

IBM System/370 Models 155 & 165



Console of the System/370 Model 155.

MANAGEMENT SUMMARY

The first two models in IBM's long-awaited new computer line, introduced on June 30, 1970, represent an extension, rather than a redesign, of the architecture of the IBM System/360. Though the System/370 encompasses no revolutionary technological breakthroughs, it takes full advantage of the current state of the art in virtually every aspect of computer design. For current users of the medium-to-large-scale System/360 Models 40 through 75, the System/370 provides significant performance increases without reprogramming. These improvements in performance are achieved primarily through higher internal speeds, larger memory capacities, and expanded I/O channel capabilities.

The System/370 central processors effectively utilize a number of design innovations that were introduced earlier in the largest members (Models 85 and 195) of the System/360. By far the most significant hardware feature is a fast, semiconductor-type buffer storage unit that holds large blocks of data and instructions ready for use by the processor, thereby greatly reducing the effective

The System/370 Models 155 and 165 offer significant performance improvements over the medium-to-large-scale IBM System/360 computers. Emphasizing compatibility with the System/360, the new computers use most of IBM's existing peripheral equipment and software together with some impressive new facilities.

CHARACTERISTICS

MANUFACTURER: International Business Machines Corporation, 112 East Post Road, White Plains, New York 10601.

MODELS: System/370 Models 155 and 165.

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 4 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" format; 2 words, consisting of 56-bit fraction and 7-bit hexadecimal exponent, in "long" format; or 4 words in "extended precision" format (optional in Model 155 and standard in Model 165).

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).

MAIN STORAGE

STORAGE TYPE: Magnetic core.

CAPACITY: See table and price list.

CYCLE TIME: Model 155—2.07 microseconds per 16-byte access, with no interleaving. Model 165—2.0 microseconds per 8-byte access, with 4-way interleaving. Note: The effective main storage speed is considerably higher than these figures indicate because of the semiconductor-type buffer storage (see table), which greatly reduces the number of main storage references required in most applications.

CHECKING: All data paths between the central processor, buffer storage, and main storage are parity-checked by byte. When data is stored, an error-correcting code is substituted for the parity bits. When the data is retrieved, single-bit errors are detected and corrected automatically.

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▷ cycle time of the main core storage. The System/370 also makes use of Block Multiplexer Channels, introduced in February 1970 for Models 85 and 195. These channels can handle extremely high data transfer rates and can control non-data-transfer operations on multiple I/O devices concurrently with interleaved transfers of blocks of data.

The System/370 computers use most of the same peripheral devices as the System/360, plus two impressive new additions: the 2000-µm 3211 Printer and the fast, large-capacity 3330 Disk Storage Facility. Software support consists of the existing System/360 Operating System (OS) and Disk Operating System (DOS) facilities, augmented by several new (and separately priced) software products that were announced along with the System/370. The thousands of System/360 users who are still running programs written for second-generation IBM computers have not been forgotten; IBM is offering "integrated emulators" that enable a System/370 to process emulated programs along with native-mode System/370 programs in a multiprogramming mix. Another emulator facilitates conversions from DOS to OS by making it possible to run DOS jobs in an OS environment on a Model 155.

Along with performance and compatibility, IBM is strongly stressing increased reliability in the System/370. Admitting that the System/360 initially failed to operate at the reliability level its customers had come to expect, IBM has paid a great deal of attention to reliability and ease of maintenance in designing the System/370. At announcement time, more than 14,000 system hours had already been logged on ten Model 155's at various IBM locations, and individual elements of the Model 165 had also undergone intensive testing. An automatic retry capability for central processor operations and error-correcting circuits for main storage will often make it possible to continue processing despite hardware faults. Finally, new hardware and software facilities, together with centrally located maintenance data banks, will facilitate equipment servicing.

Though the System/370 Models 155 and 165 represent attractive upgrade machines for many current users of the System/360 Models 40 through 75, they are far too costly for the thousands of Model 25 and 30 users who have been eagerly awaiting a new IBM computer to handle their expanding throughput requirements. To satisfy the needs of this important segment of the computer market, at least one more model will almost certainly be added to the System/370 line when IBM decides that the optimum time has arrived.

PROCESSOR MODELS

The System/370 Model 155, designed as a growth computer for System/360 Model 40 and 50 users, ▷

▶ and most multiple-bit errors are detected and signalled so that appropriate program action can be taken.

STORAGE PROTECTION: The Store and Fetch Protection features, which guard against inadvertent overwriting and/or unauthorized reading of data in specified 2048-byte blocks of storage, are standard in Models 155 and 165.

CENTRAL PROCESSORS

INDEX REGISTERS: Both 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: Consists of all of the 150 instructions that comprise the System/360 "universal instruction set" plus 13 new "enhancement instructions." (The 7 instructions associated with the Extended Precision Floating Point Feature are optional in Model 155 and standard in Model 165.)

The System/370 instruction set includes complete arithmetic facilities for processing variable-length decimal, fixed-point binary, and floating-point binary operands, as well as instructions which handle loading, storing, comparing, branching, shifting, editing, radix conversion, code translation, logical operations, packing, and unpacking. In addition, a group of "privileged instructions," usable only by the operating system, handle input/output and various hardware control functions.

The 13 new instructions are:

- Compare Logical Characters Under Mask (CLM)
- Compare Logical Long (CLCL)
- Insert Characters under Mask (ICM)
- Load Control (LCTL)
- Move Long (MVCL)
- Set Clock (SCK)
- Shift and Round Decimal (SRP)
- Start I/O Fast Release (SIOF)
- Store Channel ID (STIDC)
- Store Characters under Mask (STCM)
- Store Clock (STCK)
- Store CPU ID (STIDP)
- Store Control (STCTL)

These new instructions facilitate programming and reduce execution times for record blocking and unblocking, long move and compare operations, decimal arithmetic, and various hardware control functions.

INSTRUCTION TIMES: See table. Instruction times for Model 155 are not available at this writing, and the Model 165 times are subject to considerable variation from the listed times because of the complex interactions among the various functional units. IBM states that on typical programs Model 155 internal speeds are 3.5 to 4 times as fast as the System/360 Model 50, while Model 165 internal speeds are 2 to 5 times as fast as the System/360 Model 65.

OPTIONAL FEATURES: Extended Precision Floating Point (standard in Model 165) permits arithmetic operations on floating-point operands with a precision of 28 hexadecimal digits. ▶

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CHARACTERISTICS OF THE SYSTEM/370 PROCESSOR MODELS

	Model 155	Model 165
MAIN STORAGE		
Cycle time, microseconds	2.07	2.0
Bytes fetched per cycle	16	8
Storage interleaving (maximum)	none	4-way
Minimum capacity (bytes)	262,144	524,288
Maximum capacity (bytes)	2,097,152	3,145,728
BUFFER STORAGE		
Cycle time, nanoseconds	115	80
Bytes fetched per cycle	2	4
Minimum capacity, bytes	8,192	8,192
Maximum capacity, bytes	8,192	16,384
PROCESSOR SPEEDS		
Machine cycle time, nanoseconds	115	80
Add time, microseconds (32-bit binary fields)	?	0.16
Add time, microseconds (5-digit decimal fields)	?	0.42
PROCESSOR FEATURES		
IBM 1400 Series & 7010 Compatibility	optional	no
IBM 7070/7074 Compatibility	no	optional
IBM 7080 Compatibility	no	optional
IBM 7090 Series Compatibility	no	optional
OS/DOS Compatibility	optional	no
Extended Precision Floating Point	optional	standard
High-Speed Multiply	no	optional
Direct Control	optional	standard
CHANNELS		
No. of Selector Channels	none	0 to 6
No. of Block Multiplexer Channels	2 to 5	0 to 11
No. of Byte Multiplexer Channels	1 or 2	0 to 2
Maximum total I/O data rate, bytes/second	5,400,000	8,000,000

operates at 3.5 to 4 times the internal speed of the Model 50. It offers from 262,144 to 2,097,152 bytes of core storage—four times the maximum storage capacity available to Model 50 users. Though the Model 155's core cycle time is a surprisingly slow 2.07 microseconds, 16 bytes of information are fetched or stored during each cycle. The 8,192-byte buffer storage, like the central processor, has a 115-nanosecond cycle time. Instruction fetching is overlapped with instruction execution.

Two Block Multiplexer Channels and one Byte Multiplexer Channel are standard in the Model 155, and up to three more Block Multiplexer Channels and a second Byte Multiplexer Channel can be added. The Model 155 can handle a total I/O data rate of up to 5.4 million bytes per second.

Direct Control (standard in Model 165) provides six external interrupt lines which are independent of the normal data channels, plus two instructions which provide for single-byte data transfers between an external device and main storage.

High-Speed Multiply (for Model 165 only) reduces the time required for a long-precision floating-point multiply from 1.87 to 0.61 microseconds, and cuts the fixed-point multiply time from 0.78 to 0.42 microsecond.

The **Channel-to-Channel Adapter** permits direct communication between two System/370 processors via their standard I/O channels. The adapter occupies one control unit position on each of the two channels it interconnects.

The **Extended Channel Feature** (for Model 165 only) increases the maximum number of I/O channels from 7 to 12.

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▷ The Model 155 is already in production and immediately available for benchmark testing by prospective customers. Initial customer deliveries are scheduled for February 1971, although IBM cautions that the production build-up will be gradual, reaching capacity in the last quarter of 1971. The Model 155 will be manufactured in Poughkeepsie and in IBM World Trade Corporation plants in Montpellier, France, and Fujisawa, Japan. Monthly rentals for typical Model 155 systems will range from about \$32,000 to \$80,000.

The System/370 Model 165 is designed as an upgrade machine for users of System/360 Models 65 and 75. It operates at from 2 to 5 times the internal speed of the Model 65 and offers from 524,288 to 3,145,728 bytes of core storage. Four-way interleaving of 8-byte accesses to core storage, coupled with 8,192 or 16,384 bytes of 80-nanosecond buffer storage, add up to high performance despite a slow 2-microsecond core cycle time. The processor has an 80-nanosecond cycle time, and the fetching and decoding of several instructions is automatically overlapped with the execution of one instruction at a time.

A Model 165 system can include three different types of I/O channels. Up to 6 Selector Channels, 11 Block Multiplexer Channels, and 2 Byte Multiplexer Channels can be installed (though the total number of channels may not exceed 12). Total I/O data rates in excess of 8 million bytes per second can be accommodated.

Initial customer deliveries of the Model 165 are scheduled for April 1971. The production rate will build up to capacity in the last quarter of 1971. The Model 165 will be manufactured in Kingston, New York, and Havant, England. Monthly rentals for typical Model 165 systems will range from about \$70,000 to \$150,000.

HARDWARE FEATURES

The two System/370 processors share many significant characteristics with the earlier System/360 processors (Models 25 and above). 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 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. ▷

▶ **COMPATIBILITY FEATURES:** The System/370 processors can be equipped with extra-cost compatibility features and associated emulator routines that enable them to execute programs written for earlier IBM computers, as listed in the table. These "integrated emulators" enable emulated programs to be processed along with native-mode System/370 programs in a multiprogramming mix under operation system control. In general, their use requires a System/370 with I/O devices equivalent to those of the system to be emulated (plus the devices required by the operating system), and with more core storage capacity and processing power. Only the more common peripheral devices can be emulated.

A single compatibility feature for Model 155 permits programs written for the IBM 1401, 1440, 1460, 1410, and 7010 computers to be run under either DOS or OS control.

Model 165 can be equipped to emulate the IBM 7070 and 7074 (at approximately 3 times the internal speed of the 7074), the 7080 (at approximately twice its internal speed), or the 709, 7090, 7094 and 7094 II (at approximately 1.5 times the internal speed of the 7094 II). All Model 165 emulators run under OS control.

The OS/DOS Compatibility Feature (for Model 155 only) facilitates DOS-to-OS conversions by making it possible to run DOS programs under control of the Operating System/360 (MFT or MVT). The DOS Emulator runs as a problem program under OS control. It can be multiprogrammed with other OS jobs, and it in turn can use the multiprogramming options of DOS.

CONSOLE INPUT/OUTPUT: Model 155 offers a choice of two Console Printer-Keyboards. The 3215 uses a matrix printing unit that operates at 85 characters per second. The 3210 is a newly designed unit that prints at 15 characters per second. An additional 3210 Console Printer-Keyboard can be installed in a remote area (such as the installation's tape library or scheduling room).

Every Model 165 system includes a 3066 System Console, which provides a CRT display with 4K buffer, an alphanumeric keyboard, a microfiche maintenance display to facilitate servicing, and a plugboard that permits reconfiguration of main storage. The console can be located up to 30 feet away from the central processor, and multiple consoles can be used if desired.

INPUT/OUTPUT CONTROL

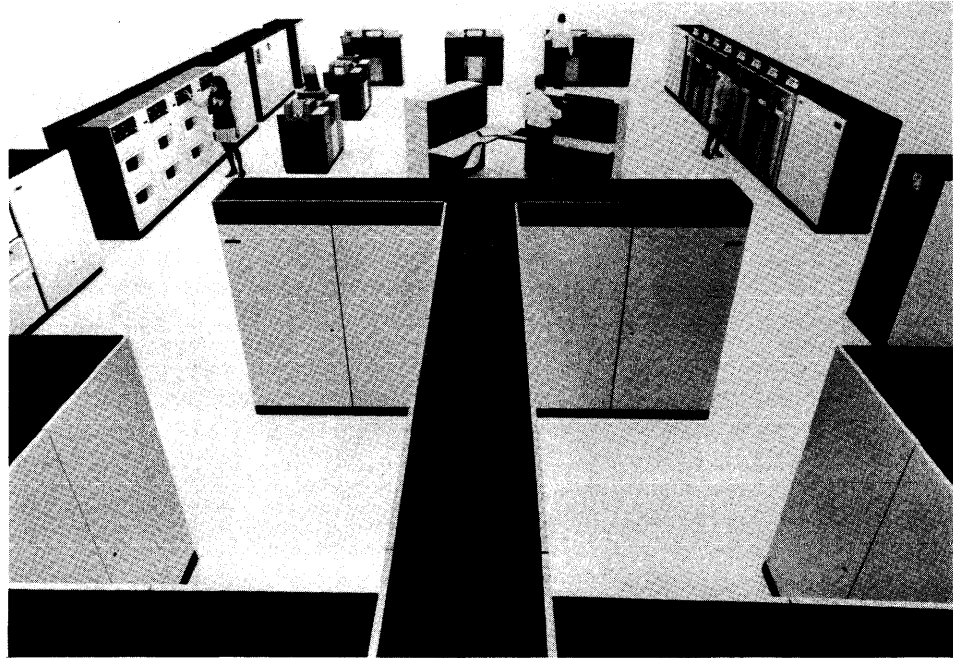
I/O CHANNELS: The System/370 employs three distinct types of I/O channels:

Byte Multiplexer Channels have a single data path that can be shared by a number of simultaneously operating low-to-medium-speed I/O devices (in "multiplex mode") or monopolized by a single faster device (in "burst mode"). In either case, one byte of data at a time is transferred between main storage and an I/O device. These channels are functionally compatible with the System/360 Multiplexer Channels.

Block Multiplexer Channels provide a single data path that can be shared by a number of 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. Data moves to or from an I/O device one byte at a time and is buffered to a width of 16 bytes for ▶

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The central processing and core storage unit (foreground) dominates this view of a Model 165 installation. The new 3330 Disk Storage Facility is shown with the operator at upper left.



▷ The System/370 adds 13 new instructions to the System/360's already large instruction set. The new instructions will help reduce execution time and program storage requirements by enhancing decimal arithmetic performance, eliminating the need for multiple "move" instructions, and facilitating the blocking and unblocking of records.

The Byte-Oriented Operand Feature, standard in the System/370, allows users to ignore, in part, the restriction that non-decimal operands must be stored in core locations whose addresses are integral multiples of the operand length. It is important to note, however, that significant performance degradation is likely to occur if programmers are allowed to take advantage of this feature and ignore the usual boundary constraints on operand placement.

Two standard hardware features help to make the System/370 a more "time-conscious" system. An improved interval timer with a resolution of 3.3 milliseconds facilitates the timing of short-duration tasks, while a new time-of-day clock with a 1-microsecond resolution provides a consistent measure of elapsed time for job accounting, communications, and real-time functions.

The buffer storage unit consists of 8,192 or (in Model 165 only) 16,384 bytes of fast-access semiconductor storage. For all processor fetch operations, the buffer storage control determines whether the referenced data is available in buffer storage. If so, buffer storage is accessed; if not, core storage is accessed and the addressed data is both transmitted to the processor and loaded into buffer ▷

▶ communication with main storage. These channels can also operate in Selector Channel mode, in which case they are functionally compatible with the System/360 Selector Channels.

Selector Channels permit high-speed data transfer operations by one peripheral device at a time. The channel remains busy throughout the time a channel program is in operation, even when no data is being transferred.

The Model 155 Processor includes one Byte Multiplexer Channel and two Block Multiplexer Channels as standard equipment. Up to three more Block Multiplexer Channels and a second Byte Multiplexer Channel (which takes the place of one of the Block Multiplexer Channels) are optional. (Selector Channels are not used with the Model 155). Each Byte Multiplexer Channel provides from 128 to 256 subchannels (depending upon the system's main storage capacity), and 8 of these subchannels can be shared by 2 or more connected I/O devices. Each Block Multiplexer Channel provides 16 shared subchannels and from 96 to 480 nonshared subchannels (depending upon main storage capacity). Each model 155 Block Multiplexer Channel can accommodate data rates of over 1.5 million bytes per second.

A Model 165 system can include a maximum of six 2860 Selector Channels, two 2870 Byte Multiplexer Channels, and/or eleven 2880 Block Multiplexer Channels. The total number of I/O channels is limited to 7 in the basic Model 165 system and 12 if the Extended Channel Feature is installed.

Each 2860 Selector Channel handles one I/O operation at a time, at a data rate of up to 1.3 million bytes per second.

Each 2870 Multiplexer Channel provides 192 subchannels. Optionally, selector subchannels can be added—▶

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▷ storage. Buffer loading is performed in units of 32-byte "blocks" in Model 165 and 16-byte "halfblocks" in Model 155. A continuously updated index array provides rapid references to the core storage addresses of all data contained in buffer storage. Thus, in most applications there is a fairly high probability that the operands and instructions required by the processor will already be present in buffer storage and rapidly accessible. Moreover, all buffer storage operations are automatic and completely "transparent" to the System/370 programmer; he can simply ignore the existence of the buffer storage when writing his programs.

All System/370 central processor operations are under microprogram control. In the Model 155, the processor and I/O channels share the read-only storage and processor logic by switching control at specified points within their respective microprograms. The Model 165 uses I/O channels which are fully independent of the processor. The control storage in the Model 165 processor consists of 2048 words of read-only storage (ROS) and 512 words of writable control storage (WCS); each control word is 108 bits long. Installation of one of the Compatibility Features adds 1024 more words of WCS to the Model 165.

The use of microprogram control opens up fascinating future possibilities for the System/370. For example, when IBM feels the time is ripe, the System/370 processors could conceivably assume a radically different instruction repertoire and functional characteristics. Many of the functions now performed by software could be "built into the hardware" through the development of suitable control microprograms (the much-discussed "firmware" concept).

The System/370 circuit technology is in line with the current state of the art. The central processors employ IBM's Monolithic Systems Technology (MST). The monolithic chips used in the Model 155, for example, are 80 mils (0.080 inch) square, contain from 2 to 8 circuits, and have switching times of 6 to 8 nanoseconds. The buffer storage units employ circuit technologies that extend well into the medium-scale integration (MSI) range; each memory chip is 112 mils square and contains 64 memory circuits and 8 driver circuits. Packaging techniques for both the processor and memory circuits represent an extension of the IBM Solid Logic Technology (SLT) used in most System/360 models. The chips are placed on a ceramic substrate and encapsulated in half-inch-square modules.

Curiously absent from the initial System/370 announcement was any capability for effective multiprocessing. It is not currently possible for two or more System/370 processors to share a common bank of core storage—even though this capability is now available for the System/360 Model 65 and has long been a feature of competitive lines such as the Control Data 6000 Series, GE-600 Series, and UNIVAC 1108.

▶ up to 4 on the first 2870 in a Model 165 system, and up to 2 on the second. Each selector subchannel can handle one I/O operation of up to 180,000 bytes per second at a time, concurrently with multiplexed I/O operations on the basic channel. The aggregate data rate for the basic multiplexer channel may not exceed 110,000 bytes per second, and the maximum total data rate for all operations on a 2870 Multiplexer Channel is 670,000 bytes per second.

Each 2880 Block Multiplexer Channel provides 64 subchannels. Data is transferred in burst mode, to or from one device at a time, at up to 1.5 million bytes per second. The optional Two-Byte Interface permits data rates of up to 3.0 million bytes per second.

CONFIGURATION RULES: In general, each System/370 channel can accommodate up to 8 peripheral control units and address as many as 256 devices. Most System/370 peripheral devices can be connected to any of the three types of channels. High-speed tape, disk, and drum units require either a Block Multiplexer or Selector Channel, and card readers, printers, and other low-speed devices will normally be connected to a Byte Multiplexer Channel.

SIMULTANEOUS OPERATIONS: Concurrently with computing, a System/370 can control a maximum of one high-speed I/O data transfer operation per Block Multiplexer Channel, one high-speed I/O operation per Selector Channel, and one low-speed I/O operation on each subchannel of a Byte Multiplexer Channel. Alternatively, a Byte Multiplexer Channel can operate in burst mode and handle a single higher-speed I/O operation.

The maximum total I/O data rate for all channels is 5.4 million bytes per second for a Model 155 system and over 8 million bytes per second for a Model 165 system.

MASS STORAGE

2305 FIXED-HEAD STORAGE: Provides fast access to medium-sized quantities of information. 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.

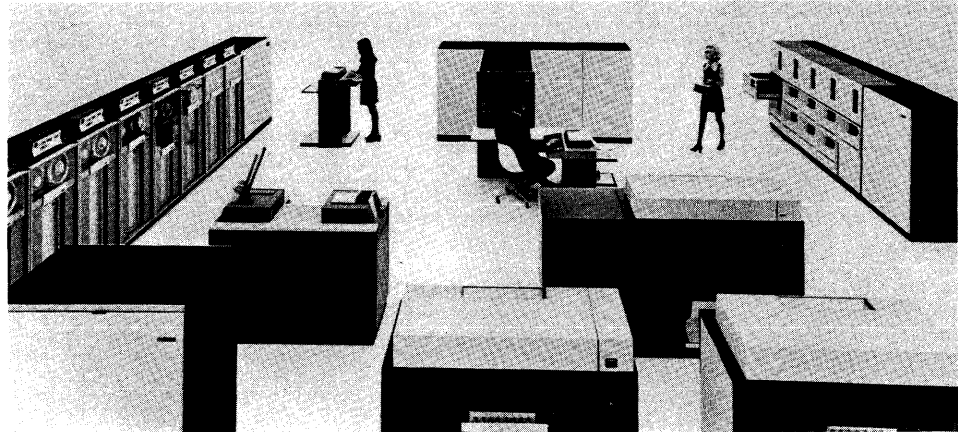
The 2305 Model 1, usable only with the System/370 Model 165, stores up to 5.4 million bytes of data. Each of the 384 addressable tracks can hold up to 14,136 bytes. Average access time is 2.5 milliseconds, and data transfer rate is 3.0 million bytes per second.

The 2305 Model 2, usable with either Model 155 or 165, 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 System/370 Block Multiplexer Channels. 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.

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A typical disk/tape configuration of the Model 155.



▷ PERIPHERAL EQUIPMENT

Only two completely new peripheral devices were introduced with the System/370, but each represents a significant evolutionary advance in performance.

The 3211 Printer uses an improved version of IBM's now-familiar horizontal-chain printing technique to achieve speeds of 2000 lines per minute with the standard 48-character set. The Universal Character Set feature makes it possible to use large, custom-designed character sets and still achieve impressive printing speeds, and a 180-byte forms control buffer replaces the usual carriage control tape. Unfortunately, the 3211's increased performance is accompanied by a nearly equivalent increase in price. As compared with the 1100-lpm IBM 1403-N1 Printer and its associated train cartridge and control unit, the 3211 provides an 82 percent improvement in rated printing speed at a 70 percent increase in monthly rental (\$2,800 versus \$1,647). Thus, when reliability and operational flexibility are considered, many installations that employ multiprogramming will probably choose a pair of 1403-N1 Printers rather than a single 3211.

The 3330 Disk Storage Facility, a logical extension of the design concepts employed in the earlier 2314 Direct Access Storage Facility, shapes up as a truly outstanding mass storage device in every respect. As compared with an 8-drive 2314-A facility, an 8-drive 3330 facility provides 3.4 times the storage capacity (800 million bytes versus 233 million), half the average head-positioning time (30 milliseconds versus 60), two-thirds the average rotational delay (8.4 milliseconds versus 12.5), and 2.6 times the data transfer rate (806,000 bytes per second versus 312,000)—at only 1.53 times the 2314-A's monthly rental cost (\$7,600 versus \$4,970). The 3330 should open up a host of new applications that require rapid access to large on-line data banks.

Also usable with the System/370 is the 2305 Fixed-Head Storage Facility, introduced in February 1970 for System/360 Models 85 and 195. The 2305 provides extreme-

▷ **3330 DISK STORAGE:** Provides fairly rapid access to extremely large quantities of data stored in interchangeable 3336 Disk Packs. Each 3330 Disk Storage Module contains two independent disk drives, each mounted in a powered drawer for operating convenience. Up to four 3330 modules (eight drives) can be connected to a 3830 Storage Control, which occupies one control unit position on a System/370 Block Multiplexer Channel. Rotational Position Sensing and Multiple Requesting, as described under the 2305 above, are standard features. A Command Retry facility enables the 3330 subsystem to recover from many errors without the use of time-consuming error recovery programs. Error correction coding circuitry in the control unit permits detection and correction of bursts of errors up to 11 bits in length on a single track.

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 3330 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. Deliveries are scheduled to begin in August 1971.

OTHER MASS STORAGE DEVICES: Most of the System/360 mass storage units, such as the 2314 Direct Access Storage Facility, can also be used with the System/370. Please refer to the System/360 report (70C-491-03) for descriptions of these units. Exceptions are the 2301 Drum Storage and 2302 Disk Storage, which have been displaced by the improved System/370 devices.

INPUT/OUTPUT UNITS

3211 PRINTER: Provides high-speed printed output by means of an endless "train" of 432 type characters that move horizontally in front of the print 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

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▷ ly fast access to comparatively small quantities of data, making it ideal for systems residence functions, directories, and work files.

Communications control functions in the System/370 will be handled, as in the System/360, by the 2701 Data Adapter Unit and the 2703 Transmission Control, which place the communications processing burden squarely upon the associated central processor. Though numerous companies are now supplying "front-end" communications processors for use with the System/360, IBM has to date failed to endorse the concept by introducing a similar unit for either the System/360 or 370.

Of the vast array of peripheral devices available for the System/360, most are also usable with the System/370. Exceptions include the 2301 Drum, which is superseded by the 2305, and the 1231 and 1285 Optical Readers, for which IBM anticipates insufficient customer demand.

SOFTWARE

IBM has insured against a repetition of the System/360 software development crisis by enabling the System/370 computers to use most of the software which is already in use with the System/360. Specifically, the Model 165 will use the Operating System/360 (OS), while Model 155 users can choose either OS or the simpler but less powerful Disk Operating System (DOS). Associated with each of these operating systems is a broad range of compilers, utility routines, and application programs. After years of agonizing development work, the System/360 software has now reached a point where it can perform virtually all of the advertised functions—though its efficiency in many areas still leaves ample room for improvement.

Concurrently with the System/370 introduction, IBM announced a number of new and enhanced software products. Most of the new products can also be used with certain models of the System/360, and nearly all are separately priced, with monthly license fees ranging from a modest \$40 to a hefty \$1,060.

COMPATIBILITY

IBM promises that the System/370 will offer a high degree of program and data compatibility with the System/360. Current System/360 users will be able to run their application programs on a System/370 with little or no modification. Two minor changes to the System/360 architecture may be of significance to certain users: (1) the ASCII mode hardware facility is not implemented in the System/370, and (2) the handling of invalid signs on decimal operands is different.

Otherwise, all of the new hardware features of the System/370 appear to represent extensions, rather than ▷

▶ 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.

The 3211 Printer and its associated 3811 Control Unit can be used with System/370 Models 155 and 165, and also with System/360 Models 30, 40, 50, 65, 67, 75, 85, 91, and 195. Deliveries are scheduled to begin in December 1971.

OTHER INPUT/OUTPUT UNITS: Most of the System/360 I/O units that are usable with a Model 40, 50, or 65 can also be used with the System/370 Model 155. Similarly, most of the System/360 I/O units that are usable with a Model 65 or 75 can also be used with the System/360 Model 165. Please refer to the System/360 report (70C-491-03) for descriptions of these units.

COMMUNICATION CONTROL

System/370 data communication functions will be controlled by the IBM 2701 Data Adapter Unit, 2703 Transmission Control, 2711 Line Adapter Unit, and/or 7770 Audio Response Unit. Please refer to the System/360 report (70C-491-03) for descriptions of these units.

Nearly all of the IBM communication terminal equipment covered in the Peripherals section of DATAPRO 70 can be used with the System/370. Examples are the 2740 and 2741 Communication Terminals, the 2260 and 2265 Display Stations, and the 2780 Data Transmission Terminal.

SOFTWARE

GENERAL: Software support for the System/370 Models 155 and 165 is basically the same as that provided for the System/360. Support for the System/370 is, however, provided at only two levels. The Model 155 can run under control of either the Disk Operating System (DOS) or the Operating System (OS). The Model 165 runs under control of only the Operating System. Two versions of OS support are provided: Multiprogramming with a Fixed Number of Tasks (MFT) and Multiprogramming with a Variable Number of Tasks (MVT). Software support for the new 3330 Disk Storage Facility will be provided, at first customer shipment, under both the MFT and MVT versions of OS, while the 2000-lpm 3211 Printer will be supported under both DOS and OS.

Since the System/370 is compatible with the System/360 and actually operates under control of basically the same software, the great variety of System/360 DOS and OS compilers, assemblers, utilities, application packages, etc., will also be available, for the most part, for use with the ▶

IBM System/370 Models 155 & 165

▷ modifications, of the System/360 architecture. As a result, it should be fairly easy to execute existing System/360 programs on a System/370—usually with no need for reassembly or recompilation. Conversely, it will *not* be possible to directly execute System/370 programs on a System/360 if they make use of the System/370's new instructions or other new hardware features—but this type of downward compatibility is of far less importance to most users.

Integrated emulation is an important System/370 option that will enable users to run IBM 1400 Series and 7010 programs on a Model 155 and to run IBM 7070 Series, 7080, or 7090 Series programs on a Model 165. These new compatibility options run under control of the regular operating system, enabling emulator jobs to be processed as part of a multiprogramming mix. Thus, IBM has granted another reprieve to the thousands of users who have not yet gotten around to converting their second-generation programs—and simultaneously ensured that a high percentage of these users will stay “locked in” to IBM for several more years.

It is fairly safe to predict that the forthcoming swing from System/360 to System/370 will be marked by a noteworthy *lack* of conversion problems. The reason is simply that neither IBM nor its users can afford another conversion nightmare of the type that accompanied the advent of the System/360 in the mid-sixties, and IBM is obviously taking great pains to avoid a recurrence. The similarity of the System/370 architecture to that of the System/360, coupled with the use of essentially the same peripheral equipment and software, should help to ensure comparatively smooth, straightforward conversions this time.

SUPPORT

The System/370 computers will receive essentially the same “unbundled” support as the System/360, which means that users must now pay separately for most of the educational courses and technical support that were formerly included in IBM's equipment prices.

Most of the existing System/360 software facilities were delivered prior to IBM's unbundling announcement in June 1970 and are therefore available to System/370 users at no additional cost. But most System/370 users will find it advantageous to use the improved assembler, compilers, sort routines, and other software products that were announced along with the System/370—and these new products are separately priced. Thus, it is becoming apparent that IBM computer users will henceforth be subjected to subtle pressures toward continual upgrading—to IBM's economic advantage—of their software as well as their hardware.

▶ System/370. Complete descriptions of the DOS and OS software facilities can be found in Report 70C-491-03.

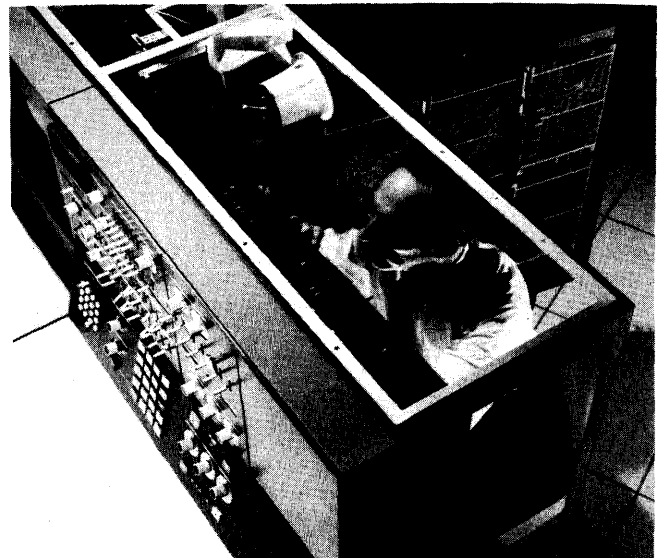
IBM also announced several new and enhanced software products with its announcement of the System/370. These new products can be used not only with the System/370, but also with certain models of the System/360. Most of the new software products, described in the following paragraphs, are offered for use under a licensing agreement at separate monthly charges ranging from \$40 to \$1,060.

PL/I OPTIMIZING COMPILER: A new PL/I compiler will be provided, offering improvements in both compiling and object program execution speeds through proper use of three optimization options. Two versions will be provided, for DOS and OS environments. Both versions also offer several improved language facilities over the existing PL/I F-level language. The OS version of the new PL/I compiler supports the OS/360 Time-Sharing Option (TSO) and can also interface with the Telecommunications Access Method.

Both PL/I versions support the Extended Precision Floating Point feature of the System/370 hardware. This feature is simulated when the hardware facility is not present. Both versions also include new debugging aids to provide better diagnostics and improved tracing capabilities.

The new compilers are upward-compatible with existing DOS and OS PL/I compilers, so programs written for the earlier compilers can be compiled by the newer versions. The new DOS PL/I compiler is scheduled for delivery in July 1971; the OS version is due in September 1971.

COBOL: New versions of the USA Standard (now called the American National Standard or ANS) COBOL compilers have been announced for use under both DOS and OS. IBM emphasizes that these COBOL compilers include all the features prescribed for the COBOL language by the American National Standards Institute (ANSI).



▶ An IBM technician checks out the 3066 System Console, control and maintenance center of the Model 165 system.

IBM System/370 Models 155 & 165

▷ ECONOMICS OF THE SYSTEM/370

The System/370 processors clearly offer significantly more performance per dollar to current users of the medium-to-large-scale System/360 computers. But it is equally clear that the user must really *need* that additional performance in order to justify upgrading, because a move to the System/370 will lead to increased equipment costs in nearly every case.

Core storage is dramatically less expensive in the System/370 than in the System/360, mainly because the System/370's buffer storage enables IBM to extract high overall performance from relatively slow core memories. (For example, a 262K-byte increment of core storage, which can be added to a System/370 Model 155 or 165 for only \$3,000 a month, costs \$6,195 a month for a System/360 Model 50 and \$9,245 a month for a Model 65.) But the System/370 central processors are considerably *more* costly than the System/360 processors they are meant to replace. (A Model 155 processor with the minimum 262K bytes of core storage, for example, rents for \$21,500 a month, compared with only \$15,140 a month for a System/360 Model 50 processor with equivalent storage and I/O channels.)

Thus, the entry cost of System/370 computing will be substantially higher than the rentals currently being paid by most System/360 Model 40 and 50 users—and completely out of the ballpark for virtually all Model 25 and 30 users. In order to justify an upgrade to a System/370, a user will generally have to really need substantially higher internal speed and a larger core storage capacity. Then, if he really wants to take full advantage of the new hardware capabilities, he'll have to be prepared to redesign some of his present programs and cope with the increased operational complexities of all-out multiprogramming.

This reasoning leads us to the conclusion that the System/370 Models 155 and 165 have by no means obsoleted all of the installed System/360 Models 40 through 75. And, of course, that's exactly how IBM planned it: increased performance for those System/360 users who need it and are willing to pay the price, without sudden obsolescence of the whole customer base of installed System/360 computers and loss of the vast revenues it provides. □

▶ Among the enhancements added to the earlier IBM ANS COBOL compilers are the following, all designed to assist in source language debugging: formatted tracing of a selected number of procedures; printing the identification number of the COBOL statement being executed at the time of an unusual program termination; producing a sorted cross-reference list; and, for the DOS version, providing formatted dumps of core storage and selected data at designated points during execution. Another

addition to both compilers is the ability to accept and create ASCII magnetic tape files and labels.

IBM states that the core storage requirements for these new COBOL compilers will be the same as the requirements for the earlier versions. The new DOS COBOL compiler is scheduled for delivery in June 1971; the OS version is due in March 1971.

FORTTRAN H: A new FORTRAN compiler will feature improved computational and input-output handling capabilities. The Extended Precision Floating Point hardware feature is supported (and simulated when not present in the hardware). This feature provides a floating point fraction of 28 hexadecimal digits, providing about 34 decimal digits of precision. Input/output control is improved by handling high-speed data transfers asynchronously and by eliminating the use of the FORMAT statement for some list-directed I/O.

Additions have also been made to the FORTRAN H library, and a new Automatic Function Selection feature of the language facilitates referencing these library and built-in functions. The new FORTRAN H compiler is scheduled for delivery in March 1971.

ASSEMBLER H: The System/370 announcement included an improved version of the OS/360 Assembler H. Its principal feature is improved assembling speed. IBM states that the improvement can range as high as 50 percent or more.

Assembler H will include the capability to handle the System/370's 13 new instructions. It will also provide macro language extensions, improved diagnostics, support of the Extended Precision Floating Point feature, and batched assemblies within a single job step.

The new Assembler H is upward compatible with the existing System/360 assemblers. It is scheduled for delivery in February 1971 with the first Model 155 systems.

SORT/MERGE: An enhanced version of the OS/360 Sort/Merge utility program, called OS-SM1, can function equally well with System/360 or 370 systems. Its features and capabilities are similar to those of the DOS-SM1 Sort/Merge package, announced in April 1970, which can also function with the System/370. Existing user-prepared control cards and exit routines can be used with no change when using the new Sort/Merge programs.

The new OS Sort/Merge should be approximately 10 percent faster than its earlier counterpart, and the DOS improvement can be up to 42 percent, according to IBM. The OS Sort/Merge program fully supports the new 3330 Disk Storage Facility.

The new OS and DOS Sort/Merge programs include support for ASCII-formatted files recorded on 9-track magnetic tape. They also offer expanded exit facilities to assist the user in writing his own-code additions to the sort/merge process.

The new OS Sort/Merge program is scheduled for delivery in January 1971.

IMS II (INFORMATION MANAGEMENT SYSTEM—Version 2): A new version of an IBM Program Product previously announced for use with the System/360, IMS II is designed to ease the task of creating, maintaining, ▶

IBM System/370 Models 155 & 165

▶ and accessing large direct-access data files. Both versions of IMS function only under the Operating System (OS).

Perhaps the most significant feature of IMS II is its support of the new 3330 Disk Storage Facility. Also, a new data base indexing capability permits the inter-relating of multiple data bases. Access to logically related data files stored on direct-access devices can be in either direct or indexed direct fashion.

IMS II is provided in two versions, one for batch processing environments and one for data communications environments in which the access to centrally stored data files takes place through remote terminals. The communications version supports the following devices:

- 1030 Data Collection System
- 1050 Data Communication System
- 2260 Display Station
- 2740 Communication Terminal
- 2780 Data Transmission Terminal

The communications version of IMS II basically acts as a message handling control system. The user must provide the programs, written in COBOL or PL/I, to process these messages. IMS II provides, in addition, message editing and remote terminal diagnostic facilities.

Other features of IMS II include a checkpoint-restart capability for both batch and communications environments, and improved "fail-soft" functions that the user can optionally employ through the OS macro services STAE and SPIE.

IBM plans to deliver IMS II by March 1971. It is expected to be upward-compatible with IMS I used with the System/360.

GPSS V: The System/370 announcement included a "new and improved" version of the System/360's General Purpose Simulation System. The new version can handle larger problems involving more entities through the optional use of disk files for auxiliary storage. Transactions, the common units which move through a GPSS model over a period of time, may have up to 1,020 parameters. Parameter data types can now include byte and single-precision floating point formats.

Two additional features of GPSS V include (1) a new interface that permits two-way communication between GPSS V and user routines written in PL/I, and (2) the ability to dynamically change resource availability during a run to account for either availability or non-availability of a specific resource.

The OS version of GPSS V is scheduled for delivery in November 1970; a DOS version is due in December 1970.

DATA/360-OS: The announcement of DATA/360-OS with the System/370 extends the capabilities of the previously announced DATA/360-DOS program product. Both versions can be used on either a System/360 or System/370.

DATA/360 is a software system that permits on-line data entry to a System/360 or 370 through IBM 2260 Display Stations. It appears to be IBM's long-term answer to the keypunch-verifier replacement market (notwithstanding the existence of the somewhat limited IBM 50 Data Inserter for key-to-tape applications). The new OS version of DATA/360 offers most of the features of the DOS version, plus these additions:

1. Support of up to 48 local 2260 Display Stations.
2. Seven format levels per source document.
3. Up to 24 fields per record.
4. The ability to add or delete records at any time.
5. A user exit to permit use of own-code routines for such purposes as verifying check digits.

RECOVERY MANAGEMENT SYSTEM (RMS): The System/360's RMS software package is designed to gather data on hardware malfunctions and automatically corrected machine errors for use by IBM Customer Engineers in their diagnostic and maintenance activities. RMS is an improved version of a similarly named system used with the large-scale System/360 computers. In addition to its data collection functions, RMS can determine that certain hardware failures need only be logged and that processing can be allowed to continue uninterrupted. ▶



This Model 155 central processor is being tested in IBM's Poughkeepsie plant.

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► **RETAIN/370:** This is a totally new system maintenance software package introduced with the System/370. Its acronym stands for "Remote Technical Assistance and Information Network." Its purpose is to provide special assistance to the IBM Customer Engineers when they encounter unusual difficulties in solving complex hardware maintenance problems.

IBM will store data banks of technical information on hardware problems in Technical Support Centers in New York, Chicago, and Los Angeles. Through RETAIN/370, Customer Engineers can dial up access to these data banks and request any available information on the specific problems at hand. A technician at the support center will view any available information on a display screen and relay anything pertinent to the Customer Engineer. If the results are uninformative, the technician at the support center can initiate remote testing of the malfunctioning unit or system for his own analysis and evaluation. When a solution is finally reached, it is stored in the support center's data bank for use whenever a similar problem arises.

PRICING

EQUIPMENT: The following systems illustrate typical System/370 configurations. Obviously, they comprise only a small sampling of the extensive configuration possibilities within the System/370 line. All necessary control units and adapters are included in the indicated prices, and the quoted rental prices include equipment maintenance.

MODEL 155 TAPE/DISK SYSTEM: Consists of 262K Model 155 Processor with two Block Multiplexer Channels and one Byte Multiplexer Channel, four-drive 2314-A Direct Access Storage Facility (116 million bytes), eight 2401 Model 5 Magnetic Tape Units (120KB) and dual-channel tape control, 2540 Card Read Punch, 1403 Model N1 Printer, and 3210 Console Printer-Keyboard. Monthly rental and purchase prices are approximately \$33,000 and \$1,543,000, respectively.

EXPANDED MODEL 155 TAPE/DISK SYSTEM: Consists of 1048K Model 155 Processor with four Block Multiplexer Channels and two Byte Multiplexer Channels, eight-drive 3330 Disk Storage Facility (800 million bytes), twelve 2420 Model 5 Magnetic Tape Units (160KB) and two tape controls, two 2540 Card Read Punches, two 3211 Printers, and 3215 Console Printer/Keyboard. Monthly rental and purchase prices are approximately \$56,800 and \$2,662,000, respectively.

MODEL 165 TAPE/DISK SYSTEM: Consists of 524K Model 165 Processor, three Selector Channels, one Byte Multiplexer Channel, nine-drive 2314-A Direct Access Storage Facility (233 million bytes on-line), twelve 2401

Model 6 Magnetic Tape Units (180KB) and two dual-channel tape controls, 2540 Card Read Punch, 1403 Model N1 Printer, and 3066 System Console. Monthly rental and purchase prices are approximately \$70,800 and \$3,332,000, respectively.

EXPANDED MODEL 165 TAPE/DISK SYSTEM: Consists of 2097K Processor with Buffer Expansion and High-Speed Multiply features, four Block Multiplexer Channels, two Byte Multiplexer Channels, two 8-drive 3330 Disk Storage facilities (1600 million bytes), 2305 Model 2 Fixed-Head Storage Facility (11.2 million bytes), twelve 2420 Model 7 Magnetic Tape Units (320KB) and two tape controls, two 2540 Card Read Punches, two 3211 Printers, and 3066 System Console. Monthly rental and purchase prices are approximately \$124,200 and \$5,873,000, respectively.

SOFTWARE: System/360 software which was being distributed by the IBM Program Library as of June 23, 1969, will be available to System/370 users at no additional charge. All subsequent 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.

SUPPORT: IBM Systems Engineering assistance is available to System/370 users at a basic rate of \$28 per hour for Model 155 systems and \$35 per hour for Model 165 systems.

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/370 components, is 10% of the basic hourly rate (i.e., 10% of 1/176 of the monthly rental for each hour of extra use). ■

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EQUIPMENT PRICES

		Purchase Price	Monthly Maint.	Rental (1-year lease)*
PROCESSORS AND MAIN STORAGE				
3155	Processing Unit (for Model 155 system; requires 3360 Mod. 1, 2, or 3 Processor Storage)			
	H; 262,144 bytes	888,000	2,160	18,500
	HG; 393,216 bytes	889,200	2,160	18,525
	I; 524,288 bytes	890,400	2,160	18,550
	IH; 786-432 bytes	912,000	2,170	19,000
	J; 1,048,576 bytes	914,400	2,170	19,050
	Jl; 1,572,864 bytes	991,200	2,240	20,650
	K; 2,097,152 bytes	1,015,200	2,250	21,150
3165	Processing Unit (for Model 165 system; requires 3360 Mod. 4 or 5 Processor Storage)			
	I; 524,288 bytes	1,584,000	3,960	33,000
	J; 1,048,576 bytes	1,588,800	3,970	33,100
	Jl; 1,572,864 bytes	1,608,000	4,000	33,500
	K; 2,097,152 bytes	1,622,400	4,050	33,800
	KJ; 3,145,728 bytes	1,670,400	4,150	34,800
3066	System Console (required in Model 165 system)	148,800	460	3,100
3067	Power and Coolant Distribution Unit (required in Model 165 system)	110,400	110	2,300
9447	208/230-volt Motor Generator Set (for Model 165)	15,000	—	Purchase only
9449	440-volt Motor Generator Set (for Model 165)	15,000	—	Purchase only
3360	Processor Storage			
	Mod. 1; 262,144 bytes (for Model 155)	132,000	290	3,000
	Mod. 2; 393,216 bytes (for Model 155)	198,000	435	4,500
	Mod. 3; 524,288 bytes (for Model 155)	264,000	580	6,000
	Mod. 4; 262,144 bytes (for Model 165)	132,000	290	3,000
	Mod. 5; 524,288 bytes (for Model 165)	264,000	580	6,000
PROCESSING UNIT FEATURES AND CHANNELS				
For 3155 Processing Unit (Model 155):				
1433	Third Block Multiplexer Channel	13,125	15	375
1434	Fourth Block Multiplexer Channel	12,250	12	350
1435	Fifth Block Multiplexer Channel	6,125	6	175
1850	Channel-to-Channel Adapter	12,250	10	350
3274	Direct Control	3,000	5	100
3700	Extended Precision Floating Point	8,400	20	175
3950	IBM 1401/1440/1460/1410/7010 Compatibility	16,000	20	400
4990	Second Byte Multiplexer Channel	13,125	15	375
5450	OS/DOS Compatibility	10,000	20	250
7844	Adapter for 3210-1 Printer/Keyboard	7,200	10	150
7845	Adapter for 3210-2 Printer/Keyboard	8,160	10	170
7855	Adapter for 3215 Printer/Keyboard	9,600	10	200
3210	Console Printer-Keyboard (for Model 155)			
	Mod. 1; 15 char/sec; local	5,600	85	175
	Mod. 2; 15 char/sec; remote	5,760	90	180
3215	Console Printer-Keyboard; 85 char/sec (for Model 155)	8,000	55	200
For 3165 Processing Unit (Model 165):				
1432	Buffer Expansion (to 16K bytes)	72,000	75	1,500
3850	Extended Channels	21,600	90	450
4520	High-Speed Multiply	124,800	150	2,600
7117	IBM 7070/7074 Compatibility	139,680	250	2,910
7118	IBM 7080 Compatibility	139,680	250	2,910
7119	IBM 709/7090/7094/7094II Compatibility	139,680	250	2,910
2860	Selector Channel (for Model 165)			
	Mod. 1; one channel	97,855	55	2,100
	Mod. 2; two channels	139,435	90	2,995
	Mod. 3; three channels	181,120	120	3,895
1850	Channel-to-Channel Adapter (for 2860)	9,455	3.75	225
2870	Byte Multiplexer Channel (for Model 165)	103,500	97	2,195
6990	Selector Subchannel—First (for 2870)	17,400	15	400
6991	Selector Subchannel—Second (for 2870)	10,585	10	250
6992	Selector Subchannel—Third (for 2870)	10,585	10	250
6993	Selector Subchannel—Fourth (for 2870)	10,585	10	250
2880	Block Multiplexer Channel (for Model 165)			
	Mod. 1; one channel	141,000	450	3,000
	Mod. 2; two channels	202,100	600	4,300
7850	Two-Byte Interface (for 2880)	16,450	8	350

* Rental prices include equipment maintenance.

IBM System/370 Models 155 & 165 EQUIPMENT PRICES

		<u>Purchase Price</u>	<u>Monthly Maint.</u>	<u>Rental (1-year lease)*</u>
MASS STORAGE				
2305	Fixed Head Storage Facility			
	Mod. 1; 5.4 million bytes (for Model 165 only)	230,300	585	4,900
	Mod. 2; 11.2 million bytes (for Models 155 and 165)	183,300	555	3,900
2835	Storage Control			
	Mod. 1; for 2305 Mod. 1	141,000	525	3,000
	Mod. 2; for 2305 Mod. 2	117,500	445	2,500
3330	Disk Storage; 2-drive module; 200 million bytes	61,100	200	1,300
3830	Storage Control (for up to four 3330 modules)	112,800	170	2,400
8170	Two-Channel Switch (for 3830)	9,400	10	200
3336	Disk Pack (for 3330)	1,000	Time & mat'ls.	Purchase only

NOTE: Please refer to the IBM System/360 Equipment Prices (Report 70C-491-03) for prices of other mass storage equipment that can be used in a System/370.

INPUT/OUTPUT UNITS

3211	Printer; 2000 lpm	81,600	380	1,700
3216	Interchangeable Train Cartridge (for 3211)	11,550	170	350
5554	18 Additional Print Positions (for 3211)	2,640	8	55
3811	Control Unit (for 3211 Printer)	36,000	120	750
5553	18 Additional Print Positions (for 3811)	960	5	20
2821-6	Control Unit (for single 2540 Card Read Punch)	14,960	90	440

NOTE: Please refer to the IBM System/360 Equipment Prices (Report 70C-491-03) for prices of other input/output and communications equipment that can be used in a System/370.

SOFTWARE PRICES

Program Product	Monthly Use Charge
PL/I Optimizing Compiler (DOS or OS)	\$250
Additional Language Features for ANS COBOL, Version 3 (DOS)	75
Additional Language Features for ANS COBOL, Version 3 (OS)	40
Extensions of FORTRAN H Compiler (OS)	260
Extensions of FORTRAN H Library (OS)	90
Improved Assembler H (OS)	225
OS-SM1 Sort/Merge (OS)	60
IMS II — batch version (OS)	500
IMS II — batch and communications version (OS)	1,060
Enhancements to GPSS	75

* Rental prices include equipment maintenance.