IBM System/370

MANAGEMENT SUMMARY

IBM's System/370 series was introduced in June 1970. The System/370 accounts for approximately 20 percent of the currently installed computer systems in the United States. The System/370 family of medium-to-large-scale computer systems includes a total of 23 central processor models. Price/performance advances have caused IBM to supersede most of these models, leaving only two models, the 138 and 148, currently in limited new production.

In March 1977, IBM unveiled the 303X series as the first successor series to the System/370 Models 155 through 168. With the introduction of the 303X new processors, IBM offered enhanced price/performance over the System/370. The most significant enhancements were System/370 System Extensions, which are firmware (control storage) implementations of certain frequently executed portions of the control programs.
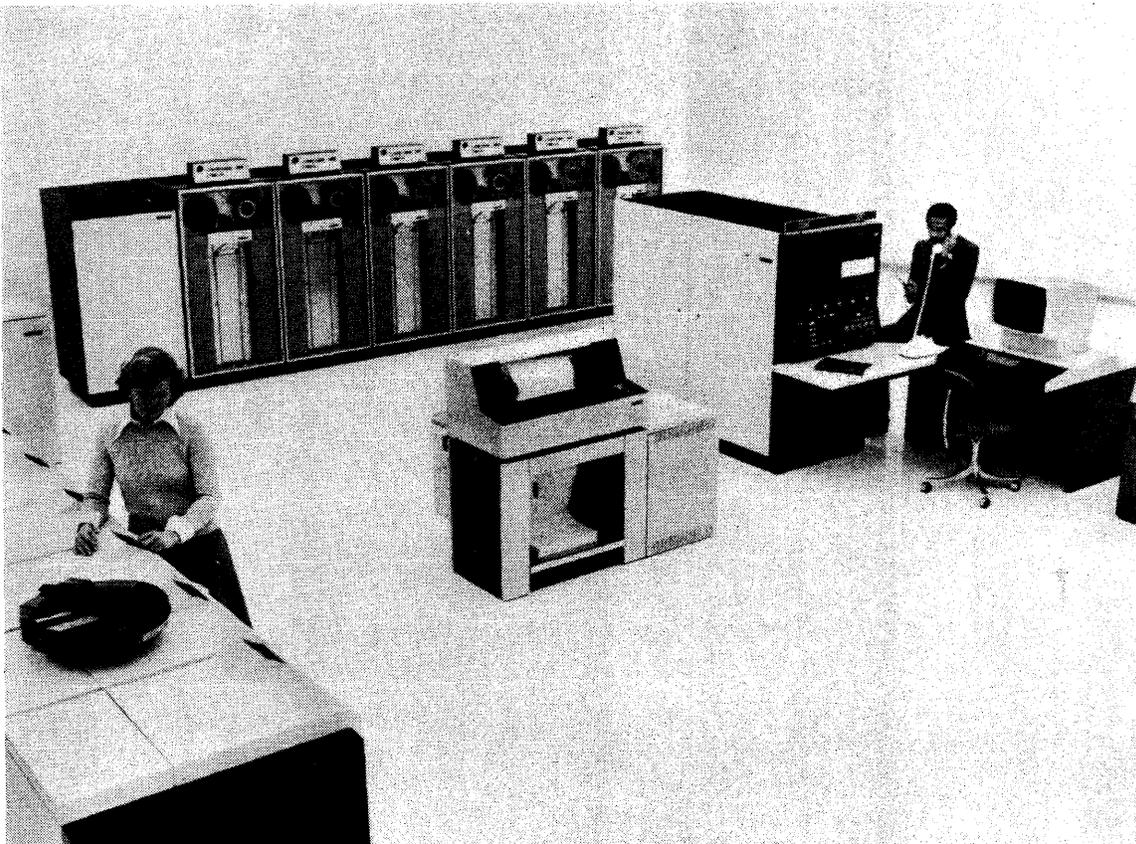
The long-awaited medium-scale 43XX processors made their debut in January 1979. The first two processors, the 4331 and 4341, offer a strikingly improved price/performance and new hardware that utilizes effectively such developments as high density packaging, thin-film ▷

The ten-year old IBM System/370 accounts for over 20 percent of all installed computer systems in the United States today. Although the System/370 computer family includes 23 distinct processors, only the Models 138 and 148 are in limited new production. All other models are marketed on an as-available basis, having been replaced in IBM's marketing by the 303X or 4300 processors. This comprehensive report summarizes the entire System/370 line, along with a summary of the experience of 277 System/370 users.

CHARACTERISTICS

MANUFACTURER: International Business Machines Corporation, Data Processing Division, 1133 Westchester Avenue, White Plains, New York 10604. Telephone (914) 696-1900.

MODELS: System/370 Model 115 through Model 195. At this writing, Models 138 and 148 are in limited new production and Models 115, 115-2, 125, 125-2, 158, 158MP, 158-3, 168, 168MP, and 168-3 are not in new production and are sold on an as-available basis only. Models 135, 135-3, ▶

The Model 138 is one of the two System/370 processor models still in new limited production at this writing.

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CHARACTERISTICS OF THE SYSTEM/370 PROCESSOR MODELS

	Model 115	Model 115-2	Model 125	Model 125-2	Model 135	Model 135-3
SYSTEM CHARACTERISTICS						
Date of first introduction	March 1973	Nov. 1975	Oct. 1972	Nov. 1975	March 1971	June 1976
Date of first delivery	1st Qtr. 1974	Aug. 1976	April 1973	Feb. 1976	May 1972	1st qtr. 1977
Virtual storage capability	Standard	Standard	Standard	Standard	Standard	Standard
Number of central processors	1	1	1	1	1	1
Principal operating systems	DOS/VS	DOS/VS	DOS/VS	DOS/VS	DOS/VS, OS/VS1	DOS/VS
Production status	Not in new production	Not in new production	Not in new production	Not in new production	No longer marketed	No longer marketed
MAIN STORAGE						
Storage type	Semicond. (MOS)	Semicond. (MOS)	Semicond. (MOS)	Semicond. (MOS)	Semicond. (bipolar)	Semicond. (bipolar)
Read cycle time, nanoseconds	480	480	480	480	770	540
Write cycle time, nanoseconds	480	480	480	480	935	608
Bytes fetched per cycle	2	2	2	2	2 or 4	2 or 4
Storage interleaving (maximum)	None	None	None	None	None	None
Minimum capacity, bytes per system	65,536	65,536	98,304	98,304	98,304	262,144
Maximum capacity, bytes per system	196,608	393,216	262,144	524,288	524,288	524,288
Increment size, bytes	32,768	32,768-131,072	32,768 or 65,536	32,768-131,072	49,152 to 131,072	65,536 or 131,072
BUFFER STORAGE						
Cycle time, nanoseconds	—	—	—	—	—	—
Bytes fetched per cycle	—	—	—	—	—	—
Minimum capacity, bytes	None	None	None	None	None	None
Maximum capacity, bytes	None	None	None	None	None	None
PROCESSING UNIT						
Machine cycle time, nanoseconds	480	480	480	480	275-1485	275-1485
Relative performance level (estimated)	1.00	1.40	1.45	1.80	2.90	3.80
Processing unit features:						
Control storage, bytes	20,480 to 28,672	12,288 to 20,480	12,288 to 20,480	16,384 to 24,576	24,576 to 49,152	131,072
Clock Comparator & CPU Timer	Standard	Standard	Standard	Standard	Optional	Optional
Direct Control	No	No	No	No	Optional	Standard
Dynamic Address Translation	Standard	Standard	Standard	Standard	Standard	Standard
Floating Point	Optional	Optional	Optional	Optional	Optional	Optional
Extended Precision Floating Point	Optional	Optional	Optional	Optional	Optional	Optional
High-Speed Multiply	No	No	No	No	No	No
3880 Storage Control for 3330/3333, 3340/3344, and 3350	No	No	No	No	No	No
Integrated 2319 Disk Control	No	No	No	No	Optional	Optional
Integrated 3330 Disk Control	No	No	Standard	Standard	Optional	No
Integrated 3340/3344 Disk Control	Std. 3340	Standard	Std. 3340	Standard	Optional	Optional
Integrated 3350 Disk Control	No	No	No	No	No	No
Integrated 1403 Printer Control	No	No	Optional	Optional	Optional	Optional
Integrated 3203 Printer	Optional	Optional	Optional	Optional	No	No
Integrated 5203 Printer	Optional	Optional	No	No	No	No
Integrated Card I/O	Optional	Optional	Optional	Optional	No	No
Integrated Communications Control	Optional	Optional	Optional	Optional	Optional	Optional
Compatibility features:						
IBM 1401/1440/1460 Compatibility	Optional	Optional	Optional	Optional	Optional	Optional
IBM 1410/7010 Compatibility	No	No	No	No	No	No
IBM 7070/7074 Compatibility	No	No	No	No	No	No
IBM 7080 Compatibility	No	No	No	No	No	No
IBM 709/7090/7094 Compatibility	No	No	No	No	No	No
IBM 360/20 Compatibility	Optional	Optional	Optional	Optional	Optional	Optional
OS/DOS Compatibility	No	No	No	No	Standard	Standard
IBM 1502 & 2311 Compatibility	Optional	Optional	Optional	Optional	No	No
CHANNELS						
No. of Selector Channels per system	None	None	None	None	0 to 2	None
No. of Block Multiplexer Channels	None	None	None	None	0 to 2	0 to 2
No. of Byte Multiplexer Channels	0 or 1	0 or 1	0 or 1	0 or 1	1	1
Maximum total I/O data rate, bytes/second	900,000	900,000	900,000	900,000	2,400,000	2,600,000

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CHARACTERISTICS OF THE SYSTEM/370 PROCESSOR MODELS (Continued)

	Model 138	Model 145	Model 145-3	Model 148	Model 155	Model 155-II
SYSTEM CHARACTERISTICS						
Date of introduction	June 1976	Sept. 1970	June 1976	June 1976	June 1970	Aug. 1972
Date of first delivery	Nov. 1976	July 1971	2nd qtr. 1977	Jan. 1977	Feb. 1971	April 1973
Virtual storage capability	Standard	Standard	Standard	Standard	No**	Standard
Number of central processors	1	1	1	1	1	1
Principal operating systems	DOS/VS, OS/VS1	DOS/VS, OS/VS1, OS/VS2	DOS/VS, OS/VS1	DOS/VS, OS/VS1, OS/VS2	DOS/VS, OS/MFT, OS/MVT	DOS/VS, OS/VS1, OS/VS2
Production status	Limited new production	No longer marketed	No longer marketed	Limited new production	No longer marketed	No longer marketed
MAIN STORAGE						
Storage type	Semicond. (MOS)	Semicond. (bipolar)	Semicond. (bipolar)	Semicond. (MOS)	Core	Core
Read cycle time, nanoseconds	710-770	540	540	405	2070	2070
Write cycle time, nanoseconds	935	608	608	540	2070	2070
Bytes fetched per cycle	2	4 or 8	4 or 8	4	16	16
Storage interleaving (maximum)	None	None	None	None	None	None
Minimum capacity, bytes per system	524,288	164,840	196,608	1,048,576	262,144	262,144
Maximum capacity, bytes per system	1,048,576	2,097,152	2,031,616	2,097,152	2,097,152	2,097,152
Increment size, bytes	524,288	49,152 to 262,144	126,976 to 524,288	1,048,576	131,072 to 524,288	131,072 to 524,288
BUFFER STORAGE						
Cycle time, nanoseconds	—	—	—	—	115	115
Bytes fetched per cycle	—	—	—	—	2	2
Minimum capacity, bytes	None	None	None	None	8,192	8,192
Maximum capacity, bytes	None	None	None	None	8,192	8,192
PROCESSING UNIT						
Machine cycle time, nanoseconds	275-1485	203-315	180-270	180-270	115	115
Relative performance level (estimated)	3.9	5.45	7.1	7.7	10.0	10.0
Processing unit features:						
Control storage, bytes	131,072	32,768 to 65,536	131,072	131,072	Not spec'd.	Not spec'd.
Clock Comparator & CPU Timer	Standard	Optional	Optional	Standard	No**	Standard
Direct Control	Optional	Optional	Optional	Optional	Optional	Optional
Dynamic Address Translation	Standard	Standard	Standard	Standard	No**	Standard
Floating Point	Standard	Optional	Optional	Standard	Standard	Standard
Extended Precision Floating Point	Standard	Optional	Optional	Standard	Optional	Optional
High-Speed Multiply	No	No	No	No	No	No
3880 Storage Control for 3330/3333, 3340/3344, and 3350	No	Optional	Optional	Optional	No	Optional
Integrated 2319 Disk Control	No	No*	Optional	No	No	No
Integrated 3330 Disk Control	No	Optional	No	No	No	No
Integrated 3340/3344 Disk Control	Optional	Optional	Optional	Optional	No	No
Integrated 3350 Disk Control	No	No	No	No	No	No
Integrated 1403 Printer Control	Optional	No	No	No	No	No
Integrated 3203 Printer	Optional	No	No	Optional	No	No
Integrated 5203 Printer	No	No	No	No	No	No
Integrated Card I/O	No	No	No	No	No	No
Integrated Communications Control	Optional	No	No	No	No	No
Compatibility features:						
IBM 1401/1440/1460 Compatibility	Optional	Optional	Optional	Optional	Optional	Optional
IBM 1410/7010 Compatibility	No	Optional	Optional	Optional	Optional	Optional
IBM 7070/7074 Compatibility	No	No	No	No	Optional	Optional
IBM 7080 Compatibility	No	No	No	No	No	No
IBM 709/7090/7094 Compatibility	No	No	No	No	No	No
IBM 360/20 Compatibility	Optional	No	No	No	No	No
OS/DOS Compatibility	Standard	Standard	Standard	Standard	Optional	Optional
IBM 1052 & 2311 Compatibility	No	No	No	No	No	No
CHANNELS						
No. of Selector Channels per system	None	1 to 4	None	None	None	None
No. of Block Multiplexer Channels	2	1 to 4	1 to 4	4	2 to 5	2 to 5
No. of Byte Multiplexer Channels	1	1	1	1	1 or 2	1 or 2
Maximum total I/O data rate, bytes/second	2,600,000	5,300,000	5,300,000	5,000,000	5,400,000	5,400,000

*Optionally available for Models GE through 1 of the 145 Processing Unit, which are no longer in production, but not for Models H2 through J2.

**Virtual storage capability can be added to a purchased Model 155 through field installation of the Dynamic Address Translation facility, which converts it into a Model 155-II.

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CHARACTERISTICS OF THE SYSTEM/370 PROCESSOR MODELS (Continued)

	Model 158	Model 158-3	Model 158 MP	Model 158-3 MP	Model 165	Model 165-II
SYSTEM CHARACTERISTICS						
Date of introduction	Aug. 1972	March 1975	Feb. 1973	March 1975	June 1970	Aug. 1972
Date of first delivery	April 1973	Sept. 1975	March 1974	Sept. 1975	April 1971	Dec. 1973
Virtual storage capability	Standard	Standard	Standard	Standard	No*	Standard
Number of central processors	1	1	2	2	1	1
Principal operating systems	DOS/VS, OS/VS1, OS/VS2	DOS/VS, OS/VS1, OS/VS2	OS/VS2, Release 2	OS/VS2, Release 2 & Release 3	OS/MFT, OS/MVT	OS/VS1, OS/VS2
Production status	Not in new production	Not in new production	Not in new production	Not in new production	No longer marketed	No longer marketed
MAIN STORAGE						
Storage type	Semicond. (MOS)	Semicond. (MOS)	Semicond. (MOS)	Semicond. (MOS)	Core	Core
Read cycle time, nanoseconds	1035	1035	1035	1035	2000	2000
Write cycle time, nanoseconds	690	690	690	690	2000	2000
Bytes fetched per cycle	8 or 16	8 or 16	8 or 16	8 or 16	8	8
Storage interleaving (maximum)	None	None	None	None	4-way	4-way
Minimum capacity, bytes per system	524,288	524,288	1,048,576	1,048,576	524,288	524,288
Maximum capacity, bytes per system	6,291,456	6,291,456	12,582,912	12,582,912	3,145,728	3,145,728
Increment size, bytes	524,288 or 1,048,576	524,288 or 1,048,576	524,288 or 1,048,576	524,288 or 1,048,576	524,288 or 1,048,576	524,288 or 1,048,576
BUFFER STORAGE						
Cycle time, nanoseconds	115	115	115	115	80	80
Bytes fetched per cycle	2	2	2	2	4	4
Minimum capacity, bytes	8,192	16,384	8,192	16,384	8,192	8,192
Maximum capacity, bytes	8,192	16,384	8,192	16,384	16,384	16,384
PROCESSING UNIT						
Machine cycle time, nanoseconds	115	115	115	115	80	80
Relative performance level (estimated)	15.0	16.4	27.0	29.4	34.5	34.5
Processing unit features:						
Control storage, bytes	Not spec'd.	Not spec'd.	Not spec'd.	Not spec'd.	Not spec'd.	Not spec'd.
Clock Comparator & CPU Timer	Standard	Standard	Standard	Standard	No*	Standard
Direct Control	Optional	Optional	Optional	Optional	Standard	Standard
Dynamic Address Translation	Standard	Standard	Standard	Standard	No*	Standard
Floating Point	Standard	Standard	Standard	Standard	Standard	Standard
Extended Precision Floating Point	Optional	Optional	Optional	Optional	Standard	Optional
High-Speed Multiply	No	No	No	No	Optional	No
3880 Storage Control for 3330/3333, 3340/3344, and 3350	Optional	Optional	Optional	Optional	No	Optional
Integrated 2319 Disk Control	No	No	No	No	No	No
Integrated 3330 Disk Control	Optional	Optional	Optional	Optional	No	No
Integrated 3340/3344 Disk Control	Optional	Optional	Optional	Optional	No	No
Integrated 3350 Disk Control	No	No	No	No	No	No
Integrated 1403 Printer Control	No	No	No	No	No	No
Integrated 3203 Printer	No	No	No	No	No	No
Integrated 5203 Printer	No	No	No	No	No	No
Integrated Card I/O	No	No	No	No	No	No
Integrated Communications Control	No	No	No	No	No	No
Compatibility features:						
IBM 1401/1440/1460 Compatibility	Optional	Optional	Optional	Optional	No	No
IBM 1410/7010 Compatibility	Optional	Optional	Optional	Optional	No	No
IBM 7070/7074 Compatibility	Optional	Optional	Optional	Optional	Optional	Optional
IBM 7080 Compatibility	No	No	No	No	Optional	Optional
IBM 709/7090/7094 Compatibility	No	No	No	No	Optional	Optional
IBM 360/20 Compatibility	No	No	No	No	No	No
OS/DOS Compatibility	Optional	Optional	Optional	Optional	No	No
IBM 1052 & 2311 Compatibility	No	No	No	No	No	No
CHANNELS						
No. of Selector Channels per system	None	None	None	None	0 to 6	0 to 6
No. of Block Multiplexer Channels	2 to 5	2 to 5	4 to 10	4 to 10	0 to 11	0 to 11
No. of Byte Multiplexer Channels	1 or 2	1 or 2	2 to 4	2 to 4	0 to 2	0 to 2
Maximum total I/O data rate, bytes/second	Not spec'd.	Not spec'd.	7,500,000	7,500,000	8,000,000	8,000,000

*Virtual storage can be added to a purchased Model 165 through field installation of the Dynamic Address Translation facility, which converts it into a Model 165-II.

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CHARACTERISTICS OF THE SYSTEM/370 PROCESSOR MODELS (Continued)

	Model 168	Model 168-3	Model 168 MP	Model 168-3 MP	Model 195
SYSTEM CHARACTERISTICS					
Date of introduction	Aug. 1972	March 1975	Feb. 1973	March 1975	July 1971
Date of first delivery	Aug. 1973	June 1975	March 1974	June 1975	2nd qtr. 1973
Virtual storage capability	Standard	Standard	Standard	Standard	No
Number of central processors	1	1	2	2	1
Principal operating systems	OS/VS1, OS/VS2	OS/VS1, OS/VS2	OS/VS2 Release 2 & Release 3	OS/VS2 Release 2 & Release 3	OS/MVT
Production status	Not in new production	Not in new production	Not in new production	Not in new production	No longer marketed
MAIN STORAGE					
Storage type	Semicond. (MOS)	Semicond. (MOS)	Semicond. (MOS)	Semicond. (MOS)	Core
Read cycle time, nanoseconds	480	480	480	480	756
Write cycle time, nanoseconds	480	480	480	480	756
Bytes fetched per cycle	8	8	8	8	8
Storage interleaving (maximum)	4-way	4-way	4-way	4-way	16-way
Minimum capacity, bytes per system	1,048,576	1,048,576	2,097,152	2,097,152	1,048,576
Maximum capacity, bytes per system	8,388,608	8,388,608	16,777,216	16,777,216	4,194,304
Increment size, bytes	1,048,576	1,048,576	1,048,576	1,048,576	1,048,576
BUFFER STORAGE					
Cycle time, nanoseconds	80	80	80	80	54
Bytes fetched per cycle	4	4	4	4	8
Minimum capacity, bytes	8,192	32,768	8,192	32,768	32,768
Maximum capacity, bytes	16,384	32,768	16,384	32,768	32,768
PROCESSING UNIT					
Machine cycle time, nanoseconds	80	80	80	80	54
Relative performance level (estimated)	41.8	45.5	75.3	81.8	86.4
Processing unit features:					
Control storage, bytes	Not spec'd.	Not spec'd.	Not spec'd.	Not spec'd.	Not spec'd.
Clock Comparator & CPU Timer	Standard	Standard	Standard	Standard	No
Direct Control	Standfard	Standard	Standard	Standard	Standard
Dynamic Address Translation	Standard	Standard	Standard	Standard	No
Floating Point	Standard	Standard	Standard	Standard	Standard
Extended Precision Floating Point	Standard	Standard	Standard	Standard	Standard
High-Speed Multiply	Optional	Optional	Optional	Optional	Standard
3880 Storage Control for 3330/3333, 3340/3344, and 3350	Optional	Optional	Optional	Optional	No
Integrated 2319 Disk Control	No	No	No	No	No
Integrated 3330 Disk Control	Optional	Optional	Optional	Optional	No
Integrated 3340/3344 Disk Control	Optional	Optional	Optional	Optional	No
Integrated 3350 Disk Control	Optional	Optional	Optional	Optional	No
Integrated 1403 Printer Control	No	No	No	No	No
Integrated 3203 Printer	No	No	No	No	No
Integrated 5203 Printer	No	No	No	No	No
Integrated Card I/O	No	No	No	No	No
Integrated Communications Control	No	No	No	No	No
Compatibility features:					
IBM 1401/1440/1460 Compatibility	No	No	No	No	No
IBM 1410/7010 Compatibility	No	No	No	No	No
IBM 7070/7074 Compatibility	Optional	Optional	Optional	Optional	No
IBM 7080 Compatibility	Optional	Optional	Optional	Optional	No
IBM 709/7090/7094 Compatibility	Optional	Optional	Optional	Optional	No
IBM 360/20 Compatibility	No	No	No	No	No
OS/DOS Compatibility	No	No	No	No	No
IBM 1052 & 2311 Compatibility	No	No	No	No	No
CHANNELS					
No. of Selector Channels per system	0 to 6	0 to 6	0 to 12	0 to 12	0 to 6
No. of Block Multiplexer Channels	0 to 11	0 to 11	0 to 22	0 to 22	0 to 13
No. of Byte Multiplexer Channels	0 to 2	0 to 2	0 to 4	0 to 4	0 to 2
Maximum total I/O data rate, bytes/second	16,000,000	16,000,000	28,000,000	28,000,000	3,000,000

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technology, intelligent controllers, and advanced firmware. The IBM 4331 processor with 524,288 bytes of memory offers a lower purchase price and up to four times the instruction execution rate of a System/370 Model 115 with 65,536 bytes of memory. It appears to offer performance in the same range as the System/370 Model 138 at a fraction of the 138's price.

PROCESSOR MODELS

At the System/370 height of product maturity, there were 23 distinct central processor models, including both uniprocessor (UP) and multiprocessor (MP) models of the larger systems. During the past few years, most of these models have been withdrawn from production by IBM, leaving only the Models 138 and 148 in limited new production at this writing.

The highlights of the two System/370 models still in production are described in the following paragraphs. Information on the entire System/370 line can be found in the Characteristics Section of this report. Also, a summary of the characteristics in chart form appears on the second through the fifth pages of this report.

Models 138 and 148, introduced in June 1976, offered increases in internal performance of approximately 28 to 43 percent over their respective predecessors, the 370/135 and 370/145, at prices much lower than those of the Model 135 and 145 mainframes—about 45 percent less for purchase and some 22 percent less for rental. Both systems employ MOSFET main memories and control storage instead of the bipolar memories used in the 370/135 and 145. The reloadable control store in both the 138 and 148 is 128K bytes—five times the capacity of the 370/135 and four times that of the 370/145.

The Model 138 is offered with either 524K or 1 million bytes of main memory, 128K bytes of reloadable control store, a 1920-character display console, one byte multiplexer channel, one block multiplexer channel, extended control-program support, and VS APL performance assists. IBM claims the Model 138 offers approximately a 29 to 36 percent internal performance increase over the System/370 Model 135.

The standard Model 148 configuration consists of either 1 or 2 million bytes of main memory, 128K bytes of control store, a display console, one byte multiplexer channel, four block multiplexer channels, a word buffer, extended control-program support, and VS APL performance assists. The 148 is estimated to yield a 28 to 43 percent internal performance improvement over the System/370 Model 145.

The System/370 Models 138 and 148 both have a 1920-character input/output display console and keyboard for operator communications. The CRT can accommodate 24 80-character lines of information. In addition, two printers, the 3286-2 and 3287, may be added for hardcopy output. The 3286 is a 66-cps unit that provides storage for

145, 145-3, 155, 155-II, 165, 165-II and 195 are no longer marketed by IBM. See the table on the preceding pages for a summary of all the processor models and their characteristics.

Beyond providing a listing in the table, processors no longer marketed are not covered in this report.

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.

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: See table.

CAPACITY: See table and price list for main storage and reloadable control storage capacities.

CYCLE TIME: See table. For Models 158 through 168-3, the effective main storage speeds are considerably higher than the figures would seem to indicate because of the semiconductor 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 and main storage are parity-checked by byte. When data is stored, an error-correcting code is substituted for the parity bits. (An 8-bit modified Hamming code is appended to each 8-byte "doubleword" of data.) When the data is retrieved, single-bit errors are detected and corrected automatically, 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 all models.

CENTRAL PROCESSORS

INDEX REGISTERS: 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 basic System/370 instruction set consists of all of the instructions that comprise the System/360 "commercial instruction set" (i.e., the standard System/360 set plus the decimal arithmetic instructions), together with from 13 to 27 new instructions.

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▷ up to 1920 characters. The 3287 features bi-directional printing at speeds of 80 cps (Model 1) or 120 cps (Model 2).

Both the 138 and 148 also provide native attachment capability for one or two 3203 Model 4 Printers. The 3203-4 is a stand-alone version of the 1200-lpm 3200 Model 2 printer used with System/370 Models 115 and 125.

All I/O units that can be attached to a System/370 Model 135 are also available on the Model 138 with the exception of the 3210 and 3215 console printer-keyboards. Attachment of the 2319 disk storage units is available only as part of a 2314 Series B Direct Access Storage Facility. Similarly, all I/O units that can be attached to a System/370 Model 145 are also available on the Model 148 with the exception of the 3210 and 3215 console printer-keyboards.

Extended control-program support is a hardware assist that reduces the CPU time needed to execute certain frequently used supervisor functions in both VM/370 and OS/VS1. This feature can reduce the amount of VM/370 supervisor-state time by up to 55 percent, and that a reduction of 13 to 18 percent in OS/VS1 supervisor-state time has been measured on a Model 138, and 9 to 20 percent on a Model 148.

Both the Model 138 and Model 148 also provide an APL assist. This feature is, in effect, an APL emulator that replaces functions performed by the APL software interpreter to provide improved performance for applications when running in conjunction with the VS APL Program Product.

HARDWARE FEATURES

The System/370 processing units 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, when operating in the System/360-style Basic Control mode, they use a base-plus-displacement addressing scheme that permits direct addressing of up to 16 million bytes of core storage.

The System/370 adds from 13 to 27 new instructions to the System/360's already large instruction set. Thirteen of ▷

▶ The basic System/370 instruction set includes complete arithmetic facilities for processing variable-length decimal and fixed-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. Floating-point arithmetic instructions are standard in Models 138, 148, and the larger models (see table).

The 13 non-System/360 instructions in all System/370 processors are:

   Compare Logical Characters Under Mask (CLM)
   Compare Logical Long (CLCL)
   Halt Device*
   Insert Characters under Mask (ICM)
   Load Control (LCTL)*
   Move Long (MVCL)
   Set Clock (SCK)*
   Shift and Round Decimal (SRP)
   Store Channel ID (STIDC)*
   Store Characters under Mask (STCM)
   Store Clock (TCK)
   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.

In addition, all models with virtual storage capabilities have five instructions for Dynamic Address Translation:

   Load Read Address
   Reset Reference Bit
   Purge Translation Look-Aside Buffer
   Store Then AND System Mask
   Store Then OR System Mask

INSTRUCTION TIMES: Average execution times, in microseconds, for some representative instructions are as follows:

	115	125	138	148	168-3
Add (32-bit binary)	14.5	9.7	2.6	1.7	0.33
Multiply (32-bit binary)	189.9	143.4	25.2	16.0	0.66
Divide (32-bit binary)	210.26	245.5	40.9	31.1	3.28
Load (32-bit binary)	11.3	7.7	2.2	1.1	0.19
Store (32-bit binary)	11.8	82.0	2.2	1.2	0.21
Add (6-digit packed decimal)	107.6	47.8	36.2	8.2	1.17
Compare (6-digit packed decimal)	92.3	46.3	26.8	7.3	1.05
Add (short floating-point)	51.6	53.0	11.1	5.7	0.80
Multiply (short floating-point)	168.9	190.7	23.5	15.5	0.70
Divide (short floating-point)	231.5	231.0	31.8	25.7	2.95
Add (long floating-point)	64.8	66.9	10.0	7.1	0.83
Multiply (long floating-point)	472.5	565.8	28.4	38.5	1.29
Divide (long floating-point)	713.8	641.6	75.8	80.4	7.73

Instruction timings for the Model 168-3 were derived by scaling the times given for the no longer available Model 158- ▶

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▷ the new instructions 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. System/370 processors with virtual storage also include five additional instructions that facilitate control of the Dynamic Address Translation facility. As many as nine more instructions are available for certain processor models to aid in implementing OS/VS2 Release 2 and above, VTAM, and/or multiprocessing.

PERIPHERAL EQUIPMENT

IBM has developed a number of noteworthy mass storage and input/output units primarily for use with the System/370 which when announced represented significant improvements in performance and economy as well as major advancements in peripheral technology. One of the first examples was the high-performance 3330 Disk Storage Facility. This was followed by the double-density 3330 Model 11, and then by the unique 3340 Direct Access Storage Facility that incorporated both fixed and moving heads and a new removable sealed cartridge which incorporates the disks, access arms, read/write heads, and spindle.

Other new peripheral devices included the 3344 Direct Access Storage (which is equivalent to four 3340 Direct Access Storage drives), the ulta-large capacity 3850 Mass Storage System, the 3350 Direct Access Storage Facility (a large-capacity, fixed-disk replacement for the 3330 Disk Storage Facility), the 2,000-lpm 3211 Printer, the super-fast 3800 printing Subsystem, the low-priced 3411 Magnetic Tape Subsystem, the highly cost-effective 3420 Magnetic Tape Units (including models that record at 6250 bytes per inch), the 96-column 2596 Card Read Punch, the 3881 Optical Mark Reader, the 3886 Optical Character Reader, the 3890 MICR Document Processor, and the 3505 Card Reader and 3525 Card Punch, which share a microprogrammed control unit. Available only with the Model 115, 115-2, 125, 125-2, 138, and 148 systems is the 3203 printer, an improved replacement for the 1403 N1 Printer. Detailed descriptions of all these units can be found in the "Characteristics" section of this report.

COMMUNICATIONS

In March 1972, IBM unveiled the 3705 Communications Controller, a minicomputer-based "front-end" processor that contains from 16K to 240K bytes of core storage and can control up to 352 communications lines. In February 1973, IBM added the smaller, program-compatible 3704, which handles up to 32 lines. In November 1975, IBM unveiled the 3705-II, an enhanced version that features MOS memory and improved performance at a lower cost than the original 3705.

When connected to a System/370 computer, the 3704 and 3705 can use either the Network Control Program (NCP) or the 2701/2/3 Emulation Program. When the ▷

▶ 1. All floating-point instructions are data-dependent and may vary substantially from the average timings given. No allowance has been made for CPU degradation due to channel interference.

RELOADABLE CONTROL STORAGE: All System/370 central processor operations are controlled by micro-programming. In the Model 115 and 125, the microprograms for the Machine Instruction Processor (MIP) or Instruction Processing Unit (IPU), Service Processor (SVP), and Input/Output Processors (IOP's) reside in discrete MOSFET Reloadable Control Storage (RCS) areas, which are separate from main storage. The microprograms are loaded into RCS by means of a small read/write disk drive, the Console File, which contains a removable magnetic "diskette." IBM supplies prewritten diskettes containing all the control microprograms and Field Engineering diagnostics required for a specific installation.

The basic Machine Instruction Processor (MIP) micro-program for the Model 115 and Model 115-2 resides in 20K 22-bit words of RCS. One or two additional 4,096-word increments may be added to support optional features such as System/360 Model 20 compatibility, 1401/1440/1460 compatibility, floating-point, or extended precision floating-point.

The basic IPU microprogram for the Model 125 and Model 125-2 resides in 12,288 22-bit words of RCS, and one or two additional 4,096-word increments may be added to support optional IPU features, such as the options for the 115, plus 2311 Model 2 compatibility.

In the Model 138, 148, 158, and 158-3 Processing Units, the microprograms reside in a semiconductor memory unit also called Reloadable Control Storage (RCS) and are also loaded into RCS by means of a small read-only disk unit called the Console File.

Models 135-3, 138, 145-3, and 148 each have 131,072 bytes of RCS with expansion capabilities.

The control storage for a Model 168 or 168-3 consists of 2K 108-bit control words written in read-only storage (ROS) and 512 words of RCS. The IBM 7070/7074, 7080, or 7090/7094 compatibility feature adds 1024 additional control words to the RCS. The RCS is loaded from a console file or under microprogrammed control.

DYNAMIC ADDRESS TRANSLATION: This facility is the mechanism that translates the virtual storage addresses contained in instructions into real main storage addresses as each instruction is executed. All virtual models can address a virtual storage space of 16,777,216 bytes. A two-level address translation process divides the virtual storage space into segments of either 65,536 or 1,048,576 bytes, which are in turn divided into pages of either 2,048 or 4,096 bytes, depending upon the operating system.

OPERATIONAL MODES: All models can operate in either the Basic Control (BC) or Extended Control (EC) mode. The BC mode maintains general upward compatibility with the System/360 architecture and programming. In the EC mode, the Program Status Word (PSW) and the layout of the permanently assigned lower main storage area are altered to support Dynamic Address Translation and other new system control functions; therefore, the virtual-storage-oriented operating systems must be used.

OPTIONAL FEATURES: The table on pages 70C-491-04b through -04e indicates which of the following features are standard or optional in each of the processor models.

The Clock Comparator and CPU Timer feature provides expanded system timing facilities. The Clock Comparator ▶

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NCP is used, the 3704 or 3705 relieves the central processor of many routine tasks such as line control, character and block checking, character buffering, polling, and error recovery.

Virtually the entire complement of IBM communications terminals can be connected to a System/370—as can literally hundreds of terminals from independent suppliers.

In September 1974, IBM announced its Advanced Function for Communications through Systems Network Architecture (SNA). This facility has become the foundation for developments in IBM's data communications product line. The approach includes a single communications access method, the Virtual Telecommunications Access Method (VTAM); a single, standardized line discipline, Synchronous Data Link Control (SDLC); a Network Control Program, operating on the IBM 3704 or 3705 Front-End Communications Controller in conjunction with VTAM to control the network; and a family of compatible terminals, such as the 3767 Communication System, the 3770 Data Communication System, and models of the widely used 3270 Information Display System equipped to handle SDLC transmission. Also included in the System Network Architecture are the special-purpose IBM 3600 Banking System, the 3650 Retail System, the 3660 Supermarket System, and the 3790 Programmable Terminal, as well as the IBM 8100 series of smaller processors, and the System/32, System/34, and System/38 small business computer systems.

The SDLC line protocol has the following key characteristics: 1) it is bit-oriented and therefore independent of any specific transmission code; 2) it does not utilize control characters but utilizes positional significance to indicate prescribed functions; 3) it is well suited to handle full-duplex transmission, unbalanced information flow, and unequal frame lengths—capabilities that are advantageous in remote job entry and inquiry/response applications; and 4) it permits communications terminals with dissimilar characteristics to share a single communication line, reducing line costs in communications networks.

IBM plans to release new versions of ACF/TCAM, (ACF/TCAM Version 2 R3), ACF/VTAM (ACF/VTAM/VS), NTO and ACF/NCP (ACF/NCP/VS R3) beginning in mid-1980. The new versions will be available for users of the OS/VS1, MVS, and DOS/VSE operating systems. The aim of the new TCAM/VTAM versions is to provide increased flexibility through additional computer terminal links, improved reliability through user programming of alternate data paths, and enhanced functions in multiprocessor networks through greater latitude in the placement of points of control. Automatic use of alternate data paths is particularly valuable when unrecoverable error transmissions are encountered.

Automatic rerouting is an attractive feature of the packet-switched public networks (such as Telenet and Tymnet)

provides a means for causing an interrupt when the standard Time-of-Day Clock reaches a program-specified value. The CPU Timer is a binary counter that is decremented every microsecond and causes an interrupt when its value reaches zero. Additional instructions are provided to set and store both the Clock Comparator and the CPU timer.

The Floating-Point Arithmetic feature, a no-cost option, provides instructions to perform floating-point arithmetic operations on both short (1-word) and long (2-word) operands.

The Extended Precision Floating-Point feature provides 7 instructions for performing floating-point arithmetic on 4-word (16-byte) operands that provide a precision of up to 28 hexadecimal or 34 decimal digits. The Floating-Point Arithmetic feature is a prerequisite.

The Direct Control Feature provides two additional instructions plus 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. (The External Signals feature provides only the six interrupts for the Model 115, 115-2, 125, and 125-2).

High-Speed Multiply is available only on the Model 168 and 168-3. It reduces the time required for long-precision floating-point and fixed-point multiple instructions. For Model 165, the times are reduced from 1.87 to 0.61 microseconds and from 0.78 to 0.42 microseconds, respectively.

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.

Other processor options are described in the following sections on Compatibility Features, Input/Output Control, and Communications Control.

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 operating 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.

The OS/DOS Compatibility Feature 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. The DOS Emulator Program, the DOS Supervisor, and up to three DOS processing-program partitions are all executed in a single MFT partition or MVT region of at least 38K bytes; the DOS Emulator Program alone requires 22K to 26K bytes of main storage. IBM states that the internal speed of executing DOS job streams in OS/DOS Compatibility mode on a Model 145 varies from approximately 1.0 to 4.3 times faster than execution of the same job streams under DOS control on a 360/40.

The 1401/1440/1460, 1410/7010 Compatibility Feature is a field-installable option that provides the capability to emulate IBM 1410 and 7010 programs in addition to all the facilities of the 1401/1440/1460 Compatibility Feature ▶

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▷ that was previously unavailable with SNA networking. This, along with the other new features, may be seen as an effort by IBM to meet the needs of large-volume communications users who have been considering a move to the X.25-supported networks. IBM has not yet offered any communications support of the X.25 packet communications protocol.

Other features of the new TCAM and VTAM releases will add enhanced monitoring of network activity, error recording, and operator alert for possible problem areas.

The new Network Control Program release, ACF/NCP/VS R3, operating in conjunction with ACF/TCAM Version 2 R3 and ACF/VTAM/VS, will reportedly enhance networking of 370X nodes and provide facilities for specializing communications lines and incorporating multiple data routes. Networking of 370X nodes is enhanced by the ability of up to eight IBM computers to control interconnected controllers and terminals. IBM claims that one or more computers or controllers can be taken out of service and returned with a minimum disruption to data communications during the transition. With specialized lines, users would select a data path depending on the type of traffic (i.e., interactive, batch, etc.). Extensive interconnection between hosts and nodes includes parallel links between 3705 controllers and provides network backup if one node should fail. These two features should increase network efficiency and reliability.

The NTO Release 2 program product offers IBM large-system users a significant enhancement: support for start-stop terminals. The terminals supported include the IBM 2740 and 2741 and other teletypewriter devices. Since NTO Release 2 will be supported by CICS/VS, some terminals currently supported by BTAM can now also be supported by ACF/TCAM Version 2 R3, ACF/VTAM/VS, and ACF/NCP/VS R3. An intermediate release, ACF/NCP/VS R2.1, in conjunction with the IBM Network Problem Determination Application (NPDA), will provide facilities to collect and organize error statistics from the network.

For more details refer to the Characteristics section.

SOFTWARE

Users of the virtual-storage System/370 processors Models 138 and 148 can choose from three operating systems: DOS/VS, OS/VS1, and OS/VS2. Another operating system, VM/370, manages the real resources of a System/370, including CPU time, to create and control multiple concurrent virtual machines by permitting the use of multiple operating systems.

DOS/VS is an upward extension of DOS that supports virtual storage, permits up to seven jobs to be processed simultaneously, includes a relocating loader, and features the POWER spooling facility as a built-in function. Althoguh DOS/VS can theoretically support up to 16 ▷

▶ described above. The associated emulator routines require a minimum of 28K bytes of main storage under DOS and 22.5K bytes under OS.

The 7070/7074 Compatibility Feature is an option that provides the capability to execute programs written for an IBM 7070 or 7074 system.

An integrated emulator for IBM 7074 programs, which requires the 7070/7074 Compatibility feature on a Model 158 CPU, is also available. It operates under OS or OS/VS to provide concurrent emulation with multiprogramming, tape formatting programs for conversions between 7074 and OS spanned variable-length record formats, and placement of 7074 and other jobs in a single job-stream.

The 7080 Compatibility Feature provides the capability to execute, under OS control, programs written for an IBM 7080 system.

The 709/7090/7094 Compatibility Feature provides the capability to execute, under OS control, programs written for an IBM 709, 7090, 7094, or 7094 II system.

The System/360 Model 20 Compatibility Feature enables a Model 125 or 125-2 to execute, under DOS control, programs written for a System/360 Model 20 card, tape, or disk system.

The 1052 and 2311 Model 1 Compatibility Features are no-charge options that make it possible to use DOS, Version 3 or 4, on the Model 125 or 125-2. The 1052 Compatibility Feature (required for both Versions 3 and 4) permits emulation of the 1052 Printer-Keyboard by the 5213 Console Printer and the Model 125's standard console keyboard. The 2311 Model 1 Compatibility Feature (required for DOS Version 3 only) permits emulation of 2311 Model 1 disk files on 3333/3330 disk files connected to the Model 125. A single 3336 Disk Pack can hold the contents of up to eleven 1316 Packs.

The 1052 Compatibility Feature also is available at no charge for the Model 115 or 115-2. It permits the 5213 Console Printer and the Model 115 standard console keyboard to emulate a System/360 Model 1052 Printer-Keyboard. The 1052 Compatibility Feature, combined with the prerequisite 5213 Model 1 Console Printer, allows the Model 115 to operate as a remote job entry work system communicating with a host processor operating under HASP, ASP, and their virtual-storage remote job entry successors, Job Entry Subsystem 2 or 3 (JES 2 or JES 3) and Job Entry Subsystem/Remote Entry Services (JES/RES).

CONSOLE INPUT/OUTPUT: A keyboard/display operator console is an integral part of the Model 115, 115-2, 125, and 125-2 Processing Units. The console contains a typewriter-style keyboard, a CRT display, a complement of switches and lights, the Service Processor, and the Console File that loads the system's microprograms. The CRT can display sixteen 56-character lines of data. Data can be entered via the keyboard, displayed on the CRT for verification, and then directed into main storage or the CPU registers. Storage or register contents are displayed in hexadecimal notation. The keyboard and CRT can also be used as an inquiry terminal. A 5213 Printer, Model 1, can be connected to the Model 115 or 125 console via the Integrated 5213 Printer Attachment. The 5213 produces printed copies of input and output messages displayed on the CRT at a speed of 85 characters per second. Print line length is a maximum of 125 characters, spaced 10 to the inch, and vertical spacing is 6 lines per inch.

Models 138 and 148 use a display console consisting of 1920-character CRT display and keyboard, with provisions for attaching a 3286 Model 2 Printer for hard-copy output. Both ▶

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million bytes of virtual storage, most installations will get better overall results by choosing to work within a far smaller virtual storage size. And, although DOS/VS provides automatic management of main storage allocation, it requires the user to divide the virtual storage space into a maximum of seven fixed partitions and predetermine the programs to be executed in each partition.

The assembler is a superset of DOS assemblers D and F that implements all of the System/370 instructions. DOS/VS also provides two additional access methods—Virtual Sequential Access method (VSAM) and Virtual Telecommunications Access Method (VTAM). The minimum size supervisor for 370/138 is 30K and for 370/148 it is 32K. The first version of DOS/VS was released to the users in 1973. IBM has continued to enhance the DOS/VS system on a yearly basis.

The Operating System/Virtual Storage (OS/VS1) or (VS1) is an extension of OS/MFT that supports virtual storage. VS1 is divided into two main areas: the Control Program area and the Problem Program area. The Problem Program area is divided into fixed partitions (with a maximum of 15 partitions) at 64K bytes or multiples of 64K bytes with a maximum of 52 partitions. The real storage in OS/VS1 is managed by the operating system in blocks of 2K bytes called pages. The Page Supervisor is responsible for allocating and deallocating pages in real storage and for initiating page-in and page-out operations between auxiliary storage and processor storage.

The OS/VS1 Supervisor performs interrupt handling, task supervision, timer supervision, storage supervision, I/O supervision, exception condition handling, and system management facilities. Release 7 is the latest release of OS/VS1 and its highlights are:

● The 3262 Printer is an impact line printer with 48-character set print belt. The 3262 Model prints at a maximum rate of 650 LPM and 3262 Model 11 prints at a maximum rate of 325 LPM.

● Enhanced Dump Facility which allows multiple system dump data sets, and allows system handshaking with VM to have OS/VS1 system dumps taken via the VMDUMP command. The Enhanced Dump Facility also provides machine-readable abend dumps and in-storage console trace.

● IOS Serviceability Enhancement which enables OS/VS1 to recognize the differences between selector and block multiplexer channel operation on an IOS Test Channel Condition Code response.

The Operating System/Virtual Storage 2 (OS/VS2) or (VS2) is an improved version of OS/MVT which provides support of a full 16 million bytes of virtual storage. VS2 handles up to 63 protected batch user regions on 42 TSO user regions (compared with a ▷

systems have three console modes: Printer-Keyboard Mode, Display Mode, and 115/125 Console-Display-Emulation Mode.

Printer-Keyboard Mode uses the keyboard for input and the CRT display for output. A 3286 Printer is recommended for this mode, but not required. The CRT, keyboard, and printer appear to the system as a 3215 Console Printer-Keyboard. This mode is supported by DOS, DOS/VS, OS/360, OS/VS, and VM/370.

Display Mode also uses the keyboard for input and the CRT display for output. The optional 3286 Model 2 Printer has a separate address and requires MCS support or equivalent. The printer appears to the Model 138 or 148 system as a 3213 Console Printer. Display Mode is not supported by DOS/VS.

In 115/125 Console-Display Emulation Mode, the keyboard and CRT display are used for input and output as in the other two modes. However, the CRT can display only 12 lines of 56 characters. When the 3286 Printer is employed, it emulates a 5213 Model 1 Printer and acts as a slave to the display console. For DOS/VS systems, the operating software must be Release 28 or greater.

Models 158 and 158-3 use an operator display console, which is supplied along with the Processing Unit as standard equipment. It contains a CRT display, keyboard, light pen, two Console Files, and microcode control storage. A stand-alone 3213 Printer, rated at 85 characters per second, can be added as an optional hard-copy output unit.

Every Model 168 and 168-3 system requires a 3066 System Console, which provides a CRT display with 4K buffer, an alphanumeric keyboard, a microfiche maintenance display to facilitate servicing, and a device for reading micropro-grams from a magnetic disk cartridge into writable control storage.

In addition to these standard console I/O units, other devices such as displays, card readers, punches, and printers can be used to provide additional console functions.

INPUT/OUTPUT CONTROL (MODELS 115-125-2)

In place of conventional I/O channels, these models use internal Input/Output Processors (IOP's) to control I/O operations. Each IOP is implemented through micropro-grams in a discrete Reloadable Control Storage area and can access main storage independently. Thus, attached I/O devices can operate concurrently with devices attached to other IOP's and with internal computing. The number of IOP's depends upon the configuration and features of each installation.

A 3340 Direct Access Storage Facility with two to four (eight for the 115-2, 125; 16 for the 125-2) disk drives can be connected directly to a Model 115 Processing Unit. A 4K DASF Control Storage Extension is required for configuring more than eight disk spindles on a Model 125-2 and is mutually exclusive with the 1403/3202 Carriage Control and any feature combination requiring the 8K Control Storage Extension. From two to four 3330 Series Disk Drives can be directly connected to a Model 125 Processing Unit. Optional integrated attachment features permit direct connection of any of the following I/O devices; no separate control units or I/O channels are required:

2560 Multi-Function Card Machine (80-column)
5425 Multi-Function Card Unit (96-column)
3203 Printer, Model 1 (600 lpm) or Model 2 (1200 lpm)
5203 Printer, Model 3 (300 lpm) for Models 115 and 115-2
5213 Console Printer (85 char/sec) ▶

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▷ maximum of 15 regions for MVT). Virtual storage is organized in pages of 4K blocks. TSO user regions are paged. The real storage utilization for TSO reflects actual requirements for program execution compared to the fixed MVT time-shared region.

An important distinction was made with the introduction of OS/VS2 Release 2. OS/VS2 was effectively divided into two operating systems and will be maintained as such. OS/VS2 versions prior to Release 2 are now known as OS/VS2 Single Virtual Systems, or SVS, while OS/VS2 Release 2 and above are now known as OS/VS2 Multiple Virtual Systems, or MVS.

The SVS supervisor is responsible for interrupt handling, task dispatching, task supervision, contents supervision, timer supervision, storage supervision, I/O supervision, page supervision and main storage supervision. The MVS supervisor provides the same function as SVS supervisor plus resource management, multiprocessing, multiple address space supervision, service and recovery management. An improved Job Entry Subsystem has numerous features. Some significant features are:

● Support of TSO foreground initiated background functions.

● Automatic scheduling of interdependent jobs.

● Deadline scheduling.

● Checkpoint/Restart support.

● Remote Job Processing

● Operation in virtual machine in the IBM Virtual Machine Facility (VM/370).

The current release of OS/VS2 (MVS) now stands at Release 3.7. This may well be the last "release" of this operating system due to IBM's recent introduction of the selectable unit. Selectable units are small microcode packages that add new features or enhance existing software systems. Instead of introducing new releases of a particular software package with several enhancements and new features, IBM will now make available various selectable units, thereby giving users the option of whether or not to take advantage of new developments as their needs dictate. Selectable units can be applied only to OS/VS2, Release 3.7 and above.

For more details on VS2 refer to the Characteristics section.

The Virtual Machine Facility/370 is a system control program (SCP) that manages a computing system's resources (CPU, storage, and input/output devices) so that all are available to many users at the same time. Each user has at his disposal the functional equivalent of a real, dedicated computing system. ▷

▶ 3410/3411 Magnetic Tape Subsystem, Model 1 (20KBS), Model 2 (40KBS), or Model 3 (80KBS)
3420 Magnetic Tape Subsystem, Model 3 (120KBS) or Model 5 (200KBS)
3504 Card Reader for Models 125 and 125-2
3525 Card Punch for Models 125 and 125-2
1403 Printer Models 2, 7 or N1 for Models 125 and 125-2

Only one card unit and one line printer can be connected to a Model 115 or 115-2 by the integrated attachment method.

The optional Byte Multiplexer Channel permits a wide variety of low-speed I/O devices to be connected to a Model 115. This channel is implemented by a microprogrammed IOP and is functionally similar to the Byte Multiplexer Channels in other System/360 and 370 models. It has 8 control unit positions and 32 subchannels. Eight of the subchannels can be shared (i.e., assigned to an I/O control unit that has up to 16 devices attached). The Byte Multiplexer Channel is designed to operate primarily in the byte-interleaved mode, which allows multiple low-speed devices on separate subchannels to operate concurrently. It can also operate in burst mode, which allows only one I/O operation at a time, but burst-mode operation of unbuffered devices is not recommended. The maximum I/O data rate for the Byte Multiplexer Channel is 19,000 bytes (115) or 25,000 bytes (115-2, 125, or 125-2) second in byte-interleaved mode and 29,000 bytes/second in burst mode. An Extended Byte Muitiplexer Channel is a prerequisite for installation of the Byte Multiplexer channel on the Model 115-2. On the 115 and 115-2, the Byte Multiplexer Channel and the Integrated Card I/O Attachment (for the 2560 MFCM or 5425 MFCU) are mutually exclusive unless RPQ Features 7B0141 and 7B0132 are installed.

No Block Multiplexer Channels or Selector Channels are available for the Models 115, 115-2, 125, or 125-2.

INPUT/OUTPUT CONTROL (MODELS 138-168-3)

I/O CHANNELS: The System/370 employs three distinct types of I/O channels in Models 138 and above:

● 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.

● 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.

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

The I/O channels are an integral part of the processing unit in Models 138 through 158, whereas Model 168 uses the separately packaged 2860 Selector Channels, 2870 Byte Multiplexer Channels, and/or 2880 Block Multiplexer Channels. ▶

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▷ VM/370 is designed for use on System/370 Model 138 and 148 which have the Dynamic Address Translation feature and Extended Control Mode option. The operating systems that can run in VM/370 virtual machines include Batch or Single User Interactive, DOS, DOS/VS, OS/MFT, OS/MVT, OS/VS1, OS/VS2 and OS-ASP, as well as the multiple-access APL/DOS-360 and the Conversational Monitor System (CMS). CMS is virtual storage-based and provides a general-purpose time-sharing capability. CMS supports the BASIC, ANSCOBOL, FORTRAN IV and PL/1 languages.

The new VM/System Product (VM/SP) with the VM/370 Release 6 SCP extends VM/370 and is the base for several program products. VS/SP is a licensed program and it is anticipated that any future enhancements to VM/370 will be made in the VM/SP. For more information see the Characteristics Section.

COMPATIBILITY

Designed as an evolutionary outgrowth of the System/360, the System/370 offers a high degree of program and data compatibility with the earlier IBM computer line. The hardware features of the System/370 represent extensions, rather than modifications, of the System/360. As a result, System/360 users can run their application programs on a System/370 in the Basic Control mode with little or no modification and, in most cases, without recompilation. Conversely, it is not 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.

To run System/360 programs in Extended Control mode, under the virtual-storage operating systems, all that is normally required is a pass through the appropriate Linkage Editor. Programs that are highly time-dependent, and certain other programs that employ nonroutine coding techniques, cannot be paged and must be run in the "virtual=real" or non-swapped mode.

Release 2 of OS/VS2 was designed around a dual-processor. HASP-like multiprocessing system; an alternate ASP-III-like network multiprocessing mode of system operation is also available. In both cases, significant upward compatibility with the respective 360/370 predecessors is maintained. This is true not only in terms of programming considerations, but also from an operational point of view. In fact, IBM recommends an upward migration path through either HASP or ASP-III as the most suitable way of growing into VS2 Release 2 and beyond.

Integrated emulation is an optional System/370 capability that permits direct execution of most programs written for IBM's second-generation 1400 and 7000 Series computers. The table beginning on page 70C-491-04b shows which compatibility features are available for each of the System/370 processor models. These compatibility ▷

▶ The Model 138 has a one-byte multiplexer channel, with 64 subchannels. The byte multiplexer channel can be expanded to 256 subchannels at no additional cost. The 138 does not have selector channels as such. Instead, it can have up to two block multiplexer channels. Devices that cannot use the block multiplexer capabilities will function as if attached to a selector channel.

Model 148 has channel configurations similar to those of the Model 138. Each has a one-byte multiplexer channel with 64 subchannels, which can be expanded to 256 subchannels at no extra cost. Both systems feature from one to four block multiplexer channels which are actually converted selector channels. These block multiplexer channels differ slightly from those used in the Model 138 by permitting expansion up to 512 subchannels. The basic block multiplexer channel is supplied with 64 subchannels and can be expanded in groups of 16. Again, no charge is made for the expansion. For the Model 148, four block multiplexer channels are standard and no expansion is possible. A word buffer is also standard.

The Model 158 Processing Unit 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 158). Each Byte Multiplexer Channel provides 256 nonshared subchannels or 8 shared and 120 nonshared subchannels. Each Block Multiplexer Channel provides 16 shared and 480 nonshared subchannels, and can accommodate data rates of over 1.5 million bytes per second.

The Model 158-3 has an expanded subchannel capability on both Byte and Block Multiplexer Channels which permits 16 or 32 devices to be assigned to a shared subchannel. The total number of shared subchannels available for the Model 158-3 Block Multiplexer Channel is 40, or 32 with a second Byte Multiplexer Channel.

The optional Integrated Storage Control, available for the Model 158, 158-3, 168, or 168-3 Processing Unit, provides two separate data paths, each capable of accommodating up to 32 IBM 3330, 3340, or 3350 series disk drives.

A Model 168 or 168-3 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 system and 12 if the Extended Channels 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 Byte Multiplexer Channel provides 192 subchannels. Optionally, selector subchannels can be added—up to 4 on the first 2870 in a 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 Byte Multiplexer Channel is 670,000 bytes per second.

Each 2880 Block Multiplexer Channel provides up to 56 nonshared subchannels and one shared subchannel. 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 a data rate 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 ▶

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options run under control of the regular operating system, enabling emulator jobs to be processed as part of a multiprogramming mix.

The swing from the System/360 to System/370 was marked by a noteworthy *lack* of conversion problems, and it is a near-certainty that the forthcoming conversions from the System/370 to the new 303X series processors will be equally smooth. 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 has obviously taken great pains to avoid a recurrence. The similarity of the System/370 and 303X architecture to that of the System/360, coupled with the use of essentially the same peripheral equipment and software, ensures comparatively smooth, straightforward conversions this time.

USER REACTION

Datapro's most recent annual survey of general-purpose computer users, conducted in 1980, yielded 277 early responses from System/370 users who collectively owned, rented, or leased 328 separate computer systems. The characteristics of the user population and composite of the ratings expressed by these users are presented in the following paragraphs and tables.

The system population was distributed as follows:

Model 115	25 systems
Model 125	24 systems
Model 135	33 systems
Model 138	57 systems
Model 145	30 systems
Model 148	41 systems
Model 155	10 systems
Model 158	68 systems
Model 165	9 systems
Model 168	31 systems

The weighted averages of the ratings supplied by these System/370 users in 14 important performance categories are presented in the "Users' Ratings" table for each processor model represented in the survey population.

The distribution of operating systems among the survey respondents was as follows:

DOS	8
DOS/VS & DOS/VSE	190
OS/VS1	33
OS/VS2 (SVS)	5
OS/VS2 (MVS)	28
OS/MFT	16
OS/MVT	5
VM/370	9
VS UNSPECIFIED	11
OTHER	4

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 are normally connected to a Byte Multiplexer Channel.

MULTIPROCESSING CONFIGURATIONS: A Model 158 MP (Multiprocessing) system consists of two 3158 MP Processing Units, a 3058 Multisystem Unit, and appropriate peripheral subsystems. Each of the two Processing Units in a system must have the same main storage capacity, which can range from 0.5 million to 4 million bytes per Processing Unit. The Model 158-3 can be configured with asymmetric storage capacities in combinations of 1, 2, 3, or 4 million bytes of main memory per processor. Each Processing Unit can have up to 6 I/O channels (5 Block Multiplexers and 1 Byte Multiplexer or 4 Block Multiplexers and 2 Byte Multiplexers). The 3058 Multisystem Unit interconnects the two Processing Units and houses a configuration control panel which the operator can use to reconfigure the system. Multiprocessor models of the Model 158 and Model 158-3 can be interconnected in multiprocessor configurations, although in this case asymmetric storage capacities are not supported. Model 158-3 MP Processing Units include an Alternate Power Down feature which allows a Processing Unit and its associated console and channels to be removed from operation and its main memory placed on-line to the remaining Processing Unit.

A Model 158 APS (Attached Processor System) consists of a Model 158 or Model 158-3 A-series central processor plus a Model 3052 Model 1 Attached Processing Unit and a 3056 Model 1 Remote Console. The 3052 APU is controlled by reloadable control storage and features a 115-nanosecond processing cycle and 16K bytes of high-speed buffer storage. Unlike the 3062 APU used in the Model 168 APS systems, the 3052 APU can execute all System/370 instructions, including Read Direct and Write Direct. It also has provisions for adding Extended Precision Floating-Point facilities. The unit also has dynamic address translation and can access 6,291,456 bytes of main storage on the host system. An integral storage control unit controls the shared-access environment between the host system and the APU. The 3052 also has provisions for the 1401/1440/1460, 1410/1470, and OS/DOS compatibility options. All system I/O functions are performed by the Model 158 host processor. Conversion to a Model 158 APS involves changing from a standard Model 158 processor to a Model 158 AP processor.

A Model 168 MP (Multiprocessing) system consists of two 3168 MP Processing Units, a 3068 Multisystem Communication Unit, and appropriate peripheral subsystems. Each of the two Processing Units can have from 1 to 8 million bytes of main storage. The two Processing Units can have different storage capacities in a 168 MP system, but IBM recommends that the two systems be configured as symmetrically as possible for higher availability. Each Processing Unit can have up to 12 I/O channels, including a maximum of six 2860 Selector Channels, two 2870 Byte Multiplexer Channels, or eleven 2880 Block Multiplexer Channels. The 3068 Multisystem Communication Unit interconnects the two Processing Units and houses a configuration control panel which the operator can use to reconfigure the system. Multiprocessing features must be added to the 3066 Systems Console and the 3067 Power and Coolant Distribution Unit. Model 168 MP and Model 168-3 MP Processing Units can be interconnected in a multiprocessor configuration.

The Model 168-3 Attached Processor System includes a Model 168-3 host central processor plus an additional Model 3062 Model 1 Attached Processing Unit and a Model 3067 Model 5 Power and Coolant Distribution Unit. The 3062 APU features an 80-nanosecond processing cycle, a 32K-byte high-speed buffer storage, and a Translation Lookaside Buffer, and has the capability to execute all System/370

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USERS' RATINGS IN TERMS OF WEIGHTED AVERAGES

	Ease of Operation	Reliability of Mainframe	Reliability of Peripherals	Responsiveness	Effectiveness	Trouble-Shooting	Education	Documentation	Operating Systems	Compilers and Assemblers	Applications Programs	Ease of Programming	Ease of Conversion	Overall Satisfaction
Model 115	3.3	3.5	2.9	3.1	3.1	2.6	2.8	2.6	3.2	3.4	3.0	3.1	3.0	3.2
Model 125	3.3	3.6	3.3	3.2	3.3	2.8	3.1	3.0	3.1	3.2	3.2	3.2	3.2	3.1
Model 135	3.1	3.5	3.1	3.5	3.0	2.8	2.6	2.6	3.0	3.2	2.6	3.0	2.8	2.8
Model 138	3.1	3.8	3.3	3.2	3.1	2.8	2.5	2.4	2.9	3.2	2.5	2.9	2.8	3.0
Model 145	3.1	3.5	3.0	3.2	3.1	2.8	2.8	2.7	3.0	3.1	2.9	2.9	2.8	3.1
Model 148	3.2	3.7	3.4	3.3	3.2	2.8	2.8	2.7	3.0	3.3	3.0	3.0	3.0	3.2
Model 155	3.1	3.4	2.7	2.7	2.3	2.2	3.0	3.2	3.1	3.1	2.7	2.8	2.4	3.0
Model 158	3.1	3.5	3.2	3.1	3.1	3.0	2.7	2.8	3.1	3.2	2.6	3.0	2.8	3.0
Model 165	3.3	3.3	3.0	3.5	3.8	3.0	3.5	3.5	3.3	3.3	2.7	2.8	2.5	3.0
Model 168	3.0	3.4	3.1	3.1	3.5	2.9	2.5	2.8	2.9	3.1	2.5	2.8	2.8	3.1
System/370 totals	3.1	3.6	3.2	3.2	3.1	2.8	2.8	2.7	3.0	3.2	2.7	3.0	2.9	3.0

Basis for computing Weighted Averages is 4 for each user rating of Excellent, 3 for Good, 2 for Fair, and 1 for Poor.

▷ About 52 percent of the systems were leased, 32 percent were purchased, and 16 percent were rented. The Models 138, 148, and 158 were among the most popular leased models. The System 370/138 was the most popular model in all three categories.

Of the 277 responses we have tabulated, the principal applications the users have installed are:

Accounting	198
Construction	10
Education	18
Government	32
Manufacturing	104
Payroll/Personnel	166
Service Bureau	30
Transportation	12
Word Processing	10
Banking/Finance	39
Distributed Processing	19
Engineering/Scientific	28
Insurance	28
Medical/Health Care	22
Retail	17
Transaction Processing	41
Utilities	11
Other	19

Of the 277 respondents, 100 indicated they plan to replace their present system in 1980 with another IBM model. Only 4 of the 277 respondents indicated they plan to replace their present system with a different manufacturer's computer system in 1980.

Of the users planning to acquire or implement additional software in 1980, 125 said they intended to acquire additional software from IBM and 138 said they planned to acquire proprietary software from other suppliers. ▷

▶ instructions except those associated with the Direct Control facility. Also included in the APU are a storage control element for accessing up to 8 million bytes of system main memory and communications logic to control the shared accessing of main storage between the 168-3 central processor and the APU. All input/output operations are performed by the Model 168-3 central processor. Model 168-3 central processors can be field-upgraded to the Model 168 Attached Processor System, and Model 168 Attached Processor Systems can be intermixed with Model 168 single-processor and Model 168 MP systems in loosely coupled configurations.

The 3838 Array Processor is an auxiliary processing unit for use with either a 370/158 or 370/168. The array processor performs high-speed vector arithmetic in parallel with the host processor. It is attached through a standard block multiplexer channel. Minimum system requirements include a 9-track, 1600-bpi magnetic tape subsystem plus MVS and selectable units for Scheduler, Supervisor 1, Supervisor 2, 3838 Vector Processing Subsystem Support (VPSS), Vector Processing Subsystem and Job Entry Subsystem (2 JES2) or Job Entry Subsystem 3 (JES3).

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, one high-speed I/O operation on the Integrated File Adapter or Integrated Storage Control (if installed), 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. Maximum total I/O data rates for all channels are shown in the tables on the second through fifth pages of this report.

MASS STORAGE

2305 FIXED-HEAD STORAGE: Provides fast access to comparatively small quantities of information. This fixed-head storage is no longer marketed by IBM. 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. This storage control is no longer marketed by IBM. A Two-Channel Switch can optionally be added to the 2835.

The 2305 Model 1, usable only with Models 168 and above, stores up to 5.4 million bytes of data. Each of the 384 ▶

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The major area of expansion is going to be in data communications: 136 users plan to expand their data communications facilities, 61 users anticipate increasing their distributed processing facilities, and another 27 users plan on implementing integrated word processing capabilities.

The users were asked if they would recommend their present system to another user in their same situation. Eighty-two percent answered they would recommend their system, eight percent said they would not recommend their present system, and another ten percent offered no opinion.

Some of the users who answered negatively said they had outgrown their system and plan to upgrade in the near future so their present system wasn't the best system for their situation now.

From a list of ten possible advantages to the system, the users were asked to check any or all significant ones. This list is presented in the order of relative importance to users.

1) Program/data carried over from other systems are compatible as vendor promised.

2) Users are happy with response time.

3) Terminals/peripherals carried over from other systems are compatible as vendor promised.

4) System is easy to expand/reconfigure.

5) Productivity aids help us keep programming cost down.

6) Database language is efficient and effective.

7) Delivery and/or installation of equipment was ahead of schedule.

8) Delivery of required software was ahead of schedule.

9) System is power/energy efficient.

10) System costs were less than expected.

The users were also requested to check a list of ten possible problems they may have encountered with the system. The majority of users didn't check that they have any problems. One percent reported they have a problem keeping up with vendor's enhancement/changes to hardware/software, and nearly one percent of the users replied that the system cost (for hardware, vendor-supplied software, support) exceeded the expected cost. A little over a half of one percent reported that the delivery and/or installation of equipment was late; the same percent of the users also reported the vendor did not provide all the promised software or support, and that the program/data compatibility were not what the vendor promised.

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 Models 148 and above, 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.

3330 DISK STORAGE, MODELS 1 AND 2: Provides fairly rapid access to large quantities of data stored in interchangeable 3336 Disk Packs. Each 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 a 16-drive 3330 subsystem can store over 1.6 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.

Two, three, or four 3330 series drives, each providing 100 million bytes of on-line storage, can be connected directly to a Model 125 or 125-2 Processing Unit; no I/O channel or attachment feature is required. The first two drives are contained in the 3333 Disk Storage and Control module. The subsystem can be expanded by adding either a 3330 Model 1 Disk Storage module, which contains two drives, or a 3330 Model 2, which contains two drives, or a 3330 Model 2, which contains two drives, or a 3330 Model 2, which contains one drive. Each drive is mounted in a powered drawer for operating convenience.

In the larger System/370 models, a 3330 subsystem can include from 2 to 32 disk drives, in 1-drive or 2-drive increments. A "channel-attached" 3330 subsystem consists of a 3830 Model 2 Storage Control and from one to four 3333 Disk Storage and Control modules, containing two drives each; the 32-Drive Expansion feature, announced in February 1973, is required when more than two 3333's are used in a subsystem. Up to three 3330 Disk Storage modules, containing one or two drives each, can in turn be attached to each 3333. The 3333 provides logic and power for the attached 3330 modules. (Alternatively, a 3830 Model 1 Storage Control, now offered only on an "as available" basis, can be used to control from one to four 3330 Disk Storage Modules, or two to eight drives; in this case, no 3333's are used.)

An "integrated" 3330 subsystem can be connected to a Model 138 via the Integrated File Adapter; to a Model 148 via the Integrated Storage Control; or to a Model 158 or 168 via the Integrated Storage Control (ISC). The ISC in a Model 158 or 168 Processing Unit includes two data paths (logical control units) and can control two 3330 subsystems containing a total of up to 64 drives.

The 3333 String Switch Feature permits program-controlled switching of a 3333 Disk Storage and Control module and its attached 3330 Disk Storage Modules between two control units or attachments. The switching can be either dynamic, with the two control units or attachments contending for the 3333 and its attached drives, or static, with the 3333 dedicated to a single control unit or attachment via an enable/disable switch. A Remote Switch Attachment permits installation of the 3333 String Switch on the configuration control panel of a Model 158 MP or 168 MP system.

3330 DISK STORAGE, MODEL 11: The 3333 Model 11 Disk Storage and Control and the 3330 Model 11 Disk Storage offer twice the capacity of the original 3330 Disk Storage units at about a 40 percent increase in price. The doubled disk pack capacity is achieved through the use of

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We interviewed a Southern insurance company that owns its 370/115 system and plans to upgrade to a 4331 system in 1980. This user was very satisfied with the 370/115. The user stated, "We are a small shop and the software enhancements are difficult to keep up with because they are too many and too frequent."

We interviewed a Western bank vice president who has a 370/125 system and is planning on upgrading to a 370/138 this year. He, too, had a problem keeping up with the software enhancements, which he said come every 60 days. Another problem he mentioned was the documentation; in looking up an item you find yourself being referred from one book to another. He said the reliability of the 370/125 was excellent and he was a very satisfied user.

An Eastern city manufacturer who has a 370/138 system installed with 17 terminals reports that the users are very happy with the response time, and his programmers are now four times more productive since going on-line. This Data Processing Manager also feels that they will have to go to the DOS/VSE Operating System in order to benefit from future software enhancements. This manager also said they are experiencing problems with their card reader and printer, but the other peripherals and the mainframe reliability are excellent.

We interviewed a county government account with a 370/148 system with a 2-megabyte memory and 70 terminals running under the DOS/VS Operating System. This installation reported poor response time on their 3720 terminal. The problem "seems to be in a CICS software module that the technical support from IBM doesn't seem to address." Also, this user didn't like the IBM policy requiring a long distance call for software information status, and the requirement of applying all software enhancements even though they have no benefit to his installation. This account plans to install a 4300 computer system and go to the DOS/VSE Operating System this year.

A manufacturer with a 370/125 installed since 1975 mentioned he plans to upgrade to a 4331 system this year. This manager said, "The up time on the 370/125 system was 98 percent last year and last month we experienced no down time at all." He also mentioned that the company is located out in the country but when a problem occurs IBM's response has been excellent. □

▶ twice as many tracks on each disk pack surface. A full 8-drive string configuration of 200-million-byte-per-pack units provide up to 1.6 billion bytes of on-line storage for System/370 Models 138 through 168 OS/VS systems.

The "double-density" Model 11 units use the same track lengths and record formats as the Model 1 and 2 units and can be connected to any of the following: a stand-alone 3830 Model 2 Disk Control (on Models 138 through 168), an Integrated File Adapter (on Model 138), or an Integrated Storage Control (on Model 148, 158, 158-3, 168, or 168-3).

A full 8-drive Model 11 subsystem string consists of four dual-spindle units (one 3333-11 and three 3330-11's). Model 11 and

Model 1 units can be mixed in a subsystem, but Model 1 drives can only operate with Model 1 packs and Model 11 drives are restricted to using Model 11 packs. No special feature is required for intermixing the two types of drives in a subsystem. To prevent operator errors, Model 11 drives have black address plugs (those on Model 1 drives are white) and the Model 11 packs carry matching black stripes. A pack improperly placed on the wrong type of spindle will neither uncover nor be accepted. The size, weight, and other physical characteristics of the disk packs and drive units are unchanged.

Support for the "double-density" Model 11 drives and their features is provided under OS/VS1, OS/VS2, and VM/370.

3340 DIRECT ACCESS STORAGE FACILITY: Provides fairly rapid random access to large quantities of data stored in interchangeable 3348 Data Modules. Usable with System/370 Models 115 through 168-3 under DOS/VS or OS/VS.

The 3340 drives are available in three models with the following configuration rules. Model A2 contains two drives and a control; it can be connected to a System/370 Model 115, 115-2, 125, or 125-2 via direct attachment, to a System/370 Model 138 via the Integrated File Adapter, to a System/370 Model 148, or 158 via the Integrated Storage Control, or to a System/370 Model 158, or 158-3 via a 3830 Model 2 Storage Control. The 3340 Models B1 and B2 contain one and two drives, respectively; they can be connected to a 3340 Model A2 to form a string of up to eight drives. The maximum numbers of 3340 drives that can be connected via the integrated attachments are 4 drives on a Model 115, 8 on a Model 115-2, 8 on a Model 125, 16 on a Model 125-2, and 64 (in 2 subsystems) on a Model 158, 158-3, 168, or 168-3. Up to 32 drives (4 strings of 8) can be connected to a 3830 Model 2 Storage Control. The use of more than 16 drives in a subsystem requires the addition of a Control Storage Extension and 32-Drive Attachment feature on the 3830 Storage Control or CPU Integrated Control. It is possible to intermix 3330 and 3340 drives on the same attachment or control under OS/VS.

Each 3340 drive accommodates one 3348 Data Module, either Model 35 or Model 70, at a time. The Data Module is a self-contained unit that includes not only the magnetic disks, but also the associated access arms and read/write heads. Since the same heads always serve the same tracks, head alignment problems should be reduced and data reliability enhanced. Each Data Module is a sealed unit 8 inches high, 16 inches wide, 18 inches long, and 16 pounds (Model 35) or 18 pounds (Model 70) in weight. Loading of the Data Module is an automatic process; the operator simply places the Data Module on a drive, closes the drive cover, and turns on a switch. Processing can begin in less than 20 seconds.

The 3348 Model 35 Data Module has 348 cylinders and a total storage capacity of 34.9 million bytes. Model 70 has 696 cylinders and a total storage capacity of 69.8 million bytes. Both models have 12 tracks per cylinder and can store up to 8368 bytes in each track. Both models exhibit the same performance: average head movement time is 25 milliseconds, average rotational delay is 10.1 milliseconds, and data transfer rate is 885,000 bytes/second.

The command set for the 3340 subsystem is essentially the same as the 2314/3330 command set with minor modifications.

A System/370 Model 125 and 3340 Disk Storage can be equipped with a no-charge compatibility feature that enables it to execute DOS programs written for either IBM 2311 Model 1 or 2314 disk files. The data from four 2311 Model 1 disk packs or one 2314 disk pack can be contained in a single 3348 Model 35 Data Module, and a 3348 Model 70 Data Module holds twice as much data. Emulation of the 2311 Model 1 and the 2314 are mutually exclusive, and emulation ▶

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can be performed only under DOS (Release 21 or later). Under DOS Release 21 through 27, the 1052 Compatibility Feature and the 5213 Model 1 Console Printer are prerequisites.

In Model 125-2 systems, the first eight spindles can operate in the compatibility mode, while spindles 9 through 16 can operate in native mode only. An optional String Switch feature on the 3340 Model A2 permits a System/370 Model 115-2 or Model 125-2 to share a maximum of two 3340 Model A2 DASF strings with any other System/370 central processor with the exception of the Model 115 and Model 125.

The 3348 Model 70F Data Module provides 502,080 bytes of fixed-head disk storage and 69.3 million bytes of storage accessed by moveable heads. The Model 70F Data Module can be used on a 3340 Model A2 or Model B2 disk drive that is equipped with the 4301 Fixed Head Feature, and can be intermixed and interchanged on a 3340 Model A2 or B2 with other 3348 Data Modules. The first five logical cylinders on the Model 70F are accessed by a fixed read/write arm, while the remaining cylinders are serviced by moving read/write heads. The performance characteristics of the 3348 Model 70 and Model 70F Data Modules are compared below:

	3348 Model 70	3348 Model 70F	
	Cylinders 0-695	Cylinders 1-5	Cylinders 0 & 6-695
Average seek time (ms)	25	0	25
Average rotational delay (ms)	10.1	10.1	10.1
Data rate (KB/sec)	885	885	885
Bytes per track	8,368	8,368	8,368
Data cylinders	696	5	691
Tracks per cylinder	12	12	12
Capacity (bytes)	69,889,536	502,080	69,387,456

Model 35 and 70 Data Modules cannot be field-upgraded to the Model 70F. Each Model 3340 Model A2 or B2 that operates with the Model 70F Data Module must be equipped with the 4301 Fixed Head Feature. A 9190 Fixed Head Attachment is also required on each system attachment to which a 3340 Direct Access Storage Facility with the Fixed Head Feature is attached, including the 3158 ISC, the 3168 ISC, the 3340 Storage and Control Frame Model 3, 4, or 5, and the 3830 Storage Control Model 2. The 2150 Control Store Extension must be added to the 3158 ISC, the 3168 ISC, the 3345 Models 3, 4, and 5, and the 3830 Model 2, which includes both the 9190 Fixed Head Attachment and the 9841 String Switch Attachment. Model 3830-2 Storage Control Units with the 8171 Two Channel Switch cannot be equipped with the 9190 Fixed Head Attachment. Software support for the 3348 Model 70F Data Module is provided under DOS/VS, OS/VS1, and OS/VS2.

3344 DIRECT ACCESS STORAGE: The 3344 Direct Access Storage units expand the storage capacity of the 3340 Direct Access Storage Facility and can be intermixed with 3340 Model B1 and B2 units in a 3340 subsystem. Each 3344 Model B2 or B2F is a two-drive unit with a capacity of 560 million bytes (279,558,144 bytes per drive). The Model B2 attaches to a 3340 Model A2 and can be intermixed with 3340 Model B drives and 3344 Model B2F units in any combination of up to three B units per 3340 Model A2. The 3344 Model B2F has the same attachment capabilities as the 3344 Model B2 but has 1,004,160 bytes of fixed-head storage per spindle, or 2,008,320 bytes per dual-drive unit. The maximum 3340 subsystem includes one 3340 A2 unit and three 3344 Model B2 or B2F units for a total of 1.8 billion bytes per string.

Each of the two drives in a 3344 Model B2 or B2F unit is equivalent in format and capacity to four logical 3348 Model 70 Data Modules. The average seek time for the moving-head storage is 25 milliseconds, average rotational delay is 10.1 milliseconds, and data transfer rate is 885,000 bytes per second. Standard features include Read-Only Switch, Rotational Position Sensing, and Full-Track Read Command.

A maximum of one 3340/3344 Direct Access Storage subsystem can be attached to a System/370 Model 138 through an Integrated File Adapter. A maximum of two 3340/3344 strings can be attached to a 3830 Model 2 controller, to a 3345 Integrated Storage Control on a System/370 Model 148, or on each path of a System/370 Model 158, 158-3, 168, or 168-3 Integrated Storage Control. Programming support is provided under DOS/VS, OS/VS1, OS/VS2, and VM/370. The Model 3344 is not available for System/370 Model 115 or 125 systems.

3350 DIRECT ACCESS STORAGE: The 3350 Direct Access Storage provides high-speed, large-capacity storage on nonremovable disks for System/370 Models 138 through 168-3.

There are four models of the 3350: the Model A2, A2F, B2, and B2F. Models A2 and A2F each contain two disk drives and an associated controller plus the logic and power supply for attachment of up to three additional 3350 Model B2 and/or Model B2F dual-disk units. Models A2F and B2F each include 1,144,140 bytes of fixed-head storage per drive (or over 2 million bytes of fixed-head storage per dual-drive unit). The average seek time for the data which is accessed by movable read/write heads, and for all of the data on the Model A2 and B2 drives, is 25 milliseconds. All models have an average rotational delay of 8.4 milliseconds and a data transfer rate of 1,198,000 bytes per second.

A standard Selective Format feature allows each Model 3350 drive to operate either in 3350 native mode or in 3330 Model 1 or 3330 Model 11 compatibility mode, with the following capacities:

	Native Mode	3330 Model 1 Compat. Mode	3330 Model 11 Compat. Mode
Bytes per track	19,069	13,030	13,030
Tracks per logical cylinder	30	19	19
Logical cylinders per drive	555	2 x 404	808
Capacity per drive (MB)	317.5	2 x 100	200

In the 3330 Model 1 and Model 11 compatibility mode, the fixed-head storage capacity of Models A2F and B2F is 742,710 bytes per drive. Other standard features include Rotational Position Sensing, error correction of single data error bursts of up to four bits, Command Retry, Read-Only Switch, and Write Format Release. An optional String Switch feature permits a 3350 subsystem to be attached to two 3830 Model 2 Control Units, 3345 Storage and Control Frames, or Integrated Storage Controllers on one central processor or two different central processors.

A 3350 subsystem must include one Model A2 or A2F drive, and can be attached to a System/370 Model 138 through 168-3 Central Processor. A Word Buffer (Feature 8810) is required on the System/370 Model 145, and an Expanded Control Store (Feature 2152) and Register Expansion (Feature 6111) are prerequisites for attachment to the 3830 Model 2 Control Unit or the Model 158, 158-3, 168, or 168-3 Integrated Storage Controller. Full programming support for the 3350 is provided under OS/VS1, OS/VS2, and VM/370 operating systems.

3880 STORAGE CONTROL: This device, announced with the IBM 4300 Series computers can be used with System/370 Models 148, 158, 158-3, 168, and 168-3.

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▶ Drives attached to a System/370 processor via the 3880 can include the 3330/3333, the 3340/3344, and the 3350, but not the 3370. The 3350 is not supported in 333X Model 1 or Model 11 compatibility mode.

Each of the two storage directors of the 3880 attaches to a block multiplexer channel of the System/370 processor. Up to four strings of direct-access storage devices can be attached to each storage director. Strings of 3333/3330 DASD's can be mixed with 3350 strings in any combination. Within a 3333/3330 string, 3333 Models 1 or 11 can attach 3330 Models 1, 2, or 11 in any combination. The 3340/3344 canot be intermixed on a storage director with 3330/3333 or 3350 drives. Storage directors may be attached to either a 1- or 2-megabyte block multiplexer channel.

The original 3880 announcement allowed for the attachment of a two-channel switch pair option. With this announcement, IBM has increased the number of switch pair options to two. A 3880 with both of the two-channel switch pair options installed allows up to four channels to be switched to each storage director. Therefore, a total of eight channels can have access to the 3880. Each two-channel switch pair may be connected to a configuration control panel via an optional remote switch attachment.

A maximum of four 3333 Model 1 or Model 11 and/or 3350 Model A2 units can be attached to each storage director. Each 3333 can attach up to three 3330's, Model 1, 2, or 11. Each 3350 Model A2 or A2F can attach up to three 3350's, Model B2, B2F, C2 or C2F. A storage director can attach up to four 3340 Model A2 units, and up to two of the 3340's can attach 3344's. If 3340's and 3344's are intermixed on a storage director, a maximum of 28 drives can be attached to that director; if only 3340's are attached, up to 32 drives are allowed.

The 3880 is supported under DOS/VSE, VM/370 Release 6, OS/VS1 Release 6.7 and Release 7.0, and OS/VS2 Release 3.8. The 3340/3344 is not supported under OS/VS2 when attached to the 3880.

3851 MASS STORAGE SYSTEM: This system combines both magnetic tape and disk storage technologies to provide on-line access to very large collections of data. The 3850 uses a cylindrical data cartridge, approximately 2 inches in diameter and 4 inches long, containing a 771-inch length of 3-inch-wide magnetic tape as the primary storage medium. Each cartridge can contain up to 50 million bytes of data, which is recorded in a format identical with that of the IBM 3336 Model 1 Disk Pack. One data cartridge, thus, can contain the equivalent of up to 202 cylinders, with 19 tracks per cylinder and 13,030 characters per track; and two data cartridges, according to IBM terminology, equal one "mass storage volume" (i.e., one 3336 Model 1 Disk Pack).

The data cartridges are stored in honeycomb-like cells in the 3851 Mass Storage Facility. Also included in the 3851 are from two to eight Data Recording Devices that transcribe the data between the magnetic tape cartridges and a group of dedicated 3333/3330 Disk Storage Drives. The data transfer rate from the magnetic tape cartridge to the Data Recording Device is 874,000 bytes per second, and the transfer rate between the 3830 Model 3 Disk Control and the central processor is 806,000 bytes per second.

Each 3851 Mass Storage Facility contains one or two Mass Storage Controls, which provide interfaces between the System/370 central processor and the disk storage system controller to initiate and control the data transfer operations between the 3851 and the disk pack drives. The minimum time required for the accessor to place a cartridge in the Data Recording Device entry position, or to restore the cartridge, is approximately three seconds, and the maximum can range from four to eight seconds depending on the size of the Mass

Storage Facility. After the cartridge is placed in the entry position of the Data Recording Device, the approximate positioning time to locate the first physical position and begin data transfer to the 3830 Model 3 Disk Control is five seconds.

The 3851 Mass Storage Facility comes in two versions, Models A and B, with four models of each version. The A series units have one Mass Storage Control, while the B series units each contain two Mass Storage Controls. All models have two accessor mechanisms; in Models A1 and B1 the second accessor serves as an alternative to an inoperative first accessor, while in Models A2 and B2 both accessors can operate simultaneously. The functional characteristics and storage capacities of all the models of the 3851 Mass Storage Facility are as follows:

	A1, B1	A2, B2	A3, B3	A4, B4
Cartridge capacity (no. of cartridges)	706	2044	3382	4720
Byte capacity (billions of bytes)	35.3	102.2	169.1	236.0
Data recording devices	2	4	6	8
Data recording controls	1	2	3	4
Accessors	2	2	2	2

A maximum of two 3851 Mass Storage Facilities from the A series of models or one 3851 Mass Storage Facility from the B series of models can be included in a 3850 Mass Storage System. The 3851 Mass Storage Facility attaches to a System/370 Byte Multiplexer or Block Multiplexer Channel and can be shared by up to four System/370 central processors, or by a maximum of two System/370 multiprocessor systems.

The IBM 3850 Mass Storage System can be extended with the addition of 12 new models, by adding storage extension frames (SEFs) to the existing mass storage facility. A storage extension frame is a data extension frame (DEF) without the data recording controller (DRC), data recording devices (DRDs) and associated power components. An SEF has the same capacity as a DEF.

The 3851 Mass Storage Facility is available in the current eight models and twelve new models. The ten A models have one mass storage control (MSC) per unit, and the ten B models have two MSCs per unit. Each 3851 has two accessor controllers and two accessor mechanisms. There must be one or two 3851 MSF A models per 3850 MSS or one 3851 MSF B model per 3850 MSS. One 3850 MSS may be attached to one to four host systems. A host system may be a UP, AP, or MP.

The integral functional units and the storage capacity of the 3851 vary by model.

Model	DRCs	DRDs	DEFs	SEFs	Cartridges	Storage Capacity (Gigabytes)
A01, B01	1	2	0	0	706	35
A11, B11	1	2	0	1	2044	102
A21, B21	1	2	0	2	3382	169
A31, B31	1	2	0	3	4720	236
A02, B02	2	4	1	0	2044	102
A12, B12	2	4	1	1	3382	169
A22, B22	2	4	1	2	4720	236
A03, B03	3	6	2	0	3382	169
A13, B13	3	6	2	1	4720	236
A04, B04	4	8	3	0	4720	236

A 3850 MSS dual library consisting of two 3851 size four A models provides storage capacity of 472 gigabytes. The size four 3851 A model can be a Model A31, A22, A13, or A04. Each data recording controller connects to one or two 3830 ▶

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▶ Model(s) 3 (staging adapters) or Integrated Storage Control (ISC) with the Staging Adapter feature.

IBM Model 3333/3330 Disk Storage Units serve as intermediary storage between the central processor and the Mass Storage Facility. A microprogrammed 3830 Model 3 Storage Control for System/370 Models 158, and 168 is required to provide the capability to interact with the Mass Storage Controller. A maximum of sixteen 3330 Model 1 or 2 or eight 3330 Model 11 Disk Pack Drives on either controller can be dedicated as "staging drives" to serve as intermediaries between the central processor and data sets stored in the Mass Storage Facility. Addresses on these drives are associated with a set of virtual drive addresses by logic within the 3830 Model 3 or Integrated Storage Control. The disk controller, working in conjunction with the Mass Storage Controller, converts virtual addresses to actual addresses on the staging drives for use by the Mass Storage Controller. The Mass Storage Facility locates the data set and maps the data into available space on the staging drives in "pages" of eight cylinders for access by the central processor. The 3830 Model 3 and the Integrated Storage Control are connected to a Block Multiplexer Channel on a System/370 Model 158 or 168.

The 3850 is supported under the OS/VS1 and OS/VS2 operating systems and uses a special Mass Storage System Communicator for control of mass storage volumes. Access methods include the BSAM, QSAM, BPAM, BDAM, VSAM, EXCP, and XDAP access methods for direct-access storage devices; use of ISAM will incur significant performance degradation. A new CONVERTV utility is available for conversion of 3336 Model 1 Disk Packs to 3850 volumes. Tape data sets and direct-access data sets, including those on 3336 Model 11 Disk Packs, can be converted to 3850 volumes by Job Control Language parameters directing file output to the 3850 Mass Storage System, or by an OS/VS data set copy utility program.

INPUT/OUTPUT UNITS

3410/3411 MAGNETIC TAPE SUBSYSTEM: These compact, low-cost tape units, designed primarily to bring magnetic tape capabilities to the small-scale systems such as the IBM System/3 Model 10, are also available for use with System/370 Models 115 through 158. 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*
Data 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/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.

3420 MAGNETIC TAPE UNIT, MODELS 3, 5, AND 7: The 3420 units incorporate the features of the earlier 2420 drives together with several worthwhile improvements. The 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 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 System/370 Models 115 through 168-3. 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.

3420 MAGNETIC TAPE UNIT, MODELS 4, 6, AND 8: These high-performance models of the 3420 Magnetic Tape Units and 3803 Tape Control provide data transfer rates of up to 1.25 million bytes per second for System/370 Models 115 through 195. The new models employ a proprietary recording method called Group Coded Recording (GCR), which permits data to be recorded on standard ½-inch tape at an effective density of 6250 bytes per inch. Information to be written on the tape is segmented into groups of characters to which a special coding character is added. When GCR-coded data is read from the tape, the uniquely coded information is restored to its original form.

The three 6250-bpi models of the 3420 Magnetic Tape Unit—Models 4, 6, and 8—provide maximum data transfer rates of 470,000, 780,000, and 1,250,000 bytes per second, respectively. All three models can be equipped to operate either at the 6250-bpi density only or at both 6250 and 1600 bpi. Unlike the earlier 3420 Models 3, 5, and 7, however, the 6250-bpi models cannot handle either 7-track tape or the 800-bpi 9-track format. The characteristics of the three 6250-bpi tape units are summarized in the following table.

	Model 4	Model 6	Model 8
Tape speed, inches/sec.	75	125	200
Data transfer rate, bytes/sec:			
At 6250 bpi	470,000	780,000	1,250,000
At 1600 bpi	120,000	200,000	320,000
Access time, milli-seconds:			
Read, at 6250 bpi	2.3	1.6	1.1
Write, at 6250 bpi	2.1	1.5	0.95
Read, at 1600 bpi	4.0	2.6	1.7
Write, at 1600 bpi	3.0	2.0	1.3
Nominal inter-block gap, inches:			
At 6250 bpi	0.3	0.3	0.3
At 1600 bpi	0.6	0.6	0.6
Maximum rewind time, seconds/2400-ft reel	60	60	45

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➤ The 3803 Model 2 Tape Control provides the power and signal connections for the 3420 Magnetic Tape Units. Up to eight 3420 drives of any model can be signal-connected to a 3803 Model 2. A 3803 Tape Control (either Model 1 or Model 2) provides power for up to eight 3420 Model 3, 4, 5, 6, or 7 drives or for a maximum of six 3420 Model 8 drives. Seven-track and nine-track tape drives with various recording densities can be intermixed on a single 3803 Model 2, and a pool of up to 16 tape drives can be switched between 2, 3, or 4 control units.

At the 6250-bpi recording density, IBM employs a more powerful encoding/checking technique that permits in-flight correction of errors occurring in any single track or in two tracks simultaneously. Moreover, errors in all nine tracks of a single data block can be corrected if they occur on no more than two tracks at a time. Long tape blocks are subdivided by "resynch bursts," which are inserted to allow error tracks to return to full operation when reading forward, thereby restoring the maximum error correction capability.

The 3420 Model 4, 6, and 8 Magnetic Tape Units employ an improved tape cleaning mechanism and a high-precision tape motion control system. The cleaning mechanism is engaged during auto-threading, rewinding, and unloading operations to remove loose contaminants from the tape surface and protect the recording head. The improved tape motion control system permits a 50 percent reduction, from 0.6 inch to 0.3 inch, in the length of the gap between blocks of recorded data and also reduces the read/write access times. Other features of the previous 3420 models, such as automatic threading, cartridge loading, digital tachometers, and a radial interface, are retained in the new models.

The 3803/3420 units can be used with System/370 Models 138 through 168-3. Software support is provided under DOS/VS, OS, OS/VS1, and OS/VS2. Customer shipments began in the fourth quarter of 1973, and field conversions of existing 3420 Magnetic Tape Units to the new models began in the first quarter of 1974.

3540 DISKETTE INPUT/OUTPUT UNIT: Reads and writes IBM diskettes ("floppy disks") as an on-line I/O unit for use with System/370 Models 115 through 158-3. The 3540 is designed primarily to read data recorded by an IBM 3740 Data Entry System (Report 70D-491-41) into a System/370 computer. Each IBM diskette is organized into 75 tracks, with 25 sectors per track and 128 bytes per sector. Only 73 of the tracks are used for data, so each diskette can store 1898 sectors or 242,944 bytes.

The 3540 consists of a control unit and either one diskette drive (Model B1) or two drives (Model B2). Each drive has a diskette hopper that can hold up to 20 diskettes. The diskettes are automatically fed from the hopper, mounted on the drive spindle for read/write operations, and then removed and stacked.

Double 128-byte buffers are associated with each drive. The diskettes revolve at 360 revolutions per minute. Effective performance, which includes program open time and diskette changing time, depends on the number of sectors read or written per revolution of the diskette and the number of tracks written per diskette. IBM quotes performance rates of 2255 to 3635 records per minute for reading diskettes when more than half the sectors per track and more than half the tracks per diskette are read. Writing operations for equivalent conditions proceed at 1250 to 2210 records per minute.

1442 CARD READ PUNCH, MODEL N1: Reads 80-column cards at 400 cpm and punches them at 160 columns per second. Usable with currently available Models 115 through 168-3; includes an integrated control unit.

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 currently available Models 115 through 168; includes an integrated control unit.

2501 CARD READER: Reads 80-column cards serially by column at either 600 cpm (Model B1) or 1000 cpm (Model B2). Usable with currently available Models 115 through 168-3; includes an integrated control unit.

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 currently available Models 115 through 168-3; includes an integrated control unit.

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 115 through 168-3; includes an integrated control unit.

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 115 through 195. The 2821 Control Unit provides fully buffered card reading and punching; some models of the 2821 can also control one or two 1403 Printers. Usable with Models 115 through 168-3.

3504 CARD READER: Reads standard 80-column cards at either 800 cpm (Model A1) or 1200 cpm (Model A2). Connects directly to a Model 125 Processing Unit via the Integrated 3504 Card Reader Attachment. Functionally identical with the 3505 Card Reader used with System/370 Models 138 through 168-3 below.

3505 CARD READER: Reads standard 80-column cards at either 800 cpm (Model B1) or 1200 cpm (Model B2). Contains its own fully buffered, microprogrammed control unit, and can be connected directly to any System/370 I/O channel. The 3505 has a 3000-card file feed hopper and two 1750-card stackers. A third, program-selectable 1750-card stacker is optional.

The Read Column Eliminate feature for the 3505 suppresses the reading (and checking) of data from specified card columns. The Optical Mark Read feature permits the reading of up to 40 columns of information marked on the cards with ordinary pencils; both marked fields and punched fields can be read during a single pass.

3525 CARD PUNCH: Punches standard 80-column cards at 100 cpm (Model P1), 200 cpm (Model P2), or 300 cpm (Model P3). Punches a row at a time, in either EBCDIC or card image mode. Utilizes the buffered control unit and power supply in the 3505 Card Reader, to which the 3525 is connected via a 3525 Adapter on the 3505. The 3505/3525 subsystem can be connected to any System/370 I/O channel. In a Model 125 system, the 3525 can be connected directly to the Model 125 Processing Unit via the Integrated 3525 Card Punch Attachment; only one 3525 can be attached in this manner, and it cannot coexist with a directly connected 2560 MFCM or 5425 MFCU.

The 3525 has a 1200-card feed hopper, two program-selectable 1200-card stackers, and a 200-card reject stacker.

2560 MULTI-FUNCTION CARD MACHINE (MFCM), MODEL A1: Combines the functions of an 80-column card reader, punch, collator, and interpreter in one unit. Reads at 500 cpm, punches at 160 columns per second, and (with the optional Card Print feature) prints on the cards at 140 print positions per second. Has two 1200-card feed hoppers and five 1300-card radial stackers. Cards can be fed from either hopper and directed to any stacker. One 2560 can be directly ➤

▶ connected to a Model 115, 115-2, 125, or 125-2 via the Integrated 2560 Attachment; it cannot co-exist with a directly connected 3525 Card Punch or 5425 MFCU.

The optional Card Print feature enables the 2560 to print 2, 4, or 6 lines on a card, operator-adjustable to any of 25 line positions. There are 64 alphanumeric print positions per line, spaced 10 to the inch. The 2560 Card Print Control feature is a prerequisite on the Model 115, 115-2, 125, or 125-2.

5425 MULTI-FUNCTION CARD UNIT (MFCU): Combines the functions of a 96-column card reader, punch, collator, and interpreter in a single unit. Has two 2000-card feed hoppers and four 600-card radial stackers. Cards fed from either or both hoppers can be read, punched, printed, and directed to any of the four stackers under program control. One 5425 can be directly connected to a Model 115, 115-2, 125, or 125-2 via the Integrated 5425 Attachment; it cannot coexist with a directly connected 3525 Card Punch or 2560 MFCU. Either the 1403 Printer/5425 MFCU Power Prerequisite or the 5425 MFCU Power Prerequisite is required on the Model 125 or 125-2, depending on whether or not a 1403 Printer is also installed.

The 5425 is available in two models. Cards are read serially at 250 cpm in Model A1 and 500 cpm in Model A2. Punching is performed serially at 60 cpm in Model A1 and 120 cpm in Model A2. Printing occurs at a speed of 60 cpm in Model A1 and 120 cpm in Model A2 when printing in any or all of the first three line positions on each card. If the fourth (lower) line position is used, the printing speed drops to 48 cpm for Model A1 and 96 cpm for Model A2. Each of the 4 lines can hold up to 32 printed characters.

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 currently available Models 115 through 158. Requires 2826 Paper Tape Control, which controls up to two 1017 Readers and two 1017 Punches.

1018 PAPER TAPE PUNCH: Punches 5- to 8-track tape at up to 120 char/sec. Usable with currently available Models 115 through 158. 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 currently available Models 115 through 158. Requires 2822 Paper Tape Reader Control.

1403 PRINTER: Provides high-quality printed output by means of a horizontal chain or train mechanism. The standard character set contains 48 characters, and the Universal Character Set (a no-charge option for Model 2 or N1 only) permits up to 240 characters to be printed. Line spacing of 6 or 8 lines per inch is operator-controlled. Standard skipping speed is 33 inches per second; a dual-speed carriage in Models 2 and N1 permits a speed of 75 inches per second on skips of more than 8 lines.

Models 2, 7, and N1 of the 1403 Printer can be connected to any System/370 processor via the 2821 Control Unit, or directly to a Model 125 via the integrated attachment and power features listed below, or directly to a Model 135 via the optional Integrated Printer Adapter. Characteristics of the three models are as follows:

> Model 2: 600 lpm (750 lpm maximum with UCS option), 132 print positions; Features 4505, 4662, and 4667 are required on a Model 125 for direct connection.

> Model 7: 600-lpm, 120 print positions; Features 4505 and 4667 are required on a Model 125 for direct connection.

> Model N1: 1100 lpm (1400 lpm maximum with UCS option), 132 print positions; Features 4505, 4662, 4667, and 4668 are required on a Model 125 for direct connection.

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 currently available Models 125 through 168-3; includes an integrated control unit.

3203 PRINTER: Uses IBM's proven horizontal-train printing technology to produce high-quality printed output from a System 370 Model 115, 115-2, 125, 125-2, 138, or 148 system. The 3203 is an improved version of the widely used 1403 Model N1 Printer and uses the same 1416 Interchangeable Train Cartridge. The 3203 is available in four models for use on the System/370; rated print speeds with the standard 48-character set are 600 lpm for Model 1 and 1200 lpm for Model 2, Model 4, and Model 5. Certain preferred character set arrangements permit speeds of up to 770 lpm for Model 1 and 1550 lpm for Model 2 and Model 4. Character sets containing from 30 to 240 characters can be used. The Universal Character Set feature, with a 240-position buffer, is standard. All models have 132 print positions. Horizontal spacing is 10 characters/inch, and vertical spacing is 6 or 8 lines/inch. Normal skipping is up to 24 inches per second with a high speed skip of up to 55 inches per second after 6 lines have passed. Forms ranging from 3.5 to 20 inches in width and from 3 to 24 inches in length can be fed. Normal skipping speed is up to 24 inches/second, with high-speed skipping at up to 55 inches/second after 6 lines have passed. A power assisted stacker is standard.

Improvements over the 1403 Model N1 include: (1) an electronic forms control buffer that controls skipping and spacing, eliminating the need to change carriage control tapes; (2) a new tractor design to simplify forms loading; (3) higher print-hammer energy to produce copies of improved quality; (4) smaller size and reduced floor-space requirements; (5) quieter operation; and (6) a vacuum cleaning system that continually cleans the print train. Additional 3203 improvements, announced subsequent to the printer's introduction, were ability to print the OCR A Size 1 font (thus creating turn-around documents automatically) and a power-assisted stacker.

Models 1 and 2 are used with the Model 115, 115-2, 125, and 125-2 processing units, while the 3203 Model 4 is for use with Model 138 and 148 processing units. Model 5 is for use with any virtual storage System/370. A single 3203 Printer, Model 1 or 2, can be connected to a Model 115, 115-2, 125, or 125-2 Processing Unit via the appropriate Integrated 3203 Printer Attachment. Up to two 3203 Model 4's can be attached to a Model 138 or 148. Model 5 is limited only by the number of control positions available on a system channel.

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 ▶

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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 can be connected to currently available Sytem/370 Models 138 through 168-3 via the 3811 Printer Control Unit.

5203 PRINTER, MODEL 3: Uses an interchangeable, horizontal-chain cartridge to produce high-quality printed output from a System/370 Model 115 or 115-2. Rated speed is 300 lpm with the standard 48-character set. The standard 96-position print line can optionally be expanded to 120 or 132 positions. Horizontal spacing is 10 characters/inch, and vertical spacing is 6 or 8 lines/inch. Skipping speed is 16.7 inches/second at the usual spacing of 6 lines/inch. Vertical format is under program control; there is no carriage control tape. The standard 48-character chain cartridge can be replaced by other operator-changeable cartridges. The Universal Character Set feature, which is standard when the 5203 is used with a 370/115, permits the use of cartridges containing up to 120 different characters. A single 5203 Model 3 Printer can be connected to a Model 115 or 115-2 Processing Unit via the 4653 Integrated 3203/5203 Printer Attachment.

3800 PRINTING SUBSYSTEM: This high-speed non-impact printer, announced in April 1975, can operate on-line to any currently available System/370 Model 148 through 168-3 operating under the OS/VS1 or OS/VS2 operating system. The printer uses an electrostatic process, referred to as "electro-photographic," using a helium-neon laser as a light source. A revolving mirror deflects the laser beam to generate a line scan; the laser beam is deflected (modulated) away from the mirror to produce a horizontal dot pattern. A vertical dot pattern is established because the mirror is faceted. Data characters received from the central processor and stored in the buffer are encoded into the dot matrix form through one or more character set patterns stored on a diskette drive.

The 3800 comes with definitions on the diskette for seven character styles, including Gothic (sans serif equivalent to the IBM 1403 or 3211 print style), Katakana (Japanese ideographs), OCR-A Size 1, OCR-B, Text 1 (upper case), Text 2 (lower case), and Format (special graphic for drawing form lines). The fonts are composed of from 37 to 64 characters or symbols, and except for Katakana, include a space character. Gothic, Katakana, and Format fonts come in three sizes corresponding to horizontal pitches of 10, 12, and 15 characters per inch. The others come in 10-pitch size only. Separate fonts are provided for all three Gothic sizes and for Text 1 and Text 2 for underscored characters.

The 3800 uses conventional single-ply continuous computer forms in any combination of 10 specific widths from 6.5 to 14.875 inches and 5 specific lengths from 3.5 to 11 inches. The pages-per-minute print rates and peak lines-per-minute rates are listed below for all five standard form lengths:

Form length, inches	Maximum lines/page		Peak speed, lpm		Peak pages/ min.
	6 lpi	8 lpi	6 lpi	8 lpi	
3.5	15	20	8,180	10,900	545
5.5	27	36	9,370	12,490	347
7	36	48	9,810	13,080	273
8.5	45	60	10,100	13,470	224
11	60	80	10,410	13,880	173

Vertical spacing is six or eight lines per inch, under program control. A Forms Overlay feature operates under program control to produce document and report formats, designs, or other constant data and to merge format with data. The Copy Modification Function permits copies to be identified with specific legends or addresses, or additions or deletions to be made to each copy under program control. Channel switching can be performed manually through the 2914 Manual Switch Model 1 or the 8170 Two-Channel Switch. Automatic switching is performed by the 8171 Dynamic Two-Channel Switch, which can be used with two channels on a single central processor for alternate path selection or to share the printer between two processors in a tightly coupled multiprocessing system. Special optional features include 127 Writable Character Generation Storage Positions (Feature 5401), which adds 127 positions to the standard 128 to allow up to 255 graphics to be printed, and the 6148 Remote Switch Attachment, which attaches the 8170 Two-Channel Switch to a configuration control panel.

The 3800 attaches to a Byte or Block Multiplexer Channel of any currently available System/370 Model 148 through 168-3 VS computer.

Attachment via a non-dedicated Selector Channel is not recommended. Initial customer deliveries were made in July 1976. Additional details about the 3800 can be found in Report 70D7-491-51.

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 any currently available Model 115 through 158-3 via a System/3670/370 Adapter.

1419 MAGNETIC CHARACTER READER: Reads and sorts MICR-encoded documents at up to 1600 per minute. Has 13 pockets. Usable with any currently available Models 115 through 168. Also usable for off-line sorting.

1287 OPTICAL READER: Optically reads printed characters into a System/370 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 through 9 and letters C, S, T, X, and Z; shapes and sizes and handprinted characters must conform with specified rules. Usable with any currently available Models 115 through 168, although only Model 5 is available with the Models 115, 115-2, 125, and 125-2 systems. Five 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 OCR A font.

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

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Model 5: Reads multiple lines of handprinted numeric digits and six letters from individual paper or card documents.

1288 OPTICAL PAGE READER: Reads alphanumeric data printed in the OCR A font from page-size documents up to 9 by 14 inches. Can also be equipped to read pencil-marked data and/or the handprinted digits 0 through 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 64 characters on each of the 50 lines). Usable with any currently available Models 138 through 168.

3881 OPTICAL MARK READER: Reads machine-printed and/or hand-marked data from documents ranging from 3 by 3 inches to 9 by 12 inches in size. Model 1 reads data directly into any currently available System/370 Model 115 through 158 at a speed of 4000 to 6000 documents per hour, depending, upon the document size. Model 2 operates off-line, transferring the data to a 3410 Model 1 Magnetic Tape Unit at a speed of 3700 to 5700 documents per hour. Model 3 operates off-line, transferring data to an IBM diskette drive at speeds of 5,700 3-by-3-inch documents or 3,800 8½-by-11-inch pages per hour. Each diskette has a storage capacity of up to 1,898 records, each 128 characters in length. Data recorded on diskettes by the 3881 Model 3 is compatible with the IBM 3741 Data Station, 3742 Dual Data Station, 3747 Data Converter, and 3540 Diskette Input/Output Unit.

Up to 2480 marking positions are available on each 9-by-12-inch document. Up to six different document formats, loaded from format control sheets, can be stored and read during the same run. An optional BCD Read feature facilitates the processing of turnaround documents, and a Serial Numbering feature prints consecutive numbers on the documents being processed.

3886 OPTICAL CHARACTER READER: Reads machine-printed characters and handprinted numerals from documents ranging from 3 by 3 inches to 9 by 12 inches in size. Can read typewritten pages measuring 8.5 by 11 inches at the rate of approximatedly 330 pages per hour for on-line input to a System/370 (3886 Model 1) or 300 pages per hour for off-line recording on magnetic tape (3886 Model 2). The 3886 reads alphanumeric characters in the OCR A and B fonts, preprinted 3/16-inch Gothic numerals, and the handprinted numerals 0 through 9 and letter X. Machine-printed and handprinted data can be read from the same document. Two output stackers permit segregation of unreadable documents. The 3886 Model 1 connects to a Multiplexer or Selector Channel of any currently available System/370 Models 115 through 168. The 3886 Model 2 operates off-line, recording data on a 3410 Model 1 Magnetic Tape Unit for later processing.

The Video Collect Features permit data read by the 3886 to be displayed on a 3277 CRT terminal for operator correction and verification and for keyed entry for nonscannable data. The 8701 Video Collect Feature permits direct attachment of a 3277 Display Station to a 3886 Model 2; either rejected characters or entire fields can be displayed for operator verification and correction before being transferred to tape storage. The 8702 Video Collect Feature, available for the 3886 Model 2 only, permits collection of video image data on a 3410 Magnetic Tape Unit for later display on a 3277 Display Station. The 8703 Video Collect Feature, available for the 3886 Model 1 only, provides the capability to transmit video image data directly to a central processor under control of user-written routines.

3890 DOCUMENT PROCESSING UNIT: A high-speed MICR sorter/reader that can be used either off-line or on-line with any currently available System/370 Model 138 through 168 under OS/VS. The 3890 is the only on-line IBM MICR unit that can run with the attached Sytem/370 operating in the virtual storage mode. This is because the unit has built-in timing and logic controls that permit it to work time-independently from the CPU or, in off-line use, to provide advanced sorting techniques to reduce the number of item passes performed.

The 3890 operates at 125,000 documents/hour for typical check mixes, and requires only one operator even at this speed. Six models, designated A1 through A6, provide 6, 12, 18, 24, 30, and 36 pockets with a capacity of 800 to 1000 documents each. The pockets can be unloaded while the unit is running. The file feed hopper holds about 4800 documents and has an automatic jogger to eliminate that operator step. Stacker selection is under internal control, time-independent from the on-line CPU. The control is loadable from an on-line computer or off-line from a disk capable of holding 23 different stacker selection programs. A second feed hopper can automatically merge divider slips under program control.

Item numbering and endorsing are optional features for the 3890. The unit also contains built-in logic for error correction of special symbols and high-order zero correction. Sequence checking, split field, high-order zero kill, and multiple column control are programmable. All features and additional pockets are field-installable. Attachment to the System/370 is via a byte multiplexer or block multiplexer channel.

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 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 any currently available System/370 Models 115 through 168-3.

TERMINALS: Numerous IBM display terminals, batch terminals, and typewriter terminals can be connected to a System/370 in remote and/or local configurations. For details, please refer to Reports 70D1-491-45, 70D2-491-11, 70D2-491-12, 70D3-491-46, 70D-491-41, and 70D4-491-43 in the Peripherals section of DATAPRO 70.

COMMUNICATIONS CONTROL

3704 AND 3705-II COMMUNICATIONS CONTROLLERS: 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 32K to 512K bytes of MOSFET memory and control up to 352 communications lines. It is available in numerous models with varying storage sizes and line capacities.

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 storage, Channel Adapters, Communications Scanners, Line Interface Bases, and Line Sets required to accommodate up to 352 communications lines.

Four different channel adapters are available providing attachment to a selector, a byte multiplexer or block multiplexer channels of System/370 or byte multiplexer channels of System/360. Three types of communications scanners are available.

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TABLE 1. COMMUNICATIONS HANDLED BY THE IBM 3705

Type of Line Interface	Transmission				Line Set	Lines per Line Set	LIB	Line Sets per LIB*	Comments
	Speed (bps)	Timing	Mode	Line					
External RS-232C modem	Up to 1200	Asynchronous	Half-duplex	Leased or switched	1A	2	Type 1	8	Cannot use Scanner Type 3.
	Up to 1200	Asynchronous	Full-duplex	Leased	1B	1			Cannot use Scanner Type 3.
	Up to 1200	Asynchronous	Half-duplex	Leased	1D	2			Any combination of speed and timing
	Up to 600	Asynchronous	Half-duplex	Switched					is possible for each Line Set 1D.
	Up to 9600	Synchronous	Half-duplex	Leased or switched					
	Up to 9600	Synchronous	Full-duplex	Leased	1H	1			
External wideband modem	19.2K or 50K	Synchronous	Half-duplex	Leased or switched	1G	1	Type 1	8	Requires Scanner Type 2 or 3.
	50K	Synchronous	Full-duplex	Leased	1T	1		4	
External Mil 188C modem	Up to 50K	Async./sync.	Half-duplex	Leased	1J	1	Type 1	8	Requires Scanner Type 2 or 3 for speeds over 7200 bps.
External CCITT V.35 modem	56K	Synchronous	Half-duplex	Leased	1S	1	Type 1	8	Requires Scanner Type 2 or 3.
	56K	Synchronous	Full-duplex	Leased	1U	1		4	
	Up to 230.4K	Synchronous	Half-duplex	Leased	1GA	1	Type 1	2	Requires Scanner Type 3.
	Up to 230.4K	Synchronous	Full-duplex	Leased	1TA	1		1	
Local attachment	Up to 1200	Asynchronous	Half-duplex	IBM cables	1C	2	Type 1	8	Maximum cable length is 200 ft. Cannot use Scanner Type 3.
	Up to 2400	Synchronous	Half-duplex	IBM cables	1F	2			Maximum cable length is 100 ft.
	14.4K or 57.6K	Synchronous	Half-duplex	IBM cables	1W	1	Type 1	8	Maximum cable length is 200 ft. Interface is CCITT V.35.
	14.4K or 57.6K	Synchronous	Full-duplex	IBM cables	1Z	1		4	Requires #4651 Business Clock.
Automatic dialing; RS-366	—	—	—	Switched	1E	2	Type 1	8	For attachment of external dialing units.
Telegraph: 20, 40, or 62.5 mA current loop	Up to 200	Asynchronous	Half-duplex	Leased	2A	2	Type 2	8	For attachment to AT&T 83B2/83B3, Western Union Plan 115A, or IBM terminals with Telegraph feature.
Internal modems or adapters (requires no external modems)	Up to 134.5	Asynchronous	Half-duplex	2-wire private	3A	2	Type 3	7	IBM Limited Distance Type 1 Line Adapters; 4.75 wire miles maximum.
	Up to 134.5	Asynchronous	Full-duplex	4-wire private	3B	2			IBM Limited Distance Type 1 Line Adapters; 4.75 wire miles maximum.
	Up to 600	Asynchronous	Half-duplex	2-wire private	4A	2	Type 4	2	IBM Limited Distance Type 2 Line Adapters; 8.25 wire miles maximum.
	Up to 600	Asynchronous	Half-duplex	Leased	4B	2			IBM Leased Line, Line Adapters, 2-wire.
	Up to 600	Asynchronous	Full-duplex	Leased	4C	2			IBM Leased Line, Line Adapters, 4-wire.
	2400 or 1200	Synchronous	Half-duplex	Leased	5A	1	Type 5	2	Point-to-point modems.
	2400 to 1200	Synchronous	Half-duplex	Leased	5B	1			Multipoint modems.
	2400 or 1200	Synchronous	Half-duplex	Switched	6A	1	Type 6	2	Auto-answer modems.
	2400	Synchronous	Half-duplex	Switched	—	1	Type 7	1	Auto-dial and auto-answer modems.
	1200 or 600	Async./sync.	Half-duplex	Leased	8A	2	Type 8	3	
	600	Asynchronous	Half-duplex	Switched	8B	2			Auto-answer modems.
	1200 or 600	Synchronous	Half-duplex	Switched					
	1200 or 600	Synchronous	Half-duplex	Switched	9A	1	Type 9	2	Auto-dial and auto-answer modems.
	Up to 1200	Synchronous	Full-duplex	Leased	10A	1	Type 10	6	
	2400 or 1200	Synchronous	Full-duplex	Leased	11A	1	Type 11	2	Point-to-point modems.
	2400 or 1200	Synchronous	Full-duplex	Leased	11B	1			Multipoint modems.
	300	Asynchronous	Half-duplex	Leased	12A	2	Type 12	2	12B includes auto-answer modems; both include modems with bidirectional interrupt signal capability, intended for IBM 3767 terminals operating as 2741's.
	300	Asynchronous	Half-duplex	Switched	12B	2			

*For speeds over 4800 bps, mix and quantity of line sets per LIB can be restricted; see text.

▶ The restrictions that apply to the Channel Adapters and Scanners affect configuration possibilities and performance in addition to the limitations imposed by the different models. The selection of Channel Adapters and Scanners is determined by the desired level of performance, the number of lines to be implemented, and the mode of operation (i.e., Emulation Mode or Network Control Mode).

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 Network Control (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 a separate multiplexer subchannel for each communications line.

The IBM 3704 is a mature product and a smaller version of the IBM 3705. 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.

The 370X can be configured and used as a remote concentrator. Communication between a remote 370X and a local 370X connected to the host computer is over a leased line operating synchronously in the full-duplex mode at 4800 bits per second or in half-duplex mode at up to 50,000 bits per second.

The capabilities of the 3705 for accommodating various types of communications lines and techniques are summarized in Table 1. Restrictions on the usage of the various Line Sets ▶ are clearly indicated.

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In general, identical software support is provided for the 3704 and 3705. Operational differences exist primarily because of the smaller main memory of the 3704, which limits the number of lines and programming features that can be accommodated at any one time.

When connected to a System/370 computer, a 370X can use either the Network Control Program (NCP) or the 2701/2/3 Emulation Program. NCP/VS, for virtual environments, includes all of the facilities of the original NCP and also has the Partitioned Emulation Programming Extension (PEP) capability which permits operation in the NCP Mode and Emulation mode concurrently.

NCP and NCP/VS provide front-end programming functions that can relieve the host processor of much of the overhead associated with managing multiple data communications lines. EP and EP/VS allow a 3705 to replace multiple 2701, 2702, and 2703 controllers with little or no modification of user application programs; operation of the host processor when EP is active is identical with activity under the previous 270X hard-wired controllers, and none of the potential benefits of front-ending is realized.

NCP/VS operates through the access method, VTAM, in DOS/VS environments and through either VTAM, TCAM, or a combination in OS/VS environments. The combination mode of operation eases conversion requirements.

VTAM is acknowledged by IBM to be the principal access method for telecommunications support under DOS/VS and OS/VS. BTAM and QTAM will not be extended, and enhancements for TCAM will be in the environment provided by VTAM under OS/VS. The chief feature of VTAM is dynamic sharing of network resources. Application programs working through VTAM have access to any terminal, line, or 3704/3705 controller in the network; for example, different application programs can initiate transmission and reception with terminals located on the same multipoint communications lines. By the same token, multiple application programs can have access to the same data base. One component of VTAM is TOLTEP, an on-line testing program for exercising and testing the complete network.

The Advanced Communications Function for NCP, ACF/NCP/VS (and related Systems Support Programs, for all operating systems) are available. The added capabilities are significant for multi-system users. Multiple System/370's can be interconnected via full- or half-duplex SDLC protocol lines linking their respective local 3705's. Any mix of VS operating systems is permissible. Transmission to a host CPU can be passed through interconnected 3705's to a down-stream CPU with minimal involvement of the host or intermediate CPU's. To utilize ACF/NCP/VS, an Advanced Communication Function for VTAM and TCAM is necessary.

ACF/VTAM supports CICS/VS, IMS/VS, Power/VS, JES1/RES, JES2/RJE, TSO, VSPC, SSS and BTP user programs. ACF/TCAM supports CICS/VS, TSO, SSS and user programs.

Another ACF feature is the capability for up to four CPU's to share a single 3705-II. Channel Adapter Types 2, 3, or 4 can be used. If more than two are used, they must all be Type 4. The computers must be at the same location, but can employ any mix of VS operating systems. The access method can be ACF/VTAM or ACF/TCAM. More than one channel adapter can be connected to one CPU, and each channel can be serviced by a different access method. This arrangement permits different terminals on the same line to communicate with different computers and/or to utilize different access methods.

A third ACF capability supports the Remote Program Loader-II (RPL-II). RPL-II can be attached to a 3705-II along with up to three channel adapters. With this attachment, a controller that normally operates as a local controller can also function as a remote to another controller. This enables the rerouting of a deactivated or a failed host computer's traffic to another CPU. In the remote state, any communication links to controllers other than the newly assigned local are not supported.

Other ACF capabilities include inbound pacing of traffic from terminals with logical units, such as 3770 programmable terminals; activating and deactivating of channel trace via an operator panel function; and concurrent tracing of up to eight lines attached to a 3705-II. When utilizing ACF, up to eight IBM computers can control interconnected controllers and terminals, thus allowing one or more computers or controllers to be taken out of service with minimum disruption. ACF/NCP also offers specialized lines depending on the type of traffic and parallel links between hosts and nodes for network backup.

The multi-System/370 user can create a fully interconnected network with minimal hardware changes and virtually no change to application programs via ACF software. ACF apparently will take users towards relegating one CPU to the job of traffic controller, freeing all other CPU's for applications processing.

Detailed reports on both the 3704 and 3705 Communication Controllers can be found in Data Communications Service. See Report C13-491-101 for the 3705 and Report C13-491-201 for the 3704.

INTEGRATED COMMUNICATIONS ADAPTER (ICA): This optional feature for the Model 115, 115-2, 125, 125-2, and 138 Processing Unit provides the basic control storage and common circuits for direct connection of synchronous (BSC) communications lines and/or asynchronous lines. The exact number is line speed dependent. For the 115 and 115-2, up to five synchronous or up to four synchronous and eight asynchronous communications lines can be configured. For the 125 and 125-2, up to six synchronous and 16 asynchronous communications lines can be configured.

The Model 138 ICA provides up to eight line adapters in any combination of the following three types:

IBM Terminal Adapter Type I, Model II—supports communication, at either 134.5 or 600 bits/second, with an IBM 1050, 2740, 2741, or System/7.

IBM Terminal Adapter Type III—supports communication, at either 1200 or 2400 bits/second, with 2260 or 2265 Display Stations and their associated control units.

Synchronous Data Adapter Type II—supports communication, in BSC mode at up to 4800 bits/second, with an IBM 2770, 2780, 2790, 3735, or any of the following IBM computers equipped for BSC transmission: System/3, System/360, 1130, or 1800. Each BSC line can operate in any of three codes: EBCDIC, ASCII, or Six-Bit Transcode. The Autoanswer feature is available for the ICA, but the Autocall feature is not.

The ICA for the 115, 115-2, 125, and 125-2 combines the functions of a Byte Multiplexer Channel and a communications control unit. Lines connected via the ICA are addressed and controlled as if they were connected to the Byte Multiplexer Channel via a 2703 Transmission Control. All combinations of BSC and asynchronous lines require the ICA Extension feature. Additional features are required to create appropriate line interfaces for the individual lines, and the associated configuration rules are quite complex. ►

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▶ Standard facilities of the ICA for BSC lines include Auto-poll, multipoint central station functions, multipoint tributary station functions, EBCDIC transparent mode, and either EBCDIC or ASCII code; the Autopoll and multipoint central station functions are provided for asynchronous lines as well.

On the 115 through 125-2 ICA, asynchronous line speeds can range from 45.5 to 600 bits/second (though the maximum number of 600-bps lines on the ICA cannot exceed four on the 115 and 115-2 and eight on the 125 and 125-2). Synchronous line speeds can range from 600 to 50,000 bits/second; but only one high-speed line (above 7200 bps) can be connected, and it must not be operated concurrently with any other line on the ICA. An ICA-equipped Model 115 through 125-2 can communicate with virtually the full gamut of IBM computers and communications terminals.

The ICA for the Model 138 is controlled by a combination of microcode and hardware logic. The amount of control storage required for the ICA microcode varies with the number of lines, the types of terminal adapters, and the features employed.

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 115 through 195. 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.

SOFTWARE

GENERAL: Software support for the System/370 Models 115 through 168-3 can be basically the same as that provided for the System/360. Alternatively, Models 115 through 168-3 can (and usually do) operate in an Extended Control (EC) or virtual mode that utilizes Dynamic Address Translation (DAT) hardware features. A multiprocessing capability is supported for the 158 MP and 168 MP systems operating in EC mode.

In Basic Control (BC) or real mode, either the Disk Operating System (DOS) or the Operating System (OS) can be used, as on the System/360. Two of the original versions of OS support provided were Multiprogramming with a Fixed Number of Tasks (MFT) and Multiprogramming with a Variable Number of Tasks (MVT). The newer, virtual-mode counterparts of these systems are the Disk Operating System/Virtual Storage (DOS/VS), the Virtual Storage 1 option of the Operating System (OS/VS1 or VS1), and the Virtual Storage 2 option of the Operating System (OS/VS2, or VS2). VS2 Release 2 goes a step further and includes support for either tightly coupled or loosely coupled multiprocessing networks.

In addition to the above virtual-storage extensions of existing operating systems, a higher-level control system called Virtual Machine Facility/370 (VM/370) is also available. VM/370 provides support for the Conversational Monitor System (CMS)—a general purpose time-sharing facility—as well as for all of the other real and/or virtual operating systems. The table shows which operating systems are available on which computer systems.

The full complement of existing System/370 Program Products is also available for the virtual machines, although a number of these programs must be run in a "virtual=real"

or non-paged mode. (Any program that modifies active channel programs, contains I/O appendage routines, uses EXCP coding, or is highly time-dependent may not be pageable.)

DISK OPERATING SYSTEM: DOS is a disk-oriented operating system for installations with at least 16K bytes of main memory and one 2311 Disk Storage Drive or 2314 or 2319 Direct Access Storage Facility. It was the most widely used of the System/360's eight operating systems, and has been discontinued in favor of DOS/VS. It is still in use on a few of the installed System/370 computers and on many of the earlier System/360's.

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. 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 access method (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 main memory, while QTAM requires at least 65K bytes.

As an optional supplement to DOS, POWER II (Priority Output Writers, Execution Processors, and Input Readers) is a Type III DOS enhancement that adds input reader and output writer capabilities similar to those of the full Operating System. In addition to direct spooling capability, POWER II also has optional Remote Job Entry facilities to support up to five batch terminals. POWER II can support one or two independent batch job streams and up to 26 I/O devices.

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. ▶

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▶ While DOS can be run directly in the BC (System/360) mode on System/370 Models 138 through 158, operation of DOS on the Model 125 requires not only BC mode, but also the 5213 Console Printer, the 1052 Compatibility Feature, and (for DOS Version 3 and above) the 2311 Model 1 Compatibility Feature.

DISK OPERATING SYSTEM/VIRTUAL STORAGE: DOS/VS was designed: (1) to extend to DOS a number of features that were previously reserved exclusively for OS, and (2) to implement support of virtual storage. Among the OS-type features added, DOS/VS allows the user to have: five problem program partitions (F1-F4 and BG) instead of three as in DOS (F1, F2, and BG); single or multi-phase user programs that are self-relocating through the use of a relocating loader; POWER (for spooling) with RJE capability as a built-in function at Sysgen time; procedure library support that allows JCL sets to be cataloged with extended support for procedures with Job Control, service program, and utility program statements; and a Dynamic Partition Priority adjustment capability to specify partition dispatching priority at Sysgen time and alter it at IPL or during system operation. Virtual storage support for the System/370 under DOS/VS recognizes up to 16 million bytes of virtual storage in pages of 2K bytes each.

The minimum supervisor required for execution of DOS/VS is 26K bytes for the System/370 Models 115, 115-2, 125, and 125-2, 30K bytes for the System/370 Models 138 and 158; and 32K bytes for the System/370 Model 148.

Through the years, IBM has continued to enhance DOS/VS with new releases coming at least once a year. Some of the more important enhancements are as follows:

- Generic Device Assignment feature that allows input/output to be assigned by device type, device class, or an address list to provide a limited degree of device independence in user programs and permit pooling of I/O devices.

- Shared Virtual Area (SVA) that contains relocatable and re-entrant program phases that can be shared by all partitions in the system.

- Support for Rotational Position Sensing on System/370 Models 115 through 158 through a link to a Rotational Position Sensing module located in the Shared Virtual Area.

- The use of alternate indexes in VSAM, which allows applications programs to access records through keys other than prime keys, to reduce requirements for sorting and maintaining data in multiple sequence.

- Relative Record Data Sets, in which records are accessed through VSAM using the record number as the key in place of an index.

- An optional fast CCW translate feature to improve DOS/VS performance.

- Expansion of VTAM support for remote 3704/3705 communications controllers to include leased and switched connection of SNA/SDLC terminals.

- Installation Productivity Option, a program product developed by IBM to reduce the time required to install future DOS/VS enhancements.

- DOS/VS Advanced Functions significantly improve the operating system by expanding the number of user partitions to seven and providing dynamic partition balancing.

DOS/VS provides a superset Assembler and two access methods not found in DOS.

Among the additions to the Assembler are the following: COPY statements are permitted anywhere in the program; the PRINT statement is effective in macro expansions; and a NOALIGN option allows utilization of the System/370 Byte-Oriented Operand feature by 360-type Assembly programs without recoding.

The Virtual Sequential Access Method (VSAM) is a major, optional data management extension that is available for both DOS/VS and OS/VS as an extension and replacement for ISAM. Data sets created by DOS/VS, OS/VS1, or OS/VS2 can be freely interchanged among the three operating systems. Among the features of VSAM are: (1) five types of indexing, including non-dense, key compression, replication, high-level main storage, and low-level with data; (2) distributed free space at the time the data set is created to eliminate ISAM-like overflow and automatically reclaim deleted record space; (3) master catalog with device independence; (4) password data set security protection; and (5) a variety of utility services, including an ISAM/SAM data set conversion facility and an ISAM Interface Program that maps ISAM requests into corresponding VSAM requests. VSAM has Class A support as an SCP component of DOS/VS, and was released in June 1973.

The Virtual Telecommunications Access Method (VTAM) is IBM's primary terminal access method and the base for future developments of teleprocessing support under DOS/VS and OS/VS. As a replacement for BTAM, TCAM, and QTAM, VTAM controls communications terminal connections and data transfers between those terminals and the user's application programs via a 370X Communications Controller. Upward compatibility is provided among all of the IBM virtual storage operating systems. Among the features of VTAM are: (1) Network Control Program (NCP) support of the 370X Communications Controllers, including dynamic sharing of terminals, lines, and the controllers themselves among user programs; (2) support of TCAM under TAM for OS/VS only; (3) terminal monitoring facilities to handle log-on requests and collect communications network accounting information; and (4) integration of the Teleprocessing On-Line Text Executive Program (TOLTEP). VTAM has Class A support as an SCP component of DOS/VS. The minimum DOS/VS System required for VTAM is 96K bytes.

POWER/VS: An extension of the earlier POWER spooling system available for DOS, POWER/VS executes under DOS/VS on a System/370 computer with at least 96K bytes of main memory. In contrast to the previous version of POWER, POWER/VS executes in the virtual mode and acquires real processor storage on an as-needed basis. It can control programs operating in both the real and virtual modes.

POWER/VS resides in one DOS/VS partition and can provide spooling of unit record input/output and priority scheduling for from one to four programs with lower dispatching priority. POWER/VS can control multiple partitions (two less than the maximum on the system). Jobs to be scheduled for execution are queued in user-assigned classes by priority within each class. Jobs can be assigned by class to specific partitions for execution, or partition-independent job classes can be utilized to achieve more balanced scheduling of all partitions. Operator commands permit the operator to modify the order in which jobs in the job queues are scheduled for execution. Job input can be retained in the queues to permit repeated execution of a job.

Printer and punched card output can be spooled to magnetic tape or disk drives, and is grouped into output ▶

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➤ classes that can be the same or different from the parent job class. A segmented output capability allows large volumes of output from a job to be segmented to permit the output to be overlapped with the completion of processing of the job. Multiple copies of output can be requested, and job output can be retained for production of additional copies.

The POWER/VS remote job entry facility can support concurrent operation of 25 terminals, including the 3780 Data Communication Terminal, the 3741 Model 2 or 4 (functioning as a 2780), 2780 Data Transmission Terminal, 2770 Data Communication System, 3770 Data Communication System, and the System/32 computer (functioning as a 3770). All terminal types can operate concurrently. Remote entry support for transmission via the Synchronous Data Link Control (SDLC) is provided for the 3771, 3773, 3774, 3775, and 3776 Communications Terminals, 3790 Communication System, 8100/DCPX Information System, and the System/32 (as a 3770). The 3784 Line Printer, 3521 Card Punch, 3501 Card Reader, and 2502 Card Reader are also supported, although concurrent operation of the printer and card punch on a single transmission from POWER/VS to the terminal is not allowed. The VTAM application program interface is used to support the SDLC terminals to permit multiple applications to transmit to and from a terminal on a per-session basis, and multi-point operation is supported.

OPERATING SYSTEM/360: OS was a comprehensive and general-purpose operating system for the larger System/360 and 370 computers. It was designed for installations with disk and/or drum storage facilities and sizeable main memory capacities. The system was 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 resident control programs alone required as much as 200K bytes of main storage.

Two basic versions of OS were available for the System/370: Multiprogramming with a Fixed Number of Tasks (MFT), and Multiprogramming with a Variable Number of Tasks (MVT). They differed primarily in the amount and flexibility of the multiprogramming operations they could control. In both versions, the control programs performed the supervisory functions of job scheduling, resource allocation, I/O scheduling, interrupt control, error handling, and storage and retrieval of data.

IBM discontinued support for both OS/MFT and OS/MVT in 1976, placing all of its software support emphasis upon the virtual storage operating systems.

OPERATING SYSTEM/VIRTUAL STORAGE: OS/VS is the true System/370 Version of OS/360. It consists of two versions—OS/VS1 (or VS/1) and OS/VS2 (or VS/2)—that directly extend the capabilities of and are highly compatible with OS/MFT and OS/MVT, respectively.

OS/VS2, in turn, was effectively divided into two separate operating systems with the introduction of OS/VS2 Release 2. OS/VS2 releases prior to Release 2 are now known as OS/VS2 Single Virtual Systems (or SVS), while OS/VS2 Release 2 and above are now known as OS/VS2 Multiple Virtual Systems (or MVS).

I/O control under all OS versions is accomplished by an extensive array of "data management" facilities. OS, 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 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." Ten data and telecommunications access methods are available under OS versions: 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), Queued Telecommunications Access Method (QTAM), and Graphic Access Method (GAM). With IBM's Information Management System (IMS), a separately priced Program Product, four hierarchical structures based on the standard OS access methods are also supported: Hierarchical Sequential Access Method (HSAM), Hierarchical Indexed Sequential Access Method (HISAM), Hierarchical Direct Access Method (HDAM), and Hierarchical Indexed Direct Access Method (HIDAM). (Refer to Report 70E-491-01, IMS, for full information.)

TCAM provides general-purpose teleprocessing support for the 270X communications controller and can also operate in conjunction with VTAM to achieve compatibility for applications which used the TCAM 3704/3705 network control mode support provided in previous operating system releases. In a TCAM/VTAM network, input/output requests issued by TCAM applications programs are intercepted and routed to VTAM for processing. VTAM provides support for communications networks operating under control of the 3704/3705 Communications Processors operating in the Network Control Program Mode, and for locally attached 3270 Display Stations or 3790 Communications Systems. In February 1976, IBM announced modifications to TCAM which allow direct communications with SNA terminals, including the 3767, 3270, 3770, and 3600 terminals, without using VTAM. VTAM includes the Teleprocessing On-Line Test Executive Program (TOLTEP) for performing on-line testing of selected terminals concurrently with other processing programs.

All OS versions provide language translators for all of the System/370 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 service routines include a sort/merge program for either tape or disk, a Graphic Programming Service that supports the 3250 Graphic Display System and the 2250 Display Unit, a Remote Job Entry system that permits jobs to be submitted to a System/370 from a remote communications terminal, a Conversational Remote Job Entry (CRJE) system that supports concurrent on-line development of applications programmers from multiple remote terminals as if each programmer were in a hands-on environment, 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.

➔ In addition to the basic facilities offered as a carry-over from OS/MFT, OS/VS1 can support a system total of up to 16 million bytes of virtual storage that is divided into 64K-byte segments and 2K-byte pages. Other facilities of VS1 include: a Job Entry Subsystem (JES1) that provides many of the most important functions of HASP, including Remote Entry Service (RES) and high-volume I/O spooling and scheduling, and supersedes HASP under VS1; additional control block protection; a Centralized Queue Manager facility with Scheduler Work Area Data Sets (SWADS) to improve utilization of the job queue and ➤

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▶ allow more jobs to be put into queue; and the Dynamic Support System (DSS), an interactive debuffer used to identify and correct VS1 programming failures.

OS/VS2 is a significantly improved version of OS/MVT. The enhancements of OS/VS2 (SVS) include support of a maximum of 16 million bytes of virtual storage that is divided into 64K-byte segments and 4K-byte pages; virtual storage support of TSO in foreground regions, including native-mode support for the 3704 and 3705 Communications Controllers under TSO; up to 63 protected batch user regions or 42 TSO user regions (instead of 15 under MVT); Dynamic Priority Scheduling, including I/O load balancing based upon respective I/O data rates; Dynamic Support System (DSS) as in VS1; and a variety of virtual storage support features, including enhancements to the Linkage Editor, Systems Management Facilities (SMF), Link Pack Area (LPA), etc.

The Time-Sharing Option (TSO) permits interactive time-sharing operations to be run concurrently with teleprocessing and batch processing on a 524K-byte or larger system. Programmers at remote terminals can develop, execute, store, and modify programs written in any OS-supported language. COBOL, FORTRAN, and Assembler "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/1. TSO uses TCAM to handle all remote terminal I/O operations. TSO supported terminals include those supported via start/stop lines such as the 1050 and 2741; those supported via binary synchronous lines such as the 3270 and 8100 Information System; SDLC terminals such as the 3270, 3770, 3790 and 8100; and local channel attached terminals such as the 2848, 3270, and 3790.

The Houston Automatic Spooling Priority System (HASP II) is a high-volume spooling package that can handle an essentially unlimited number of peripheral devices, including high-speed remote batch terminals, using direct-access devices for intermediate storage. This Type III prior-use program was developed by IBM's Houston office in conjunction with NASA.

The Asymmetric Multiprocessing System (ASP-III) (formerly Attached Support Processor) is an application program that works in conjunction with OS/VS2 to control a multiprocessing system with up to 32 processors—one of which is the host processor for ASP residence. Under ASP, the "support processor" handles all support functions (such as card reading, punching, and printing) and automates many of the operator functions while the host processor plus up to 31 additional "remote main processors" process the computational workload. The practical limit on the number of systems in an ASP network is about 4 or 5, however. ASP also supports remote job submission from binary synchronous communications (BSC) terminals via Remote Job Processing (RJP); and provides peripheral support for large job shop systems. In RJP functions, ASP is ordinarily used in conjunction with HASP to provide individual remote terminal programming support. The processors are interconnected by means of the Channel-to-Channel Adapter.

Concurrent operations of TSO, batch, and HASP are permitted under OS/VS2. HASP must be run in the "virtual =real" mode only, making all of HASP resident in real memory during execution (i.e., non-paged). ASP Version 3 support is available under OS/VS2, but also in virtual=real mode only, meaning that all of ASP must be resident in the support processor's real memory during execution. VS2 Release 1 is upward-compatible with OS/MFT, OS/MVT,

and OS/VS1, except for the Conversational Remote Job Entry (CRJE) facility, which is not supported.

OS/VS2 (MVS) is a major functional enhancement over OS/VS2 (SVS) that features support of: 1) multiprocessing for Model 158 MP and 168 MP systems; 2) larger virtual storage, with up to 16 million bytes of addressable space for each of up to 63 concurrent users; 3) a HASP-like version of the Job Entry System (JES2); 4) an ASP-III-like version of the Job Entry System (JES3); and 5) Virtual Telecommunications Access Method (VTAM) support of the 370X Communications Controllers in Network Control Program (NCP) mode.

With JES2, an optional job entry and control system that is upwardly compatible with HASP, a "tightly coupled" multiprocessing system can be supported using either two identically configured Model 158 MP systems or two not-necessarily-identical Model 168 MP systems. In tightly coupled mode, each processing unit shares the combined main storage.

For either tightly or loosely coupled multiprocessing, MVS provides a virtual I/O (VIO) paging mechanism for temporary data sets, private virtual storage of up to 16 million bytes for individual TSO users, a new System Activity Measurement Facility (MF/1) in addition to SMF to measure CPU, channel, I/O device, and paging activity as well as I/O contention and CPU/channel overlap, and extensive system integrity control measures.

Other features supported under MVS include:

- Workload Management Routines which monitor the use of processing resources in the system and allocate resources to jobs or time-sharing users in order to meet installation-specified processing objectives for jobs.

- Resource-Use Routines, a set of algorithms that monitor the use of system resources and recommend scheduling changes to the control function algorithm to optimize the utilization of system resources. Functions include input/output load balancing, adjustment of CPU utilization, maximum utilization of main memory, and removal of pages that have not been referenced within a specified amount of their CPU execution time. An Automatic Priority Group algorithm manipulates the dispatching priority within the system in order to allocate higher dispatching priority to jobs that are input/output-bound. Values collected by the workload management routines and the resource-use algorithms are evaluated by the control function algorithm against installation-supplied parameters to provide for system tuning.

- Deadline Scheduling under JES3 that dynamically alters the scheduling priority of jobs in order to meet completion deadlines. Priority aging, in which JES3 automatically increases the priority of jobs that have been rejected for scheduling a specified number of times, also is provided under JES3.

- A Network Job Processing capability to permit the transmission of program input and output (but not jobs) between compatible JES3 installations.

- Recovery capabilities for multiprocessing configurations that include alternate path retry, dynamic device reconfiguration, manual switching of peripheral devices between central processors, and alternate CPU recovery under control of the functioning central processor.

- Increased emphasis on system integrity and security to prevent programs not executing in the supervisor state, in system keys 0 through 7, or under the Authorized Program Facility from bypassing storage and fetch pro- ▶

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tection, accessing password-protected data without the appropriate password, or gaining control of the system in an authorized state.

Under JES2, from two to seven systems can share job queues and input/output queues stored on shared direct-access storage devices in what is referred to as a JES2 Multi-Access Spool environment. The JES2 Multi-Access Spool permits sharing of the workload or a JES2-controlled pool of peripheral devices among the central processors in the configuration, each of which operates asynchronously within the configuration. Jobs can be routed to any or all systems in the configuration, and one system can recover the workload of another failing processor and can assume control of the communications and unique unit record equipment of a failing system in order to continue processing of the jobs entered in the spooling queue. Conversely, a single processor can be assigned to operate in the independent mode, in which it will process only jobs that are specifically routed to it. A single processor can also be isolated for testing and diagnostics.

Either JES2 or JES3 is required with MVS. With concurrent batch and time-sharing under JES2, MVS runs in an absolute minimum 768K-byte system (with reduced functional capability and limited performance), and more comfortably in at least 1024K bytes of real storage. MVS can also be used for uniprocessor systems, most commonly with JES2, where very large virtual storage, VIO, or other functional enhancements of MVS over SVS are required.

JES3 is an upward extension of the Asymmetric Multi-processing System (ASP) that provides extensive automation of the scheduling and operator functions of up to four MVS systems, any one of which may be a shared-storage multiprocessor system. Any one of the systems, which must be operating under MVS, can act as the global processor, but OS/MVT and SVS processors can also be supported in the configuration. Both local and remotely entered jobs are scheduled from a centralized work queue through a single operator interface. Special features of JES3 include centralized scheduling of pooled input/output devices, including the use of priorities for the allocation of device types, automatic scheduling of an interdependent job network, deadline scheduling, time-sharing and remote job entry, plus support for a master console and multiple secondary consoles.

VSAM support is provided for all versions of OS/VS and is similar to VSAM support under DOS/VS, except that user exits for security routines other than standard password protection are provided. For OS/VS data set sharing, VSAM provides protection for multiple intra-region updates only.

Communications support under OS/VS2 is provided by the Basic Telecommunications Access Method (BTAM), Telecommunications Access Method (TCAM), and Virtual Telecommunications Access Method (VTAM). OS/VS2 VTAM support is similar to that provided under DOS/VS and OS/VS1.

Remote job entry under OS/VS2 is supported under JES2 and JES3, and includes facilities for multileaving transmission between the host computer and intelligent remote terminals including the IBM System/360 and System/370 central processors, the IBM 1130, and the System/3 processor models.

OS/VS2 operates on all the currently marketed models starting with the System/370 Model 148 and extending through the 168 MP virtual storage system. MVS operates with reduced functional capabilities and restricted performance in a system with 768K bytes of main memory, can perform the minimum batch processing functions in a

system with 1,024 bytes of memory, and requires 1,536K bytes of main memory to perform concurrent batch and TSO operations with JES2.

SELECTABLE UNITS: These microcode packages are collections of new and changed modules and macros that provide enhanced program functions, performance improvements, or hardware support. Selectable units are provided independently of software packages and are installable through the INSTALL macro. This new concept permits IBM to make available new, enhanced, or modified OS/VS1 or MVS components on an individual basis instead of packaging them in large program packages.

Selectable units were first announced for use with the 303X Processors through the System/370 Extended Facility and for use with the Model 158 and 168 through the System/370 Extended Feature. These microcode enhancements, in conjunction with the Systems Extensions program products made available for OS/VS1, MVS, and VM/370, yield significant performance increases. IBM states that, in an MVS system, supervisor-state execution time is reduced by 20 to 27 percent, uniprocessor throughput is improved by 14 to 18 percent, and multiprocessor system throughput is improved by 17 to 20 percent.

The modifications to MVS that permit the use of selectable units also permit easier user modifications to the operating system through the System Modification Program (SMP). This program uses the same library mechanism employed to install selectable units, to allow users to make modifications to the operating system. A record of user modifications is maintained in the Control Data Set, for purposes of recovery from improper modifications. the information contained in the Control Data Set is limited to the module name and other modules affected by the change. A copy of the previous version is not generated automatically and must be initiated prior to the change.

VIRTUAL MACHINE FACILITY/370: VM/370 is a system control program (SCP) that manages a computing system's resources (CPU, storage, and input/output devices) so that all are available to many users at the same time. Each user has at his disposal the functional equivalent of a real, dedicated computing system. VM/370 is designed for use on currently available System/370 Models 138, 148, 158, and 168, which have the Dynamic Address Translation feature and Extended Control Mode option.

VM/370 is the System/370 version of CP-67/CMS, which performs similar functions on a System/360 Model 67. Like its predecessor, VM/370 provides virtual machines and virtual storage, the ability to run multiple operating systems concurrently, and a conversational, time-sharing system.

VM/370 has two major elements: the control program (CP), which controls the resources of the real computer to provide multiple virtual machines, and the Conversational Monitor System (CMS), a subsystem that gives users a wide range of conversational time-sharing facilities, including creation and management of files and compilation, testing, and execution of problem programs.

While the VM/370 control program manages the concurrent operation of the virtual machines, one of the standard System/370 operating systems manages the work flow within each virtual machine. Because each virtual machine executes independently of other virtual machines, each one may use a different operating system, or a different release of the same operating system.

The operating systems that can run in VM/370 virtual machines include Batch or Single User Interactive DOS, DOS/VS, OS/PCP, OS/MFT, OS/MVT, OS/VS1, OS/VS2, OS-TSO, OS-ASP, PS44 and RSCS, as well as the

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multiple-access APL/DOS-360 and the Conversational Monitor System (CMS). CMS is virtual storage-based and provides a general-purpose time-sharing capability. CMS supports the BASIC, ANS COBOL, FORTRAN IV, PL/1, APL, and Assembler languages.

The control program provides each of these operating systems with virtual device support and virtual storage. The operating systems themselves execute as if they were controlling real devices and real storage, but they must not violate any restrictions.

Each virtual machine has its own virtual storage space, which may be as small as 8K bytes or as large as 16 million bytes, or any size in between that is a multiple of 4K bytes. Each virtual machine can refer only to its own virtual storage; this restriction protects each virtual machine's storage from the activities of other virtual machines. The size of each virtual storage space is defined in the virtual machine's director entry and may differ among virtual machines.

The control program provides CPU resources to each active virtual machine through time-slicing. The operating system in each virtual machine can be either single-task or multi-task. The virtual CPU can be run in either Basic or Extended Control mode. Extended Control mode includes all the facilities necessary to run VM/370 as the virtual machine's operating system. the virtual machines can execute all 370 instructions except Read Direct and Write Direct. The Diagnose instruction is also reserved for special program communication with the control program.

Storage in the virtual machine is logically divided into 64K-byte segments, which in turn are logically divided into 4K-byte pages. For each virtual machine, CP creates and maintains a set of segment and page tables to describe the virtual storage and to reflect the allocation of the virtual storage pages to page frames in real storage. These tables are used by the Dynamic Address Translation feature to locate the real storage addresses.

The operating system controlling a virtual machine may execute in Extended Control mode, permitting it to create and control virtual storage of its own, in addition to the CP-assigned virtual storage. Operating systems that can do this include OS/VS1, OS/VS2, DOS/VS, and VM/370.

The Remote Spooling Communications Subsystem (RSCS) permits multiple remote spooling operations to run concurrently in a single virtual machine. RSCS supports the 2770, 2780, 3770, and 3780 communications terminals as well as 8100/DPPX running DPPX/RJE (BSC), HASP workstations, and central processors running under HASP, ASP, RES, and JES2, and JES3. Other enhancements include support for the 3340 and 3344 Direct Access Storage Facility for spooling, paging, and virtual disk space, and an enhancement to the Conversational Monitor System that allows on-line terminal users to read, but not modify, DOS data files. The VM/370 Measurement Facility was also added to the operating system to provide data at the console on system load conditions. Another addition to CMS was support for remote 3270 display devices as virtual machine operator consoles.

The new VM/System Product (VM/SP) with the VM/370 Release 6 SCP, extends VM/370 and is the base for several program products. VS/SP is a licensed program and it is expected that any future enhancements to VM/370 will be made in the VM/SP. The VM/System Product is designed to run on the currently available System/370 Models 138, 148, 158, and 168.

The VM/SP will support the 158 MP 168 MP with as many as 16 channels per processor and a maximum of 32 channels per MP configuration. VM/SP does not simulate multi-

processing for virtual machines other than under single processor mode. Systems network architecture (SNA) console communications services will provide full VM/370 operator console interface capabilities for SNA terminal users to any virtual machine. SNA console communications services will provide the necessary interface between the Virtual Machine/VTAM Communications Network Application (VM/VCNA) program product and ICP or virtual machines.

Another feature of VM/SP is a new conversational Monitor System (CMS), which provides:

● Acceptance of parameter input of up to 255 characters each.

● Arithmetic functions of multiplication and division.

● Coexistence with the current CMS EXEC interpreter.

● Debugging facilities.

● Improved execution time.

● New string manipulation functions.

● Support of user-defined functions and subroutines.

● Support for commands to be issued either to CMS or to a specified subcommand environment, such as an editor.

The CMS editor provides the following:

● Ability to define the screen format according to individual preferences.

● Ability to extend and tailor editor commands with a powerful macro mechanism, the new CMS EXEC interpreter, which can be used to develop editor-based applications.

● Coexistence with the current CMS editor.

● Enhanced functions to handle program development, including automatic update generation.

● Extended string search facilities to improve text processing.

● Full screen support for 3270 display stations, including multiple views of the same file or of different files, selective column viewing, and automatic wrapping of lines that are larger than the screen.

● Support of all CP support keyboard/typewriter terminals.

● 3278 Model 5 and 3279 display teminal support.

With the CMS HELP facility enhancements, the user will be able to issue CMS and CP commands or subcommands directly from the screen on which a HELP file is displayed.

The CMS OS loader enables OS relocatable load modules to be used under CMS. This support provides the facility to list, copy, or compress members of a CMS library and to merge CMS load libraries.

The VM/SP spooling enhancements are:

● Ability to transfer spool files between the reader and printer queues or the reader and punch queues.

● Ability to select spool files for the QUERY command based on their hold status.

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▶ • Ability to specify the distribution code on the SPOOL command.

• Ability for the installation to specify classification titles for selected spool file classes. The title will be printed on the separator page, and optionally on each page of output.

• Association of a "form number" with each spool file and spool device.

• Capturing of the load forms control buffer (FCB) fold, and unfold CCWS in a virtual printer spool file, and their subsequent execution on the real printer.

Additional spool operator information, such as a "waiting" message when the real spool device finishes, and the ability to display the number of records left to print or punch in the current active spool file.

The IPL command enhancement is a generalized facility that will allow a user to activate an OS/VS1 guest machine without operator intervention. The single console image facility will enable the operator of a virtual machine to control multiple virtual machines from one physical terminal.

The inter-user communications vehicle (IUCV) will facilitate the transfer of messages among virtual machines and between a virtual machine and CP. All IUCV interfaces are provided at the macro level.

INFORMATION MANAGEMENT SYSTEMS: IMS provides the capabilities for generating and accessing a data base, with automatic cross-referencing among data records. IMS/VS operates under the OS/VS1 or OS/VS2 operating system. IMS-2 (IMS/360) provides the same basic functions as IMS/VS (although IMS/VS contains many more capabilities) and operates under OS/MFT or OS/MVT—or, with fixed pages, under OS/VS1 or OS/VS2. Both IMS/VS and IMS-2 offer on-line message processing with the optional on-line inquiry with IQF (Interactive Query Facility) or GIS/VS (General Information System) and batch inquiry with GIS or GIS/VS are available. In addition, a data language (DL/1), whose function is to register user I/O coding with simpler commands to IMS, is provided.

The same basic data base facilities are provided for DOS/VS users with DL/1 DOS/VS. However, its only available data communications extension is linkage to CICS/DOS/VS (Report 70E-491-02). IMS/VS can also link to CICS/VS, and IMS-2 to CICS/OS Standard, but they must then forego their own data communications features and, more significantly, IQF.

IBM released DL/1 Entry in 1975. It is a compatible subset of DL/1 DOS/VS and is upward-compatible from another IBM data base management system, VANDL-1. VANDL-1 is now a class C product, having been downgraded from class B when DL/1 Entry was announced. DL/1 Entry also supports a communictions interface to CICS/VS.

All of the foregoing programs are written in Assembly language and offer their DB facilities to users of COBOL, PL/1, and Assembly language.

Four primary physical data organizations are provided in IMS:

• Hierarchical Sequential Access Method (HSAM)—an extension of basic serial tape and disk file processing (SAM). This method offers limited data independence and no interrelatability of the data base through "pointers." In order to insert a data base record, the data base must be copied up to that point, the new record written, and the rest of the data base copied. Each record is physically present in the serial order in which it logically appears in the data base.

• Hierarchical Indexed Sequential Access Method (HISAM) —provides an imbedded hierarchy of ISAM-like data sets that are related by sets of symbolic pointers or keys. The distinguishing aspect of HISAM (or HSAM), as opposed to the hierarchical direct methods described below, is that all segments in a physical data base record are "related by physical juxtaposition." HISAM does not yield particularly good results in an on-line environment.

• Hierarchical Direct Access Method (HDAM)—stores data in a physical tree structure with all segments in a physical data base record related by direct addresses. Segments can be interrelated to each other as physical twins (multiple occurrences of the same segment type under a given parent), physical parents (segment immediately above), or physical children (first and last occurrence of each segment type immediately subordinate) through chains of pointers. HDAM uses OSAM as a base for data storage and provides very effective access to dependent segments—especially in teleprocessing environments—at some overhead cost in terms of data base size.

• Hierarchical Indexed Direct Access Method (HIDAM) provides an ISAM index to data physically stored in OSAM format. The ISAM index contains the key of a root segment and a direct address to the root segment, while the actual storage of data is done in OSAM data sets. Because the data base index and the actual base are kept on two separate data sets, reorganization of the index separately from the data is facilitated. HIDAM is the most generally appropriate and most often used data organization method for IMS applications.

In addition to the above data structures and access methods, the basic batch-oriented version of IMS (also called "DL/1 Data Base" or the DB system), can be augumented with data communications capability to produce a transaction-drive system. The DB system is a prerequisite to the DC Feature ("IMS teleprocessing"). The resulting full-scale IMS is known as the DB/DC system, and can handle both batch and on-line operations concurrently. A DB/DC system can have a wide variety of physical terminals, each of which can have one or more logical or symbolic names. Individual security parameters can be associated with each terminal's logical name.

As an alternative to the IMS Teleprocessing option, a DB/DC system can be put together using the Customer Information Control System. CICS generally provides similar functional capabilities with lower overhead in some environments. CICS was designed for relatively short program modules of about 2K to 6K bytes, while the IMS Teleprocessing option is better suited to 20K-byte modules or larger.

Also available for full DB/DC IMS systems is the Interactive Query Facility (IQF). IQF is a basic query language that offers the capability for on-line retrieval and display of data in an IMS data base. IQF consists of retrieval phrases that define, delete, list, sort, count, total, limit, and query the data base, the "when" qualifier to establish criteria for data selection; and a basic complement of relational (EQ, NE, LT, GT, LE, GE), logical (AND, OR), and arithmetic (+, -, /, *) operators. Other handy features of IQF include null words (e.g., THE, OF, FOR) set up by "define" phrases, literal and numeric constants, segment synonyms, etc.

The IQF utility is run when putting the IMS system together and for subsequent index creation or modification. IQF can be used only with the IMS DC Feature. It is not supported by CICS. IQF can be used in conjunction with the more powerful query capability of the Generalized Information System (GIS/2)—a full-scale information system—although no direct relationship between IQF and GIS/2 exists.

GIS/2 and GIS/VS, with the DL/1 Query Support Feature, can be used to produce tailored processing modules that ▶

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permit batch and on-line operations upon IMS data bases as well as a variety of other data file types. GIS is actually a sort of "super RPG" that accepts report format and query selection criteria as input and produces an object deck plus Job Control Language (JCL) as output. These GIS object modules can be executed under control as batch programs only. Full GIS query capabilities (except LIST RECORD and HOLD RECORD) are supported for IMS data bases.

HARDWARE/SOFTWARE REQUIREMENTS: IMS/VS can be implemented on currently available System/370 Models 138, 148, 158, and 168 processors. Any system-supported disk device is supported by IMS/VS. At least one Model 2400 or 3400 9-track magnetic tape unit is mandatory. The IMS/VS main memory requirements vary drastically depending on system configuration, job scheduling habits, etc., but there are some guidelines for the amount of virtual storage needed to store IMS/VS. Under version 1.1.5, the minimum disk space required to hold the system libraries and the system itself is 125 cylinders of a 3336 disk pack for a DB system only, 285 cylinders for a DB/DC configuration, and 295 cylinders for an MCS system.

IMS-2 operates on both System/360 and 370 computers with a minimum of 128K bytes for DB and 256K for DB/DC under OS/MFT. Under OS/MVT, the system requires 256K for batch-only DB and 512K for DB/DC. Under OS/VS, virtual storage requirements are similar to those required by IMS/VS. IMS-2 requires two 9-track tape units, and the DB/DC system requires an additional non-switched 1050 Data Communication System or 2740 Communication Terminal.

DL/1 DOS/VS can be installed on any System/370 computer capable of supporting a DOS/VS operating environment. A batch-only configuration requires a minimum of 90K bytes of real memory, and an on-line system requires a minimum of 160K (this includes space for CICS/DOS/VS).

DL/1 Entry will run on a currently available System/370 Model 138, 148, or 158 processor. To estimate the required main memory for this version of the system, add 12K bytes to the storage requirements for the VSAM or SAM access methods to support a batch operation, or 14K bytes to the VSAM and CICS/DOS/VS storage requirements for on-line operation.

VANDL/1, now a Class C RPQ software product, runs on either a System/360 or 370 under DOS or DOS/VS. It requires at least 14K bytes of real memory for the system plus an additional 8K to 10K bytes for the application program.

See Report 70E-491-01 in Volume 3 for more details on IMS.

CUSTOMER INFORMATION CONTROL SYSTEM: CICS is a general-purpose data communications monitor that operates in a single partition or region of an IBM System/360 or 370 under DOS or OS (or their VS counterparts) to control multiple on-line user terminals and applications. By consolidating the required communications interfaces and I/O and control functions, CICS isolates the user's applications programs from the communications environment and, to a considerable degree, from the operating system itself.

Written in Assembler language, CICS provides transaction processing support for data base management or file control programs written in Assembler, PL/1, or COBOL, thus allowing on-line applications to be developed without significantly greater difficulty than similar batch programs. In addition to supporting several external data base manage-

ment structures (e.g., IMS's DL/1, DBOMP) CICS includes some native data management capabilities.

The DOS/VS and OS/VS versions of CICS are analogous, respectively, to the DOS Standard and OS Standard versions. The VS versions have been enhanced from a functional point of view, and optimized to run more efficiently in a paged environment than the real-memory versions would. CICS/OS/VS and CICS/DOS/VS are the only versions currently supported under Class A programming support.

The Extended Telecommunications Modules Feature, when added to CICS/DOS/VS, offers support under NCP/VS for multiple 3704 and 3705 Communications Controllers in both local and remote environments. It also supports many of the SNA and pre-SNA devices. The 3601 Finance Communications Controller along with its associated loop of devices is supported by EXTM. Emulation mode and NCP/VS mode can exist in the EXTM environment, but dynamic swtiching of lines between these two modes is not supported. EXTM can coexist with BTAM in the same system without affecting the operation of either facility. For CICS/DOS/VS installations that wish to use the EXTM feature, 160K bytes of memory are required.

CICS/OS/VS also gives the user the ability to share network resources with other VTAM communications application programs. By using VTAM's read-ahead capabilities, and by providing a direct interface between the application program and the terminal control program, the system provides for more terminal I/O overlap.

The CICS partition or region is physically divided into two types of main storage:

- Static Storage, in "high" memory, which contains the CICS Nucleus, service programs, control tables, access methods, and resident user-written applications programs; and

- Dynamic Storage, in the rest of the partition or region, which contains work areas, I/O buffers, applications programs to be processed, the storage cushion, and certain additional control areas. The size of Dynamic Storage greatly influences CICS throughput and response time.

The highly modular construction of CICS, as described above, has facilitated its growth by the addition of new functional capabilities without the need for redesigning the basic system.

HARDWARE/SOFTWARE REQUIREMENTS: CICS runs on System/360 or 370 computers under DOS, OS (MFT or MVT), OS/VS1, OS/VS2, and on VM/370 configurations. Specific main memory requirements are totally dependent upon the features and functions desired in the CICS configuration. Minimum memory requirements, in a real or virtual system are: CICS/DOS Entry—30K bytes; CICS/DOS Standard—44K; CICS/OS Standard Version 2—64K; CICS/VS—48K real memory, 96K virtual memory. In a VS environment, a more realistic or "typical" requirement figure would be 134K bytes of real memory or 300K bytes of virtual memory.

In addition, each version of CICS requires at least one magnetic tape unit, 2.5 million bytes of direct-access storage (for CICS libraries and working storage), and one "Master Terminal." (The latter is a "logical" unit requirement and does not necessitate a separate, full-time terminal).

See Report 70E-491-02 for more details on CICS.

In addition to the indicated memory requirements, the user must add a minimum of 16K bytes of "real" storage for IMS ▶

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➤ if the DL/1 data base interface is required (see IMS, Report 70E-491-01).

COBOL: IBM offers COBOL compilers under DOS, DOS/ VS, OS/360, and OS/VS. DOS COBOL and OS/360 COBOL E 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.

IBM offers Language Conversion Programs to aid users in resolving the numerous detail differences between ANS COBOL and the earlier IBM COBOL languages.

The ANS Subset COBOL Compiler is an IBM Program Product, for use in DOS installations with as little as 32K bytes of storage and one disk drive. (Full ANS COBOL under OS 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.

DOS/VS COBOL, released in February 1974, executes under Release 29 (or later) of DOS/VS in approximately 60K bytes of virtual storage. DOS/VS COBOL provides all the facilities of the full DOS ANS (1968) COBOL plus the following additional facilities: 1) support for the VSAM access method; 2) support for the 5425 Multi-Function Card Unit, 3886 Optical Character Reader, 3340 Disk Storage, 5203 and 3203 Line Printers, and 3540 Diskette Input/ Output Unit; 3) a syntax-checking feature for fast source program scanning for syntax errors; 4) symbolic debugging; 5) an optional object-code optimizer; and 6) optional alpha-betized cross-referenced listings. Release 2 of DOS/VS COBOL also includes the capability to use the DOS/VS Sort/Merge program plus several source code listing and analysis functions.

For OS/360 and OS/VS, Full ANS COBOL is available in either Version 3 or Version 4, either of which is most conveniently invoked through the TSO COBOL Prompter. Both versions support TSO, and Version 4 can also be used under CMS. Version 3 (also available under DOS and DOS/VS) provides: modification of the generated code for OPEN and MOVE statements to give substantial savings in object-program space; an alphabetized cross-reference listing; a Flow Trace option that gives a formatted trace of a selected number of procedures; a Statement Number option for detailed information about the COBOL statement being executed at the time of an abnormal termination; expanded CLIST and DMAP functions to give more detailed information about the Data Division and Procedure Division; and a RERUN facility that allows automatic checkpoints at end-of-volume. In addition, ON statement count-conditional operands can be identifiers; the GIVING phrase (which requests statistics about an existing error) can be specified; and support is provided for creation and retrieval of ASCII tape files. Also, Version 3 can save machine time by batch compilation, allowing more than one COBOL source program to be processed with a single invocation of the compiler.

Version 4 of Full ANS COBOL provides the facilities of Version 3 plus advanced symbolic debugging; optimized object code; the ability to write teleprocessing (TP) programs in COBOL (in conjunction with TCAM); a COBOL library management facility; dynamic subprogram linkage giving the user object-time control of main storage; syntax-checking compilation; and string manipulation, for more flexible data handling. A Version 4 Interactive COBOL Debug is also available for use with OS under TSO.

FORTRAN: IBM offers ANS FORTRAN compilers for operation under all levels of System/370 software support as separately priced Program Products. These compilers also provide support for numerous IBM extensions to the language.

Code and Go FORTRAN and the FORTRAN IV (G1) compiler are compile-and-go and batch-mode compilers, respectively, that use the same language level as FORTRAN G and operate under the OS/360 Time-Sharing Option (TSO) as well as under OS/VS. A TSO FORTRAN Prompter is also available to set up and execute the FORTRAN IV (G1) compiler. The FORTRAN IV (II Extended) compiler operates under OS/360 or OS/VS and provides all the facilities of FORTRAN II plus extended-precision arithmetic, asynchronous I/O, and other extensions. An Interactive FORTRAN Debug is available that can be used in conjunction with the Code and Go FORTRAN and FORTRAN IV (G1) compilers in the TSO foreground or under the CMS option of VM/370.

Under DOS/VS, a DOS FORTRAN IV compiler (not a Program Product) permits the use of an enhanced ANS FORTRAN IV language that includes direct-access I/O statements and arrays of up to seven dimensions. The DOS FORTRAN IV Library Option 1, a Program Product released in February 1974, is required for support of the new peripheral devices available under DOS/VS Release 29.

PL/1: IBM currently offers compilers for PL/1, its multi-purpose programming language, under DOS, DOS/VS, OS/360, OS/VS, and ITF. PL/1 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/1 has not yet found widespread acceptance among users.

The OS/360 PL/1 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/1's co-developers, IBM and the SHARE user group. It provides facilties for handling numerous data types and arithmetic modes, dynamic storage allocation, source-language debugging, data communications, sorting, program segmentation, etc. Moreover, it ac-commodates seven different data access modes: BSAM, QSAM, BISAM, QISAM, BDAM, QTAM, and VTAM.

The DOS/VS PL/1 Optimizing Compiler, released in February 1974, provides language extensions beyond those of the PL/1 D (Version 4) and PL/1 F subsets, including compile-time preprocessing, arrays of structures, a DE-FAULT statement, file variables, and data-directed input/ output. The new PL/1 compiler also provides support for VSAM, additional debugging aids, optimization of object code, support for peripheral devices supported under DOS/ VS Release 29, the ability to access ASCII files, and communication between PL/1 object modules and FOR-TRAN, COBOL, and Assembler language object modules. The DOS/VS PL/1 Optimizing Compiler requires a maxi-mum virtual partition of 65K bytes, but can compile in 44K bytes with degraded performance.

Several other PL/1 compilers are offered as separately priced Program Products. PL/1 Optimizing Compilers offer im-provements in compilation speed, object program efficiency, and language facilities through proper use of three optimiza-tion options. The OS PL/1 Checkout Compiler is an interpretive processor for the PL/1 F language that features high translation speeds and effective diagnostic and de-bugging capabilities; it can be used in batch mode under MFT, MVT, VS1, or VS2, or in conversational mode under TSO. ITF-PL/1 uses a subset of the PL/1 language and is designed specifically for time-sharing operation under ITF.

BASIC: The BASIC language, which is gaining widespread popularity for problem-solving applications because of its ➤

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▶ 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. A virtual storage version of BASIC, for operation under DOS/VS, OS/VS1, OS/VS2, and VM/370, was added in June 1974.

The new VS BASIC, announced with the VSPC time-sharing software, replaced the currently supported BASIC language for both batch and interactive processing. It can be used with CMS under VM/370, with the Time-Sharing Option (TSO) under OS/VS2, and in the batch mode of operation under all of the IBM virtual storage operating systems.

APL: Conceived in the early 1960's by Dr. Kenneth E. Iverson, 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 DOS, DOS/VS, OS, or OS/VS. The system requires a minimum partition of 170K bytes and supports IBM 2740, 2741, and 1050 terminals.

VS APL, announced in December 1975, is an enhancement of APL/360 that executes under OS/VS1 or OS/VS2 and can also be used with the CMS component of VM/370. VS APL also includes the Data Analysis-APL Feature which allows use of the APL character set on the 3277 Model 2 Display Station and the APL Graphics Feature for the 3767 Communication Terminal.

ALGOL: As a reluctant concession to current ALGOL users, IBM offers a single ALGOL compiler, which operates under OS 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/1. Effective December 15, 1973, the ALGOL F Compiler and ALGOL F Library were demoted from service classification A to C, thus ending free support for these Program Products.

REPORT PROGRAM GENERATORS: IBM offers RPG II as a Program Product for use under DOS or DOS/VS. Both versions 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. RPG II for the System/370 is generally compatible with RPG II for the small-scale IBM System/3, where it is the principal language. All of the facilities of the System/3 language are supported except the telecommunications and automatic program overlay functions. Thus, the availability of RPG II for the System/370 represents a significant step toward improved compatibility between the System/3 and the larger IBM computers.

An enhanced RPG II for DOS/VS systems is designed to provide more efficient program execution and support for new peripheral devices, and includes features to contribute to the ease of use of the compiler. The new RPG II compiler contains over 30 functional enhancements, including edit codes, spanned records, AND/OR calculations, single-dimension arrays, use of the console to display messages and input data, use of dual I/O areas for ISAM files, and the capability for object programs compiled to process ISAM files to handle VSAM files using the VSAM Compatibility Interface. The RPG II compiler can execute in a background partition under DOS Release 24 or in a batched-job foreground partition with Release 25 or later, and requires a minimum of 14K bytes with disk work files.

Compilers for the original System/360 RPG language are also available for operation under DOS or OS/360. 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.

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/370. Assemblers are therefore furnished at all levels of System/370 software support. Facilities for handling macro-instructions and literals are provided at all levels. Though the Assembler language is essentially the same at all the various 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.

The new DOS/VS Assembler is a superset of the earlier DOS Assemblers that implements all of the System/370 instructions and promises improved performance through the use of a pre-edited macro library.

OS Assembler H is a separately priced Program Product that requires at least 200K bytes. It is upward-compatible with the other System/370 assemblers and features improved assembly speed (as much as 50 percent faster than earlier versions) macro language extensions, improved diagnostics, batched assemblies within a single job step, and support of the new machine instructions in the System/370 processors. OS Assembler H runs under MFT, MVT, VS1, or VS2. A subset of Assembler H—the System Assembler—is the only language translator provided as a standard component of VS.

UTILITY ROUTINES: Sort/Merge programs are offered at all levels of software support for the System/370. 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 are offered for both DOS and OS. In addition, a new DOS/VS Sort/Merge is available for DOS/VS Release 29 and later releases.

The DOS/VS Sort/Merge provides all the functional capabilities of the DOS Sort/Merge plus support for the 3340 Disk Storage Facility, 3330/3333 Disk Storage (including Rotational Position Sensing), SAM data sets, and the 3410, 3411, and 3420 Magnetic Tape Units. It also includes the capability to operate in both background and foreground partitions, the ability to be invoked by COBOL, PL/1, or the Auto Report Feature of RPG II, and the ability to sort or merge on control fields with mixed data formats. DOS/VS Sort/Merge requires a minimum virtual or real partition of 16K bytes.

The enhanced OS/VS version of the Sort/Merge utility program, called OS-SM1, provides additional features and improved performance over the OS Sort/Merge program. It fully supports the 3330, 3330 Model 11, and 3340 Disk Storage Facilities, ASCII-formatted files on 9-track magnetic tape, input and output on QSAM-supported devices, and expanded exit facilities to assist the user in writing his own code additions. OS/VS Sort/Merge requires a minimum of 32K bytes of main storage; a larger allocation of main memory is required for the use of VSAM files. ▶

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

8100 SIMULATOR SOFTWARE: A new IBM software aid is the Distributed Product Development System (DPDS), an 8100 simulator that runs on the System/370 computers. DPDS is an MVS (Release 3, modification level 7 or later) and TSO productivity aid than runs as a problem program on a System/370 MVS host. Application areas where DPDS could be used include program development of extensions to DPPX, program development of special I/O support (including unsupported hardware devices), and program development of new system applications and command processors intended to operate in the DPPX environment.

DPDS provides three interrelated facilities. The first, PL/DS, is a high-level programming language and macro language compiler that provides access to DPPX system services for distributed processing. The second, a program development simulator, includes an 8100 process simulator and interactive debugging facilities for PL/DS-developed programs. The final facility is a linkage editor, for input to the program simulator. The host system must provide the OS/VS2 assembler and linkage editor. Although DPDS can be executed in batch mode, it is intended primarily for use in an interactive mode.

RETAIN/370: This is a 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 is creating 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 views any available information on a display screen and relays 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.

APPLICATION PROGRAMS: An enormous number of "packaged" application programs—more than 2500 are now available for the System/370 at no charge from IBM as "Prior Use" Type I, II, III, or IV software. These programs were in general use on the System/360 prior to unbundling on December 31, 1969. While many of these programs are rather simple utilities, others are major systems representing dozens of man-years of effort that have subsequently been made available in improved and maintained versions for a fee as IBM Program Products. The Prior Use programs are provided with no free IBM support. Information concerning these programs is available in the *Catalog of Programs for IBM System/360 Models 25 and Above* (GC20-1619).

In the separately priced application programs category, three types of programs are available: Program Products, Field Developed Programs (FDP's), and Installed User Programs (IUP's). Limited support is provided for the FDP's and IUP's (which were first made available in August and October 1971, respectively); it consists only of pertinent error-correction information during the first six months after initial general availability of the programs. A full list of FDP's and IUP's with prices, dates when support ends, and reference manual numbers can be found in the *IBM Computer Information Card for FDP's and IUP's* (GB21-9949).

A list of the currently available System/370 Program Products can be found in the price list at the end of this report.

Also see the detailed reports on the two IBM Program Products of broadest general interest: IMS (Report 70E-491-01) and CICS (Report 70E-491-02).

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 are for short-term leases and include equipment maintenance.

MODEL 138 TAPE/DISK SYSTEM: Consists of 524K Model 138 Processing Unit with Integrated File Adapter and CRT console, 3340 Direct Access Storage Facility (four drives, 280 million bytes), eight 3420 Model 3 Magnetic Tape Units (120KB) and dual-channel tape controls, 3505 Model B2 Card Reader, 3525 Model P3 Card Punch, 3211 Printer, and 3286 Model 1 66 cps Printer. Monthly rental and purchase prices are approximately $21,084 and $515,835, respectively.

MODEL 148 TAPE/DISK SYSTEM: Consists of 1048K Model 148 Processor with Integrated File Adapter and CRT console, 3340 Direct Access Storage Facility (six drives, 420 million bytes), eight 3420 Model 3 Magnetic Tape Units (120KB) and dual-channel controls, 2540 Card Read Punch, 3211 Printer, and 3286 Model 1 66 cps Printer. Monthly rental and purchase prices are approximately $31,671 and $740,375, respectively.

On-call maintenance service is charged at hourly rates that are shown in the following table. The majority of System/370 equipment is in Maintenance Class 3.

	Normal Working Hours	Outside Normal Working Hours
Class 1	$61.00	$71.00
Class 2	77.00	89.00
Class 3	83.00	96.00

In addition, DPD Systems Engineering Services (SES) are available at $66.00 per hour.

LEASE TERMS: The IBM *Agreement for Lease or Rental of IBM Machines*, instituted in April 1977, defines three usage plans by which monthly charges are determined. IBM assigns each machine to one of these three plans.

Plan A provides the customer with up to 176 hours of billable time per month. Time used in excess of that amount is charged at an hourly rate that is 1/176th of the Monthly Rental Charge (MRC) multiplied by the Additional Use Charge Percent (usually 10 percent).

Plan B includes unlimited usage of the unit in the Monthly Rental Charge or Monthly Lease Charge.

Plan C monthly charges are determined by multiplying the amount of *processing* performed by the machine (not the time in use) by the Monthly Use Charge specified for the particular unit. The processing is measured by a meter attached to the unit. The monthly charges include all equipment maintenance, insurance charges, and property taxes.

The most significant change brought about by the new agreement was the ability to include equipment with differing lease terms on a single lease contract and the special long-term lease plans that had been offered under several amendments to the previous lease agreement. Specifically, the Extended Term Plan (ETP), Fixed Term Plan (FTP), Term Lease Plan (TLP), and Alternate Term Plan (ATP) were discontinued. ▶

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▶ However, the new agreement permits lease terms similar to those of the discontinued plans to be routinely implemented. Customers with existing term plan agreements can continue with those contracts and extend them in accordance with their provisions. IBM has stipulated final termination dates beyond which none of these discontinued plans may be extended. These dates are listed below.

Extended Term Plan	April 3, 1980
Fixed Term Plan	April 3, 1981
Term Lease Plan	April 3, 1982
Alternate Term Plan	April 3, 1983

Customers having no new agreement after these dates will revert to the Monthly Availability Charge under the previous lease agreement.

PURCHASE OPTIONS: In August 1974, IBM extended its Purchase Option Plan to allow users renting under the Monthly Availability Charge (MAC), Extended Term Plan (ETP), and Fixed Term Plan (FTP) to accumulate up to 36 months of purchase option credits toward the purchase of the equipment. The total amount accrued cannot exceed 50 percent of the purchase price of the equipment at the date of purchase. The 48-month Term Lease Plan also permits the accumulation of purchase credits through 48 months to a maximum of 50 percent of the purchase price. Previously, the Monthly Availability Charge contract permitted accumulation of up to 12 months of purchase option credits, and the Fixed Term Plan and Extended Term Plan included provision for accumulation of up to 24 months of purchase option credits. Under terms of the new lease agreement, users purchasing their rented or leased systems may apply between 50 and 60 percent of the accumulated monthly charges to the purchase price. The specific percentage allowed is dependent upon the equipment.

SOFTWARE: IBM has five designations for its software products: System Control Programs (SCP), Program Product (PP), Application Programs (PPA), Field-Developed Programs (FDP), and Installed User Programs (IUP).

System Control Programs provide those functions which are fundamental to the operation and maintenance of a system (e.g., loader, scheduler, supervisor, and data management) and include the DOS/VS and OS/VS operating systems and the VM/370 Virtual Machine Facility. SCP's are provided to IBM customers at no charge and to non-IBM customers for nominal distribution costs (namely, the cost of the media and a duplication charge). IBM customers also receive full IBM software support, which includes all updates, temporary fixes, and generally all enhancements to the software packages.

SCP's are modified by Selectable Units (SU's), which are microcode packages that implement the same types of enhancements that were formerly provided by subsequent releases of software packages. At present, SU's are also provided at no charge, but only to IBM customers with the appropriate equipment.

Program service is still divided into three categories, but has been designated as Central Service, Local Service, and Local Assistance instead of the A, B, and C categories used in the old agreement. The Central Service offers software support similar to that of Category "B" in the previous agreement, and Local Service is similar in provisions to the "A" category. With Central Service, customers document software problems and submit them to specified IBM service locations for analysis. The service locations respond by issuing defect correction information, which may take the form of corrected code, a notice of availability of corrected code, correction documentation, or a bypass. Local Service includes support from IBM personnel who will either make a reasonable attempt to resolve the problem by applying a local fix or providing a bypass, or will document the defect and submit it for Central Service action. Local Assistance is similar in scope to Local Service but is subject to the *availability* of IBM personnel. Each of these service categories will be offered for one of three time periods: until discontinued by IBM upon six months notice, until a designated calendar date, or for a specified number of months.

Program Products include all language processors, communications support programs, and utility programs, and are licensed separately. Monthly license charges are listed under "Software Prices" and include full IBM software support. The MVS/System Extensions and the VM/System Extensions enhancements to the OS/VS2 (MVS) and VM/370 SCP's are designated as Program Products and are also licensed separately. Application Programs (PPA's) and industry-oriented software packages are also licensed separately, including full support. Also available on an individual-charge basis, but without centralized IBM programming support, are numerous Field-Developed Programs and Installed User Programs for the System/370.

SUPPORT: IBM Systems Engineering assistance is available to System/370 users at a basic rate of $89.00 per hour.

EDUCATION: IBM "Professional Courses" are 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.■

SOFTWARE PRICES

	Monthly License Charge	Date Available
ACF/VTAM/VS Release 3 under MVS	$240	4th qtr. 1980
Under OS/VS1	240	2nd qtr. 1981
Under DOS/VSE	85	1st qtr. 1981
ACF/VTAM/VS Release 3 Networking feature under MVS	600	4th qtr. 1980
Under OS/VS1	600	2nd qtr. 1981
Under DOS/VSE	160	1st qtr. 1981
ACF/TCAM/Version 2 R3 under MVS	450	4th qtr. 1980
Under OS/VS1	450	1st qtr. 1981
ACF/TCAM/Version 2 R3 Networking feature under MVS	800	4th qtr. 1980
Under OS/VS1	800	1st qtr. 1981
ACF/NCP/VS R2.1	120	2nd qtr. 1980
ACF/NCP/VS R3	120	2nd qtr. 1981
NTO Release 2	100	1st qtr. 1981
NPDA	32	3rd qtr. 1980
Support programs for installation of NCP programming	35	—
DPDS Under MVS on System/370	500	July 1979
MVS/System Extensions	1,250	—
VM/370 System Extensions	1,200	—