

# IBM 3090 Series

## MANAGEMENT SUMMARY

The February announcement of the new IBM 3090 Series was truly an industry event, as any major announcement coming from IBM tends to be. Although first reviews of the 3090 Processor Complex were mixed, there could be little doubt the old blue magic that has made IBM the undisputed computer industry leader will probably carry over to this newest generation of processors. To maintain its commanding lead over its closest mainframe competitors, IBM is betting its new top-end 3090 Series will deliver enough power and new technology punch to keep its biggest *Fortune 500* customers satisfied for still another product cycle.

The first installments in the much-awaited processor series are the 3090 Models 200, a dyadic processor with 64 megabytes of shared central storage and the Model 400, a four-way processor with 128 megabytes of shared central storage. The Model 200 will be available for delivery in November 1985 and the Model 400 will be available by the second quarter of 1987. The new series is aimed at users whose computing requirements may be growing 50 percent or more a year. IBM customers whose requirements have already outgrown the capacity of a 3084, IBM's previous top-end model, are prime candidates for the new 3090 Complex.

Continuing a marketing strategy begun with the 303X Series back in 1977, IBM has made the new 3090 Series compatible with the functions and features of the previous top-end 308X Series. Users migrating from the 308X Series can use most of the same peripherals and software.

Shortly after the February 1985 announcement of the new 3090 Series, much of the early criticism focused on processor performance and delivery dates. Based on estimates compiled by CW Communications, the Model 200 is rated at about 29.3 MIPS (millions of instructions per second) or ➤

The 3090 Processor Complex Models 200 and 400 are designed to meet the processing needs of users with very large-scale computing requirements. The 3090 Series is positioned to provide an extended growth path for IBM 308X users and includes such innovations as "expanded storage," a feature designed to reduce system overhead.

**MODELS:** 3090 Model 200 and Model 400.  
**CONFIGURATION:** The Model 200 is a dyadic processor with 64 megabytes of shared central storage. The Model 400 is a four-way processor with 128 megabytes of shared central storage.

**COMPETITION:** Burroughs A 15 Series, Honeywell DPS 90 Series, Sperry 1100/90, Control Data Corporation Cyber 180 Model 860, and NAS Alliance Series.

**PRICE:** Base purchase prices range from \$4,600,000 for the Model 200 to \$8,744,000 for the Model 400.

## CHARACTERISTICS

**MANUFACTURER:** International Business Machines Corporation, Old Orchard Road, Armonk, New York 10504. Contact your local IBM representative. In Canada, 1150 Eglinton Avenue, Don Mills, Ontario. Telephone (416) 443-2111.

**MODELS:** IBM 3090 Model 200, dual-processor model; and Model 400, four-processor model.

**DATE ANNOUNCED:** See Table 1.

**DATE FIRST DELIVERED:** See Table 1.



*The IBM 3090 Model 200 dual-processor, shown here, and the 3090 Model 400 four-way processor are IBM's newest top-of-the-line, large-scale computer systems. They feature Emitter Coupled Logic and Thermal Conduction Modules, and achieve a cycle time of 18.5 nanoseconds.*

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▷ roughly equal to the MIPS rating for the 3084, IBM's previous top-end model. Users needing processor performance greater than the currently available 3084 or the soon-to-be-available Model 200 will have to wait two years for the delivery of the Model 400, rated at 52.7 MIPS.

To gauge relative performances between the 308X and the two 3090 models, IBM released its own numbers. According to IBM, the Model 200 has 1.7 to 1.9 times the internal throughput rate of the 3081 Model KX operating in a commercial environment under MVS/XA, and 1.9 to 2.9 times the internal throughput rate of the 3081 Model KX operating under the same operating system in an engineering/scientific environment.

The more powerful Model 400 comes with 1.7 to 1.9 times the instruction execution rate of the 3090 Model 200 in single image mode. When partitioned, the Model 400 approximates the performance of two Model 200s.

In addition, IBM improved the cycle time achieved in the new 3090 Series. The 3090 models have a rated cycle time of 18.5 nanoseconds compared with the 24 nanosecond cycle time of the 308X Series.

To improve system throughput, IBM has switched to Emitter Coupled Logic, a faster technology than the transistor-to-transistor logic used in the 308X, and also makes use of a new cache memory concept called expanded storage. The Model 200 can be outfitted with up to 128 megabytes of the so-called expanded storage in two 64-megabyte increments. The Model 400 can be outfitted with up to 256 megabytes of expanded storage in 128-megabyte increments. This expanded storage facility improves system performance by reducing the paging and swapping load to channel-attached paging devices in storage constrained and heavy paging environments. The facility transfers 4K-byte pages to and from central storage synchronously with processor operations. Expanded storage involves operating system instructions rather than application software. Additionally, the operation is under full control of the operating system rather than users. By helping to curtail channel traffic between central storage and attached I/O devices, expanded storage helps reduce system overhead and enhances throughput. The introduction of the expanded storage option has not squelched speculation that IBM may at some point increase I/O channel transfer speed from the current three megabytes per second to six megabytes per second. To date, IBM has not commented on the channel-speed issue.

In conjunction with the 3090 announcements, IBM also introduced related operating system software enhancements, including Virtual Machine support in an Extended Architecture environment. Virtual Machine/Extended Architecture System Facility is seen as a new commitment to VM in the 31-bit environment. Other software-related announcements centered around IBM's renewed interest in scientific and engineering applications. New releases supporting such applications include Interactive Executive, IBM's implementation of Unix System V, Engineering/Scientific Support System Release 1.1, which provides addi-

### ▶ DATA FORMATS

**BASIC UNIT:** 8-bit byte. Each byte can represent one alphanumeric character, two BCD digits, or eight binary bits. Data can be represented as 32-bit words, 64-bit doublewords, and 128-bit extended words for floating-point arithmetic.

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

**FLOATING-POINT OPERANDS:** One word, consisting of 24-bit fraction and 7-bit hexadecimal exponent in "short" format; two words, consisting of 56-bit fraction and 7-bit hexadecimal exponent in "long" format; or four words in "extended precision" format.

**INSTRUCTIONS:** 2, 4, or 6 bytes in length, specifying zero, one, or two memory addresses, respectively.

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

### MAIN STORAGE

**STORAGE TYPE:** 288-bit memory chips.

**CAPACITY:** 64 to 128 megabytes. See Table 1 for capacities of individual models.

**CYCLE TIME:** See Table 1.

**INSTRUCTION REPERTOIRE:** The 3090 Series uses the System/370 Universal Instruction Set for binary, decimal, and floating-point arithmetic operations. The instruction set has 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.

**CHECKING:** The processor controller plays a major role in error detection and recovery. Data paths between the central processor and central storage are parity-checked by byte. Parity bits are included in each command or data word. When the data are 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. For processors using the expanded storage option, single-bit and double-bit errors are detected and corrected for all data read from expanded storage. Triple-bit errors and some multiple-bit errors are also detected, but not corrected. Unrecoverable errors are flagged.

**STORAGE PROTECTION:** Key-controlled storage protection provides both store and fetch protection, preventing unauthorized access or modification of information in central storage. Store protection prevents the contents of main storage from being altered by storage addressing errors in programs or input from I/O devices. Fetch protection prevents the unauthorized fetching of data and instructions from main storage. Up to 15 programs and their associated main storage areas can be protected at one time. A 7-bit storage key, acting as a security lock, protects each 4K-byte block of storage. Key-controlled protection is standard on all System/370 models.

**RESERVED STORAGE:** Similar to the System/370, main memory is reserved for interrupt routines, program status words, CPU timer logout area, machine-check interrupt code, and register save area.

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TABLE 1. SYSTEM COMPARISON

MODEL	Model 200	Model 400
<b>SYSTEM CHARACTERISTICS</b>		
Date announced	February 12, 1985	February 12, 1985
Date first delivered	November 1985	Second Quarter 1987
Field upgradable to	Model 400	—
Relative performance	1.7 to 1.9*	1.7 to 1.9*
Number of processors	2	4
Cycle time, nanoseconds	18.5	18.5
Word size, bits	32	32
Operating systems	MVS/XA, MVS/SP, VM/XA	MVS/XA, MVS/SP, VM/XA
<b>MAIN MEMORY</b>		
Type	288K-bit chip	288K-bit chip
Minimum capacity, bytes	64MB	128MB
Maximum capacity, bytes	64MB	128MB
Increment size	—**	—**
Cycle time, nanoseconds	—	—
<b>BUFFER STORAGE</b>		
Minimum capacity	128KB	256KB
Maximum capacity	128KB	256KB
Increment size	—	—
<b>INPUT/OUTPUT CONTROL</b>		
Number of channels:		
Byte multiplexer	0-4	0-8
Block multiplexer	32, 40, 48	64, 80, 96
Word	—	—
Other	—	—

\*Model 200 figures are relative to internal throughput of 3081 Model KX. Model 400 figures are relative to the Model 200. \*\*Although conventional main memories are nonexpandable, both models can be outfitted with optional expanded storage. The Model 200 can be configured with up to 128 megabytes of expanded storage and the Model 400 can be configured with up to 256 megabytes. See text for more details.

ditional device and functional support, and the VS Fortran Program Multitasking Facility, which provides a performance boost for customers using the new 3090 processors. Another software product enhancing scientific capabilities, according to IBM, is the System/370-XA Sort Assist, which provides sort improvements for the DFSORT 7 product. IBM claims the product is helpful in applications involving heavy data manipulations.

To ease the disk memory squeeze overtaking many of its customers, IBM brought out new Extended Capability 3380 DASD models a week before it announced the 3090 Processor Complex. These are the Models AD4, BD4, AE4, and BE4. The AD4 and BD4 each have capacities of 2.52 gigabytes per unit. The Models AE4 and BE4 have capacities of 5.04 gigabytes per unit.

### COMPETITIVE POSITION

Shortly after IBM announced the 3090 Processor Complex in February, most of its mainframe rivals wasted little time trotting out their own 3090-class processors. Honeywell Information Systems, Burroughs Corporation, and National Advanced Systems (NAS) all brought out mainframe lines employing similar state-of-the-art technologies. Also, a month before the February IBM 3090 announcement, Control Data Corporation quietly introduced three new members of the Cyber 180 Series family using similar advanced technology. Amdahl Corporation, an IBM plug-compatible vendor, and Sperry Corporation have yet to announce systems comparable to the 3090 class.

The Honeywell DPS 90, announced in March, features one-, two-, three- and four-processor complexes plus a fully

### CENTRAL PROCESSORS AND MEMORY

The 3090 Series consists of the Model 200, a dyadic processor, and the Model 400, a four-way processor. The Model 400 can be partitioned to approximate the performance of a Model 200 on each side of the partition. In addition to the central processor complex, which includes shared central storage, and buffer memory and 32 to 64 integrated channels, Models 200 and 400 processors require at least one of the following components;

- 3092 Processor Controller Model 1 or 2;
- 3097 Power and Coolant Distribution Unit Model 1;
- 3370 Direct Access Storage Model A2, each with a string-switch feature;
- Access to a channel-attached IBM 3803 Tape Control Unit Model 2 or equivalent and its associated IBM 3420 Magnetic Tape Unit Model 4, 6, or 8;
- 3864 Modems Model 2 with an automatic calling unit feature or equivalent;
- 3089 Power Units Model 3 or other 400 Hz power source; and
- operator display station for system control program communications.

For a detailed rundown of how many of each component must be configured with either the Models 200 and 400, please refer to the Configuration Rules section of this report.

Processor hardware technology is built around the use of Emitter Coupled Logic (ECL) and Thermal Conduction Modules (TCM). EML is faster than the transistor-to-transistor logic IBM uses in the 308X Series. To dissipate the heat, IBM makes extensive use of its TCM technology. TCMs are helium-filled, encapsulated modules covered by

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TABLE 2. MASS STORAGE

MODEL	3350 Disk	3375 Disk	3380 Disk
Cabinets per subsystem	1 to 32	1 to 32	1 to 16
Disk packs/HDA's per cabinet	2 HDAs	1 HDA	2 HDAs
Capacity	317.5MB per HDA	819.7MB	1260MB or 2520MB per HDA
Tracks/segments per drive unit	33,300	—	—
Average seek time, msec.	25	19	15 to 17
Average access time, msec.	33.4	29.1	23.3 to 25.3
Average rotational delay, msec.	8.4	10.1	8.3
Data transfer rate	1,198,000 bytes/sec.	1,859,000 bytes/sec.	3,000,000 bytes/sec.
Controller model	3830-2 or 3880-1, -2, -11, or 21	3880-1 or -2	3880-2, -3, -13, or -23
Comments	Fixed-head models available; Model A2 includes logic and power for up to 3 B2s or 2 B2s and 1 C2 unit	Model A1 includes logic and power for up to 3 B1s or 2 B1s and 1 D1 unit	Model A4 includes logic and power for up to 3 B4 units

➤ redundant tandem processor. Main memory ranges from 32 to 256 megabytes. The new series also uses current mode logic, (similar to emitter coupled logic) and 256K-bit memory chips. The new Burroughs top-end processor line is the A 15, which features eight models in various configurations using from one to four processors. The A 15 uses emitter coupled logic (ECL), very large scale integration air cooled gate array technology, and 256K-bit RAM memory chips. Main memory ranges from 24 to 192 megabytes. The NAS AS/XL processor line uses ECL logic, very large scale integration circuitry, and 256K-bit MOS chips. Main memory ranges from 32 to 256 megabytes. CDC Cyber Models 840, 850, and 860 use ECL circuits and large-scale integration arrays, and 256K-bit memory chips. Main memory can range from 16 to 128 megabytes. In addition, all the processors feature high-speed buffer (cache) memories of varying capacities to help enhance throughput.

The IBM 3090 Series contains features similar to all these competing systems. Like the other vendors, IBM now employs ECL circuitry, said to be faster than the transistor-to-transistor logic used on the 308X Series. IBM has also begun using higher density 288K-bit memory chips. IBM uses an oddball 288K-bit chip rather than the standard 256K-bit value because IBM was able to make use of extra room on the chip. Main memory ranges from the non-expandable 64 megabytes on the Model 200 to 128 megabytes on the Model 400.

In addition to a 64K-byte buffer memory on each central processor, IBM introduced the "expanded storage" option, which can range from a maximum capacity of 128 megabytes on the Model 200, to a maximum of 256 megabytes on the Model 400. The expanded storage feature is said to enhance throughput through a reduction of the swapping and paging load to channel-attached paging devices.

Not to be outdone, NAS, an IBM plug-compatible vendor, has come up with its own arsenal of special cache memories to enhance throughput. A new feature available for the NAS AS/XL Series is a one-megabyte dynamic working storage subsystem that serves as a caching system between the main memory and the cache buffer, thereby reducing access time for the machine's I/O and instruction proces-

➤ cold plates through which chilled water circulates to absorb heat. A TCM contains up to 100 silicon chips mounted on a multilayered ceramic substrate. Each central processor uses nine TCMs with the associated circuit board. Overall design makes external wiring or cabling unnecessary.

**MEMORY AND STORAGE OPERATIONS:** To improve system performance and throughput, the processors feature three memory hierarchies. They are shared central storage (main memory), a high-speed buffer memory, and optional expanded storage. The Model 200 comes with 64 megabytes of shared central storage and the Model 400 comes with 128 megabytes of shared central storage. In addition to main memory, each processor contains a 64K-byte buffer memory, which handles instruction, operand, and data fetches.

A third level of memory that's optionally available for the Models 200 and 400 is expanded storage. The expanded storage memory helps reduce paging and swapping loads to channel-attached paging devices in storage constrained and heavy paging environments. Controlled by the system control program, expanded storage transfers 4K-byte pages to and from central storage. The Model 200 can be outfitted with up to 128 megabytes of expanded storage in 64 megabyte increments, and the Model 400 can be outfitted with up to 256 megabytes of shared expanded storage in 128 megabyte increments.

**CENTRAL PROCESSORS:** Each central processor is microcode controlled and contains an instruction element (IE), execution element (EE), control storage element (CSE), and buffer control element (BCE).

The IE controls the sequencing of all instructions and can handle multiple instructions at the same time. The IE decodes instructions; calculates addresses; sends fetch requests to the BCE in central storage; determines fetch priority, and controls storage requests. In addition, it provides the EE with operation codes, operands, and operand addresses.

The Execution Element (EE) executes instructions set up by the IE and operates in parallel with the IE. The EE processes instructions and interruptions; overlaps operations with the IE; initiates control functions, and performs various logic and arithmetic functions. Arithmetic results can include fixed point, fixed-point multiply, convert to binary, convert to decimal, floating point, and extended-precision floating point.

The Control Storage Element (CSE) contains the microcode needed for controlling the EE. The CSE controls microcode execution in the central processor and contains the support-

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➤ sors. Another level of cache is a high-speed cache storage subsystem, using 4K-byte ECL RAM devices, with switching speed at 4.5 nanoseconds. These components implement the 256K-byte cache buffer in each instruction processor on the system, and provide fast storage for microcode control programs.

Another key comparison point is disk capacity. Burroughs features the B 9494-12 with a storage capacity of 1.32 gigabytes. The Honeywell MSU 3380 disk drive, a unit Honeywell purchases on an OEM basis from IBM, has a disk-drive capacity of 1.85 gigabytes. The NAS 7380-AE and BE have disk-drive capacities of 5.04 gigabytes. Shortly before the 3090 announcement, IBM brought out enhanced 3380 Models AE4 and BE4 disk drives which also feature 5.04-gigabyte capacity. For computer sites where floor space and storage capacity are at a premium, IBM and NAS disk products offer a clear capacity advantage, giving the two vendors an edge over rivals in this critical area.

For a comparison of MIPS rating as compiled by CW Communications, let's examine the NAS AS/XL and the Burroughs A 15 to see how they stack up against the IBM 3090. Products that compete against the dyadic Model 200 are the NAS AS/XL Model 60, and the Burroughs A 15 Model I. The NAS AS/XL Model 60, a uniprocessor featuring between 32 and 256 megabytes of main memory, was rated at 28 MIPS. A basic Model 60 sells for \$4,840,000. The Burroughs Model I, featuring between 24 and 96 megabytes of main memory, was rated at 32.4. A basic Model I sells for \$4,530,000. The IBM Model 200, rated at 29.3 MIPS, sells for \$4,600,000.

Products that compete against the IBM Model 400 are the NAS Model 80 and the Burroughs A 15 Model N. The NAS dual-processor Model 80, which features 64 to 256 megabytes of main memory, was rated at 50 MIPS. A basic Model 80 sells for \$8,970,000. The Burroughs four-processor Model N, featuring 24 to 192 megabytes of main memory, was rated at 59.5 MIPS. A basic system sells for \$8,435,000. The IBM Model 400 rated at 52.7 MIPS, sells for \$8,744,000. In both comparisons with the IBM Models 200 and 400, Burroughs leads IBM and NAS with more MIPS for the money.

These rough MIPS comparisons suggest a telling point. MIPS ratings for NAS dual-processor Model 80 and the Burroughs four-processor Model N examined here easily exceed the 29.1 MIPS offered on the four-processor 3084 Model QX, IBM's previous top-end model. This brings up an interesting quandary for IBM and IBM 3084 users who have outgrown the system and need the power of the Model 400. IBM has announced the Model 400 will not be available until the second quarter of 1987, while Honeywell, Burroughs, and NAS have announced they will deliver their systems much sooner. Honeywell announced it will begin volume shipments in early 1986. Burroughs will begin shipping its one and two processor models this year. Shipments of the larger three and four processor models will begin within the first half of 1986. Whether IBM sticks to its planned delivery date of the Model 400 in the face of this competition remains to be seen.

➤ ing control storage areas and registers that are used by the central processors.

The Buffer Control Element (BCE) handles the movement of data to and from memory, performs dynamic address translation, and controls the high-speed buffer. The BCE contains the 64K-byte high-speed buffer, a buffer directory, a translation lookaside buffer (TLB), and Dynamic Address Translation (DAT) hardware.

The high-speed buffer, as noted above, provides faster access to instructions. While data is being referenced during instruction execution, the high-speed buffer, the buffer directory, and the TLB are accessed at the same time for address comparison.

The buffer directory contains the absolute central storage addresses for data residing in the high-speed buffer. The TLB stores the real address of the referenced paged for a translated virtual address in central storage, making subsequent translations for the same virtual address unnecessary because the real address is immediately available in the TLB. The DAT translates virtual addresses to real addresses and loads them in the TLB.

**OPERATIONAL MODE:** The 3090 Series supports both System/370 and 370-XA operational modes. In System/370 mode, the 3090 supports S/370 extended facility, 3033 extension, and extended addressing. Additionally, up to 16 channels can be assigned to a channel set operating under MVS/SP 1. 3.5, and up to 32 channels per channel set when operating under VM/High Performance Option, Release 3.6. In 370-XA mode, the 3090 supports 31-bit addressing, bimodal addressing, larger and more flexible I/O configurations, channel path selection under hardware control, and support for Start Interpretive Execution instruction by allowing support of guest S/370 or 370-XA virtual machines. What follows are larger explanations of some of the features available under either mode.

**ADDITIONAL FEATURES:** Other standard features on the 3090 Processor Complex include:

- Channel indirect addressing, which permits contiguous areas of virtual storage to be mapped into noncontiguous areas of real storage.
- Channel set switching, which (in S/370 mode only) dynamically switches channel sets between processors under program control should one of the central processors fail. Up to 32 channels for each channel set are supported, depending on the system control program used.
- Datastreaming, which permits data-transfer rates up to three megabytes/second on block multiplexer channels, and cable lengths up to 400 feet.
- Extended addressing, which (in S/370 mode only) permits the addressing of real storage of up to 64 megabytes of central storage on the 3090 Model 200 operating under the MVS/SP or VM/SP with the VM/SP High Performance Option.
- A 31-bit addressing capability, which (in 370-XA mode only) provides for a virtual storage addressing range of up to two gigabytes. In 370-XA mode, bimodal addressing capabilities permit both 24-bit and 31-bit programs to execute concurrently.
- System/370 extended facility, which (standard in S/370 mode only) speeds up certain supervisor functions, improves the efficiency of dynamic address translation, improves CPU performance, and improves system integrity by providing special protection for low-address main storage vital to the system control program, all while operating under MVS/SP.

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TABLE 3. INPUT/OUTPUT UNITS

Magnetic Tape Units	Number of Tracks	Recording Density, Bits/Inch	Encoding	Tape Speed Inches/Sec.	Transfer Rate, Bytes/Sec.
3420: Model 3	7	556/800	NRZI	75	41,700/60,000
	9	800	NRZI	75	60,000
	9	1600	PE	75	120,000
Model 5	7	556/800	NRZI	125	69,500/100,000
	9	800	NRZI	125	100,000
	9	1600	PE	125	200,000
Model 7	7	556/800	NRZI	200	111,200/160,000
	9	800	NRZI	200	160,000
	9	1600	PE	200	320,000
Model 4	9	1600	PE	75	120,000
	9	6250	GCR	75	470,000
	9	1600	PE	125	200,000
Model 6	9	6250	GCR	125	780,000
	9	1600	PE	200	320,000
Model 8	9	6250	GCR	200	1,250,000
	9	1600	PE	200	320,000
3410/3411: Model 1	7	200/556/ 800	NRZI	12.5	2500/6900/ 10,000
	9	800	NRZI	12.5	10,000
	9	1600	PE	12.5	20,000
Model 2	7	200/556/ 800	NRZI	25	500/13,900/ 20,000
	9	800	NRZI	25	20,000
	9	1600	PE	25	40,000
Model 3	7	200/556/ 800	NRZI	50	10,000/ 27,800/ 40,000
	9	800	NRZI	50	40,000
	9	1600	PE	50	80,000
3430	9	1600	PE	50	80,000
	9	6250	GCR	50	312,500
3480	18	38,000	—	79	3,000,000
Printers	Printing Speed	Print Positions	Horizontal Spacing, Chars./Inch	Vertical Spacing, Lines/Inch	Form Size, Inches
3203 Model 5	1200 lpm	132	10	6 or 8	3.5 to 20.0 wide, 3.0 to 24.0 long
3800: Model 1	Up to 20,040 lpm	136, 163, 204	10, 12, 15	6, 8, 12	6.5 to 14.75 wide, 3.5 to 11.0 long
	Model 3*	Up to 20,040 lpm	136, 163, 204	10, 12, 15	6, 8, 12
3820 Model 1	20 pgs/min.	—	10, 12, other	—	7.0 to 8.5 wide, 10.5 to 14 long
4245 Model 12	1200 lpm	132	10	6 or 8	3.5 to 22.0 wide, 3.0 to 24.0 long
4245 Model 20	2000 lpm	132	10	6 or 8	3.5 to 22.0 wide, 3.0 to 24.0 long
4248 Model 1	2200, 3000, or 3600 lpm	132 std.; 168 opt.	10	6 or 8	Not specified

\*Model 3 can operate in all-points-addressable mode.

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TABLE 4. TERMINALS

MODEL	3178	3179	3180	3278	3279
<b>DISPLAY PARAMETERS</b>					
Max. chars./screen	1920	1920	1920 to 3564	960 to 3564	1920 to 2560
Screen size (lines x chars.)	24 x 80	24 x 80	24/32/43 x 132	12 to 43 x 80, 27 x 132	12/24/32/43 x 80
Symbol formation	7 x 14 dot matrix	7 x 11	7 x 11	7 x 11	7 x 11
Character phosphor	Green	White	White	White	White
Total colors/no. simult. displayed	—	Up to 7	—	—	Up to 7
<b>KEYBOARD PARAMETERS</b>					
Style	Data Entry, typewriter	Modifiable	Data entry, typewriter	Several	Several
Character/code set	ASCII, EBCDIC	ASCII, EBCDIC	ASCII, EBCDIC	ASCII, EBCDIC	ASCII, EBCDIC
Detachable	Standard	Standard	Standard	Standard	Standard
Program function keys	10/12 Standard	24 Standard	24 Standard	Standard	Optional
<b>OTHER FEATURES</b>					
Buffer capacity	—	—	—	—	6 prog. sym. sets
Tilt/swivel	Standard	Standard	Standard	No	No
Graphics capability	No	No	No	No	Yes
<b>TERMINAL INTERFACE</b>	RS-232-C	RS-232-C	RS-232-C	RS-232-C	RS-232-C

➤ **ADVANTAGES AND RESTRICTIONS**

When first announced, the new 3090 Processor Complex was greeted in many corners with a rousing ho hum. For all the ballyhoo and anticipation the long-awaited processor series generated, many IBM watchers felt a sense of let-down when it appeared the real leap in power and technology would not be available for another two years when the Model 400 is delivered. CW Communications pegged the Model 400 at 51 MIPS (millions of instructions per second) while the Model 200, rated at 29.3 MIPS, appears comparable in power to the IBM 3084. The Model 200 is scheduled to be delivered in November. However, some pluses are immediately available for users contemplating a move to the 3090 before the delivery of the Model 400.

With the announcement of the 3090 Series, IBM unveiled several enhancements for increasing throughput. First, IBM switched from the transistor-to-transistor logic used in the 308X Series to the faster Emitter Coupled Logic. Second, the industry leader souped up the CPU cycle time from 24 nanoseconds in the 308X Series to 18.5 in the new 3090 Series. Thirdly, IBM introduced the concept of expanded storage, an optional feature that helps ease the paging and swapping load of the processor and reduces system overhead. The Model 200 comes with 64 megabytes of nonexpandable shared central storage and can be outfitted with up to 128 megabytes of expanded storage in 64 megabyte increments. The Model 400 comes with 128 megabytes of shared central storage and up to 256 megabytes of shared expanded storage in 128-megabyte increments.

For the moment, expanded storage option, attachable to the CPU, is IBM's answer to the I/O channel-speed bottleneck. Expanded storage takes advantage of the fact that the CPU complex can process data at a much faster rate than peripheral devices can send it. Maximum I/O channel speed in datastreaming mode remains at three megabytes per second. Despite IBM claims that expanded storage will prove to be an effective solution, industry analysts believe the expanded storage concept will not be the total answer. ➤

- • **Byte-oriented operand feature**, which allows fixed-point, floating point, and logical storage operands of most unprivileged instructions to appear on any byte boundary without causing a specification exception and a program interruption. This feature does not apply to instruction addresses, privileged instructions, or channel-command words.
- **Virtual machine assist (VMA)**, which (standard in S/370 mode only) improves central processor performance when operating under VM/SP High Performance Option by reducing the amount of time in the real supervisor state.
- **Preferred Machine Assist**, which (standard in S/370 mode only) is designed to improve the performance of an MVS guest machine running under VM/SP. The feature allows any MVS/SP release that supports more than 16 megabytes of real storage to use real storage greater than 16 megabytes when operating as a virtual-equals-real virtual machine.
- **Start Interpretive Execution (SIE) Assist**, which (standard 370-XA mode only) provides improved performance of V=R preferred guests.
- **3033 Extension**, which provides dual address-space facility to aid communication between virtual address spaces, provides for faster I/O queuing, and provides for a suspend-and-resume facility. This last feature gives the program a controlling function over the execution of a channel program.

**3092 PROCESSOR CONTROLLER:** The 3092 Processor Controller Models 1 and 2 is a major system component which performs many key monitoring and control functions for the Models 200 and 400. When Model 200 users upgrade to a Model 400, they must also upgrade from a 3092 Controller Model 1 to a Model 2. Processor activities include:

- power sequence control and initialization;
- power on and off;
- monitoring and control of power supplies, temperatures and coolant flows;
- support for S/370 or 370-XA modes of operation;
- control of the configuration of hardware elements; and ➤

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➤ At some point, they still expect IBM to increase the I/O channel speed to six megabytes per channel, a development that's been expected for some time. In this regard, IBM is not saying what its plans are.

To take full advantage of the expanded storage concept, users who haven't done so already, will have to migrate to the System/370 Extended Architecture operating system. New operating software releases that support the extended architecture are MVS/SP-JES3 Version 2 Release 1.3 and 1.5. Extended architecture offers such enhancements as storage constraint relief through 31-bit addressing, the dynamic channel subsystem, and a number of reliability, availability and serviceability features.

Another area of advantage centers around upward growth compatibility. Users outgrowing a 308X Series processor can migrate to the 3090. Field upgradability is not possible between the two systems, but the 3090 will support the same software and peripherals supported on the 308X Series. For the time being or until IBM announces otherwise, users who want to install a Model 400 cannot migrate to it directly. The Model 400 is only available through a field upgrade of a Model 200.

When making price comparisons between the new 3090 Series and competing systems, users should be aware of what the 3090 Series includes. Most of the necessary components are priced separately. The Model 200 includes the central processors, 64 megabytes of main memory, a 64K-byte buffer, and 32 integrated channels. Priced separately are the optional expanded storage, the 3092 Processor Controller Model 1, the 3097 Power and Coolant Distribution Unit, two 3089 Model 3 Power Units, two 3370 Model A2 DASDs, two 3180 Model 145 Display Stations, and the 3864 Model 2 Modem.

### USER REACTION

A user reaction report will not be available until the first Model 200s are delivered later this year. The Model 400, of course, is not scheduled for availability until the second quarter of 1987. □

- • control unit function for required and optional consoles and an optional printer.

#### Other functions include:

- local and remote alarm capabilities;
- error recovery;
- execution of error analysis routines for isolation of failing field replaceable units;
- diagnostic capabilities; and
- full processor complex remote service capability.

In addition, the controller collects information for three areas: system activity display frames, I/O problem determination frames, and status information for customer problem analysis frames.

Each controller model includes two processor elements (A-side and B-side) and requires the following for full-processor support: two 3370 DASD Model A2 units (each with a string-switch feature); access to a channel-attached 3803 Tape Control Unit Model 2 (or equivalent) and its associated 3420 Magnetic Tape Unit Models 4, 6, or 8 (or equivalent), and one 3864 Modem Model 2 (or equivalent) with an automatic calling unit feature.

While one processor element remains active, the other processor acts as a backup processor. It also continues to monitor the active processor and stands at the ready should the active processor fail. In most cases, if the active processor fails, a switchover to the backup processor occurs.

The 3092 Controller contains a system power panel that includes power on and off switches, emergency power off, and power status and service mode indicators.

When the 3090 Processor Complex is initialized, the 3092 validates areas of central storage as error-free data locations, records failing storage locations, and assigns the hardware system area in central storage based on continuous error-free locations. When power sequencing is complete, the processor controller performs an initial microprogram load.

Another major 3092 feature is error-recovery. The controller logs errors as they occur and then analyzes and correlates multiple symptoms, and isolates the failure to the failing field-replaceable units. When system attempts to correct errors fail or when errors occur frequently, an audible alarm is sounded to bring the problem to the attention of the operator. Other activities and features include enhancements to automate the reporting of problems and remote support access to assist with problem resolution.

**3097 POWER AND COOLANT DISTRIBUTION UNIT:** This unit contains the power distribution functions, heat exchanger, pumps, and controls necessary to cool the liquid-cooled portion of the processor complex. Other features include an I/O Power Sequence Control capability for power on and off control of up to 128 I/O control units.

**3089 POWER UNIT MODEL 3:** This unit supplies 400 Hz power to the 3090 Processor Complex. The unit contains a motor-generator housed in a noise-suppressing frame and was designed for machine-room environments.

**The 3180 DISPLAY STATION MODEL 145:** This display station is used as either a system or maintenance console. The 3090 Model 200 requires a system console for interaction with the processor complex and the two 3092 processor elements and a service support console. The Model 400 requires two system consoles and a system support console. The service support console must be placed within 33 feet of the 3092 controller, while the system display can be placed 4,921 feet from the 3092.

**3864 MODEM MODEL 2:** This is required to obtain service for the 3090 Processor Complex. A unit comes equipped with an Automatic Calling Unit (#5801) and a dedicated telephone line for the remote service facilities.

**ERROR HANDLING:** Error detection and correction can be performed at several levels. Should automatic recovery procedures fail, a user has access to problem analysis frames and procedures to facilitate recovery and also has access to the remote service facility (RSF).

The 3092 Processor Controller usually plays a key role in error recovery. The controller provides both automatic recovery from many hardware malfunctions such as errors in main storage and reports machine or channel-check interruptions. When an error is detected, the 3092 automatically ➤



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► performs error analysis to pinpoint the error and isolate the field-replaceable unit or units that could be causing the problem. When detected, the controller logs in the problems and offers diagnosis.

When errors cannot be corrected automatically, users can begin problem analysis procedures from the system console index frame. If the problem was caused by a power malfunction, the first of a set of power status problem analysis frames is displayed. When the problem lies elsewhere, the first of a second set of problem analysis frames is displayed. Problem analysis categories include non-I/O hardware errors; unsuccessful IPL; enabled or disabled wait state; interface control checks; I/O device errors, and operator console lockout.

When it's determined that assistance from the remote service facility (RSF) is required, the operator can initiate remote service from the problem analysis procedures or by invoking the RSF authorization frame and establishing the remote connection. When the service request is authorized, a telephone number is automatically dialed over the public switched network to establish a connection with a remote modem. The remote modem acknowledges the connection and activates the RSF. The RSF can assume control over the 3090 system and manipulate the processor unit through remote control.

**INTERRUPTS:** Two types of interrupts can be generated: normal and error. Normal interrupts include channel end, device end, attention status, and busy status. Error interrupts include those caused by data parity error, address parity error, invalid buffer address, keyboard, parity error, keyboard invalid address, command byte parity, and invalid command.

**RAS FEATURES:** Reliability, availability, and serviceability features are implemented throughout the 3090 Processor Complex. RAS capabilities include:

- TCM/ECL technology that provides a low intrinsic failure rate;
- A dual processor controller that can switch over to and initialize the functional side should the other side fail;
- Multiple security provisions for data integrity and system security;
- Alternate input for like functions using service language commands, display frames, and function keys; and
- Multiple consoles for monitoring functional console activity and for backup.

Availability features include:

- Automatic error detection and correction in both central storage and expanded storage;
- Storage deallocation;
- Ability to take a failing channel off-line;
- Automatic fault isolation concurrent with operation; and
- Operator problem analysis procedures to correct problems without the need for a service call.

Serviceability features include:

- On-site problem solving through use of field-replaceable unit isolation, trace tables, and logout error recording; and
- Automatic remote service capability.

## CONFIGURATION RULES

The 3090 Model 200 Processor Complex consists of two central processors, a 3092 Processor Controller Model 1, and a 3097 Power and Coolant Distribution Unit. It also requires two 3089 Power Unit Model 3s or other appropriate 400 Hz source of power, two IBM 3370 Direct Access Storage Device Model A2s with string switch (#8150), two IBM 3180 Model 145 display stations, and an IBM 3864 Modem Model 2 equipped with Automatic Calling Unit (#5801).

The Model 400 Processor Complex consists of four central processors, a 3092 Processor Controller Model 2, and two 3097 Power and Coolant Distribution Units. It also requires four power units (3089 Model 3), or other appropriate 400 Hz source of power, two 3370 Model A2s with String Switch (#8150), three 3180 Model 145 display stations, and two 3864 Model 2s, each equipped with Automatic Calling Unit. (#5801).

## I/O CHANNEL SUBSYSTEM

The channel subsystem (CSS) handles all I/O operations for the central processors. The CSS controls communication between a configured channel, control unit, and device. The I/O configuration data set (IOCDS), selected at system initialization, identifies channel, control unit, and device configurations to the channel subsystem. The I/O Configuration Program creates the IOCDS, which is stored on 3370 DASDs attached to the processor controller. During initialization, the IOCDS information is used to build necessary control blocks in the hardware system area of central storage. In addition, the CSS contains a channel control element (CCE), which interacts with central storage, the central processors, and the channels. In operation, the CCE initiates and ends channel operations, provides central storage access control, and assigns priorities for I/O operations.

The 3090 Model 200 has a channel subsystem consisting of 32 standard integrated channels and up to 16 optional channels that can be added in eight-channel increments. In all, up to 48 channels are possible. All channels can be configured as block-multiplexer channels and up to four channels may be optionally configured as byte multiplexer channels in the field. Channels not needing byte-multiplexer operation can be set up for block-multiplexer operation. For the Model 400 in single-image operation, the number of channels and central processors is doubled. The Model 400 can have 64, 80, or 96 integrated channels. Up to eight channels can be optionally configured as byte multiplexer channels in the field.

In byte-multiplexer operation, channels can be used either in byte-multiplex mode or in burst mode. In byte-multiplex mode, several relatively slow-speed I/O devices can operate concurrently. In block-multiplex operation, channels can operate either in high-speed transfer mode or in datastreaming mode. In datastreaming mode, a block multiplexer channel can transfer at up to three megabytes per second, and 1.5 megabytes per second in high-speed transfer or DCI mode. Each byte multiplexer channel is capable of operating with an aggregate data rate in the range of 90K to 300K bytes per second for data transfer burst sizes of four bytes or more. Configurations consisting of control units with faster I/O interface tags and larger data transfer burst sizes can achieve the higher performance.

Up to eight control units can be attached to a channel, and each channel can address up to 256 I/O devices. The total number of devices attached to a Model 200 or 400 is 4,096 minus the number of channels defined by using the I/O Configuration Program.

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► Channels may operate in either System/370 Extended Architecture (370-XA) mode or System/370 Mode. In 370-XA mode, up to four channel paths are available to any attached I/O device. During any I/O operation, one of the available channel paths to any specific I/O device is selected. Channel path selection is a hardware function rather than a system-control program function. In System/370 mode, any channel may be assigned any valid channel address without concern for priority. Logically, channels are organized into two sets, one per central processor. Operating under the MVS/System Product, Version 1 Release 3.5, up to 16 channels can be assigned to a channel set, while the maximum is 32 channels per channel set when operating under the VM/High Performance Option Release 3.6. Channel set switching is a standard feature available on this processor.

### MASS STORAGE

Currently available mass storage devices supported by the 3090 Series are listed in Table 2.

### INPUT/OUTPUT UNITS

For tape drives and printers supported on the 3090 Series, refer to Table 3. Punch card equipment is listed in the Equipment Prices.

**3814 SWITCHING MANAGEMENT SYSTEM:** This facility is designed to aid in the management of complex DP configurations by providing centralized control of control-unit switching. The 3814 uses an integrated microcode-driven processor and features password authorization, stored configurations, and extensive self-diagnostic functions. The 3814 system consists of three basic units, each available in four models. These include the Models A1 to A4 control units, Models B1 to B4 remote units, Models C1 to C4 expansion units, and the 3604 Model 6 Keyboard/Display Unit.

For a more detailed report on the 3814 and its features please refer to Report 70D9-504MK-101 in Volume 2.

**TERMINALS:** For information on the primary terminals supported on the 3090 Series, please refer to Table 4.

### COMMUNICATIONS CONTROL

**3705 COMMUNICATIONS CONTROLLER:** This programmable front-end network processor can be connected to either a byte or block multiplexer channel on a 3090 processor.

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 communication lines. Configuration rules for the 3705 are quite complex. 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 56,000 bits per second. In the Network Control Program (NCP) mode, data is transferred between the 3705 and the host computer via a single subchannel interface.

The 3705-II offers significant price/performance improvements over the original model, now designated the 3705-I. (The 3705-I is no longer available.) The 3705-II is available in 44 different models depending upon the number of frames and the storage capacity, which ranges from 32K to 512K bytes. Processor cycle time is 1.0 microseconds on Models E1-E8, F1-F8, G1-G8, and H1-H8, and 900 nanoseconds on

Models J1-J4, K1-K4, and L1-L4. Other 3705-II features include a high-speed Communications Scanner, an upgraded Channel Adapter that transfers data in blocks of 32 characters, transmission speeds to 9600 bps in synchronous mode, a maximum transmission rate of 56,000 bps, and a Cycle Utilization Counter that accumulates statistical data to assist in measuring machine performance.

The entry-level 3705-80 series consists of Models 81, 82, and 83. The 3705-80 has 256K bytes of storage and supports 4, 10, or 16 communication lines. The 3705-80 can be used as a front-end communications processor or as a remote concentrator linked to a local 3705-II Controller.

When connected to a host IBM processor, a 3705 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.

The 3705 Controllers are supported under the VTAM and TCAM access methods. The Advanced Communications Function for NCP, ACF/NCP/VS (and related Systems Support Programs), adds capabilities for multiple-processor environments. An X.25 NCP Packet Switching Interface is now available for use with ACF/NCP/VS. To utilize ACF/NCP/VS, the Advanced Communication Function for VTAM and TCAM is required. 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.

**3725 COMMUNICATIONS CONTROLLER:** The 3725 consists of the Model 1 and the Model 2. It consists of a central control unit which operates under control of the Advanced Communications Function/Network Control Program, Emulator Program, or Partitioned Emulator Program. Main storage is available in 512K-, 786K-, or 1024K-or, on Model 1, 2048K-byte sizes. It can be attached to either byte or block multiplexer or selector channels on the host processor. Up to six channel adapters are available with two adapters standard in the base frame and four can be added via the 3726 Expansion Unit. With the optional two-processor switch feature, connection can be made to a maximum of eight processors, six of which can operate concurrently. The Maintenance and Operator Subsystem allows for host-independent maintenance. Communication scanners and line interfaces are provided by a transmission subsystem. The scanners are microprocessor-based and can control eight Line Interface Couplers with up to 32 lines. The 3727 Operator Console provides an operator interface to the Maintenance and Operator Subsystem of the 3725.

The 3725 supports X.25, X.21, and V.35 attachment and line speeds ranging from 50 bits per second to 256K bits per second.

Model 1 consists of the 3725 Communication Controller and the 3726 Communication Controller Expansion. Up to 256 full-duplex or half-duplex lines may be attached with Model 1. Model 2 allows for attachment of up to 24 full-duplex or half-duplex lines. Model 2 is field-upgradable to Model 1.

**NETWORK COMMUNICATIONS CONTROL FACILITY (NCCF):** NCCF Version 2 executes on MVS/370 and/or MVS/XA in compatibility mode. It supports ACF/VTAM and ACF/TCAM through a network operator with facilities for controlling data communications networks. With NCCF, network operations are performed from designated 3270 terminals, which free the system console operator from network responsibilities. NCCF also provides communications and data base facilities for the collection, ►

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► storage, and retrieval of network errors in support of the Network Problem Determination Application (NPDA).

Another new product relating to peripherals is the IBM 3044 fiber-optic channel extender link. The product allows peripherals to be placed up to 6,600 feet (2 kilometers) farther away from IBM processors. According to IBM, remote printer displays and other low- to medium-speed peripherals using the fiber-optic link can run at speeds almost matching the speeds of devices locally connected to a central processor.

## SOFTWARE

## Operating Systems

The 3090 Processor Complex is supported natively by the MVS/SP and VM/SP operating systems. Any program written for the System/370 or 370-XA mode can be run on a 3090 using MVS/SP or VM/SP provided the program: 1) is not time-dependent, 2) is not dependent on system facilities and peripherals that may be present or absent from a 3090 configuration, and 3) does not depend on results or functions as defined in the System/370 Principles of Operation as being unpredictable, model dependent, or deviations, 4) does not depend in 370-XA mode on the contents of instruction parameter fields B and C on interception of the SIE, and 5) does not depend (in S/370 mode) on the presence of the 2K-byte page size, or the presence of storage protection keys associated with 2K-byte blocks of storage.

**MVS (MULTIPLE VIRTUAL STORAGE):** MVS (OS/VS2) is IBM's large-scale operating system, designed to handle multiprocessor configurations. MVS provides a virtual I/O (VIO) paging mechanism for temporary data sets and private virtual storage for up to 16 million bytes for individual TSO users. Workload Management Routines monitor the use of processing resources and allocate resources to jobs or time-sharing users. MVS also provides Resource-Use Routines, a set of algorithms that monitor the use of system resources and recommend scheduling changes to optimize the utilization of system resources. Deadline scheduling under JES3 dynamically alters the scheduling priority of jobs in order to meet completion deadlines. Other MVS facilities include a network job processing capability that permits the transmission of program input and output between compatible JES3 installations and recovery capabilities for multiprocessing configurations, including alternate path retry, dynamic device reconfiguration, and manual switching of peripheral devices between central processors.

Communications support under MVS is provided by the Advanced Communication Function/Telecommunications Access Method (ACF/TCAM) and Advanced Communication Function/Virtual Telecommunications Access Method (ACF/VTAM).

Remote job entry under MVS is supported under the Job Entry Systems, JES2 and JES3. Facilities are included for multileaving transmission between the host computer and intelligent remote terminals.

MVS provides language translators for all of the System/370 programming languages: Assembler, RPG, Cobol, Fortran, PL/1, and Algol. Users of Assembler, Cobol, or Fortran, in fact, are offered a choice of two or more translators.

To improve certain performance characteristics of the MVS product, IBM introduced microcode-based enhancements such as MVS/System Extensions (MVS/SE). The availability of MVS/SE is made possible through the System/370 Extended Facility feature, standard in all 308X and 3090 systems. Among its features, MVS/SE provides reduced processor time to execute certain frequently used

control program functions, faster address translation by more efficient use of the translation lookaside buffer (TLB), improved system availability through storage protection, and improved system resource utilization.

MVS/System Product (MVS/SP), the next stage of MVS enhancements, is the current product targeted for use in the 308X and 3090 systems. Utilizing JES2 and JES3, MVS/SP is available in two versions and several releases, which are described below.

*MVS/System Product—Version 1:* MVS/SP is a generic term referring to the various announced releases of MVS/SP-JES2 (5740-XYS) and MVS/SP-JES3 (5740XYN).

MVS/SP-JES2/3 Version 1 Release 3.5 provides support for IBM 3090 Series processors in System/370 mode, simplifies global resource serialization processing, and provides standalone dump support for the 3480 Magnetic Tape Subsystem in full-function mode. This release does not support the expanded storage option available on 3090 processors.

MVS/SP-JES2 Version 1 Release 3.6 provides virtual storage constraint relief in the JES2 private area by using the 31-bit addressing and extended private virtual storage capabilities of MVS/XA. Release 3.6 also includes SPOOL restructuring and constraint removal, improved SPOOL offload facility, and enhancements to the \$SCAN facility. Additionally, the release reduces planned outages through operator-modifiable initialization parameters and changes to JES2 initialization-definition statements.

*MVS/System Product Version 2:* MVS/SP Version must be installed in conjunction with the Data Facility Product. The two programs are known collectively as MVS/Extended Architecture (MVS/XA) and are designed to support the new System/370 Extended Architecture. The Data Facility Product provides data management, device support, program library management, and utility functions. MVS/XA also requires Assembler H Version 2, a functional replacement for OS Assembler H Release 5, and SMP Release 4.

MVS/SP Version 2 includes all of the functions of Version 1 Release 3 plus a number of enhancements. Version 2 supports 31-bit real and virtual storage addressing. It also supports larger and more flexible I/O configurations. Some of the I/O processing previously performed by the operating system is now a hardware function. Channel path selection and I/O busy condition management provide up to four channel paths to each I/O device. The facility also increases I/O device accessibility by allowing each central processor to initiate operations with any of the I/O devices and to handle any I/O interruption conditions. Improved RAS, including page protection for significant system areas, a new system trace facility, and improved dumping and formatting options are also included.

MVS/SP-JES2/3 Version 2 Release 1.3 provides support for the 3090 Processor Complex in System/370 Extended Architecture (370-XA) mode. The release supports the expanded storage option for the 3090 processor and also provides for additional reliability, availability, and serviceability enhancements.

MVS/SP-JES2/3 Version 2 Release 1.5 provides virtual storage constraint relief through MVS-XA exploitation, and expanded trace facilities. Additionally, the release provides two new JES3 user exits, improved usability for job networking, and greater flexibility in coding initialization statements.

MVS/XA Data Facility Product Version 2 Release 1 provides support for IBM disk storage devices, tape and printer devices, in addition to virtual storage constraint relief below the 16-megabyte line. Specifically the release provides sup- ►

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► port for the IBM 3380 Extended Capability Models AD4/BD4 and AE4/BE4, the IBM 3430 Magnetic Tape Subsystem, and the IBM 4245, 4248 and 3262 Model 5 line printer. Also featured are Direct Access Device Space Management enhancements in allocation and partial release and increase available virtual storage below the 16-megabyte line.

DFSORT Release 7 improves sorting performance in MVS/XA environments by using IBM System/370-XA Sorting Assists and providing virtual storage constraint relief.

VM: VM 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/her disposal the functional equivalent of a real, dedicated computing system. VM provides virtual machines with the ability to run multiple operating systems concurrently and with a conversational time-sharing system.

VM has four major elements: the control program (CP), which controls the resources of the real computer to provide multiple virtual machines; 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; the remote spooling communications system (RSCS), which permits users to transmit and receive files from remote stations; and the interactive problem control system (IPCS), which provides system diagnostics routines.

The Virtual Machine/System Product High Performance Option Release 3.6 and 4.2, functionally equivalent to VM/SP HPO Release 3.4, provides support for the IBM 3090 Model 200 in S/370 architecture, its expanded storage, and up to 48 channels. VM/SP HPO will also support the 3090 Model 400 in partitioned processing mode when the processor becomes available.

The *VM/XA Systems Facility* supersedes the *VM/XA Migration Aid*, which was designed to ease the conversion from MVS/SP Version 1 to MVS/XA. The *VM/XA Systems Facility* incorporates all of the facilities of the *VM/XA Migration Aid Release 2*, including concurrent support for one MVS/SP Version 1, DOS/VSE, or OS/VS1 preferred virtual machine and one or more MVS/XA test machines with test and debugging facilities. In addition, the *VM/XA Systems Facility* supports the IBM 3090 processors and the *Start Interpretive Execution (SIE) Assist* feature. Additionally, it provides dedicated-only support of the 3090 expanded storage. Furthermore, dedicated support is provided for the 3880 Model 23 Storage Control, the 3380 Model AE4 and BE4 DASD units, the 3370 DASD, and the 3430 tape unit. The *VM/XA Systems Facility* will exploit the full dyadic capabilities of the IBM 4381-3, 3081, 3090 Model 200, 3084, and 3090 Model 400 (in partitioned mode) by enabling V=R guest operating systems to simultaneously run on both instruction processors in full dyadic mode.

INTERACTIVE EXECUTIVE/370 (IX/370): IX/370 is IBM's implementation of the Unix System V operating system. Designed for the VM/SP environment, IX/370 runs as a guest under VM/SP Release 3.0 or later. IX/370 includes the following functions based on Unix System V: support for IBM and other full-duplex ASCII terminals, the Bourne shell command language, a hierarchical file system, a text processing and document preparation facility, the ability to control and track document and source code changes, and the ability to copy files to other Unix systems. In addition, IBM has added the following extensions to Unix: virtual memory support, multiple IX/370 system support, file system enhancements that allow data block sizes of 4096 bytes, extended file and logical record locking, and a full-screen editor with windowing.

### Data Management

INFORMATION MANAGEMENT SYSTEM: IMS provides the capabilities for generating and accessing a data base, with automatic cross-referencing among data records. IMS/VVS operates under MVS. IMS/VVS offers on-line message processing with the optional IQF (Interactive Query Facility) or GIS/VVS (General Information System), and batch inquiry with GIS or GIS/VVS 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.

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 childing (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 (IMS/VVS-DB) can be augmented with data communications capability to produce a transaction-driven system. The DB system is a prerequisite to the DC Feature. 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 IMS/VVS-DC, a DB/DC system can be put together using the Customer Information Control System. CICS generally provides similar functional capabilities ►

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► with lower overhead in some environments. CICS was designed for relatively short program modules of about 2K to 6K bytes, while the IMS/VS-DC is better suited to 20K-byte modules or larger.

See Report 70E-504MK-101 in Volume 3 for more details on IMS.

**EXTENDED RECOVERY FACILITY (XRF):** XRF is an MVS/XA and SNA enhancement designed to increase the availability of IMS/VS Version 2 DB/DC transaction processing. XRF is now included in IMS/VS Version 2 and in MVS/SP Version 2 Release 1.3 with the Availability Enhancement. XRF uses additional hardware and software to create an alternate IMS/VS Version 2 subsystem and keeps the alternate subsystem synchronized with the active subsystem. Whenever service to end users is disrupted, the alternate IMS/VS subsystem takes over the work load of the active system. XRF thus reduces the time that end users are prevented from accessing the system.

**CUSTOMER INFORMATION CONTROL SYSTEM:** CICS/OS/VS is a general-purpose data communications monitor that operates under MVS 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.

See Report 70E-504MK-201 in Volume 3 for more details on CICS.

#### Compilers and Assemblers

**COBOL:** VS Cobol II, announced in February 1984, was specifically designed for MVS/370 and MVS/XA systems. IBM has stated that the new program will provide the base for future Cobol language enhancements. VS Cobol II features reentrant object code, support for 31-bit addressing, structured programming language, interactive debugging capabilities, and improved object code optimization. IBM intends to provide a conversion aid that will convert most OS/VS Cobol source code to new code that is compatible with both OS/VS Cobol and VS Cobol II.

VS Cobol II conforms to ANSI standard Cobol X3.23-1974, but the report writer and communications modules are not supported. Extensions to the standard Cobol include support of the INITIALIZE statement, a COPY enhancement that allows nesting of COPY statements that do not contain the Replacing clause, access to VSAM return codes, and extended graphics character set data-type literals.

**FORTRAN:** IBM's VS Fortran language is compatible with the ANSI X3.9-1978 and ISO 1539-1980 standards. VS Fortran is a reentrant compiler that operates under CMS as well as under MVS and MVS/XA. Features include VSAM device support, structured programming aids, improved diagnostics, interactive debug, and batch symbolic debug.

The VS Fortran Program Multitasking Facility is a set of routines added to the VS Fortran Library to permit a VS Fortran application program to simultaneously use all processors in a multiprocessor system. The Multitasking Facility is designed to improve system throughput during the execution of large processor-bound jobs.

**PL/1:** IBM offers two OS/VS PL/1 compilers: the Checkout Compiler and the Optimizing Compiler. The Checkout Compiler is usually used first for program creation and debugging, and the Optimizing Compiler is then used to create load modules that are optimized for execution speed. The OS/VS PL/1 compilers run under MVS, VM/CMS, or TSO. The PL/1 Optimizer Release 4 is the preferred release level for MVS/XA.

**BASIC:** Two versions of the Basic language are available. IBM Basic runs under VM/SP-CMS and is designed for ease of use by terminal users. It conforms to current Basic language standards. VS Basic is designed to operate in virtual storage environments. It can be used with CMS under VM/370, with TSO under MVS, with Virtual Storage Personal Computing (VSPC) under MVS, and in the batch mode of operation under all of the IBM virtual storage operating systems.

**APL:** VS/APL is an enhancement of APL/360 that executes under MVS. It can also be used with the CMS component of VM/370 and with TSO, CICS/VS, and VSPC under MVS. VS/APL features include interactive language facilities; on-line access to VSAM files in VSPC, CICS, TSO, and CMS; access to DL/I data bases; and full-screen management and graphical support for 3270 display devices via the Graphical Data Display Manager (GDDM).

**REPORT PROGRAM GENERATORS:** IBM's RPG II uses 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. An enhanced RPG II was 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 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.

**ASSEMBLERS:** Assembler H Version 2 is the standard symbolic assembly language used to write machine-oriented programs for all models of the 3090. It is upward-compatible with other System/370 assemblers and features new machine instructions for processors operating in Extended Architecture mode, bimodal addressing in the MVS/XA environment, new channel command words, and operation in the CMS environment of VM/SP and VM/SP Migration Aid.

**PASCAL:** Pascal/VS operates with MVS, MVS/XA, TSO under MVS, and CMS under VM. It supports the proposed ISO language standard, plus the following extensions: separate compilation, dynamic character strings, additional I/O capabilities, and improved control over data. Pascal/VS includes structured programming features and linkages to Fortran, Cobol, PL/1, and Assembler language subprograms.

#### Program Development

The Interactive System Productivity Facility (ISPF) Version 2.1.2 for MVS is a common dialog manager for IBM licensed programs and application development. Capabilities include: support of an ISPF/GDDM environment, extensions to the table services, an interface to TSO Extensions Release 2, and support for the 3290 terminal. Version 2.1.2 uses 31-bit addressing mode and includes APL2 support.

The Interactive System Productivity Facility/Program Development Facility (ISPF/PDF) Version 2.1.2 for MVS is used to create and maintain both source programs and text data. ISPF/PDF provides interfaces to many system facilities through the use of menus which relieve the user of the need to know the specific command syntax of the interactive system being used. Version 2.1.2 uses 31-bit addressing mode and supports the Kanji language. Both ISPF and ISPF/PDF provide virtual storage constraint relief (VSCR) and allow growth of ISPF and ISPF/PDF by using the extended address space of MVS/XA. ►

## IBM 3090 Series

### ► PRICING

**MAINTENANCE:** IBM offers both contract and on-call maintenance support. The basic monthly maintenance charge includes any period of 9 consecutive hours between 7:00 a.m. and 6:00 p.m. Monday through Friday. Customers may also purchase extended maintenance coverage that includes 12, 16, 20, or 24-hour coverage on weekdays, Saturdays, Sundays, and holidays. A premium is also charged for 9-hour, 5-day maintenance in which the 9-consecutive-hours period falls outside the 7:00 a.m. to 6:00 p.m. limits.

For users without a maintenance contract, the 3090 Series is maintained under per-call class 3. Under this class, the per-call charge during regular hours is \$165 per hour and the per-call charge during off hours is \$190 per hour.

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

Plan D is a monthly rental charge which includes complete maintenance coverage for 7 days per week, 24 hours per day. After the first three months, this charge includes all parts and on-site maintenance during prime-time Monday through Friday for 9 hours selected by the customer between 7:00 a.m. and 6:00 p.m. There is an option for additional coverage.

The most significant change brought about by the 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. 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 Products (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 MVS and VM/370 operating systems. SCPs 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. All other IBM software is separately priced.

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

In addition, basic monthly charges have been established for maintenance of the IBM system control programs and other licensed program products. The minimum term of agreement is one year. Customers with multiple systems will have a choice as to how they can have local programming support handled at their locations. Users who have IBM perform local program support at all computer sites pay the Basic Monthly License fee for all locations. Users who decide, however, to control the installation and support of designated licensed programs from a central site, pay the Basic License Fee at the central site and a Distributed Systems License Option (DSLO) monthly fee for all other locations. The DSLO rates are lower than the basic monthly support charges.

Support charges for the systems software products described in this report are listed at the end of the equipment price list. Local programming support for 3090 systems is provided in two categories: Category A, which includes support for VM/370 Release 6, and Category B, which includes all SCPs in Category A, MVS Release 3.8, and all supporting SCPs for MVS/SP. Refer to the following chart for monthly rates.

### LOCAL PROGRAMMING SUPPORT CHARGES

Processor	Monthly Program	Monthly
	Support Charge (\$)	Multiple Program Support Charge (\$)
Model 200:		
Category A	1,990	3,184
Category B	2,835	4,536
Model 400:		
Category A	2,710	4,336
Category B	3,865	6,184

## IBM 3090 Series

► All other programming service and assistance is charged at \$182 per hour during regular hours and \$209 per hour during nonregular hours.

Program Products include all language processors, communications support programs, and utility programs, and are licensed separately. Application Programs (PPAs) are problem- and industry-oriented software packages that 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 3090 Series.

**SUPPORT CENTER:** The centralized IBM Support Center provides 24-hour, 7-day customer access by telephone (an 800 number is provided). It utilizes the Software Support Facility data base, which incorporates every problem encountered and resolved (or unresolved) by the central support group. The customer is assisted in making out any APAR (program problem report), and gets advice on temporary fixes or bypasses.

The Support Center is the first level of support. If it cannot resolve a problem, the customer is put in touch with the Change Team Support Specialist, who is directly familiar with the section of coding relating to the problem being reported. If, after working with this individual, the problem still cannot be resolved, the PSR (Program Support Representative) from the customer's local office will be dispatched to assist. Under the new support plan, many of the facilities that were previously provided by IBM support personnel at no charge have become billable activities.

**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.

**EQUIPMENT:** The following systems illustrate possible 3090 configurations. They include all the necessary control units and adapters, but do not include any specialized software.

**3090 MODEL 200:** Consists of the Model 200 Processor with 64 megabytes of main memory, 128 megabytes of expanded storage, one 3092 Processor Controller Model 1, one 3097 Power and Coolant Distribution Unit, two 3089 Power Unit Model 3s, two 3370 Direct Access Storage Model A2s with string switch, two 3180 Display Station Model 145s, one 3864 Modem Model 2 equipped with Automatic Calling Unit, 90 3278 Display Unit Model 2s, three 3274-31A Communications Controllers, nine 6901 Terminal Adapters, three 3880 Controllers, three 3380-AE4 Disk Drive/Controllers, nine 3380-BE4 Disk Drives, six 3430-A1 Tape Drive/Controllers, 16 3430-B1 Tape Drives, and three 4245 Model 20 (2000-lpm) printers. The purchase price is \$7,964,967, the monthly maintenance is \$18,550, and the monthly rental on a one-year contract is \$607,811.

**3090 MODEL 400:** Consists of the Model 400 Processor with 128 megabytes of main memory, 256 megabytes of expanded storage, one 3092 Processor Controller, two 3370 DASD Model A2s, two Power & Coolant Distribution Units, four 3089 Model-3 Power Units, three 3180-145 System Consoles, two 3864 Model 2 Automatic Call Units, 90 3278 Display Units, three 3274-31A Communications Controllers, nine 6901 Terminal Adapters, three 3880 Controllers, three 3380-AE4 Disk Drive/Controllers, nine 3380-BE4 Disk Drives, six 3430-A Tape Drive/Controllers, 16 3430-B Tape Drives, and three 4245 2000-lpm printers. The purchase price is \$13,177,289, the monthly maintenance is \$26,490, and the monthly rental on a one-year contract is \$1,041,789. ►

## IBM 3090 Series

### EQUIPMENT PRICES

		Purchase Price (\$)	Monthly Maint. (\$)	Monthly Rental Charge* (\$)	Monthly Charge (2-Year Lease)* (\$)
<b>► PROCESSORS &amp; FEATURES</b>					
Model 200	Processor Complex; consists of CPU, 64 megabytes of main memory, 64K-byte buffer, and 32 integrated channels; requires 3092-1 Processor Controller, 3097 Power & Coolant Distribution Unit, two 3089-3 Power Units, two 3180-145 System Consoles, and a 3864-2 Automatic Call Unit	4,600,000	5,900	383,350	—
Model 400	Processor Complex; consists of CPU, 128 megabytes of main memory, 64K-byte buffer, and 64 integrated channels; requires 3092-2 Processor Controller, two 3097 Power & Coolant Dist. Units, four 3089-3 Power Units, three 3180-145 System Consoles, and two 3864-2 Automatic Call Units	—	11,910	728,650	—
—	Field upgrade from Model 200 to Model 400 (The Model 400 will only be available through an upgrade of a Model 200).	4,144,000	—	—	—
Channel Groups: Model 200					
3850	First Additional Channel Group for the Model 200; 8 channels	130,000	145	10,830	—
3851	Second Additional Channel Group for the Model 200; 8 channels. Requires 3850.	130,000	145	10,830	—
Channel Groups: Model 400					
3850	First additional channel group for A side; 3850 and 3852 are corequisite or prerequisite	130,000	145	10,830	—
3851	Second additional channel group for A side; 3851 and 3853 are corequisite or prerequisite	130,000	145	10,830	—
3852	First additional channel group for B side; 3850 and 3852 are corequisite or prerequisite	130,000	145	10,830	—
3853	Second additional channel group for B side; 3851 and 3853 are corequisite or prerequisite	130,000	145	10,830	—
Expanded Storage: Model 200					
5064	64 megabytes	475,000	500	39,580	—
5128	128 megabytes	830,000	900	69,170	—
6128	Expansion from 64 megabytes to 128 megabytes; requires 5064	355,000	400	29,580	—
Expanded Storage: Model 400					
5064	64 megabytes for A side; 5064 and 7064 are corequisite or prerequisite	475,000	500	39,580	—
7064	64 megabytes for B side; 5064 and 7064 are corequisite or prerequisite	475,000	500	39,580	—
5128	128 megabytes for A side; 5128 or 7128 requires 128 megabytes on other side	830,000	900	69,170	—
7128	128 megabytes for B side; 5128 or 7128 requires 128 megabytes on other side	830,000	900	69,170	—
6128	64 megabytes to 128 megabytes for A side; 6128 or 8128 requires 128 megabytes on other side	355,000	400	29,580	—
8128	64 megabytes to 128 megabytes for B side; 6128 or 8128 requires 128 megabytes on other side	355,000	400	29,580	—
3092-1	Processor Controller for the 3090 Model 200	200,000	1,125	16,670	—
3092-2	Process Controller for 3090 Model 400	—	1,295	19,580	—
—	Upgrade from 3092 Model 1 to 3092 Model 2	35,000	—	—	—
3097-1	Power and Coolant Distribution Unit for 3090-200 and 400	121,000	220	10,080	—
4650	I/O Power Sequence Control for the 3090-200 and 400	8,000	50	667	—
3089-3	Power Unit; 3090-200 requires two 3089-3s; 3090-400 requires four 3089-3s	38,000	90	3,165	—
3180-145	Console Display Station; two required on the 3090-200, and three on the 3090-400	2,395	300	—	—
5801	Automatic Call Unit for the 3864-2 Modem	1,090	192	—	—
3044-C01	Fiber Optic Channel Extender Link; channel unit	8,500	25	—	—
3044-DO1	Fiber Optic Channel Extender Link; downstream unit	8,500	25	—	—

\*Includes equipment maintenance.

\*\*Four-year lease.

\*\*\*Five-year lease.

NC—No charge.

T&M—Time & material.



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		Purchase Price (\$)	Monthly Maint. (\$)	Monthly Rental Charge* (\$)	Monthly Charge (2-Year Lease)* (\$)
<b>MASS STORAGE</b>					
3350	Direct Access Storage; 317.5MB per drive:				
	Model A2; Dual Disk Drive	32,030	173.00	2,103	1,790
	Model A2F; Dual Disk Drive with 2MB fixed-head storage	39,970	224.00	2,620	2,230
	Model B2; Add-on Dual Disk Drive	25,360	130.00	1,674	1,425
	Model B2F; Add-on Dual Disk Drive for 2MB fixed-head storage per drive	33,300	182.00	2,191	1,865
	Model C2; Two-drive disk storage and associated control	33,130	182.00	2,191	1,865
	Model C2F; Two-drive disk storage and associated control	41,070	234.00	2,708	2,305
	1320 Primary Controller Adapter (permits selection of A2/AF controller as on-line controller via manual switch on the C2/C2F)	220	1.50	15	13
	8150 String Switch for 3350 A2, A2F, C2, C2F	3,690	9.50	257	219
3370	Direct Access Storage:				
	Model A1; Single Disk Drive; 571.3MB	35,480	147.00	1,563	1,330
	Model B1; Add-on Single Disk Drive for attachment to Model A1	26,600	110.00	1,173	998
	Model A2; 729.8MB; contains logic and power for up to three Model B2 units	35,480	134.00	2,030	—
	Model B2; connects to a 3370 Model A2	26,600	101.00	1,520	—
	8150 String Switch for 3370 A1	3,830	1.50	168	143
3375	Direct Access Storage; 819.7MB per drive:				
	Model A1; contains logic and power for up to three Model B1 units	38,040	139.00	1,563	1,330
	Model B1; connects to a 3375 Model A1	28,770	105.00	1,251	1,065
	Model D1; provides dual controller function in a 3375 string; requires one Model A1 and two Model B1s	36,290	128.00	1,486	1,265
	4951 Model D1 Attachment for Model A1	2,590	6.00	95	81
	4952 Model D1 Attachment for Model B1	NC	NC	NC	NC
	8150 String Switch Feature for 3375 A1	3,795	1.50	168	143
	3375 Model B1 to D1 Upgrade	7,520	—	—	—
3380	Direct Access Storage:				
	Model A4; 2.52 billion bytes of storage; connects to one 3880 storage director	77,680	285.00	4,471	3,805
	Model AA4; 2.52 billion bytes of storage; connects to two 3880 storage directors	88,780	325.00	5,105	4,345
	Model B4; connects to a Model A4 or AA4 unit	64,440	240.00	3,466	2,950
	Model AD4; 2.52 billion bytes per unit; connects to two 3880 storage directors	88,780	295.00	4,730	—
	Model BD4; connects to a Model AD4 or AE4 unit	64,440	215.00	3,440	—
	Model AE4; 5.04 billion bytes per unit; connects to two 3880 storage directors	134,740	295.00	7,030	—
	Model BE4; connects to a Model AE4 or AD4 unit	110,400	215.00	5,735	—
3880	Storage Control; includes two storage directors:				
	Model 1; each storage director can attach up to four 3350 A2/A2F, or 3375 A1 or D1 in any combination	60,270	176.00	3,819	3,250
	Model 2; provides one storage director for 3350 or 3375 storage and one for 3380 storage	60,270	176.00	3,819	3,250
	Model 3; provides two storage directors for 3380 storage	60,270	176.00	3,819	3,250
	Model 4; provides one storage director which can attach up to four 3375 Model A1s	35,000	82.50	2,195	—
	Model D11; paging subsystem for 3350	216,350	609.00	10,346	8,805
	Model B13; includes two cache storage directors for 3380; 4 megabytes	179,950	519.00	8,390	7,140
	Model D13; same as B13, but with 8 megabytes	224,300	640.00	10,716	9,120
	Model D21; subsystem for paging and swapping data; 8 megabytes (requires 8170)	143,750	575.00	8,305	—
	Model E21; same as D21, but with 16 megabytes	183,750	600.00	10,470	—
	Model G21; same as D21, but with 32 megabytes	263,750	650.00	14,800	—
	Model H21; same as D21, but with 48 megabytes	343,750	700.00	19,130	—
	Model J21; same as D21, but with 64 megabytes	423,750	750.00	23,460	—
	Model D23; connects to 3380 to form cache/DASD subsystem; 8 megabytes (requires 8170)	143,750	575.00	8,305	—
	Model E23; same as D23, but with 16 megabytes	183,750	600.00	10,470	—
	Model G23; same as D23, but with 32 megabytes	263,750	650.00	14,800	—
	Model H23; same as D23, but with 48 megabytes	343,750	700.00	19,130	—
	Model J23; same as D23, but with 64 megabytes	423,750	750.00	23,460	—
	3880 Model Upgrades:				
	Model 1 to Model D21	83,480	—	—	—
	Model 1 to Model E21	123,480	—	—	—
	Model 1 to Model G21	203,480	—	—	—
	Model 1 to Model H21	283,480	—	—	—
	Model 1 to Model J21	363,480	—	—	—

\*Includes equipment maintenance.

\*\*Four-year lease.

\*\*\*Five-year lease.

NC—No charge.

T&amp;M—Time &amp; material.

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	Purchase Price (\$)	Monthly Maint. (\$)	Monthly Rental Charge* (\$)	Monthly Charge (2-Year Lease)* (\$)
Model D11 to Model D21	80,000	—	—	—
Model D11 to Model E21	120,000	—	—	—
Model D11 to Model G21	200,000	—	—	—
Model D11 to Model H21	280,000	—	—	—
Model D11 to Model J21	360,000	—	—	—
Model D21 to Model E21	55,000	—	—	—
Model D21 to Model G21	135,000	—	—	—
Model D21 to Model H21	215,000	—	—	—
Model D21 to Model J21	295,000	—	—	—
Model E21 to Model G21	80,000	—	—	—
Model E21 to Model H21	160,000	—	—	—
Model E21 to Model J21	240,000	—	—	—
Model G21 to Model H21	80,000	—	—	—
Model G21 to Model J21	160,000	—	—	—
Model H21 to Model J21	80,000	—	—	—
Model X21 to Model X23	2,745	—	—	—
Model 3 to Model D23	83,480	—	—	—
Model 3 to Model E23	123,480	—	—	—
Model 3 to Model G23	203,480	—	—	—
Model 3 to Model H23	203,480	—	—	—
Model 3 to Model J23	283,480	—	—	—
Model B13 to Model D23	80,000	—	—	—
Model B13 to Model E23	120,000	—	—	—
Model B13 to Model G23	200,000	—	—	—
Model B13 to Model H23	280,000	—	—	—
Model B13 to Model J23	360,000	—	—	—
Model D13 to Model D23	80,000	—	—	—
Model D13 to Model E23	120,000	—	—	—
Model D13 to Model G23	200,000	—	—	—
Model D13 to Model H23	280,000	—	—	—
Model D13 to Model J23	360,000	—	—	—
Model D23 to Model E23	55,000	—	—	—
Model D23 to Model G23	135,000	—	—	—
Model D23 to Model H23	215,000	—	—	—
Model D23 to Model J23	295,000	—	—	—
Model E23 to Model G23	80,000	—	—	—
Model E23 to Model H23	160,000	—	—	—
Model E23 to Model J23	240,000	—	—	—
Model G23 to Model H23	80,000	—	—	—
Model G23 to Model J23	160,000	—	—	—
Model H23 to Model J23	80,000	—	—	—
6148 Remote Switch Attachment	NC	NC	NC	NC
6149 Remote Switch Attachment, Additional	NC	NC	NC	NC
6150 Remote Switch Attachment for Eight-Channel Switch	NC	NC	NC	NC
6550 Speed Matching Buffer for 3380	9,705	40.00	553	471
8170 Two-Channel Switch Pair	6,225	11.00	390	332
8171 Two-Channel Switch Pair, Additional	16,610	38.50	1,053	896
8172 Eight-Channel Switch	22,850	53.50	1,451	1,235

MAGNETIC TAPE EQUIPMENT

3420	Magnetic Tape Units:				
	Model 3; 120,000 bytes/sec. at 1600 bpi; 75 ips	11,930	226.00	648	544
	Model 4; 470,000 bytes/sec. at 6250 bpi; 75 ips	15,340	226.00	907	762
	Model 5; 200,000 bytes/sec. at 1600 bpi; 125 ips	16,000	248.00	874	734
	Model 6; 780,000 bytes/sec. at 6250 bpi; 125 ips	17,920	248.00	1,045	878
	Model 7; 320,000 bytes/sec. at 1600 bpi; 200 ips	17,920	297.00	1,035	869
	Model 8; 1250 bytes/sec. at 6250 bpi; 200 ips	19,880	365.00	1,240	1,042
	6420 6250 bpi Density Feature (for 3420 Models 4, 6, and 8)	1,600	68.00	88	74
	6425 6250/1600 bpi Density Feature (for 3420 Models 4, 6, and 8)	2,205	90.00	128	108
	6631 Single Density Feature (for Models 3, 5, and 7)	2,870	67.50	150	126
	3550 Dual Density Feature (for Models 3, 5, and 7)	3,705	113.00	196	165
	6407 7-Track Feature (for Models 3, 5, and 7)	2,870	98.00	150	126
3430	Magnetic Tape Subsystem				
	Model A1; Tape Unit and Control	33,400	251.00	2,175	—
	Model B1; Tape Unit Only	16,900	176.00	1,155	—

\*Includes equipment maintenance.

\*\*Four-year lease.

\*\*\*Five-year lease.

NC—No charge.

T&M—Time & material.

## IBM 3090 Series

		Purchase Price (\$)	Monthly Maint. (\$)	Monthly Rental Charge* (\$)	Monthly Charge (2-Year Lease)* (\$)
3803	Tape Controller:				
	Model 1; for 3420 Model 3, 5, and 7 drives	20,680	144.00	1,125	945
	Model 2; for 3420 Model 3 through 8 drives	27,550	199.00	1,640	1,378
	5310 9-Track NRZI Feature (permits connection of 800-bpi drives to 3803-2)	3,080	2.00	158	133
	6320 7-Track NRZI Feature (permits connection of 800-bpi drives to 3803-2; 5310 is prerequisite)	1,515	2.00	79	66
	Multiple Tape Control Switches (for switching up to sixteen 3420 tape drives between up to four 3803 control units):				
	1792 For 2 Tape Controls	6,130	14.00	328	276
	1793 For 3 Tape Controls	7,820	23.00	425	357
	1794 For 4 Tape Controls	9,195	23.00	498	418
	3551 Dual Density Feature (for 3803-1)	2,300	3.50	119	100
	6148 Remote Switch Attachment	910	—	48	40
6408 7-Track Feature (for 3803-1)	2,300	3.50	119	100	
8100 Two-Channel Switch	4,600	6.50	243	204	
3480	Model A22 Tape Controller	65,430	385.00	3,880	—
	Model B22 Magnetic Tape Unit	43,120	240.00	2,545	—
	1511 Channel Attachment, First	5,785	21.00	331	—
	1512 Channel Attachment, Second	5,785	21.00	331	—
<b>PUNCHED CARD EQUIPMENT</b>					
2501	Card Reader (with control):				
	Model B1; 600 cpm	19,610	144.00	623	—
3505	Model B2; 1000 cpm	19,920	158.00	767	—
	Card Reader:				
3505	Model B1; 800 cpm	36,030	293.00	1,350	—
	Model B2; 1200 cpm	37,270	400.00	1,595	—
3525	5450 Optical Mark Read	10,130	108.00	399	—
	6555 Selective Stacker	2,845	15.00	101	—
	8103 3525 Punch Adapter	6,370	8.00	236	—
	8105 3525 Read/Punch Adapter	7,010	11.00	296	—
	8100 3525 Card Print Control	3,810	11.00	129	—
	Card Punch:				
	Model P1; 100 cpm	25,520	199.00	960	—
	Model P2; 200 cpm	26,520	269.00	1,210	—
	Model P3; 300 cpm	27,520	336.00	1,455	—
	1533 Card Read Feature	7,645	50.00	283	—
	1421 Basic Card Print	16,750	198.00	621	—
5273 Multi-Line Card Print	1,365	57.50	166	—	
8339 Two-Line Card Print	874	8.00	25	—	
<b>PRINTERS</b>					
3203	Printer, Model 5; 1200 lpm, 132 print positions	33,875	451.00	2,155	1,835
	1416 Interchangeable Train Cartridge (required)	2,930	T&M	178	—
4245-12	Models 12 and D12 High-Speed Printers; 1200 lpm	28,000	300.00	1,850	—
4245-20	Models 20 and D20 High-Speed Printers; 2000 lpm	35,000	400.00	2,340	—
4248	Printer, Model 1; 2200 to 3600 lpm; 132 print positions	75,000	1,070.00	6,205	—
	3751 Additional 36 Print Positions (plant installation)	10,000	110.00	615	—
	3753 Additional 36 Print Positions (field installation)	15,000	110.00	615	—
3820	Page Printer; 20 pages/minute	28,350	310.00	1,680	—
	3050 EIA Interface Attachment	500	10.00	34	—
	3055 S/370 Channel Interface Attachment	2,600	40.00	164	—
	3035 Control Storage Memory, 128KB	750	10.00	46	—
	3005 Pattern Storage Memory, 256KB	1,050	10.00	61	—
	3010 Pattern Storage Memory, 512KB	1,700	20.00	102	—
	3020 Pattern Storage Memory, 1024KB	3,000	40.00	184	—

\*Includes equipment maintenance.

\*\*Four-year lease.

\*\*\*Five-year lease.

NC—No charge.

T&amp;M—Time &amp; material.

IBM 3090 Series

	Purchase Price (\$)	Monthly Maint. (\$)	Monthly Rental Charge* (\$)	Monthly Charge (2-Year Lease)* (\$)
3025 Pattern Storage Memory, 2048KB	6,000	80.00	368	—
3030 Pattern Storage Memory, 3072KB	9,000	120.00	552	—
3065 Pattern Storage Memory, 4096KB	12,000	160.00	736	—
3800 Printing Subsystem**				
Model 1; up to 20,040 lpm	330,750	1,080	14,880	11,450
Model 3; up to 20,040 lpm; 240 x 250 picture elements	330,750	719.00	13,910	—
5401 Additional Character Generation Storage	4,695	27.50	148	114
8170 Two-Channel Switch (Model 1)	10,270	21.50	396	306
8180 Two-Channel Switch (Model 3)	10,270	21.50	396	—
1490 Burster-Trimmed-Stacker	52,500	332.00	2,220	1,705
7810 Tape to Print Subsystem Feature	12,630	53.50	589.00	453
1010 Accumulator (Model 3 only)	21,250	128.00	893	—
1021 Accumulator Expansion (Model 3 only)	5,445	39.50	228	—
5410 Raster Printer Storage, Additional (Model 3 only)	8,655	8.00	363	—
6148 Remote Switch Attachment (Model 3 only)	NC	NC	NC	—
8171 Dynamic Two-Channel Switch (Model 3 only)	NC	NC	NC	—

TERMINALS

Cluster Controllers:

3274 Model 21A; local, SNA mode	14,220	72.00	874	744
3274 Model 21B; local, 3272 mode	14,220	74.50	874	744
3274 Model 21C; remote; requires 3701	9,900	55.50	613	522
3274 Model 21D; local, 3272 mode	14,220	79.50	674	744
3274 Model 31A; local, SNA mode	16,650	90.00	1,026	873
3274 Model 31C; remote; requires 3701	12,420	73.50	764	650
3274 Model 31D; local, 3272 mode	16,650	97.50	1,026	873
3274 Model 41A; local, SNA mode	18,230	58.00	1,083	922
3274 Model 41C; remote; requires 3701	13,840	40.00	820	698
3274 Model 41D; local, 3272 mode	18,230	58.00	1,083	922
3274 Model 51C; remote; requires 3701	4,885	37.50	282	240
3274 Model 61C; remote; requires 3701	7,600	27.00	434	369
Terminal Adapters (for Models -21X, -31X, and -51C only)—				
6901 Type A1; devices 9 through 16	918	2.00	52	44
6902 Type A2; devices 17 through 24	918	2.00	52	44
6903 Type A3; devices 25 through 32	918	2.00	52	44
7801 Type B; requires 5550	986	4.00	60	51
7802 Type B1; devices 1 through 4	986	4.00	60	51
7803 Type B2; devices 5 through 8	831	2.50	52	44
7804 Type B3; devices 9 through 12	831	2.50	52	44
7805 Type B4; devices 13 through 16	831	2.50	52	44
1801 Control Storage Expansion	790	4.00	50	43
3701 External Modem Interface; requires 6302 or 6303	337	3.00	16	14
6302 Common Communications Adapter; SDLC or BSC; up to 9600 bps with Type A only Terminal Adapters and up to 7200 bps with Type B or mix; -21C, -31C, -41C, -51C, and -61C only	365	2.00	14	12
6303 High Performance Communications Adapter; SDLC or BSC; 9600 bps with Type B Terminal Adapters or mix; -21, -31C, -41C, -51C, and -61C only	1,010	8.50	58	49
8801 Watertight Power Connector; -21A/B/D, -31A/D, and -41A/D	NC	NC	NC	NC
3680 Encrypt/Decrypt; -1C, 3274 -21C, -31C, -41C, -51C, and -61C only	1,780	2.00	85	72
5650 Dataphone Digital Service; point-to-point; -21C, -31C, -41C, -51C, and -61C only	840	1.50	36	31
5651 Dataphone Digital Service; multipoint; -21C, -31C, or -51C only	840	1.50	36	31
5655 X.21 Adapter; nonswitched networks; -41C or -61C only	800	1.50	33	28
5656 X.21 Adapter; switched networks; -41C or -61C only	800	2.00	41	35
3299 Terminal Multiplexer	1,175	—	—	—

Note: Effective April 21, 1984, IBM no longer accepts lease/rental orders for any model of the 3274 Control Unit.

\*Includes equipment maintenance.

\*\*Four-year lease.

\*\*\*Five-year lease.

NC—No charge.

T&M—Time & material.

## IBM 3090 Series

		Purchase Price (\$)	Monthly Maint. (\$)	Monthly Rental Charge* (\$)	Monthly Charge (2-Year Lease)* (\$)
<b>Cluster Display Stations:</b>					
	3278 Model 1; 960 char.	1,855	10.00	99	84
	3278 Model 2; 1920 char.	1,965	10.00	102	87
	3278 Model 3; 2560 char.	2,145	10.50	123	105
	3278 Model 4; 3440 char.	2,255	11.50	126	108
	3278 Model 5; 3564 char.	2,575	12.50	148	126
	3178 Model C1; 1920 char., w/75-key Data Entry keyboard	1,660	—	—	—
	3178 Model C2; 1920 char., w/87-key Typewriter keyboard	1,720	—	—	—
	3178 Model C3; 1920 char., w/87-key Typewriter keyboard and numeric pad	1,720	—	—	—
	3178 Model C4; 1920 char., w/87-key Typewriter keyboard and numeric pad	1,720	—	—	—
	3178 Machine Elements—				
	75-Key Data Entry Keyboard	360	—	—	—
	87-Key Typewriter Keyboard	420	—	—	—
	87-Key Typewriter Keyboard and Numeric Pad	420	—	—	—
	Video Element	350	—	—	—
	Logic Element	950	—	—	—
	3180 Model 1; w/Typewriter or Data Entry keyboard	2,295	—	—	—
	3180 Machine Elements—				
	122-Key Typewriter Keyboard	295	—	—	—
	122-Key Data Entry Keyboard	295	—	—	—
	Video Element	950	—	—	—
	Logic Element	1,015	—	—	—
<b>Color Display Stations:</b>					
	3279 Model S2A; base color; 1920 char.	3,160	18.00	170	145
	3279 Model S2B; extended color; 1920 char.	3,490	18.00	174	148
	3279 Model S3G; extended color; 2560 char.	5,190	24.00	262	223
	3279 Model 2X; base/extended color; 1920 char.	3,235	18.00	175	149
	3279 Model 3X; base/extended color; 2560 char.	3,775	18.50	192	163
	3179 Model 1; 1920 char.; w/122-key Typewriter keyboard	2,295	—	—	—
3850	Extended Function (Model 2X or 3X)	420	2.00	14	12
<b>Keyboards:</b>					
	For 3276/3278—				
4621	75-Key EBCDIC Typewriter	417	1.50	19	16
4622	75-Key EBCDIC Data Entry	417	2.50	19	16
4623	75-Key EBCDIC Data Entry, keypunch layout	417	2.50	19	16
4624	75-Key ASCII Typewriter	417	1.50	19	16
4626	87-Key EBCDIC Typewriter/Text; 3278 only	569	2.00	23	20
4627	87-Key EBCDIC Typewriter; 3278/3274 only	569	2.00	23	20
4628	87-Key ASCII Typewriter; 3278/3274 only	569	2.00	23	20
4629	87-Key EBCDIC Typewriter/Text; 3278 only	569	2.00	23	20
	For 3278/3279—				
4640	87-Key EBCDIC Typewriter Overlay	569	2.00	23	20
4651	87-Key EBCDIC Attribute Select Typewriter	569	2.00	23	20
4652	87-Key EBCDIC Attribute Select Typewriter/APL	569	2.00	23	20
<b>3278 Display Station Options:</b>					
1009	Address Keylock; 3276 only	56	—	62	—
3620	Character Set Extension	644	2.50	26	23
6360	Selector Light Pen	548	0.50	21	18
4999	Magnetic Reader Control	379	3.50	15	13
<b>3278/3279 Display Station Options:</b>					
5790	Programmed Symbols (PS)	853	2.50	36	31
8750	Video output (3279 Model 3X only)	702	1.00	25	21

\*Includes equipment maintenance.

\*\*Four-year lease.

\*\*\*Five-year lease.

NC—No charge.

T&amp;M—Time &amp; material.

IBM 3090 Series

	Purchase Price (\$)	Monthly Maint. (\$)	Monthly Rental Charge* (\$)	Monthly Charge (2-Year Lease)* (\$)
<b>SYSTEM MANAGEMENT</b>				
3814	Switching Management System (requires one Model A):			
	Model A1; Controller; 4 x 4 switch	47,480	145.00	2,438
	Model A2; Controller; 4 x 8 switch	60,420	189.00	3,106
	Model A3; Controller; 8 x 4 switch	64,740	185.00	3,331
	Model A4; Controller; two 4 x 4 switches	69,570	203.00	3,588
	Model B1; Remote Unit; 4 x 4 switch	39,710	98.00	2,044
	Model B2; Remote Unit; 4 x 8 switch	52,660	143.00	2,706
	Model B3; Remote Unit; 8 x 4 switch	56,970	138.00	2,931
	Model B4; Remote Unit; two 4 x 4 switches	61,800	156.00	3,181
	Model C1; Expansion Unit; 4 x 4 switch	37,980	95.00	1,950
	Model C2; Expansion Unit; 4 x 8 switch	50,930	139.00	2,613
	Model C3; Expansion Unit; 8 x 4 switch	55,240	134.00	2,838
	Model C4; Expansion Unit; two 4 x 4 switches	60,070	153.00	3,094
	3604 Keyboard/Display, Model 6, one required	1,745	14.50	126
	1520 Channel Expansion Internal—4 Control Unit Interfaces	1,550	1.00	80
	1521 Channel Expansion Internal—8 Control Unit Interfaces	3,100	1.00	156
	153X Channel Expansion External	5,350	1.00	273
	181X Control Unit Power Sequencing	518	1.00	25
	6010 Remote Two-Channel Switch Control—Basic	5,180	19.50	263
	6011 Remote Two-Channel Switch Control—Additional	2,415	14.50	124
	6350 System Power Sequencing—Additional	207	—	8
<b>COMMUNICATIONS EQUIPMENT</b>				
3705-II	Communications Controller:			
	Model E1 (32K bytes, 64 lines)	38,230	161.00	2,003
	Model E2 (64K bytes, 64 lines)	39,800	181.00	2,191
	Model E3 (96K bytes, 64 lines)	41,370	201.00	2,379
	Model E4 (128K bytes, 64 lines)	42,940	221.00	2,045
	Model E5 (160K bytes, 64 lines)	44,510	240.00	2,755
	Model E6 (192K bytes, 64 lines)	46,080	260.00	2,943
	Model E7 (224K bytes, 64 lines)	47,650	279.00	3,131
	Model E8 (256K bytes, 64 lines)	49,220	300.00	3,325
	Model F1 (32K bytes, 160 lines)	51,530	176.00	2,685
	Model F2 (64K bytes, 160 lines)	53,100	194.00	2,879
	Model F3 (96K bytes, 160 lines)	54,670	215.00	3,067
	Model F4 (128K bytes, 160 lines)	56,240	234.00	3,255
	Model F5 (160K bytes, 160 lines)	57,810	254.00	3,443
	Model F6 (192K bytes, 160 lines)	59,380	273.00	3,631
	Model F7 (224K bytes, 160 lines)	60,950	293.00	3,819
	Model F8 (256K bytes, 160 lines)	62,520	313.00	4,007
	Model G1 (32K bytes, 256 lines)	64,830	189.00	3,372
	Model G2 (64K bytes, 256 lines)	66,400	209.00	3,560
	Model G3 (128K bytes, 256 lines)	67,970	227.00	3,748
	Model G4 (128K bytes, 256 lines)	69,540	248.00	3,936
	Model G5 (160K bytes, 256 lines)	71,110	267.00	4,124
	Model G6 (192K bytes, 256 lines)	72,680	288.00	4,318
	Model G7 (224K bytes, 256 lines)	74,250	306.00	4,506
	Model G8 (256K bytes, 256 lines)	75,820	327.00	4,694
	Model H1 (32K bytes, 352 lines)	78,130	202.00	4,060
	Model H2 (64K bytes, 352 lines)	79,700	222.00	4,248
	Model H3 (96K bytes, 352 lines)	81,270	242.00	4,436
	Model H4 (128K bytes, 352 lines)	82,840	261.00	4,624
	Model H5 (160K bytes, 352 lines)	84,410	281.00	4,812
	Model H6 (192K bytes, 352 lines)	85,980	301.00	5,000
	Model H7 (244K bytes, 256 lines)	87,550	321.00	5,188
	Model H8 (256K bytes, 352 lines)	89,120	341.00	5,376
	Model J1 (320K bytes)	71,020	345.00	5,405
	Model J2 (384K bytes)	74,160	385.00	5,781
	Model J3 (448K bytes)	77,300	424.00	6,157
	Model J4 (512K bytes)	80,440	464.00	6,537
	Model K1 (320K bytes)	84,320	358.00	6,087
	Model K2 (384K bytes)	87,460	398.00	6,468
	Model K3 (448K bytes)	90,600	437.00	6,844
	Model K4 (512K bytes)	93,740	477.00	7,220
	Model L1 (320K bytes)	97,620	372.00	6,774
	Model L2 (384K bytes)	100,760	412.00	7,150
	Model L3 (448K bytes)	103,900	452.00	7,526
	Model L4 (512K bytes)	107,040	491.00	7,908

\*Includes equipment maintenance.  
 \*\*Four-year lease.  
 \*\*\*Five-year lease.  
 NC—No charge.  
 T&M—Time & material.

## IBM 3090 Series

	Purchase Price (\$)	Monthly Maint. (\$)	Monthly Rental Charge* (\$)	Monthly Charge (2-Year Lease)* (\$)
Attachment Bases:				
1301 Type 1	641	0.50	27	23
1302 Type 2	641	0.50	27	23
Channel Adapters:				
1541 Type 1	2,700	9.00	177	151
1542 Type 2	6,470	9.00	334	284
1543 Type 3	12,910	12.00	679	578
1544 Type 4	4,410	8.00	286	243
8002 Two-Channel Switch	2,090	2.50	103	88
Communications Scanners:				
1642 Type 2	4,750	9.00	320	272
1643 Type 3	17,210	34.00	1,150	979
1644 Type 3 High Speed	25,120	40.50	1,545	1,315
4650 Business Machine Clock	424	1.00	15	13
4651 Business Machine Clock	880	1.50	41	35
Communication Line Attachment Features:				
4701 Line Interface Base Type 1	1,105	3.00	69	59
4714 Line Set Type 1D	1,030	3.00	63	54
4715 Line Set Type 1E	1,030	2.50	49	42
4717 Line Set Type 1G	2,050	6.00	135	115
4719 Line Set Type 1J	1,455	2.50	69	59
4720 Line Set Type 1S	3,020	6.00	148	126
4722 Line Set Type 1GA	2,695	6.00	135	115
4723 Line Set Type 1TA	4,850	9.00	244	208
4725 Line Set Type 1T	4,850	9.00	244	208
4726 Line Set Type 1U	5,440	11.00	275	234
4727 Line Set Type 1W	4,720	6.00	226	192
4728 Line Set Type 1Z	8,640	11.00	421	358
4702 Line Interface Base Type 2	1,455	2.50	69	59
4721 Line Set Type 2A	1,030	3.50	49	42
4703 Line Interface Base Type 3	2,515	2.50	125	107
4731 Line Set Type 3A	850	1.50	39	34
4732 Line Set Type 3B	850	1.50	39	34
4708 Line Interface Base Type 8	1,455	3.50	69	59
4781 Line Set Type 8A	1,490	4.50	71	60
4782 Line Set Type 8B	1,920	6.00	94	80
4709 Line Interface Base Type 9	1,455	2.50	69	59
4791 Line Set Type 9A	1,785	11.00	103	88
5000 Line Interface Base Type 10	1,685	2.50	79	67
4784 Line Set Type 10A	2,685	5.50	135	115
Remote Concentrator Feature:				
6261 Remote Program Loader-II	9,335	26.50	491	418
3705-80	Communications Controller:			
Model 81 (256K bytes, 4 lines)	36,600	240.00	1,839	1,565
Model 82 (256K bytes, 10 lines)	46,600	251.00	2,415	2,055
Model 83 (256K bytes, 16 lines)	52,600	262.00	2,844	2,420
Channel Adapters:				
1551 Type 1	3,340	9.50	207	176
1544 Type 4	4,410	8.00	286	243
8002 Two-Channel Switch	2,090	2.50	103	88
Business Machine Clocks:				
1409 50 bps	424	1.00	15	13
1410 110 bps	424	1.00	15	13
1412 200 bps	424	1.00	15	13
1413 300 bps	424	1.00	15	13
1414 600 bps	424	1.00	15	13
1415 1200 bps	424	1.00	15	13
1416 2400 bps	424	1.00	15	13
Communications Line Attachment Features:				
6712 Line Set Type 2	5,440	11.00	275	234
6713 Line Set Type 3	4,850	9.00	244	208
6714 Line Set Type 4	2,060	4.00	100	85
6715 Line Set Type 5	10,320	14.50	497	423
5657 Line Set Type 8	2,600	3.50	122	104
5658 Line Set Type 9	1,550	3.00	71	60
6261 Remote Program Loader	9,335	26.50	491	418

\*Includes equipment maintenance.

\*\*Four-year lease.

\*\*\*Five-year lease.

NC—No charge.

T&amp;M—Time &amp; material.

IBM 3090 Series

		Purchase Price (\$)	Monthly Maint. (\$)	Monthly Rental Charge* (\$)	Monthly Charge (2-Year Lease)* (\$)
3725	Communications Controller:				
	Model 1; up to six channel adapters and from 512K to 1024K bytes of main storage capacity	75,000	224.00	3,725	—
	Model 2; up to two channel adapters and 512K bytes of main storage capacity (Model 2 to Model 1 Upgrade charge is \$16,000)	60,500	200.00	2,810	—
	1561 Channel Adapter	6,750	8.50	337	—
	4666 Internal Clock Control	1,500	2.00	73	—
	4771 LAB Type A	19,000	17.00	943	—
	4772 LAB Type B	26,400	29.00	1,315	—
	4911 LIC Type 1	2,600	2.00	131	—
	4921 LIC Type 2	3,000	2.00	148	—
	4931 LIC Type 3	3,000	2.00	148	—
	4941 LIC Type 4A	2,600	2.00	131	—
	4942 LIC Type 4B	3,000	2.00	148	—
	7100 Storage Increment 256K	4,375	20.00	217	—
	8320 Two Processor Switch	4,000	3.00	200	—
3726	Communications Controller Expansion	32,000	42.00	1,585	—
3727	Operator Console	2,390	27.00	182	—

\*Includes equipment maintenance.

\*\*Four-year lease.

\*\*\*Five-year lease.

NC—No charge.

T&M—Time & material.

SOFTWARE PRICES

		Initial Charge		Monthly Charges		Monthly Licensed Program Support (\$)
		Basic License (\$)	DSLO (\$)	Basic License (\$)	DSLO (\$)	
5740-XYS	MVS/SP-JES2 Version 1					
	Release 1 and 2	—	—	2,040	11	225
	Release 3 through 3.6	—	—	2,031	1,521	225
5740-XC6	MVS/SP-JES2 Version 2					
	Releases 1.0, 1.1, 1.2, and 1.5	12,000	9,000	4,000	3,000	629
5740-XYN	MVS/SP-JES3 Version 1					
	Release 1	—	—	2,015	1,510	110
	Release 3 through 3.5	—	—	2,229	1,669	484
5665-291	MVS/SP JES3 Version 2					
	Releases 1.0, 1.1, 1.2, and 1.5	13,500	10,125	4,500	3,375	1,250
5664-167	VM/SP					
	Releases 1, 2, 3, and 3.1	—	—	414	310	63
5664-169	VM/XA Systems Facility					
		10,500	7,875	3,500	2,625	583
5664-173	VM/SP High Performance Option					
	Release 3.0, 3.2, and 3.4	4,980	3,740	1,660	1,240	128
5667-126	Interactive Executive/370 (IX/370)	10,000 up	—	—	—	475
5665-284	Data Facility Product					
	Releases 1.0, 1.1, and 1.2	1,485	1,110	495	370	77
5668-962	Assembler H Version 2	435	326	145	108	7
5668-958	VS Cobol II Compiler and Library	6,000	4,500	1,000	750	50
5668-940	VS Cobol II Library	2,400	1,800	400	300	50
5740-CB1	Cobol OS/VS Compiler and Library Version 2 Release 3	—	—	342	256	14
5748-FO3	VS Fortran Compiler and Library Release 2	699	524	233	174	17
5748-LM3	VS Fortran Library Release 2	207	155	69	51	7
5734-FO2	Fortran IV (G1) Compiler	—	—	92	69	10
5734-FO3	Fortran IV (H Extended) Compiler	—	—	399	299	16
5734-LM3	Fortran IV Library	—	—	123	92	16
5734-FO5	Fortran Interactive Debug	—	—	*240	—	—
5668-903	VS Fortran Interactive Debug Release 2	1,800	1,300	300	225	25
5748-XX1	VS Basic	—	—	514	385	18
5668-996	IBM Basic	1,050	786	350	262	36
5748-AP1	VS APL Release 4	—	—	361	270	39
5734-PL1	PL/1 Optimizing Compiler Release 4	—	—	277	207	37
5734-PL2	PL/1 Checkout Compiler Release 3	—	—	538	403	7
5734-PL3	PL/1 Optimizing Compiler and Library Release 4	—	—	372	279	50
5734-LM4	PL/1 Resident Library	—	—	60	45	7
5734-LM5	PL/1 Transient Library	—	—	35	26	7
5746-RG1	RPG II	—	—	150	112	7
5796-PNQ	Pascal/VS	—	—	201	—	—

\*Also available for a one-time charge of \$3,600.



## IBM 3090 Series

		Initial Charge		Monthly Charges		Monthly Licensed Program Support (\$)
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5740-XX2	IMS/VS Version 1 Release 3	—	—	1,685	1,265	180
	Data Communications Feature	—	—	2,105	—	180
5665-332	IMS/VS Version 2 Release 1 (will be available in 1st Qtr. 1986)	—	—	3,900	2,925	825
5665-319	Interactive System Productivity Facility (ISPF) for MVS Version 2.1.2	600	450	190	142	30
5665-317	Interactive System Productivity Facility/Program Development Facility (ISPF/PDF MVS) for MVS Version 2.1.2	3,500	2,625	500	375	14
5740-XX7	GIS/VS (Generalized Information System/VS)	—	—	1,255	942	86
5740-XXF	DB/DC Data Dictionary	—	—	1,040	779	108
5740-XX1	CICS/OS/VS Release 6	5,350	4,010	1,785	1,335	145
5748-XXH	Graphical Data Display Manager (GDDM) Release 3	715	536	149	112	33
5740-SM1	DFSORT (Data Facility Sort) Release 7	—	—	231	173	18
5750-ESE	Engineering/Scientific Support System-Entry					
5668-947	Network Communications Control Facility (NCCF) Version 2 Release 2	2,100	1,890	350	315	50
5668-920	Network Problem Determination Application (NPDA) Version 3 Release 2	1,650	1,237	264	198	22
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5665-285	TSO Extensions for MVS/370	1,405	1,055	469	352	82
5665-293	TSO Extensions for MVS/XA	1,405	1,055	520	390	101
5735-RC3	ACF/TCAM Version 2	2,420	1,815	874	655	91
5665-280	ACF/VTAM Version 2	3,745	2,809	1,245	934	225
5665-288	MVS/Operator Communication Control Facility (MVS/OCCF)	990	740	330	245	8

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