IBM System/360 Model 20

MANAGEMENT SUMMARY

The Model 20 is the smallest member of the IBM System/360 family of computers, but by no means the least significant. Its introduction in April 1964 brought a multitude of users under the System/360 umbrella who might never have come that route otherwise. The Model 20 held a dominant roll as the industry's leading small-scale data processing system until the introduction of the IBM System/3 (Report M11-491-501), which offered greater speed, versatility, and economy.

With nearly 15,000 installations worldwide at its height, the Model 20 proved to be a reliable, low-cost way for users to make the transition from tabulating equipment to computer systems.

As originally conceived, the Model 20 was a card-oriented system. Since then, the hardware and software have been progressively expanded and improved, so that it now offers a fairly wide choice of processor models, peripheral equipment, and software support.

In March 1968, IBM announced slowed-down versions of the Model 20 Processor, the 2203 Printer and the unique 2560 Multi-Function Card Machine. These "Submodel 3 and 4" systems cost about 20 to 25 percent less than the original "Submodel 1 and 2" systems and yield roughly 30 percent less throughput in typical applications. The new models further reduced the cost of entry into System/360 data processing. Thus, they served as an effective counter-attack to the small, low-cost computers that had recently been introduced by several of IBM's major competitors.

An even more significant announcement in June 1968 wiped out the advantage that several competitors had established by marketing comparably-priced processors that were far faster than the original Model 20. The new Submodel 5 Processor changed the picture by offering internal speeds about three times as fast as those of ▷

Once the world's most widely used small-scale business data processing system, the Model 20 has been largely superseded by IBM's newer System/3. The Model 20 is available in six processor models and in card, tape, and disk-oriented configurations, but its compatibility with the larger System/360 and 370 computers is limited.

CHARACTERISTICS

MANUFACTURER: International Business Machines Corporation, General Systems Division, 875 Johnson Ferry Road N.E., Atlanta, Georgia 30342.

MODELS: System/360 Model 20, Submodels 1, 2, 3, 4, 5, and 6. All are "no longer in new product production" by IBM.

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," while four consecutive bytes form a "word."

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

FLOATING-POINT OPERANDS: No facilities for floating-point arithmetic are provided.

INSTRUCTIONS: 2, 4, or 6 bytes in length, specifying 0, 1, or 2 memory addresses, respectively. There are 16 memory-to-memory instructions, 9 memory/immediate instructions (1 operand a literal), 7 register/memory instructions, and 4 register-to-register instructions.

INTERNAL CODE: EBCDIC (Extended Binary-Coded Decimal Interchange Code).

MAIN STORAGE

CAPACITY: 4,096, 8,192, 12,288, or 16,384 bytes in Submodels 1 thru 4; 8,192, 12,288, 16,384, 24,576, or ▶
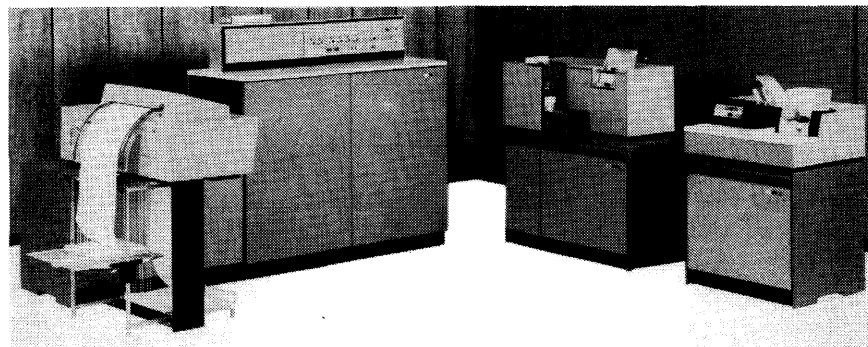
The IBM System/360 Model 20 in a card-oriented configuration. To the left of the CPU is the 2203 Printer, and the 1442 Card Punch and 2501 Card Reader are on the right.

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▷ Submodels 1 and 2 at a price increase of only about $100 per month. Submodel 5 accesses two bytes of data in each 2-microsecond core storage cycle, whereas the earlier models required 3.6 microseconds to access a single byte. Moreover, Submodel 5 offers up to 32,768 bytes of core storage, whereas the previous maximum was 16,384 bytes. Finally, Submodel 5 is the only Model 20 processor that can be equipped with 60KB magnetic tape units, with an emulator for the second-generation IBM 1401 and 1440 computer systems, and with up to four (rather than two) disk units.

Then, in May 1971, IBM rounded out the Model 20 line by introducing the Submodel 6 Processor. The Submodel 6 has the same 3.6-microsecond core storage cycle time as Submodels 1 and 2, but the newer model accesses two bytes per cycle and boasts 70 percent higher internal speed and improved I/O simultaneity, coupled with significantly lower rental prices. Programs written for Submodels 1 through 4 run without change on a similar Submodel 6 configuration, but it is necessary to alter and recompile the programs to take advantage of the improved overlap capabilities of the Submodel 6. Although the Submodel 6 Processor uses "reconditioned major elements," it is not possible to field-upgrade one of the earlier processors to a Submodel 6.

The Model 20 has no integrated operating system analogous to those for the larger System/360 models, but adequate complements of software are provided at three different levels—for card, tape, and disk-oriented systems with at least 4K, 8K, and 12K bytes of core storage, respectively. IBM has placed less emphasis on the development of generalized programs for specific applications than some competing manufacturers, such as Honeywell and NCR.

RPG (Report Program Generator) had been around in the days of the IBM 1401, but it was far less effective than the RPG language developed for use on the System/360. RPG was promoted quite heavily as "the language" to use on the Model 20. It is comparatively easy to learn and is well suited for the routine business data processing applications that form the bulk of the workload for most Model 20 installations. Unfortunately, RPG has also been pressed into service in many applications where it is cumbersome and inefficient (e.g., where complex calculations or data management operations are required).

Model 20 RPG is upward-compatible with the RPG for the larger System/360 models with one exception: the 2560 Multi-Function Card Machine (MFCM), which is not available on System/360 computers above the Model 25. Other minor differences do not prevent recompiling of original source decks on larger System/360 models.

The first truly high-level language for the Model 20, PL/1, was introduced in 1968. The compiler requires a minimum of 16K bytes of main memory and at least one disk drive. Other popular languages such as COBOL and FORTRAN have not been implemented on the Model 20 ▷

▶ 32,768 bytes in Submodel 5; 8,192, 12,288, or 16,384 bytes in Submodel 6.

CYCLE TIME: 3.6 microseconds per 1-byte access in Submodels 1 thru 4; 2.0 microseconds per 2-byte access in Submodel 5; 3.6 microseconds per 2-byte access in Submodel 6.

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

STORAGE PROTECTION: None.

CENTRAL PROCESSORS

CONTROL STORAGE: See "1401/1440 Compatibility," below.

REGISTERS: 8 general registers are used for indexing, base addressing, and as accumulators. Each register is one halfword (16 bits) in length.

INDIRECT ADDRESSING: None.

INSTRUCTION REPERTOIRE: 36 instructions, including decimal add, subtract, multiply, and divide; binary add and subtract; edit; code translate; compare; etc. Most of the Model 20 instructions are the same as those of the larger System/360 models, but the input/output and some control instructions are different.

INSTRUCTION TIMES: See table below; the times shown are for two-address decimal addition of signed five-digit (three-byte) fields and for one-address binary addition of halfword (16 bit) fields. All times are expressed in microseconds.

	Decimal Addition	Binary Addition
Submodels 1 & 2	473	209
Submodels 3 & 4	739	209
Submodel 5	160	58
Submodel 6	289	104

Overall internal processing speed of the Submodel 3 and 4 Processors is rated as 70 percent of that of Submodels 1 and 2.

Overall internal processing speed of the Submodel 5 Processor is rated as three times that of Submodels 1 and 2.

Overall internal processing speed of the Submodel 6 Processor is rated as approximately 1.7 times that of Submodels 1 and 2 and 0.55 times that of Submodel 5.

OPTIONAL FEATURES: Extra-cost features, called attachments, controls, or channels, must be added to the Model 20 Processor to accommodate each of the standard peripheral devices; these are listed in the "Equipment Prices" section.

1401/1440 COMPATIBILITY: This optional feature, available only for the Submodel 5 Processor, enables a Model 20 system to execute programs written for the earlier IBM 1401 and 1440 computers. The feature is a free-standing emulator that does not function under any operating system. It requires the loading of a special emulator microprogram deck that replaces the standard Model 30 microprograms in control storage. Internal speed of the Submodel 5 Processor in compatibility mode averages 95 percent of the 1401's speed, while overall throughput naturally depends upon the emulating I/O devices used. All standard 1401 and 1440 instructions and ▶

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PERIPHERALS/TERMINALS

DEVICE	DESCRIPTION	SPEED
MAGNETIC TAPE EQUIPMENT		
2415-1	2 drives, 800 bpi, 9-track*, 18.75 in/sec	15 KBS
2415-2	4 drives, 800 bpi, 9-track*, 18.75 in/sec	15 KBS
2415-3	6 drives, 800 bpi, 9-track*, 18.75 in/sec	15 KBS
2415-4	2 drives, 1600 bpi, 9-track*, 18.75 in/sec	30 KBS**
2415-5	4 drives, 1600 bpi, 9-track*, 18.75 in/sec	30 KBS**
2415-6	6 drives, 1600 bpi, 9-track*, 18.75 in/sec	30 KBS**
2401-1	1 drive, 800 bpi, 9-track*, 37.5 in/sec	30 KBS
2401-2	1 drive, 800 bpi, 9-track*, 75 in/sec	60 KBS
2401-4	1 drive, 1600 bpi, 9-track*, 37.5 in/sec	60 KBS
CARD EQUIPMENT		
2560-A1	Multi-function Card Machine, reads, punches, prints, 80-column	500/120 cpm
2560-A2	Multi-function Card Machine, reads, punches, prints, 80-column	310/90 cpm
2501-A1	Reader, 80-column	600 cpm
2501-A2	Reader, 80-column	1000 cpm
2520-A1	Read/Punch, 80-column, row by row	500 cpm
2520-A2	Punch, 80-column, row by row	500 cpm
2520-A3	Punch, 80-column, column by column	300 cpm
PRINTERS		
2203-A1	120 column, typebars, 52 characters***	350 lpm***
2203-A2	120 column, typebars, 52 characters***	260 lpm***
1403-2	132 column, chain/train, 48 characters	600 lpm
1403-7	132 column, chain/train, 48 characters	465 lpm
1403-N1	132 column, chain/train, 48 characters	1100 lpm
PRINTER-KEYBOARD		
2152	Keyboard input-typed output	15.5 cps
MAGNETIC CHARACTER READERS		
1255	MICR Reader/sorter, up to 12 pockets	Up to 750 dpm
1419	MICR Reader/sorter, 13 pockets	1600 dpm

* Seven-track capability is optional.
** Optional 800-bpi feature yields rated speed of 15 KBS.
***Speed varies with size of character set as follows:

Character Set Size	2203 Model A1	2203 Model A2
13 characters	750 lpm	600 lpm
39 characters	425 lpm	300 lpm
52 characters	350 lpm	260 lpm
63 characters	300 lpm	230 lpm

NOTE: All peripheral equipment is manufactured by IBM.

▷ by IBM—but independent software vendors can provide them.

Although IBM has maintained a high degree of program and data compatibility among all of the System/360 and System/370 processors from Model 22 through Model 195, there are some significant incompatibilities between the Model 20 and these larger models. The Model 20's limited instruction repertoire is largely a subset of that of the larger processors, but the input/output instructions and certain control instructions are different. Furthermore, the Model 20 has eight general registers which are one halfword (16 bits) in length, whereas the larger System/360 processors have 16 general registers which are a full word (32 bits) in length. These differences are not fully resolved by the assemblers for the respective models. ▷

▶ most of the special features can be emulated, though the Processing Overlap feature cannot. The following 1401/1440 I/O devices can be emulated by the functionally equivalent Model 20 I/O units: 1401 and 1442 Card Read Punch, 1442 Card Reader, 1444 Card Punch, 1403 or 1443 Printer, 1407 or 1447 Console, 1311 Disk Storage Drives, and 729, 7330, or 7335 Magnetic Tape Units. The Model 20 system must have at least as much core storage as the 1401 or 1440 system it emulates (e.g., an 8K Model 20 can execute a program that required 8,000 characters in a 1401 or 1440).

INTERRUPTS: In the Model 20, interruption is provided only for the "Channel End" I/O condition (the time in the mechanical cycle of the device at which the data transfer has been completed) in an established priority sequence. Interrupt masking is permitted. ▶

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▷ Moreover, differences in disk recording formats make it impossible for a larger System/360 model to read disk packs written by a Model 20, or vice versa, though the packs are physically interchangeable. (An extra-cost option for the System/360 Model 25 enables it to emulate the Model 20.)

Pricing changes have taken place over the last few years in both the rental and sale prices of the various Model 20 mainframes and peripherals. While the rental prices have gone up somewhat (partly reflecting increases in maintenance charges), the purchase prices have generally gone down. This was IBM's way of inducing some users to switch from rental to purchase, thereby reducing its inventory of the out-of-production Model 20 equipment.

The System/3 has long since displaced the Model 20 as IBM's lowest-priced and fastest-selling business data processing system. The 1969 announcement of the System/3 Model 10 introduced a system that was considerably less expensive and easier to use than the System/360 Model 20, and many users of small Model 20's took advantage of the opportunity to "upgrade" into the System/3. Three years later, in 1972, some of the returned Model 20 Processors reappeared as the basis for the IBM 2922 Programmable Terminal.

Those Model 20 users who continued to view even the smallest System/370 configuration as too rich an upgrade were provided with a more attractive growth system with the July 1973 announcement of the System/3 Model 15. The Model 15 supports the 2560 Multi-Function Card Machine, which is the key peripheral device in most 360/20 installations, and a field-developed program was made available to aid in converting 360/20 RPG programs into Model 15 RPG II. The July 1975 unveiling of the System/3 Model 12 presents yet another viable growth path within the IBM fold. Model 12 system users can rent 80- or 96-column card I/O units while converting to a diskette-based system if they wish.

Mention of the System/360 has been conspicuously absent from recent IBM announcements of enhancements and new peripheral products for both the System/3 and the smaller System/370 models. Obviously IBM has recognized that the System/3, as planned, has superseded the Model 20 as its small general-purpose computer system. Since most Model 20's were rented from IBM, a large percentage of the remaining System/360 Model 20 users can be expected to follow IBM's lead either into the System/3 family or up to the System/370 Model 115, where Model 20 emulation is available. Users would do well, however, to examine the competitive offerings from Burroughs, Honeywell, NCR, and UNIVAC, all of which offer attractive products in this lucrative market.

USER REACTION

Summarized below are the results of the 1974 Datapro survey of users' experience with computer systems, which drew responses from 19 System/360 Model 20 users representing 45 installed systems. ▷

► PHYSICAL SPECIFICATIONS: Operating temperature must be 60° to 90° F. with noncondensing relative humidity of 20% to 65%. Power requirements are 208 or 230 volts, 3-phase, 4-wire, 60 Hertz. Voltage tolerance is +10% to -8%. A system consisting of a 2501 Card Reader, 1403 Printer, 2415 Model 2 Magnetic Tape Unit, and 2020 Processor requires 180 square feet and dissipates about 26,000 to 28,000 BTUs of heat per hour.

INPUT/OUTPUT CONTROL

CONFIGURATION RULES: A maximum of three card I/O units, one printer, one magnetic character reader, one magnetic tape control with up to six tape drives, two or four disk storage drives, one printer-keyboard, and one communications adapter can be connected. Not all I/O devices can be used with all processor submodels, however, and only one unit of any given machine type (except disk and tape drives) can be connected.

SIMULTANEOUS OPERATIONS. In Submodels 1 through 4, computing, printing, card reading, card document printing, and punching can all occur simultaneously. Magnetic tape, disk file, and high-speed communications data transfer, however, occur in "burst mode"; computing and other I/O operations (except on the buffered 1403 Printer) cannot occur at the same time.

In Submodel 5, one of each of the following functions can be executed simultaneously: computing, printing, card reading, punching, typing, magnetic tape input or output, disk file input or output, and communications input or output.

The Submodel 6 Processor has overlap capabilities similar to those of Submodel 5, except that if a 2203 Printer is used, tape and disk read/write operations cannot always be overlapped with other I/O operations.

I/O INTERFERENCE: Fairly low during card reading, punching, and printing operations; e.g. the 2501 Model A1 Card Reader delays the processor for 5.5 milliseconds per 100-millisecond card read cycle. (But note that in Submodels 1 thru 4, processing is halted for the entire duration of a magnetic tape or disk file I/O operation.)

MASS STORAGE

2311 DISK STORAGE DRIVE, MODELS 11 AND 12: These are lower-capacity versions of the 2311 Model 1 Drives used in the larger System/360 models. All models use the same 1316 Disk Pack, but format differences make it impossible for a 2311 Model 11 or 12 to read data written by a 2311 Model 1, or vice versa.

Model 11 stores up to 5.4 million bytes and has an average head movement time of 75 milliseconds. Model 12 stores up to 2.7 million bytes and has an average head movement time of 60 milliseconds.

For both models, average rotational delay is 12.5 milliseconds and data transfer rate is 156,000 bytes/second.

Data is stored in 270-byte sectors, 10 sectors per track. Up to 27,000 bytes can be read or written at each position of the comb-type access mechanism. One read/write head serves each disk surface. Model 11 can access all 200 data tracks on each disk surface, while Model 12 can access only 100 of the tracks.

Up to two 2311 Drives (Model 11 or 12, not intermixed) can be connected to a Submodel 2 or 4 Processor; up to four 2311 Drives (models 11 and/or 12 in any combination) to a Submodel 5 Processor; and up to two ►

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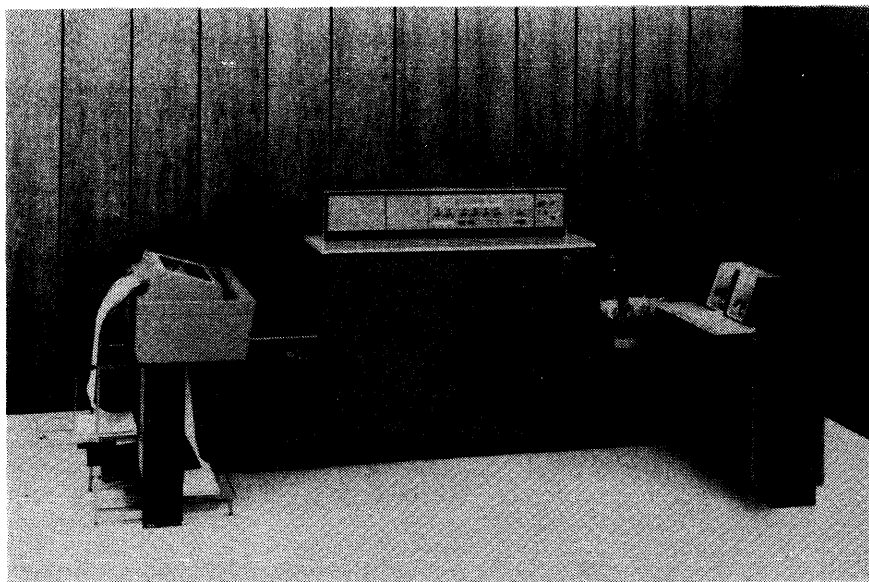
This card-oriented Model 20 system includes the distinctive 2560 Multi-Function Card Machine (right), which combines the functions of an 80-column card reader/punch, collator, and interpreter in a single unit. Cards fed from either of two 1200-card feed hoppers can be read, punched, printed upon, and fed into any of five 1300-card stackers under program control.

	Excellent	Good	Fair	Poor	WA*
▷ Ease of operation	9	8	1	1	3.3
Reliability of mainframe	14	5	0	0	3.7
Reliability of peripherals	7	10	1	0	3.3
Maintenance service:					
Responsiveness	8	10	1	0	3.4
Effectiveness	6	12	1	0	3.3
Technical support	4	7	6	1	2.8
Manufacturer's software:					
Operating system	5	5	3	0	3.2
Compilers and assemblers	7	5	3	0	3.3
Applications programs**	3	3	2	1	2.9
Ease of conversion	4	2	3	2	2.7
Overall satisfaction	6	11	2	0	3.2

* Weighted Average on a scale of 4.0 for Excellent.

**Ten of the 19 users were not using IBM applications software.

Thus, the level of user satisfaction with the Model 20 was quite high in all areas except technical support, applications programs, and ease of conversion. Upon recontact in July 1975, two of the five users we interviewed reported no change in their installations. However, three others had made system changes from 12K or 16K Model 20 Disk Programming Systems to an IBM System/370 Model 135, an IBM System/360 Model 30, and a Burroughs B 1728.

Partial survey returns received in July 1975 from current Model 20 users (six users and six systems) showed a generally similar pattern, as summarized below.

	Excellent	Good	Fair	Poor	WA*
Ease of operation	2	3	0	1	3.0
Reliability of mainframe	4	2	0	0	3.7
Reliability of peripherals	3	2	1	0	3.3
Maintenance service:					
Responsiveness	2	3	1	0	3.2
Effectiveness	2	3	1	0	3.2
Technical support	1	2	1	1	2.6
Manufacturer's software:					
Operating system	0	3	1	0	2.8 ▷

▶ 2311 Drives (Models 11 and/or 12) to a Submodel 6 Processor. Disk storage cannot be used with a Submodel 1 or 3 Processor.

INPUT/OUTPUT UNITS

See Peripheral/Terminals table.

COMMUNICATION CONTROL

BINARY SYNCHRONOUS COMMUNICATIONS ADAPTER (BSCA): Enables a Model 20 to communicate with a suitably equipped IBM System/360, System/370, System/3, 1130, or 1800 computer, or with a 2770 Data Communications System or a 2780 Data Transmission Terminal. The BSCA can be installed only on a Submodel 2, 4, 5, or 6 Processor with at least 8K bytes of core storage. Transmission is in half-duplex binary synchronous communications (BSC) mode over a single switched or leased line. Either ASCII or EBCDIC transmission code can be used. Transmission speed can be set at 600, 1,200, 2,000, 2,400, 4,800, 19,200, 40,800, or 50,000 bps; a High Speed feature is required for operation at or above 19,200 bps.

Several optional features are available to enhance the capabilities of the BSCA. The Full Transparent Text Mode feature permits transmission and reception of data in 8-bit binary image form as well as in EBCDIC or ASCII code. The Station Selection feature enables the BSCA-equipped Model 30 to operate as one of a number of BSC terminals on a multipoint line. The Internal Clock feature generates timing signals for use with modems that lack a clocking facility. The Automatic Calling feature enables the Model 20 to dial and initiate a call to a remote BSC terminal under program control.

SOFTWARE

PROGRAMMING SYSTEMS: No integrated operating system is available for the Model 20, but IBM offers software facilities at three basic levels:

CARD PROGRAMMING SUPPORT (CPS): A set of stand-alone, card-oriented programs that require 4K bytes of storage and support a maximum of 16K. Principal components are a Report Program Generator, Basic Assembler, Input/Output Control System, and a group of utility programs. ▶

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	Excellent	Good	Fair	Poor	WA*
Compilers and assemblers	1	3	2	0	2.8
Applications programs**	1	2	2	0	2.8
Ease of conversion	1	1	3	1	2.8
Ease of programming	1	5	0	0	3.2
Overall satisfaction	1	5	0	0	3.2

* Weighted Average on a scale of 4.0 for Excellent.

**Five of the six users were using IBM applications software.

Our July 1975 survey of computer users also revealed some additional facts about migration patterns from the Model 20 to other systems:

Number of Conversions	New System
7	System 3 (mostly Model 10)
1	System/360 Model 22
1	System/360 Model 25
1	System/360 Model 40
1	System/370 Model 115
1	System/370 Model 125
1	Burroughs B 2731
1	Burroughs B 3500
1	Honeywell 2032A
1	Univac 9200

It is clear that the Model 20 is nearing the end of a long and illustrious life cycle. Yet our surveys show that most of its users are still well satisfied with this workhorse system.□

TAPE PROGRAMMING SUPPORT (TPS): A set of control, processing, and service programs for tape-oriented Model 20 systems. At least 8K bytes of core storage, four magnetic tape drives, card equipment, and a printer are required for full utilization of the TPS facilities. Principal components include a Report Program Generator, Assembler, Input/Output Control System, Sort/Merge Program, Initial Program Loader, Basic Monitor, Job Control, and various service and utility routines. The Basic Monitor and Job Control routines facilitate operations by providing automatic job-to-job transition and selective retrieval of programs from a system tape. The service programs handle maintenance of the system tape.

DISK PROGRAMMING SUPPORT (DPS): A set of control, processing, and service programs for disk-oriented Model 20 systems. At least 12K bytes of core storage, one 2311 Disk Storage Drive, card equipment, and a printer are required. Principal components incude a Report Program Generator, Assembler, PL/1 Compiler, Input/Output Control System, Sort/Merge Program, Initial Program Loader, Basic Monitor, Job Control, and various service and utility routines. The Basic Monitor and Job Control routines provide automatic job-to-job transistion and selective retrieval of programs from a system disk. The service programs facilitate maintenance of the system disk.

PL/1: The Model 20 PL/1 Compiler supports a subset of OS/360 PL/1, a high-level language designed to handle both business and scientific problems. The Model 20 PL/1 language is also a subset of the DOS/360 "Basic PL/1" language, except that one Model 20 facility, "arrays of structures," is not available in the DOS version. The Model 20 version accommodates data structures of up to eight levels, arrays of up to three dimensions, character strings, floating-point data items, variable-length tape records, sequential and indexed sequential disk files, free-form input, built-in functions, and static and automatic storage

allocation. Extensive diagnostic and debugging aids are provided. The PL/1 compiler requires at least 16K bytes of core storage, one 2311 Disk-Drive, card reader, and printer.

ASSEMBLERS: The three Model 20 Assemblers permit programs to be coded in a symbolic assembly language that is largely, though not completely, compatible with the Assembler language for the larger System/360 models. IOCS in particular differs, along with halfword register instructions.

The Basic Assembler is a one-for-one assembler that requires two passes and offers no macro facilities. Separate versions are available for card and tape systems with at least 4K bytes of core storage.

The TPS and DPS Assemblers provide macro-instruction facilities, literals, and other significant language extensions. The TPS version requires an 8K Processor and at least 3 tape drives, while the DPS version requires a 12K Processor and at least 1 disk drive.

REPORT PROGRAM GENERATORS: RPG is the most widely used programming language in Model 20 installations. The programmer prepares a set of specifications describing the input data, calculations, and desired output. The RPG then generates a program to perform the required functions. The Model 20 RPG's are of the "compile and go" type, but the object program can be punched into cards for future use if desired. Language facilities include multiple I/O files, table look-up, branching, report headings, and comprehensive diagnostics. A high degree of upward compatibility with the RPG's for the larger System/360 models is provided.

CPS (4K Card) RPG generates programs that handle card files and produce printed reports. Input records can be obtained from up to 3 different files.

TPS (8K Tape) RPG can generate programs that process multiple card and tape files. Up to 3 input files, 3 output files, and a printer can be used. Tape records can be fixed or variable in length and blocked or unblocked.

DPS (12K Disk) RPG can generate programs to process up to 29 card, tape, and disk files in any combination. Disk files can be organized in either sequential or indexed sequential fashion, and indexed sequential files can be processed either sequentially or randomly. Disk records are of fixed or variable in length and blocked or unblocked. Recent additions to the facilities of DPS RPG include: (1) a CHAIN function that permits immediate retrieval of records from indexed sequential files; (2) an EXCPT function that allows multiple or exception records to be output during detail or total calculations; (3) edit codes that simplify the editing of output fields; (4) a subroutine facility that reduces the need to write repetitive coding; and (5) user date fields that enable use of date from the monitor communications region.

INPUT/OUTPUT CONTROL SYSTEM (IOCS): A set of macro-instructions that facilitate the coding of input/ output operations. Available for use with all three Model 20 programming systems (CPS, TPS, and DPS), and in special versions designed to simplify control of the communications adapters and magnetic character readers.

SORT/MERGE PROGRAMS: Available for both 8K Tape and 12K Disk systems. These are generalized programs which require input specifications defining the parameters of each sort or merge. User-coded routines can be inserted into the input and output phases. The sort keys can be contained in up to 12 different fields with a total length of up to 256 bytes. The tape version uses from three to six ▶

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▶ tape drives and handles fixed or variable length, blocked or unblocked records. The disk version uses from one to four disk drives and handles blocked or unblocked records of fixed length.

UTILITY ROUTINES: A broad range of useful utility routines is available. They perform program loading, data transcription, file maintenance, diagnostic, and other commonly required functions. Four Punched-Card Utility Programs enable a Model 20 system equipped with a 2560 MFCM to perform most of the functions of punched-card tabulating machines: collating, matching, sequence checking, gangpunching, reproducing, listing, summary punching, sorting, etc.

The Remote Job Entry (RJE) Work Station Programs enable a Model 20 equipped with the Binary Synchronous Communications Adapter to submit OS/360 jobs to a remote System/360 or 370 computer for execution and to receive output. RJE support for Model 20 is provided under CPS, TPS, and DPS.

APPLICATION PROGRAMS: The limited number of fully supported application packages currently available from IBM includes the following:

Bill of Material Processor: Has the capability to load, maintain, retrieve, and reorganize part number master and product structure records. System requirements are a 16K CPU, card reader and punch, printer, and two 2311 disks.

Hospital Accounts Receivable: Enables small hospitals to perform the major processing runs in the hospital accounts receivable area. System requirements are a 12K CPU, one 2560, one 2203 with 52-character set, and two 2311's.

Hospital Patient Billing: Enables small hospitals to install a patient billing system with a minimum of programming effort. System requirements are a 16K CPU, one 2560, one 2203 with 52-character set, and two 2311's.

Requirements Planning and Inventory Control System: A group of integrated programs designed to help manufacturing companies achieve economic management of their manufacturing inventories. Programs are provided to create and update the order file, update inventory status with all transactions, plan future requirements by explosion and forecasting, and assure an economic coverage of requirements by means of an order policy based on stock-out point and order quantity rules. System requirements are a 16K CPU, card reader and punch, printer with 48-character set, and two 2311 disks.

Wholesale IMPACT: Enables Model 20 users to use the IMPACT system of inventory management. System requirements are a 16K CPU, printer, card reader and punch, two 2311 disks, and one 2415 magnetic tape unit.

PRICING

POLICY: The IBM 360/20 Series is available for lease or purchase. Certain peripherals have up to two-year leases available, but the majority of the 360/20 equipment is available on the short-term lease plan only. The standard IBM rental contract includes equipment maintenance and entitles the customer to up to 176 hours of billable time per month. Time used in excess of that amount is charged for, on all machines equipped with meters, at an extra-use rate.

The 2311 Disk Storage Drive, 2415 and 2401 Magnetic Tape Units, and 1403 and 2203 Printers are available on a 12-month lease or 24-month lease.

SOFTWARE: Nearly all of the Model 20 software was in use before IBM's June 1969 unbundling announcement and is still available to users at no extra cost. No separately priced IBM Program Products for the Model 20 have been announced to date. All of the CPS, TPS, and DPS software facilities are in Programming Service Classification C; this means that the programs are now considered essentially bug-free and will no longer receive central programming support, although users can still get Field Engineering help on a billable basis.

SUPPORT: IBM Systems Engineering assistance is available to Model 20 users at $52.00 per hour from GSD.

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

EQUIPMENT: Prices for the following typical Model 20 configurations include all necessary attachments and control units. Monthly rental prices include equipment maintenance and are based on IBM's short-term rental rates.

MINIMUM CARD SYSTEMS: Consists of 4K Submodel 3 Processor, 2560 Model A2 MFCM, and 2203 Model A2 Printer. Monthly rental and purchase prices are approximately $1,536 and $42,450, respectively.

For the above configuration with the faster Submodel 1 Processor, 2560 Model A1 MFCM, and 2203 Model A1 Printer, monthly rental and purchase prices are approximately $1,992 and $56,280, respectively.

TYPICAL DISK SYSTEM: Consists of 12K Submodel 6 Processor, 2501 Model A2 Card Reader, 1442 Model 5 Card Punch, 1403 Model 7 Printer, and two 2311 Model 11 Disk Storage Drives. Monthly rental and purchase prices are approximately $3,997 and $104,771, respectively.

For the above configuration with the faster Submodel 5 Processor, monthly rental and purchase prices are approximately $4,342 and $116,051, respectively.■

IBM System/360 Model 20

EQUIPMENT PRICES

		Purchase Price	Monthly Maint.	Monthly Rental*
PROCESSORS AND MAIN STORAGE				
2020	Processing Unit, Submodel 1	$11,740	$ 67.00	$ 641
	B1: 4,096 bytes	16,200	76.00	899
	C1: 8,192 bytes	22,000	87.00	1,215
	BC1: 12,288 bytes	27,360	94.00	1,525
	D1: 16,384 bytes			
2020	Processing Unit, Submodel 2	13,470	72.00	737
	B2: 4,096 bytes	17,930	81.00	997
	C2: 8,192 bytes	23,730	92.00	1,310
	BC2: 12,288 bytes	29,090	100.00	1,630
	D2: 16,384 bytes			
2020	Processing Unit, Submodel 3	8,210	67.00	454
	B3: 4,096 bytes	10,370	76.00	576
	C3: 8,192 bytes	13,950	87.00	778
	BC3: 12,288 bytes	17,360	94.00	977
	D3: 16,384 bytes			
2020	Processing Unit, Submodel 4	9,220	72.00	504
	B4: 4,096 bytes	11,260	81.00	627
	C4: 8,192 bytes	14,810	92.00	827
	BC4: 12,288 bytes	18,220	100.00	1,025
	D4: 16,384 bytes			
2020	Processing Unit, Submodel 5	18,950	162.00	1,120
	C5: 8,192 bytes	24,070	180.00	1,420
	BC5: 12,288 bytes	30,200	189.00	1,750
	D5: 16,384 bytes	38,100	209.00	2,180
	DC5: 24,576 bytes	44,430	236.00	2,625
	E5: 32,768 bytes			
2020	Processing Unit, Submodel 6	11,150	180.00	737
	C6: 8,192 bytes	16,860	200.00	1,025
	BC6: 12,288 bytes	22,850	209.00	1,275
	D6: 16,384 bytes			
3901	1401/1440 Compatibility Feature (for 2020 Submodel 5 only)	5,880	52.00	350
MASS STORAGE				
7495	Disk Storage Control for 2020 Submodel 2	4,230	7.50	286
7495	Disk Storage Control for 2020 Submodel 4 (2311 Model 11)	4,230	7.50	286
7496	Disk Storage Control for 2020 Submodel 4 (2311 Model 12)	3,165	7.50	218
7497	Disk Storage Control for 2020 Submodel 5	4,230	7.50	286
7498	Disk Storage Control for 2020 Submodel 6	4,230	7.50	286
2311	Disk Storage Drive			
	Mod. 11: 5.4 million bytes	16,510	90.50	670
	Mod. 12: 2.7 million bytes	14,430	56.50	410
1316	Disk Pack	360	—	—
MAGNETIC TAPE INPUT/OUTPUT				
4658	Input/Output Channel (required on 2020 for 2415)	2,820	7.50	190
2415	Magnetic Tape Unit and Control			
	Mod. 1: 2 tape drives; 800 bpi	32,950	215.00	882
	Mod. 2: 4 tape drives; 800 bpi	52,690	384.00	1,410
	Mod. 3: 6 tape drives; 800 bpi	72,420	558.00	1,935
	Mod. 4: 2 tape drives; 800 or 1600 bpi	40,010	246.00	1,065
	Mod. 5: 4 tape drives; 800 or 1600 bpi	64,260	439.00	1,710
	Mod. 6: 6 tape drives; 800 or 1600 bpi	85,510	635.00	2,350
3228	Data Conversion Feature (for 2415; 7125, 7127, or 7135 required)	1,935	1.50	51
5320	Nine-Track Compatibility (for 2415 Mod. 4, 5, 6)	5,825	17.00	157
7125	Seven-Track Compatibility (for 2415 Mod. 1, 2, 3)	2,145	2.00	56
7127	Seven-Track Compatibility (for 2415 Mod. 4, 5, 6)	4,085	5.00	110
7135	Seven- & Nine-Track Compatibility (for 2415 Mod. 4, 5, 6)	6,675	24.00	179
5301	Native Tape Attachment (required on 2020 Submodel 5 for 2401 Models 1, 2)	9,410	309.00	563
5302	Native Tape Attachment (required on 2020 Submodel 5 for 2401 Model 4)	11,425	453.00	686
5320	Nine-Track Compatibility (for 2401 on 2020 Submodel 5)	3,215	78.00	190
7125	Seven-Track Compatibility (for 5301 on 2020 Submodel 5)	1,075	34.50	60
7126	Seven-Track Compatibility (for 5302 on 2020 Submodel 5)	2,360	58.50	139
7135	Seven- & Nine-Track Compatibility (for 5302 on 2020 Submodel 5)	5,210	58.50	311

* Rental prices include equipment maintenance.
**One-time charge.

IBM System/360 Model 20

EQUIPMENT PRICES

		Purchase Price	Monthly Maint.	Monthly Rental*
MAGNETIC TAPE INPUT/OUTPUT (Continued)				
2401	Magnetic Tape Unit			
	Mod. 1: 30KB at 800 bpi	14,440	129.00	393
	Mod. 2: 60KB at 800 bpi	20,940	147.00	570
	Mod. 4: 60KB at 1600 bpi	16,530	156.00	452
3471	Dual Density Feature (for 2401 Mod. 4)	1,100	2.50	27
5121	Mode Compatibility (for 2401 Mod. 1, 2 with 5302)	426	NC	10
CARD INPUT/OUTPUT				
Attachments for 2020 Processing Unit:				
4460	1442 Model 5 Attachment (Submodels 1, 2, 5, 6)	560	3.50	35
8090	2501 Attachment (Submodels 1, 2, 5, 6)	383	2.50	24
8092	2520 Model A1 Attachment (Submodels 1, 2, 5, 6)	935	10.00	60
8095	2520 Model A2, A3 Attachment (Submodels 1, 2, 5, 6)	486	4.00	29
8099	2560 Model A1 Attachment (Submodels 1, 2, 5, 6)	1,410	7.50	93
8100	2560 Model A2 Attachment (Submodels 3, 4)	1,410	7.50	93
1580	Card Print Control (Submodels 1, 2, 5, 6; needs 1575 on 2560)	466	3.50	29
1442	Card Punch, Model 5; 160 col/sec	9,720	112.00	346
2501	Card Reader			
	Mod. A1: 600 cpm	12,330	62.00	262
	Mod. A2: 1,000 cpm	12,550	88.50	346
2520	Card Read Punch, Mod. A1: 500 cpm	35,380	211.00	996
2520	Card Punch, Mod. A2: 500 cpm	31,630	198.00	886
2520	Card Punch, Mod. A3: 300 cpm	31,410	156.00	639
2560	Multi-Function Card Machine			
	Mod. A1: reads 500 cpm; punches 160 col/sec	21,230	209.00	838
	Mod. A2: reads 310 cpm; punches 120 col/sec	15,590	209.00	652
Card Print Feature for 2560 Mod. A1:				
1575	First Two Lines	4,625	28.00	180
1576	Second Two Lines (requires 1575)	4,625	28.00	180
1577	Third Two Lines (requires 1576)	4,625	28.00	180
PRINTERS				
Attachments for 2020 Processing Unit:				
4442	1403 Mod. 2 Attachment (Submodels 1, 2, 5, 6)	4,230	39.50	286
4447	1403 Mod. 7 Attachment (Submodels 1, 2, 5, 6)	4,135	39.50	255
4448	1403 Mod. N1 Attachment (Submodels 1, 2, 5, 6)	4,422	39.50	350
5575	Printer Features Control (Submodels 1, 2, 5, 6, for 6410 or 6411 on 1403 Models 2, N1)	991	2.50	69
8637	Universal Character Set Adapter (Submodels 2, 5, 6, for 8640 or 8641 on 1403)	289	5.50	15
8082	Attachment for standard 2203 Mod. A1 (Submodels 1, 2, 5, 6)	1,040	7.50	69
8083	Attachment for 2203 Mod. A1 with 5558 (Submodels 1, 2, 5, 6)	1,040	7.50	69
8084	Attachment for standard 2203 Mod. A2 (Submodels 3, 4)	1,040	7.50	69
8085	Attachment for 2203 Mod. A2 with 5558 (Submodels 3, 4)	1,040	7.50	69
3480	Dual Feed Carriage Control (for 3475 on 2203)	201	2.00	10
1403	Printer			
	Mod. 2: 600 lpm; 132 print positions	22,000	339.00	970
	Mod. 7: 600 lpm; 120 print positions	21,140	263	815
	Mod. N1: 1100 lpm; 132 print positions	38,140	392.00	1,135
1376	Auxiliary Ribbon Feeding (for 1403 Mod. 2, 7)	2,000	29.50	92
4740	Interchangeable Chain Cartridge Adapter (1403 Mod. 2, 7)	2,030	NC	92
6410	Selective Tape Listing Feature (for 1403 Mod. N1)	7,505	17.00	236
6411	Selective Tape Listing Feature (for 1403 Mod. 2)	5,260	17.00	236
8640	Universal Character Set Feature (for 1403 Mod. N1)	426	1.75	10
8641	Universal Character Set Feature (for 1403 Mod. 2)	299	1.75	10
1416	Interchangeable Train Cartridge (for 1403 Mod. N1)	2,665	Time & Mat'ls.	101
2203	Printer			
	Mod. A1: 300 to 750 lpm (63 down to 13 in character set)	13,880	140.00	599
	Mod. A2: 230 to 600 lpm (63 down to 13 in character set)	10,620	140.00	458
5558	24 Additional Print Positions (for 2203)	1,495	6.00	51
3475	Dual Feed Carriage (for 2203)	3,035	14.50	114
7815	Tape Channels, 6 Additional (for 2203; 3475 required)	367	1.00	10

* Rental prices include equipment maintenance.
**One-time charge.

IBM System/360 Model 20

EQUIPMENT PRICES

		Purchase Price	Monthly Maint.	Monthly Rental*
MISCELLANEOUS INPUT/OUTPUT UNITS				
8070	Printer-Keyboard Attachment (2020 Submodels 2, 4, 5, 6)	1,745	7.00	108
2152	Printer-Keyboard	5,745	92.50	176
1255	Magnetic Character Reader			
	Mod. 1: 500 dpm, 6 stackers	35,460	288.00	949
	Mod. 2: 750 dpm, 6 stackers	40,590	460.00	1,155
	Mod. 3: 750 dpm, 12 stackers	55,260	606.00	1,520
3215	Dash Symbol Transmission (for 1255)	35	NC	56**
4380	51-Column Card Sorting (for 1255)	661	NC	16
4520	High-Order Zero & Blank Selection (for 1255 Mod. 3)	1,315	5.50	34
7060	Self-Checking Numbers (for 1255)	2,135	2.50	56
6320	System/360 Model 20 Adapter (required on 1255)	6,605	24.00	176
1419	Magnetic Character Reader: 1,600 dpm	120,100	480.00	2,795
7081	Serial I/O Channel (required on 2020 Submodels 2, 5, 6)	1,990	11.50	126
COMMUNICATIONS EQUIPMENT				
2074	Binary Synchronous Communications Adapter (for 2020 Submodels 2, 4, 5, 6)	6,555	29.50	525
1315	Automatic Calling (for 2074)	477	1.25	39
4100	Full Transparent Text Mode (for 2074)	280	1.00	24
4500	High Speed: 19,200 bps (for 2074)	678	1.25	58
4501	High Speed: 40,800 bps or 50,000 bps (for 2074)	678	1.25	58
4703	Internal Clock (for 2074)	352	1.00	29
7477	Station Selection (for 2074)	409	1.00	34

* Rental prices include equipment maintenance.
**One-time charge.

IBM System/38

▶ capability of transferring up to 2.5 megabytes per second in byte mode and up to 5 megabytes per second in half-word mode. All peripherals that can be configured with the System/38 Model 3XX operate in byte mode. All peripherals except the 3370 Mass Storage Unit operate in byte mode on the System/38 Model 5XX. The 3370 operates in half-word mode.

IBM states that the System/38 I/O structure was designed with three major objectives in mind. The first objective to make use of LSI technology, the System's virtual addressing capability, and multiprogramming at the channel program level. The second objective was to employ a queued asynchronous structure, thus causing minimum impact on the processor because of channel program stacking. The final objective was to provide the channel bus (and thus the channel) with multiple I/O interface capability for feature addition and future configuration expansion. According to IBM, these design criteria were met with:

* A queued asynchronous system channel boundry.

* Employment of a channel processor. The processor executes single or multiple channel commands, allows direct memory access, provides for multiplexed I/O and supports intelligent I/O adapters on a common channel bus.

* Distributing function from the I/O managers, which translate data management I/O requests into channel programs, to the intelligent I/O adapters.

SIMULTANEOUS OPERATIONS: The processor provides overlapped operation of instruction fetch and execution functions. Employment of microprocessors in the channel, communications subsystem, work station controller, and line printer controller download some responsibility from the processor and allow for some simultaneity.

CONFIGURATION RULES

Each 5381 submodel includes a CPU; either 512K, 768K, 1024K, 1280K, 1536K, 1792K, or 2048K bytes of main memory; 4K or 8K bytes of control storage; from one to six spindles of disk storage (64.5 to 387.1 megabytes); a diskette magazine drive; a system console keyboard/display; an operator/service panel; and a workstation controller.

Optionally available devices for the System/38 include up to four communications lines (multiple devices per line), up to two 650-lpm printers, a multi-function card unit, and a magnetic tape subsystem with from one to four drives. System/38 Model 5 may also attach from one to four spindles of 3370 Disk Storage (571.3 to 2285.5 megabytes).

The workstation controller provides for direct local attachment of IBM 5250 Information Display System devices to the System/38. It provides 8 ports for attaching workstations (keyboard displays and/or printers) directly to the system in any combination. These 8 ports permit attachment of up to 12 devices. Devices supported via the workstation controller include the 5251 Models 1 and 11 Display Stations, the 5252 Dual Display Station and the 5256 Model 1, 2, and 3 Printers. (The Model 5252 display station is counted as two devices). The Device Control Expansion feature (5331/2) or the Device Interface Expansion feature (5321/2) can be used with a workstation controller to provide for up to 8 additional 5250 devices; thus, each appropriately featured workstation controller can support up to 20 workstations. A System/38 can support two workstation controllers, each with its own expansion feature; thus providing for a maximum of 40 of the IBM 5250 devices per system.

One of the more important units that is integral to the 5381 System Unit is the diskette magazine drive. This unit provides three functions; save/restore, diskette I/O, and CE servicing. The storage capacity of each diskette depends on type and formatting. Three types of diskette may be read by the unit in three different formats. Maximum capacity for the drive is 24 million bytes.

The Device Control Expansion feature does not provide any additional cable connectors but provides the necessary control storage to support eight devices attached via the cable connectors provided by workstation controllers.

The Device Interface Expansion feature provides the necessary control and eight twinax cable connectors for attachment of 5250 devices.

The Processor Unit Expansion 1 feature (6300) is an I/O board/power supply that is required for attaching the 1501 Communications Attachment or a second workstation controller.

The Processor Unit expansion 2 feature (6301) is an I/O board/power supply that is required for attaching the 5424 Multi-function Card Unit, the 3411 Magnetic Tape Unit, or a 5211/3262 Line Printer.

The Processor Unit Expansion 3 feature (6302) is an air circulating/cable assembly that is required for the 1501 Communications Attachment, 5302 Second Workstation Controller, the 5424 Multi-function Card Unit, the 3411 Magnetic Tape Unit, or a second 5211/3262 Line Printer.

The Processor Unit Expansion 4 feature (6303) is a power expansion assembly that is required to attach the 3411 Magnetic Tape Unit or the 3370 Disk Drive. ▶

IBM System/38

▶ The following table shows the processor unit expansion features required in order to include specific I/O capabilities on a System/38.

I/O FUNCTION REQUIRED	EXPANSION FEATURE REQUIRED			
	#1 (6300)	#2 (6301)	#3 (6302)	#4 (6303)
Communications Attachment	Yes	No	Yes	No
Second Workstation Controller	Yes	No	Yes	No
Multi-function Card Unit	No	Yes	Yes	No
Magnetic Tape Unit	No	Yes	Yes	Yes
Second Line Printer	No	Yes	Yes	No
3370 Disk Storage	No	No	No	Yes

MASS STORAGE

DISK STORAGE: The 5381 System Unit can contain from one to six spindles of integrated nonremovable disk storage. Each spindle has a storage capacity of 64,520,192 bytes. The disk rotational speed is 3125 rpm, providing a data transfer rate of 1.031 million bytes per second. Average rotational delay is 9.6 milliseconds. Cylinder to cylinder, average, and across-all-track head movement times are 9, 27, and 46 milliseconds respectively. There are 512 bytes per sector, 33 sectors per track (with one spare), 16,384 bytes per track, and 180,224 bytes per cylinder (11 tracks).

DISKETTE STORAGE: A diskette magazine drive is standard on the System/38 and provides three functions: save/restore, diskette I/O, and CE servicing. The diskette magazine drive has two magazine positions and three slots for individual diskettes. Each magazine can contain up to 10 diskettes, resulting in a total on-line capacity of 23 diskettes. IBM diskette types 1, 2, and 2D can be read and written. The storage capacities of the various diskette types is given in the following table.

Diskette Type	Bytes Per Sector	Diskette Capacity (bytes)
Diskette 1	128	246,272
	256*	284,160
	512*	303,104
Diskette 2	128*	492,544
	256*	568,320
	512*	606,208
Diskette 2D	256	985,088
	512*	1,136,640
	1024	1,212,416

*Only supported at the machine interface level

IBM states that the performance of the diskette magazine drive will vary depending on system work load, the quantity of data files, and the length of data files involved.

3370 DIRECT-ACCESS DISK STORAGE DEVICE: Provides up to 285.6 megabytes of storage per actuator and 571.3 megabytes per drive. The 3370 attaches to the System/38 Model 5XX via the 1130 Disk Storage Attachment.

The 3370 employs new thin-film technology heads and high-density LSI circuitry. Each 3370 has a single 571.3-megabyte spindle of disks which are accessed by two independent, movable actuators. Seeking with either actuator may be overlapped with seeking and/or reading/writing on the other actuator. Each actuator accesses one 25 285.6-megabyte DASD volume and has a separate address on the channel.

The 3370 head disk assembly (HDA) consists of two actuators and two disk component volumes assembled as a unit. These units are field-replaceable and movable only by IBM Field Engineering.

The 3370 makes use of fixed block architecture. Fixed block architecture provides for recording data in permanent pre-formatted 512-byte blocks on the disk surface. Each block of data is separately addressable and separately accessible, either singly or in contiguous strings of a variable number of blocks (maximum, approximately, 65,000). One 3370 actuator (volume) spans 558,000 blocks of user space. User data is mapped, regardless of record size, to one or more 512-byte blocks on the disk.

On the 3370, data block position sensing is automatic. The fixed block architecture provides for relative block addressing. The 3370 has the capability to correct single data error bursts of up to 9 bits as well as to detect all single error bursts up to 16 bits in length. Command retry enables the storage control to recover from certain subsystem errors without recourse to system error recovery procedures. A switch for each drive address provides the means to protect data from being rewritten or erased. When the read/write switch is in the read-only position, any write command is rejected. The switch's state can be changed only when the device is not selected.

The 3370 has 558,000 blocks per actuator, 285,696,000 bytes per actuator, and 571,392,000 bytes per drive. Minimum, average, and maximum head movement times are 5, 20, and 40 milliseconds, respectively. Average rotational delay is 10.1 milliseconds, and the data transfer rate is 1.859 megabytes per second.

The 3370 is available in two models. The 3370 Model A11 contains the control adapter functions required for attachment to the 430 Disk Storage Attachment. The 3370 Model B11 attaches through an A11 unit. Up to three 3370 Model B11's can be attached to a 3370 Model A11 for a maximum of four units per System/38.

INPUT/OUTPUT UNITS

SYSTEM CONSOLE: Integral with the processor, the console consists of a 1024-character CRT (16 lines of 64 characters), a keyboard, and an operator service panel. The CRT displays attributes including protected fields, underscore, and nondisplay. The keyboard has a typewriter-like layout with 24 command function keys. A U.S. or multinational upper/lower character set can be selected. Keyboard entry of hexadecimal characters is permitted. With the exception of power-on IMPL, start CPF, and other functions requiring the operator service panel, system operator tasks may be performed at any authorized 5251/5252 attached to the system.

5250 SYSTEM MULTIPLE UNITS AND CLUSTERING: Feature 2680 provides the capability to connect multiple 5251 Models 1 and 11, 5252's, and 5256's to a single cable. Feature 2550 allows the attachment of up to four workstations, including 5251 Models 1 or 11, 5252's, or 5256's; feature 2551 increases the number of directly attached workstations to eight.

For all other units, please refer to the Peripherals/ Terminals table on the third page of this report.

COMMUNICATIONS CONTROL

The System/38 is provided with a multi-line communications capability through a facility integrated into the 5381 System Unit. Four building blocks each with its own features can be configured to provide the desired functionality. These building blocks are the communications attachment, communications control, line base, and line interfaces. ▶

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▶ **MODEL 1501 COMMUNICATION ATTACHMENT:** This unit and its features provides basic system control and common circuits for up to four remote communications lines on a concurrent basis. Voice grade transmissions across private or common carrier lines are supported at 600, 1200, 2400, 4800, 7200, and 9600 bps. Through the use of the 1501 and its features, System/38's communications lines can support connection to one or more IBM System/370, or 303X host processors. The System/38 is viewed by the host as an RJE workstation emulating an IBM 3770 terminal, and is therefore supported under applications such as CICS/VS and IMS/VS.

The System/38 communicates with IMS/VS applications operating under OS/VS1 or OS/VS2 (MVS) and CICS/VS applications operating under DOS/VS, OS/VS1, or OS/VS2 (MVS) in System/370 Models 145 to 168 for IMS/VS and Models 135 to 168 for CICS/VS and 303X processors. Communications with any of these operating systems running under VM/370 is also supported. Access within the host is through VTAM, ACF/VTAM, TCAM, or ACF/TCAM.

With the System/38 using SDLC protocol in an SNA network, data communications into the host will be via a 370X front end, which will require NCP/VS or ACF/NCP/VS, as appropriate.

Only one 1501 is allowed per system.

MODEL 5500/5501/5502/5508 1200-BPS INTEGRATED MODEMS: These versions of the 1200 bps line interface with integrated modem rely on internal clocking contained in the 3200 Line Base. The 550X interfaces can alternatively be operated at 600 bps via parameter modification to the CPF software. For private lines, the non-switched interface (#5500) is available. For switched lines, interfaces with Auto Answer (#5501) and manual answer (#5502) are available. There is also a non-switched with switched network backup (with Auto Answer) interface (#5508). The devices communicating with the System/38 must also be equipped with a similar 1200 bps integrated modem interface.

The 5500 provides for a cable attachment directly to a non-switched (2- or 4-wire) facility, type 3002. Both the 5501 and 5508 provide for cable attachment to a common carrier arrangement, type CBS or equivalent. The 5502 provides for cable attachment to a common-carrier arrangement, type CDT or equivalent. The 550X cannot be installed with either Model 3701 or 5650/5651.

MODEL 5760 AUTO CALL ADAPTER: This unit enables the System/38 to initiate a data link with a remote station automatically. Under program control, this unit automatically dials into a switched network facility, available in conjunction with the EIA interface. Each line with an Auto Call unit takes two interface positions, and therefore reduces the total number of line connections possible. The 5760 cannot be installed on the same line position with any other line interface type, and is installable in line position 2, 3, or 4 only.

MODEL 5640/5641/5740/5741 INTEGRATED MODEMS: These units are microprocessor based and operate over public switched network facilities or nonswitched leased lines. Multipoint control, multipoint tributary or point to point operation can be configured in the nonswitched modem (5640 and 5740). The switched modems (5641 and 5741) connect directly through an integrated protective coupler (pending FCC approval). These units feature improved data throughput due primarily to lower error rates according to IBM. These units allow the system operator to select a half speed option if the line error rate increases due to a poorly received signal. Remote site modems are switched to the new data rate automatically without operator intervention. Model

5640 operates on 4 wire nonswitched lines with an 8.5 millisecond delay at 2400 bps, while Model 5740 operates on the same lines at 4800 bps with a 24 millisecond delay. For Models 5640 and 5740, line conditioning is not required on non-switched lines. Models 5641 and 5741 operate with integrated auto-answer capability for switched networks. Model 5641 operates at 2400 bps while Model 5741 operates at 4800 bps.

MODEL 2000 COMMUNICATIONS ATTACHMENT: This feature works with the 1501 Communications Attachment to provide for multiplexing of up to four line appearances. The Model 2000 provides the necessary basic control storage and circuits for SDLC control on the attached lines. One Model 2000 is allowed per System/38.

MODEL 3200 LINE BASE: This features works in conjunction with the 1501 Communications Attachment and provides internal clocking for the 5501 Integrated Modems and interface for one of four line interface types that can be configured.

A separate line base is required for each communications line attachment. Under the System's Control Program Facility (CPF), each line operates with half-duplex SDLC protocol. Transmission at 600, 1200, 2400, 4800, 7200, or 9600 bps over leased (non-switched) or telephone (switched) lines is supported. Each line can operate at a different speed.

MODEL 3701 EIA INTERFACE: Provides for attachment of any external modem with RS-232C characteristics. Only one Model 3701 is allowed per Model 3200. IBM external modems which may be attached via Model 3701 and their speeds are as follows: 3863, 2400 bps; 3864, 4800 bps; 3865, 9600 bps; 3872 Model 1, 2400/1200 bps; 3874 Model 1, 4800/2400 bps; and 3875 Model 1, 7200/3600 bps.

MODEL 5650/5651 DIGITAL DATA SERVICE ADAPTER (DDSA): An integrated data link adapter for data transmission over the AT&T nonswitched Dataphone Digital Service Network. The first version (#5650) supports point-to-point and multi-point lines. The other version (#5651) supports the System/38 operating on a multipoint line as a tributary to a host, which serves as the control processor. Speeds of 2400, 4800, and 9600 bps are supported with the DDS adapters. Remote workstations that are to be linked to the System/38 via DDS require the 5251 (Model 2 or 12) to have the DDS adapter for multipoint, tributary lines (#5651).

SOFTWARE

CONTROL PROGRAM FACILITY (CPF): The system support program product for the System/38, CPF provides many integrated functions that are designed to satisfy the installation requirements for a multiprogrammed, batch, and on-line interactive system. The major facilities and features of CPF are described in the following paragraphs.

The *object management facilities* of CPF allow objects to be grouped and located in the system. The general term "object" is used to refer to any named item (such as a program or a file) that is stored in the system. The general term is used because all kinds of objects are located in the same manner. The object management facilities allow users to name the objects they want without needing to specify the exact locations of the objects. Certain functions of CPF, which are valid for many different types of objects, can be performed through a single set of commands. For example, functions that provide security or backup copies of objects apply to all object types.

The *work management facilities* of CPF provide the framework through which the system and all the work ▶

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➤ performed on the system are controlled. These facilities provide the system functions needed to support a multiprogramming environment and to manage contention between jobs for main storage and other system resources. The work management facilities allow work to be submitted by the user, presented to the machine for execution, and controlled by the system operator.

Through the work management facilities, specialized operating environments, called subsystems, control the use of resources needed for different types of work. When CPF is installed, it includes subsystems that support interactive, batch, and spooling processing. Although the work management facilities can be used to tailor subsystems to provide specialized operating environments, the system is fully operational when it is installed. By starting, controlling, and terminating subsystems, the system operator can control entire operating environments through the control language.

The *data management facilities* of CPF support both data base files and device files. Data base data management provides the functions required for creating data base files and performing input/output operations to them. Device data management provides similar operations for devices attached to the system, including functions to support the display devices.

Generally, the data base files or display device files are described apart from the programs that use the files. That is, the attributes of each field (such as its length, data type, and position in a record) are specified in the file description rather than in the program. These data descriptions are created with the use of the data description specifications. A specification form (similar to an RPG specification form) provides a common format for describing the data. The form provides fixed columns for frequently specified and required information and keyword specifications for less frequently specified options.

Other device files are usually described in the traditional manner where the records and fields are described in the programs that use them. The spooling functions support the usual operations for reading files from input devices and writing files to output devices so that programs using the files are not tied directly to the external devices.

The *application program development facilities* of CPF enable a programmer to perform most application development activities interactively from a workstation. These activities include entering source programs into the data base; compiling programs concurrently with normal system operations; testing programs in a protected environment so that production files are not inadvertently changed by a program that is being tested; debugging a program on-line, using CPF-provided functions to locate program errors; alternating between two interactive jobs simultaneously, such as reviewing a display of a compilation listing and reviewing the values of program variables; and correcting the program source code and recompiling the program.

The *operator control facilities* of CPF enable a system operator to control the operations of jobs and subsystems, respond to system messages, and perform other operations normally performed by a system operator. These operations can be performed from any workstation and are not restricted to a single person.

The *security facilities* allow various levels of control over the access to objects by individual workstation users. As security requirements change, the control provided by the security facilities can be modified.

The *save/restore functions* of CPF allow applications and data files to be backed up concurrently with unrelated system operations. These functions can be used to maintain backup copies of system and application objects, and the copies can be used to recover from system or application malfunctions.

The *control language* is the primary interface to CPF and can be used concurrently by users at different workstations. A single control language statement is called a command. Commands can be entered individually from workstations entered as part of batch jobs, or used as statements to create control language programs. All of the commands use a consistent syntax. Each command is made up of a command name and parameters. A command name usually consists of a verb, or action, followed by a noun or phrase that identifies the receiver of the action. In addition, CPF provides prompting support for all commands, default values for most command parameters, and validity checking to ensure that a command is entered correctly before the function is performed. Thus, the control language provides a single, flexible interface to many different system functions that can be used by different system users.

RPG III: The only language currently available for the System/38 is RPG III. RPG III is upward-compatible from System/3 RPG II, but minor source code changes may be required. System/38 RPG III offers a number of enhancements over previous RPG products, including the following:

● Externally described data allows the user to eliminate or minimize the input and output specifications for externally described data files.

● Full procedural file specification allows the user to process the same file in both a random and sequential manner in the same program by the use of explicit input/output specifications.

● Explicit input/output operations provide enhancements to existing file processing operation codes as well as new file processing and control operation codes.

● Program structure allows the user to write a program without the requirement of a primary file.

● RPG III programs can call other programs.

● Data structures allow the redefinition of a storage area and the processing of either the entire data structure or any of the subfields.

● Multiple-occurrence data structures allow many advanced applications to be programmed in a straightforward manner.

● Indicators as data allow the user additional control of indicator status.

● DO loops allow for automatic loop counting.

● IF/ELSE operations allow the execution of a series of RPG III operations without the use of branching or indicator control.

● Program control of exception/error handling allows the RPG III user to control the exception/erros which can be raised by data management, and system and machine functions.

INTERACTIVE DATA BASE UTILITIES: A System/38 program product consisting of a source entry utility for creating and maintaining program-language source files, a data file utility for creating and maintaining data files and for displaying specific records from data files, and a query utility for extracting and presenting information from data files. These utilities are capable of supporting both ➤