110	1.00	25
5300	NCR Optical Type Font (for 1287)	4,450	5.00	98
5370	Numeric Handwriting (for 1287)	35,600	51.00	790
5479	Optical Mark Reading (for 1287)	4,450	5.00	98
1288	Optical Page Reader	227,000	1,240.00	4,850
3850	Expanded Symbol Set (for 1288)	3,110	3.50	69
5370	Numeric Handwriting (for 1288)	53,400	76.00	989
5479	Optical Mark Reading (for 1288)	5,240	7.00	98
6550	Serial Numbering (for 1288)	12,700	61.00	295
1418	Optical Character Reader			
	Mod. 1; 3 stackers	119,000	200.00	2,570
	Mod. 2; 13 stackers	132,000	234.00	2,870
	Mod. 3; 3 stackers	140,000	222.00	3,040
1428	Alphameric Optical Reader			
	Mod. 1; 3 stackers	137,000	234.00	2,960
	Mod. 2; 13 stackers	150,000	269.00	3,260
	Mod. 3; 3 stackers	158,000	257.00	3,430
1255	Magnetic Character Reader			
	Mod. 1; 500 dpm, 6 stackers	39,400	214.00	821
	Mod. 2; 750 dpm, 6 stackers	45,100	341.00	999
	Mod. 3; 750 dpm, 12 stackers	61,400	448.00	1,320
3215	Dash Symbol Transmission (for 1255)	35	No charge	51 (1-time)
4380	51-Column Card Sorting (for 1255)	734	No charge	15
4520	High-Order Zero & Blank Selection (for 1255 Mod. 3 only)	1,460	5.00	30
7060	Self-Checking Numbers (for 1255)	2,330	2.50	49
6360	System/360/370 Adapter (required on 1255)	22,000	31.50	459
1259	Magnetic Character Reader; 600 dpm	62,300	265.00	1,380
1412	Magnetic Character Reader; 950 dpm	90,400	174.00	1,970
1419	Magnetic Character Reader; 1600 dpm	109,000	245.00	2,420
7720	System/360 Adapter (required for use of 1285, 1412, 1418, 1419, or 1428)	5,240	6.50	106
DISPLAYS				
2250	Display Unit			
	Mod. 1; connects directly to a channel	52,200	160.00	1,080
	Mod. 3; requires 2840 Display Control	31,600	180.00	1,580
1245	Alphameric Keyboard (for 2250 Mod. 1 or 2)	3,550	4.00	74
4785	Light Pen (for 2250 Mod. 1 or 2)	4,740	11.00	98
1001	Absolute Vectors (for 2250 Mod. 2)	13,800	10.00	346
1002	Absolute Vectors and Control (for 2250 Mod. 1)	15,800	11.00	397
1498	Buffer; 4,096 bytes (for 2250 Mod. 1)	16,600	7.00	346
1499	Buffer; 8,192 bytes (for 2250 Mod. 1)	23,700	10.00	494
1880	Character Generator (for 2250 Mod. 1)	17,800	15.25	372
3240	Display Copier Attachment (for 2250 Mod. 1)	3,320	2.00	69
3251	Display Copier Attachment (for 2250 Mod. 2)	3,320	2.00	69
2285	Display Copier	29,900	122.00	622
2840	Display Control (for up to two 2250 Mod. 2's)	73,400	143.00	3,950
3352	Display Multiplexer (for 2840; controls up to two more 2250 Mod. 2's)	8,160	73.25	397
2260	Display Station			
	Mod. 1; for use with 2848 Mod. 3 Control	989	8.25	30
	Mod. 2; for use with 2848 Mod. 1, 2, 21, or 22	989	8.25	30
4766	Alphameric Keyboard (for 2260)	612	1.50	20
4767	Numeric Keyboard (for 2260)	306	1.00	10
2848	Display Control (for 2260 Display Stations)			
	Mod. 1; for up to 24 Mod. 2's; 240 chars. each	16,000	23.25	367
	Mod. 2; for up to 16 Mod. 2's; 480 chars. each	17,100	23.75	397
	Mod. 3; for up to 8 Mod. 1's; 960 chars. each	18,300	24.25	428
	Mod. 21; for up to 24 Mod. 2's; 240 chars. each	33,300	28.50	739
	Mod. 22; for up to 16 Mod. 2's; 480 chars. each	35,600	28.50	790
	Display Adapters (one-required on 2848 for each pair of 2260 Displays connected):			
3355	For 2848 Mod. 1	1,530	2.00	40
3356	For 2848 Mod. 2	3,060	4.00	81
3357	For 2848 Mod. 3	3,840	5.00	102

* Rental prices include equipment maintenance.

IBM System/360 Models 22-195

EQUIPMENT PRICES

		Purchase Price	Monthly Maint.	Rental (short-term lease)*
DISPLAYS (Continued)				
3368	For 2848 Mod. 21	2,670	2.00	59
3369	For 2848 Mod. 22	5,340	3.00	118
3858	Expansion Unit (for 2848 Mod. 1 or 2)	2,300	No charge	56
3859	Expansion Unit (for 2848 Mod. 1, 2, or 3)	1,870	No charge	45
3868	Expansion Unit (for 2848 Mod. 21 or 22)	2,220	No charge	49
7927	2053 Adapter (for 2848 Mod. 1 or 2)	1,530	3.25	40
7928	1053 Adapter (for 2848 Mod. 3)	1,530	3.25	40
7938	1053 Adapter (for 2848 Mod. 21 or 22)	4,670	5.50	104
4787	Line Addressing (for 2848)	459	1.25	10
5340	Non-Destructive Cursor (for 2848; requires 5341)	438	1.00	10
5341	Non-Destructive Cursor Adapter (for 2848)	219	0.50	5
1053	Printer (maximum of 1 per 2848; requires 1053 Adapter)	1,970	10.00	49
AUDIO RESPONSE				
7770	Audio Response Unit (up to 4 lines)	56,900	39.25	1,180
4677	I/O Line Expander (for 7770; up to 4 more lines)	8,310	12.75	173
4679	I/O Line Panel (for 7770; one 4679 required for each 8 lines beyond the first 8)	3,550	2.00	74
4668	I/O Line Frame (for 7770; required for over 16 lines)	9,490	2.50	197
8721	Six Additional Vocabulary Words (for 7770)	4,740	2.50	98
7772	Audio Response Unit (up to 2 lines)	29,600	27.50	617
4667	I/O Line Expander (for 3rd & 4th lines on 7772)	11,800	12.75	246
4675	I/O Line Expander (for 5th & 6th lines on 7772)	11,800	12.75	246
4476	I/O Line Expander (for 7th & 8th Lines on 7772)	11,800	12.75	246
8722	One Additional Vocabulary Word (for 7772)	10	No charge	Purchase only

COMMUNICATIONS EQUIPMENT

Detailed configuration and pricing data for the IBM 2701, 2702, 2703, 3704, and 3705 Communications Controllers can be found in Reports 70D-491-30 through 70D-491-32. Detailed descriptions and prices of the numerous IBM remote terminals that can be used with a System/360 computer are contained in Reports 70D-491-02 through 70D-491-13.

* Rental prices include equipment maintenance.

SOFTWARE PRICES

Program Products—Systems	Monthly Use Charge
ANS Subset COBOL Compiler and Library (DOS)	153
ASCII Magnetic Tape Utilities (DOS)	102
Assembler H (OS)	229
Code and Go FORTRAN (OS)	280
Data Set Utilities (OS)	102
FORTTRAN IV Library, ASCII (DOS)	51
FORTTRAN IV (H Extended) Compiler (OS)	265
FORTTRAN IV Library, Mod II (OS)	91
FORTTRAN IV (G1) Compiler (OS)	66
FORTTRAN IV Library, Mod 1 (OS)	66
Full ANS COBOL V4 Compiler and Library (OS)	178
Full ANS COBOL V3 Compiler (DOS)	56
ITF PL/I (OS)	122
ITF PL/I (TSO)	122
ITF PL/I (DOS)	122
PL/I Checkout Compiler (OS)	346
PL/I Optimizing Compiler (OS)	255
PL/I Optimizing Compiler (DOS)	255
RPG II (DOS)	96
Sort-Merge SM1 (OS)	61
Tape and Disk Sort/Merge SM1 (DOS)	80
TSO Assembler Prompter	30
TSO COBOL Prompter	30
TSO Data Utilities	147
TSO FORTRAN Prompter	30
1288 Basic Unformatted Read System (OS)	51
1288 Basic Unformatted Read System (DOS)	51

IBM System/360 Models 22-195
SOFTWARE PRICES

Program Products—Applications	Monthly Use Charge
Active Certificate Information (DOS)	306
Advanced Life Information System, V2 (DOS)	510
APL (DOS)	280
APL (OS)	408
Basic Courts System (DOS)	637
Bill Processor System—IMS/360 Bridge (OS)	153
Brokerage Account System Elements (DOS)	816
Capacity Planning—Finite Loading (DOS)	229
Capacity Planning—Finite Loading (OS)	280
Capacity Planning—Infinite Loading (DOS)	76
Capacity Planning—Infinite Loading (OS)	102
CATALIST (DOS)	1,220
Consolidated Functions Ordinary—CFO II (DOS)	306
Consumer Goods System—Allocated (DOS or OS)	153
Consumer Goods System—Forecasting (DOS or OS)	204
Coursewriter III, V2 (OS)	280
Customer Information and Control System:	
Standard System (OS)	714
Entry System (DOS)	204
Standard System (DOS)	510
DATA/360 (DOS)	51
DATA/360 (OS)	102
Data Base Organization and Maintenance Processor (DOS)	102
Display Management System (OS)	188
Electronic Circuit Analysis Program II (OS)	173
Fare Quote/Ticketing (DOS)	2,850
Fashion Reporter System (DOS)	168
FASTER LC (DOS)	102
FASTER MT (DOS)	290
Financial Terminal System (DOS)	408
Generalized Information System, V2 (OS):	
Basic Retrieval System	459
File Update and Create Feature	408
Formal Report Feature	102
Hierarchic File Support Feature	127
Utility Feature	76
Edit and Encode Feature	76
Teleprocessing Support Feature	51
File Modify Feature	51
Extended Multi-File Support Feature	76
GPSS V (DOS)	56
GPSS V (OS)	56
Graphic Analysis of Three-Dimensional Data (OS)	306
Information Management System, V2 (OS)	561
Data Communication Feature	637
Inventory Control (OS)	178
Law Enforcement Manpower Allocation System (DOS)	357
Mathematical Programming System Extended (OS)	132
Mixed Integer Programming Feature	229
MINIPERT (DOS or OS)	153
Order Allocation System (DOS)	127
Property and Liability Information System, V2 (DOS)	306
PALIS Additional File Facility (2314)	255
Power System Planning (OS)	306
Procedure Library—Mathematics (OS)	102
Project Management System IV (OS)	300
Project Management System Report Processor (OS)	51
Network Processor Feature	51
Cost Processor Feature	51
Resource Allocation Processor	204
Requirements Planning (OS)	204
Resource Allocation Facility (DOS)	173
Shared Laboratory Information System (DOS)	255
Shop Floor Control (DOS)	102
Shop Floor Control (OS)	158
Vehicle Scheduling Program Extended (DOS)	102
Vehicle Scheduling Program Extended (OS)	178