

IBM 3090 Series

MANAGEMENT SUMMARY

UPDATE: As many IBM watchers, market analysts, and industry soothsayers had been expecting, on February 11, 1986 IBM introduced two single processor entry-level 3090 models, the Model 150 and the Model 180, bringing the total number of processors within the top-end mainframe family to four. The Model 180 will be available April 1986 and the Model 150 will be available October 1986. On the same day, IBM also announced price cuts for the 3090 Model 200 and Model 400. Also, customers can now buy a fully configured, four-processor Model 400 directly from an IBM plant. Previously, a Model 400 could only be ordered as an upgrade of a Model 200. First shipments of the Model 200 began in August 1985, while the Model 400 won't be shipped until fourth quarter 1986. Other related 3090 announcements included enhancements to the expanded storage option and to operating system software. Finally, IBM announced that the new Vector Facility option, introduced October 1, 1985, can be installed on all the 3090 models.

Observers believe the 3090 price cuts along with another round of 308X price cuts are part of IBM plans to stimulate mainframe sales and to make sure 1986 does not turn out to be a repeat of the financially disappointing year 1985 was for IBM. As an additional spur to 3090 sales, IBM introduced the Models 150 and 180, two entry-level processors that are field upgradable to the two larger processors within the series, the Models 200 and 400. Additionally, the Model 400, now the most powerful mainframe IBM makes, will be available by the end of this year instead of second quarter 1987, the first announced delivery date. With these latest hardware introductions and pricing moves, IBM is apparently hoping users outgrowing 4300 and 3083 mainframes will order 3090-level processors instead of migrating through the 308X Series, a processor line nearing the end of its useful product cycle.

Both the Models 150 and 180 are each single-processor complexes that come with 32 megabytes of storage, ex- ➤

The 3090 Processor Complex Models 150, 180, 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 150, 180, 200, and 400.

CONFIGURATION: The Models 150 and 180 are single processors with 16 integrated channels and up to 64 megabytes of shared central storage. 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: Amdahl 5890, 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 \$1,300,000 for the Model 150 to \$7,944,000 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. ➤



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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▶ expandable to 64 megabytes, and a 64K-byte high-speed buffer. The Model 150 includes 16 integrated high-speed channels expandable to 24, while the Model 180 also comes with 16 integrated channels expandable to 32 channels in 8- or 16-channel increments.

Related operating system software releases that were announced with the Models 150 and 180 were MVS/SP Version 2 Release 1.7, VM/XA Systems Facility Release 2, Resource Measurement Facility Version 3 Release 4, and Resource Measurement Facility Version 3 Release 4.1. Other software products included the Engineering and Scientific Subroutine Library and the 3090 Vector Facility Simulator.

A second major 3090 hardware-related announcement centered around IBM's expanded storage concept. IBM increased maximum expanded storage capacity on the Models 200 and 400 and is making it available to the Model 180, but not the Model 150. The Model 400 can be configured with up to 512 megabytes of expanded storage and the Model 200 and Model 180 can be configured with up to 256 megabytes of expanded storage. The Model 400 can be configured with a minimum of 128 megabytes of expanded storage that can be expanded in 128-megabyte increments. The Models 180 and 200 can be configured with a minimum of 64 megabytes of expanded storage that can be expanded in 64-megabyte increments.

The Models 150 and 180 are positioned as replacements for the single-processor 3083 group. According to IBM, the Model 180 has 1.7 to 2.1 times the internal execution rate of the 3083 JX and is expected to have 1.4 to 1.6 times the performance of the Model 150 operating under MVS/XA. When outfitted with a Vector Facility, the Model 180 can achieve 4 to 9 times the performance of the 3083 JX processing engineering/scientific jobs in scalar mode.

Interestingly, the Models 200 and 400 were introduced on February 12, 1985, almost one year to the date of the announcement of the two new entry-level models. The Model 200 is a dyadic processor with 64 megabytes of shared central storage and the Model 400 is a four-way processor with 128 megabytes of shared central storage. The 3090 Series is aimed at users whose computing requirements may be growing 50 percent or more a year. IBM customers whose requirements have outgrown the capacity of a 3084, IBM's previous top-end model, are prime candidates for the two upper-end 3090 Complexes. When announced a year ago, IBM said the 3090 Model 200 had 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. The new Vector Facility will make it possible to run many engineering and scientific applications 1.5 to 3 times faster on a Model 200 than on a model not using the vector feature.

▶ 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: 288K-bit memory chips.

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

CYCLE TIME: See Table 1.

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.

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.

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.

CENTRAL PROCESSORS

The 3090 Series consists of the Models 150 and 180, two single processors, 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. If one of the processors within a Model 200 or Model 400 complex fails, the remaining central processors can continue to operate. In addition to the central processor complex, which includes shared central storage, and buffer memory and 16 to 64 integrated channels, 3090 mainframes require at least one of the following components:

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TABLE 1. SYSTEM COMPARISON

| MODEL | Model 150 | Model 180 | Model 200 | Model 400 |
|-------------------------------|----------------------------------|----------------------------------|----------------------------------|----------------------------------|
| SYSTEM CHARACTERISTICS | | | | |
| Date announced | February 11, 1986 | February 11, 1986 | February 12, 1985 | February 12, 1985 |
| Date first delivered | October 1986 | April 1986 | August 1985 | Fourth Quarter 1986 |
| Field upgradable to | Model 180 | Model 200 | Model 400 | — |
| Relative performance | — | — | — | — |
| Number of processors | 1 | 1 | 2 | 4 |
| Cycle time, nanoseconds | 18.5 | 18.5 | 18.5 | 18.5 |
| Word size, bits | 32 | 32 | 32 | 32 |
| Operating systems | MVS/SP, MVS/XA, VM/HPO, VM/XA | MVS/SP, MVS/XA, VM/HPO, VM/XA | MVS/SP, MVS/XA, VM/HPO, VM/XA | MVS/SP, MVS/XA, VM/HPO, VM/XA |
| MAIN MEMORY | | | | |
| Type | 288K-bit chip | 288K-bit chip | 288K-bit chip | 288K-bit chip |
| Minimum capacity, bytes | 32MB | 32MB* | 64MB* | 128MB* |
| Maximum capacity, bytes | 64MB | 64MB | 64MB | 128MB |
| Increment size | 32MB | 32MB | — | — |
| Cycle time, nanoseconds | — | — | — | — |
| BUFFER STORAGE | | | | |
| Minimum capacity | 64KB | 64KB | 128KB | 256KB |
| Maximum capacity | 64KB | 64KB | 128KB | 256KB |
| Increment size | — | — | — | — |
| INPUT/OUTPUT CONTROL | | | | |
| Number of channels: | | | | |
| Byte multiplexer | 0-4 | 0-4 | 0-4 | 0-8 |
| Block multiplexer | 16, 24 | 16, 24, 32 | 32, 40, 48 | 64, 80, 96 |
| Word | — | — | — | — |
| Other | — | — | — | — |

*In addition to conventional main memories, the Models 180, 200, and 400 can be outfitted with optional expanded storage. See text for more details.

➤ All the 3090 models feature 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.

When the 3090 was first announced 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.

Additional 3090 features not available with the 308X Series are Expanded Storage and a Vector Facility, both optional components.

Expanded storage is a new cache memory concept. The 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 Vector Facility, which IBM is calling an extension of the central processor's instruction and execution elements, can be added to each Model 150 and Model 180 processor ➤

- • 3092 Processor Controller Model 1 or 2;
- 3097 Power and Coolant Distribution Unit Model 1 or 2;
- 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 the Models 150, 180, 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 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.

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 150 and Model 180 come with 32 megabytes of central storage expandable to a maximum of 64 megabytes. The Model 200 ➤

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▷ and to each processor within a Model 200 or Model 400 complex. Operating under System/370 and 370/Extended Architecture modes, the Vector Facility adds 171 new instructions to the processor complex and 16 vector registers that each contain one-hundred and twenty-eight 32-bit elements. Multiplier and arithmetic/logic units can produce 32-bit or 64-bit floating-point sums, differences, and products during each machine cycle using pipelining techniques. Compound instructions can produce both a product and sum during each machine cycle. Structural design, reservoir modeling, fluid dynamics, and load flow are among the applications suited to vectorized computing. The new Vector Facility is a field-installable option that is implemented in both hardware and software. According to IBM, the facility can improve system performance for vector, parallel, and scalar operations.

To support the Vector Facility, IBM brought out several software products and enhancements. These include MVS/SP Version 2 Release 1.3 Vector Facility Enhancement; VS Fortran Version 2, a new version of Fortran enhanced for vector operations; VM/SP High Performance Option Release 4.2 Support for Vector Facility; IBM Fortran Language Conversion Program for converting earlier Fortran source language statements to the new Fortran; the Engineering and Scientific Subroutine Library, an enhanced set of vector-related mathematical subroutines; Assembler H Version 2 with Vector Facility Enhancement; and Vector Processing Subsystem/Vector Facility for simulating the IBM 3838 Array Processor.

As a precursor to the new Vector Facility, IBM announced in February 1985 other software products designed to enhance scientific and engineering applications. These include Interactive Executive, IBM's implementation of Unix System V; Engineering/Scientific Support System Release 1.1, which provides additional 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.

COMPETITIVE POSITION

With the announcement of two additional 3090 processors, price cuts for the Models 200 and 400—introduced only a year ago—and with the unveiling of an optional vector facility, IBM has proved once again it can make life most difficult for its plug-compatible mainframe (PCM) rivals, Amdahl and National Advanced Systems (NAS).

In a move sure to bring heartburn to the marketing strategists in these two PCM camps, IBM reduced the prices on the Model 200, first shipped in August 1985, and the Model 400, the four-way processor that has yet to be delivered. According to published reports, IBM is orchestrating the aggressive pricing moves out of fear the industry-wide

▶ 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 180, 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 180 and Model 200 can be configured with a minimum of 64 megabytes of expanded storage expandable in 64-megabyte increments to a maximum of 256 megabytes. Expanded Storage is not available on the Model 150, however. The Model 400 can be outfitted with a minimum of 128 megabytes of shared expanded storage expandable in 128-megabyte increments to a maximum of 512 megabytes.

Each central processor in a 3090 complex 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 supporting 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 page 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.

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

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▷ computer sales slump that made 1985 a bad year will continue into 1986.

In an earlier move, IBM pushed up the delivery date of the Model 400 from second quarter 1987 to fourth quarter 1986. The accelerated delivery schedule now makes it more difficult for PCM rivals to find opportunity among IBM customers who need the power of a Model 400 but would rather not wait.

As it stands now, NAS plans to deliver the Alliance Series, its strategic response to the 3090, by second quarter 1986, several months before the Model 400, while Amdahl won't bring out the most powerful model of its new 5890 Series until third quarter 1987.

The addition of an IBM vector facility may give users another reason to stay in the IBM fold. With the vector announcement, IBM takes a renewed interest in scientific processing, an area it all but ignored when it marketed the 308X. The oversight was not lost on PCM rivals NAS and Amdahl, both of which market vector attachments for plug-compatible systems that competed with the 308X Series. NAS brought out the 91X0 Series in 1984, while Amdahl brought out four vector processor attachments in 1985. IBM responded belatedly to this market after realizing a substantial percentage of its user base needed this capability. In a 1985 Datapro survey of mainframe users, 40 percent of IBM 3081 users said they ran engineering/scientific applications.

The pricing of the vector facility addition appears to make the option an attractive add-on for users who need vector capabilities, but are not prepared to purchase a true super-computer such as a Cray. The cost of two Vector Facilities added to a two-processor Model 200 comes to about 10 percent of the purchase price of a basic Model 200 complex. A single Vector Facility feature is rated at 108 MFLOPs (millions of floating points) per second.

The two less powerful entry-level models into the 3090 series, the Models 150 and 180, now outmatch the existing 3083 single processor group in performance. Their introduction surely signals the end of the 308X product cycle. Although IBM continues to produce 308X processors, the new uniprocessor models make it easier for 4300 or 3083 users to migrate to the 3090 Series.

Besides competition from its two major plug-compatible rivals, the IBM 3090 also competes against new processor lines brought out last year by Honeywell Information Systems, Burroughs Corporation, and Control Data Corporation. Sperry Corporation, meanwhile, has 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 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 configura- ▷

▶ 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.

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 of 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.
- 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 pro- ▶

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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/HDAs 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 |

➤ rations 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 three-model Amdahl 5890 Series includes the 5890-200 and 300 dual processors, and the 5890-600, a four-way processor. The processors use 256K-bit NMOS memory chips and feature a processor cycle time of 15 nanoseconds. Main memory ranges from 64 megabytes to 512 megabytes.

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 nonexpandable 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. 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 processors. 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 ➤

➤ gram a controlling function over the execution of a channel program.

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.

A modular unit that works closely with the 3090 complex is the 3092 Processor Controller. The 3092 Models 1 and 2 is a major system component which performs many key monitoring and control functions for all 3090 models. 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
- 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 ➤

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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 |
| Model 5 | 9 | 1600 | PE | 75 | 120,000 |
| | 7 | 556/800 | NRZI | 125 | 69,500/100,000 |
| | 9 | 800 | NRZI | 125 | 100,000 |
| Model 7 | 9 | 1600 | PE | 125 | 200,000 |
| | 7 | 556/800 | NRZI | 200 | 111,200/160,000 |
| | 9 | 800 | NRZI | 200 | 160,000 |
| Model 4 | 9 | 1600 | PE | 200 | 320,000 |
| | 9 | 1600 | PE | 75 | 120,000 |
| | 9 | 6250 | GCR | 75 | 470,000 |
| Model 6 | 9 | 1600 | PE | 125 | 200,000 |
| | 9 | 6250 | GCR | 125 | 780,000 |
| Model 8 | 9 | 1600 | PE | 200 | 320,000 |
| | 9 | 6250 | GCR | 200 | 1,250,000 |
| 3430 | 9 | 1600 | PE | 50 | 80,000 |
| 3480 | 9 | 6250 | GCR | 50 | 312,500 |
| | 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.

➤ processor on the system, and provide fast storage for microcode control programs.

ADVANTAGES AND RESTRICTIONS

When announced in February 1985, the IBM 3090 seemed to fall short of the dramatic technology breakthroughs many IBM watchers were expecting. In fact, the dyadic Model 200 appeared to be little more powerful than an existing four-way IBM 3084 QX. It soon became apparent the real performance breakthrough would not be available until the delivery of the four-way Model 400, now scheduled to be delivered by the fourth quarter of this year. With the October announcement of the new Vector Facility, however, it appeared IBM was ready to reveal heretofore hidden capabilities. A Vector Facility, which can be added to each processor, has a measured performance estimate of 108 MFLOPS.

➤ 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 complet-

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▷ In addition, the 3090 comes with state-of-the-art technology features to increase processor 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, the 3090 now uses 288K-bit memory chips. Lastly, 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 Models 180 and 200 can have up to 64 megabytes of shared central storage and can be outfitted with up to 256 megabytes of expanded storage in 64-megabyte increments. The Model 400 comes with 128 megabytes of shared central storage and up to 512 megabytes of shared expanded storage in 128-megabyte increments.

For the moment, the 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 data streaming mode remains at three megabytes per second.

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.

The protracted delivery schedule of the Model 400 continues to be a problem for users who need a four-processor configuration for more power and more operational flexibility. The Model 400 can be operated in single-image mode or partition mode. Partition mode lets users split different types of application loads. IBM users who may have been used to running in partition mode on the four-processor IBM 3084 QX may feel constricted if they migrate directly from a 3084 QX to a Model 200 which only runs in single-image mode. These users may have to live with this inconvenience until the time the Model 400s are available.

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

▶ ed, 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.

The 3097 Power and Coolant Distribution 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. The 3097 Model 2 has all the power and cooling distribution capabilities of the 3097 Model 1, but does not include the input/output power sequence control function. This provides flexibility to users who want to use I/O power sequencing on control units attached to their 3090. Additionally, Model 2 users can upgrade to a Model 1.

The 3089 Power Unit Model 3 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 is used as either a system or maintenance console. The 3090 Models 150, 180, and 200 require 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.

The 3864 Modem Model 2 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 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 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 ▶

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TABLE 4. TERMINALS

| MODEL | 3178 | 3179 | 3180 | 3278 | 3279 |
|------------------------------------|---------------------------|---------------|---------------------------|----------------------------|-------------------|
| DISPLAY PARAMETERS | | | | | |
| 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 |
| KEYBOARD PARAMETERS | | | | | |
| 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 |
| OTHER FEATURES | | | | | |
| Buffer capacity | — | — | — | — | 6 prog. sym. sets |
| Tilt/swivel | Standard | Standard | Standard | No | No |
| Graphics capability | No | No | No | No | Yes |
| TERMINAL INTERFACE | RS-232-C | RS-232-C | RS-232-C | RS-232-C | RS-232-C |

▷ 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

Datapro gathered preliminary results from the 1986 annual user survey to determine what several of the first 3090 Model 200 users think of IBM's newest mainframe family. The Models 150, 180, and 400 were not yet available when the survey was taken. The following user ratings are based on the early responses of six users who took delivery on Model 200s primarily during the fourth quarter of 1985. IBM began delivering two-processor Model 200s in October. The Model 400 won't be delivered until later this year. More complete user results that will include more IBM users will be published in June.

Included among the six respondents were two insurance companies, a utility, a chemical and petroleum firm, a retail/wholesale firm, and a transportation-related firm. Leading the list of principal applications checked off on a Datapro survey form were insurance and payroll/personnel (both four); followed by accounting and billing, order processing, and purchasing, (all three); health care, sales/distribution, and engineering (all two); and file management, construction, education, manufacturing, and mathematics (all one).

All these IBM Model 200 users upgraded from other IBM mainframes. Two upgraded from 3084s, two from 3081s, and one from a 3033u. A sixth respondent did not answer this question.

As would be expected, the results show the six sites use the Model 200s as the centers of large data processing operations. Five respondents said they use IBM Extended Architecture operating systems, five use more than 64 megabytes of main memory, and all six use more than 60 local terminals and more than 60 remote terminals. All six also use a data base management package. Three said they use IBM's IMS/VS and three said they use Cullinet's IDMS. ▷

▷ 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.

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.

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. ▷

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➤ When contacted, at least two users said they moved up to a Model 200 because they were able to arrange financially attractive lease terms with third-party vendors. None considered mainframe products from plug-compatible vendors. There were virtually no complaints about the performance of the hardware or the hardware conversion process. After replacing a 3084 with a Model 200 one user said the new processor "came up like a dream."

A former 3084 user who replaced the four-processor mainframe with the dyadic Model 200, said the new mainframe did offer slightly better performance.

A big Model 200 drawback for some users so far may center around CPU flexibility and the availability of the Model 400. Former 3084 users who were operating their four-processor system in split partition mode cannot do so with the Model 200. One respondent who used to run production on one side of the 3084 partition and test work on the other side can no longer do that with the Model 200. For the time being or until they can take delivery of a four-processor Model 400, the user said the software staff is forced to work weekends to take care of work that can't be scheduled during the week. Another user said his firm is also forced to find time on weekends to perform CPU maintenance.

Users were asked to rate their mainframes in fourteen specific areas. The results of the survey are summarized in the chart below. Keep in mind, of course, these Model 200s had only been in place at these sites for perhaps two or three months when users were asked to rate them. Users answered survey questions sometime in January or February 1986.

As the results show, the Model 200 scores well in most categories. The Model 200 has racked up very respectable scores in both hardware and software categories. Scores in maintenance service and technical support areas, traditionally weak vendor areas, are also respectable. "Ease of conversion" received the lowest score out of all the categories; however, as the chart shows, five of the respondents rated this "good" while only one rated it "fair." No one rated this excellent or poor.

| | Excellent | Good | Fair | Poor | WA* |
|----------------------------|-----------|------|------|------|------|
| Ease of operation | 4 | 2 | 0 | 0 | 3.66 |
| Reliability of mainframe | 6 | 0 | 0 | 0 | 4.00 |
| Reliability of peripherals | 5 | 1 | 0 | 0 | 3.83 |
| Maintenance service: | | | | | |
| Responsiveness | 3 | 2 | 1 | 0 | 3.33 |
| Effectiveness | 3 | 3 | 0 | 0 | 3.50 |
| Technical support: | | | | | |
| Troubleshooting | 3 | 3 | 0 | 0 | 3.50 |
| Education | 2 | 4 | 0 | 0 | 3.33 |
| Documentation | 2 | 4 | 0 | 0 | 3.33 |
| Manufacturer's software: | | | | | |
| Operating system | 5 | 1 | 0 | 0 | 3.83 |
| Compiler & assemblers | 5 | 1 | 0 | 0 | 3.83 |
| Application programs | 1 | 3 | 1 | 0 | 3.00 |
| Ease of programming | 0 | 6 | 0 | 0 | 3.00 |
| Ease of conversion | 0 | 5 | 1 | 0 | 2.83 |
| Overall satisfaction | 4 | 2 | 0 | 0 | 3.66 |

*Weighted Average on a scale of 4.0 for Excellent.

➤ 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.

SPECIAL FEATURES: To address user applications computationally intensive scientific and engineering applications, IBM offers a Vector Facility. The feature, which can be added to any processor within a 3090 complex, adds a vector extension to the basic IBM System/370 and 370 Extended architecture. The Vector Facility is suited to such applications as structural design, reservoir modeling, fluid dynamics, and load flow. The new Vector Facility is a field-installable option that is implemented in both hardware and software.

The facility can be installed on the Models 150 and 180 and on each processor of a dyadic Model 200 or a four-way Model 400, and will be supported by MVS/XA and VM/SP High Performance Option. The Vector Facility feature adds 171 new instructions and 16 vector registers each containing 128 32-bit elements. Other features include binary, 32-bit, and 64-bit floating-point operands, using contiguous, non-contiguous, and random addressing.

The new features should produce results using fewer machine cycles. Multiplier and arithmetic/logic units using pipelining techniques can produce 32-bit or 64-bit sums, differences, or products during each cycle. Compound operations are able to produce both a product and sum during each cycle. Other features designed to improve the performance of engineering/scientific jobs include high-speed multiply, fast floating-point add/subtract, fast loop control execution, and 64-bit wide data paths.

According to IBM, the facility can improve system performance for vector, parallel, and scalar operations. Engineering/scientific (E/S) jobs using the Vector Facility had 4.1 to 9.2 times the internal throughput rate of a 3081 Model Group KX per central processor. E/S jobs measured for engineering/scientific scalar processing performance had 2.1 to 3.1 times the internal throughput of a 3081 KX for each central processor. E/S jobs using the Vector Facility had 1.5 to 3 times the internal throughput of the 3090 Model 200 per central processor running in scalar mode.

A dual-processor 3090 Model 200 with two Vector Facilities yields 1.87 to 1.99 times the performance of a single-processor Model 200 with one Vector Facility.

A Model 150, running engineering/scientific scalar applications is expected to have an instruction execution rate of approximately 1.2 to 1.3 times a 3083-JX, according to IBM data. A Model 180 outfitted with a Vector Facility is expected to have the same performance as a Model 200 operating only one central processor using a Vector Facility.

PHYSICAL SPECIFICATIONS: A basic Model 200 configured with 64 megabytes of main memory and 32 channels will typically require 37.4 kVAs when operating at 400 Hz. This same configuration has a typical heat output to air of 12.1 Btus per hour. A fully configured Model 200 featuring 64 megabytes of main memory, 128 megabytes of expanded storage, and 48 channels requires 44.1 kVAs. This same configuration has a typical heat output to air of 13.2 Btus per hour. A basic Model 400 configured with 128 megabytes of main memory, 64 channels will typically require 40.0 kVA. This same configuration has a typical head output of 10.6 Btus.

CONFIGURATION RULES

➤ The 3090 Processor Complex Model 150 consists of a single central processor, a 3092 Processor Controller Model 1, a ➤

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➤ When asked if their Model 200 performed as expected, all six said "Yes." When asked if they would recommend the Model 200 to others, all six also answered in the affirmative. □

➤ 3097 Power and Coolant Distribution Unit Models 1 or 2, one 3089 Power Unit Model 3, two 3370 Direct Access Storage Model A2s each with String Switch (#8150), two 3180 Display Station Model 145s, and a 3864 Modem Model 2 equipped with Automatic Calling Unit (#5801).

The 3090 Processor Complex Model 180 consists of a single central processor, a 3092 Processor Controller Model 1, one 3097 Power and Coolant Distribution Unit, one 3089 Power Unit Model 3, or two 3089s if processor complex is configured with more than 128 megabytes of Expanded Storage and a Vector Facility, two 3370 Direct Access Storage Model A2s each with String Switch (#8150), two 3180 Display Station Model 145s, and a 3864 Modem Model 2 equipped with Automatic Calling Unit (#5801).

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).

INPUT/OUTPUT CONTROL

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.

Both 3090 Models 150 and 180 come with 16 integrated high-speed channels. The Model 150 can be configured with eight additional channels for a total of 24 integrated channels all together. An additional eight or 16 channels can be added to the Model 180 for a total of 32 channels all together. Up to four channels can be configured in the field as byte multiplexer channels, each with an aggregate data rate ranging from 90 to 300K bps.

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.

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

IBM disk storage devices are covered in Table 2.

INPUT/OUTPUT UNITS

IBM tape drives and printers are covered in Table 3.

The 3814 Switching Management System 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. 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. ➤

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► TERMINALS

IBM terminals are covered in 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 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.

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.

The 3725 Communications Controller 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-, 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.

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) 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. ►

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► **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-XY5) 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.

Multiple Virtual Storage/System Product 2.1.3 Vector Facility Enhancement supports the Vector Facility. The software product lets systems using the Vector Facility recognize a vector user and assigns the vector job to the central processor set up for vector processing. The software release features vector affinity, System Management Facilities, enhanced operator commands, and serviceability enhancements. Operating under MVS/XA, a vector affinity feature automatically allows the users to run on the central processor that has the Vector Facility. System Management Facilities provides accounting information detailing Vector Facility usage and affinity. New operator commands let operators display systems using the Vector Facility and bring the processor equipped with the Vector Facility on- or off-line. The Vector Facility can be brought off-line independent of the central processor. Additionally, the Interactive Problem

Control System and standalone dump have been enhanced. Checkpoint restart supports the Vector Facility.

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/SP-JES3 Version 2 Release 1.7 provides supports for the Model 400 in System/370 Extended Architecture mode and also provides reconfiguration support. Reconfiguration support involves those functions involved in processor side partitioning and expanded storage. A side consists of the channel paths, processors, expanded storage elements, real storage elements, and vector facilities that can support a single operating system.

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 support 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 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.

VM/SP High Performance Option Release 4.2 Support for Vector Facility supports the Model 200 equipped with the Vector Facility and will support the Model 400 with the Vector Facility in partitioned mode only. This latest release of the High Performance Option contains all the functions of the currently available VM/SP HPO Releases 3.6 and 4. VM/SP HPO Release 4 supports the execution of vector applications while also supporting VS Fortran Version 2 on CMS, Assembler H, the Engineering and Scientific Subroutine Library, additional control program commands, and applications that use the Vector facility. Such applications do not require special setups and programming. ►

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► 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.

VM/XA Systems Facility Release 2 supports the Model 400 in four-way, single-image configuration, supports the Vector Facility; upgrades the CMS component to CMS 4, and extends CMS program product support. It also supports the 3800 Model 3 in Model 1 compatibility mode, provides load parameter support, and provides a dialed terminal test/normal reset capability. Serviceability enhancements include control program trace facility and dump viewing facility component improvements.

INTERACTIVE EXECUTIVE/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.

PROGRAMMING LANGUAGES: Programming languages available with the 308X Series include VS Cobol II; OS/VS Cobol compiler and library; Cobol Interactive Debug; VS Fortran Version 2 Compiler, Library, and Interactive Debug; VS Fortran Compiler and Library; Fortran IV (H Extended) Compiler; Fortran IV (G1) Fortran H Extended Optimization Enhancement; Fortran Interactive Debug; OS Fortran IV Library (MOD II); IBM Fortran Language Conversion Program; VS Fortran Version 2 Compiler, Library and Interactive Debug; VS Fortran Version 2 Library; OS PL/1 Optimizing Compiler and Libraries; OS/VS PL/1 Checkout Compiler and the Optimizing Compiler; IBM Basic; RM Basic, a business-oriented compiler interpreter for VM/370-CMS, DOS/VSE, and SSX/VSE environments; APL2; RPG II; Assembler H Version 2; and Pascal/VS.

DATABASE MANAGEMENT: IBM's two major database management offerings are *Information Management System/VS-DB* and *Database 2 (DB2)*. By far, IMS/VS-DB continues to be the center of IBM's data system universe. IMS/VS Version 2 Release 1, the latest version first announced in 1985, allows IMS to operate under both MVS/XA and MVS/370. In addition to all the functions of IMS/VS Version 1, Version 2 also supports the *MVS/XA Extended Recovery Facility (XRF)*, virtual storage constraint relief for Fast Path users, improved DL/1 I/O error processing, dynamic backout enhancements, DL/1 scheduling changes, data sharing improvements, and several other enhancements.

XRF, a major IMS addition, 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 workload of the active system. XRF thus reduces the time that end users are prevented from accessing the system.

IMS lets users generate and access a database with automatic cross-referencing among data records. IMS/VS offers on-line message processing with the optional IQF (Interactive Query Facility) or GIS/VS (General Information System), and batch inquiry with GIS or GIS/VS is 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/VS-DB) can be augmented with data communications capability to produce a transaction-driven system. This is achieved by combining IMS/VS-DB with either *IMS/VS Data Communication (IMS/VS-DC)*, or *Customer Information Control System/VS (CICS/VS)*. The DB system is a prerequisite to ►

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

Database 2 (DB2) is IBM's relational database product that can run under either MVS/XA or MVS/370. It's designed to coexist or complement IMS/VS-DB. In addition to supporting IMS/VS, DB2 supports TSO and CICS/VS, and uses a single high-level data access language, *Structured Query Language*, to program in either high-level language or interactive mode. To simplify DASD space allocation and VSAM data set definition, DB2 uses high-level interfaces to subsystems such as VSAM. DB2 also supports disk logging and optionally available dual logging for automated recovery, and provides "help" facilities to assist all types of users. DB2 can be used to implement decision support systems and traditional applications. According to IBM, the product is particularly suited for environments in which application requirements and data structures are subject to frequent change.

DATA MANAGEMENT: IBM systems employ several data management structures to organize, access, update, retrieve, catalog, store, and generally manage data resources in addition to application packages designed for specific functions and benefits. Data management access methods may use the queued access or basic access techniques. Basic access approaches permit access of all data organizations while queued access applies only to sequential and indexed sequential data sets. Both access types each use several kinds of access methods that vary in function. *VSAM (Virtual Storage Access Method)* encompasses both access techniques. VSAM uses a modified basic and queued access technique and applies to direct and sequential data sets.

Data management tools and applications that may make use of these file structures include *DB/DC Data Dictionary* and *Query Management Facility (QMF)*.

DB/DC Data Dictionary provides a central source of information describing files, databases, programs, and user-defined resources, and how they all interrelate. The Data Dictionary can help enforce naming conventions and establish a central control point particularly within organizations that permit remote locations to develop and run their own data and programs. The application can be particularly beneficial to organizations planning to convert to a DL/1 database system, according to IBM. The dictionary simplifies the entry of DL/1 database definition and declaration for Cobol, PL/1, and Assembler language programs.

Query Management Facility (QMF) is an interactive database facility designed for users with little or no processing experience. QMF operates with DB2 in MVS/XA and MVS/370 environments. In VM/370 environments, QMF works with data in SQL/DS. End-user functions handled by QMF include ad hoc query in SQL or QBE languages, report preparation, procedure definition and execution, data preparation for graphics presentations, and definitions of a data extract that can be invoked by Data Extract, a companion IBM program.

DATA COMMUNICATIONS: Communications support under MVS is provided by the Advanced Communication Function/Telecommunications Access Method (ACF/T-CAM) and Advanced Communication Function/

Virtual Telecommunications Access Method (ACF/VTAM). Other IBM cornerstone products within the communications area are CICS/OS/VS, The Transaction Processing Facility, Time Sharing Option (TSO), Network Communication Control Facility (NCCF), and other related products.

ACF/VTAM acts as an operating system for major IBM communications subsystems. It handles resource sharing and the logical handling of users requests. ACF/TCAM is a high-level access method which supports a variety of terminals and supports most applications under MVS/370, MVS/XA, and VS1.

The Customer Information Control System (CICS/OS/VS) is a general-purpose data communications monitor that operates in a single partition or region of an IBM 308X system 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.

Written in Assembler language, CICS provides transaction processing support for database management or file control programs written in Assembler, PL/1, or Cobol, thus allowing on-line applications to be developed without significantly greater difficulty than similar batch programs. In addition to supporting several external database management structures (e.g., IMS/VS-DB's DL/1), CICS includes some native data management capabilities.

CICS/OS/VS also gives the user the ability to share network resources with other VTAM communications application programs. By using VTAM's read-ahead capabilities, and by providing a direct interface between the application program and the terminal control program, the system provides for more terminal I/O overlap. CICS/OS/VS Version 1 Release 6 provides for command-level application programs assembled with Assembler H Version 2 to use 31-bit addressing. Up to one gigabyte virtual storage requests are supported.

CICS Version 1, Release 7, announced in 1985, was released in response to IBM users who have been urging IBM to implement several major enhancements. Key improvements center around the new Resource Definition On-line (RDO) facility and an automatic installation facility for VTAM terminals. RDO makes it possible to add additional devices to a system without having to bring down the system. It also eliminates the need to reassemble the terminal control table. Additionally, users can add devices without having to define it to CICS if it has already been defined to VTAM. This feature reduces the need for terminal definitions, the storage they consume, and the administrative and programming effort required to manage them. Under Release 7, it is also possible to define terminals and ship their definitions automatically to a CICS system, eliminating any need to define a device more than once.

Other Release 7 enhancements include improved VSAM and VTAM support, CICS monitoring enhancements, additional device support, improved task control, new command level programming languages, improved IMS/VS database support. Other enhancements include intercommunication improvements, additional support for VS Cobol II and OS PL/I Optimizing Compiler and Libraries, simpler installation and customization, and CICS library improvements.

The Transaction Processing Facility supports realtime transaction processing applications using a centralized database. IBM claims a system response time using the product of consistently less than two seconds, one-to-three minute system restart times, and 98.8 percent system availability within environments that operate 24 hours a day. TPF ►

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► performs work, main storage, program, and data management functions.

Time Sharing Option (TSO), IBM's interactive facility, operates in large MVS/370 and MVS/XA environments. The facility allows each TSO users full access to MVS and a 16-megabyte address space through computer terminals. The facility supports a range of terminals that may be shared between TSO and other TCAM or VTAM applications. TSO is typically used by systems programmers who maintain system libraries, catalogs, and procedure libraries; application programmers working within batch, interactive, and DB/DC environments; program librarians who create, maintain, and control development support and production libraries; end user operating interactive programs, and Information Center users.

The Network Communications Control Facility (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, storage, and retrieval of network errors in support of the Network Problem Determination Application (NPDA).

PROGRAM DEVELOPMENT: IBM offers many tools to help programmers, end users, and various "knowledge workers" develop and maintain applications. IBM packages include Application Prototype Environment, the Screen Definition Facility/Customer Information Control System, Cross System Product Set, Cross System Product/Application Development, and Cross System Product/Application Execution, IMS Application Development Facility II, Query Management Facility, Time Sharing Option, TSO Extensions, Conversational Monitor System, and Interactive System Productivity Facility.

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.

The 3090 Vector Facility Simulator, operating under CMS virtual machines on VM/SP and VM/XA, provides software simulation of 3090 Vector Facility hardware instructions. The program offering simulates 3090 Vector Facility instructions in object programs, helps scalar applications migrate to the 3090 Vector facility and helps programmers develop new vector applications. In addition, the simulator provides statistics related to application migration and development and serves as a vector processor instruction tool. The product can run on 4300, 308X, and 3090 processors.

UTILITIES: Common IBM utilities include the IMS/VS Queue Loader, IMS/VS Message Requeuer, DFSORT (Data Facility Sort), and DOS/VS Sort/Merge.

OTHER SOFTWARE: IBM offers a number of resource management tools for users who want to better monitor peripherals and operate them more efficiently. Products that help users do this include the Data Facilities Products, MVS/XA DFP Version 2 and MVS/370 DFP, the Data Facilities Hierarchical Storage Manager (DFHSM), and the Direct Access Storage Device Migration Aid.

The Data Facility Products, MVS/XA DFP Version 2 and MVS/370 DFP, handle a number of data management functions in addition to device support, program library management, catalog support, and utility functions. Major features include space allocation for tape and disk volumes; storing, naming, and cataloging data sets; and transfer of data between real and auxiliary storage devices. DFP supports 3330/3333, 3340, 3344, 3350, 3375, and 3380 DASDs; 3880 cache storage control; 3800 Printing Subsystem; 3480 Magnetic Tape Subsystem; 3430 Magnetic Tape Subsystem; and 4245, 4248, and 3262 Model 5 impact printers.

The Data Facilities Hierarchical Storage Manager (DFHSM) is a program designed to make the best use of storage devices, using costs, capacities, and the importance of the data being manipulated as its major operating criteria. In typical operations, DFHSM will allocate active data sets to fast-access devices, such as DASDs, and moves less active data sets to less costly media such as 3480 or 3420 magnetic tape devices, or 3850 Mass Storage Subsystem or other DASDs. DFHSM provides data backup support, recovery, automatic deletion, data conversion, and compaction.

The Direct Access Storage Device Migration Aid automatically handles much of the programming required to move data from one device to another. The program recommends new blocking factors, generate control statements for utilities to move data, and identifies all affected Job Control Language statements and produce jobstreams to update them.

Vector Processing Subsystem/Vector Facility simulates the IBM 3838 Array Processor. This lets users run 3838 applications on a 4381, 308X, or 3090 host system in System/370 Extended Architecture mode running either scalar or vector modes. The facility supports the concurrent use of real and virtual 3838s.

The Engineering and Scientific Subroutine Library provides Fortran and Assembler applications programmers with a set of mathematical subroutines whose performance is enhanced through the IBM 3090 Vector Facility. The Library runs under MVS/XA or VM/SP HPO, and VM/XA. Programs generated under VS Fortran Versions 1 and 2, or Assembler H Version 2 can take advantage of the facility. In addition to vector support, scalar versions of the subroutines are also supported.

PRICING AND SUPPORT

POLICY: 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. ►

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► 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.

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.

SUPPORT: 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 308X 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.

Software support comes in several forms which are described in the following paragraphs.

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 308X 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 Support Charge (\$) | Monthly Multiple Program Support Charge (\$) |
|------------|-------------------------------------|--|
| Model 150: | | |
| Category A | 1,190 | 1,905 |
| Category B | 1,695 | 2,710 |
| Model 180: | | |
| Category A | 1,480 | 2,370 |
| Category B | 2,110 | 3,375 |
| 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 |

All other programming service and assistance is charged at \$200 per hour during regular hours and \$230 per hour during nonregular hours.

Program Products include all language processors, communications support programs, and utility programs, and are ►

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► 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 308X Series.

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.

TYPICAL CONFIGURATION: The following systems illustrate possible 308X configurations. They include all the necessary control units and adapters, but do not include any specialized software.

MEDIUM CONFIGURATION:

| | |
|---|-------------|
| 3090 Model 200 Processor Complex; 64 megabytes of main memory, 32 integrated channels | \$4,100,000 |
| 128 megabytes of expanded storage | 695,000 |
| One 3092 Processor Controller Model 1 | 200,000 |
| One 3097-1 Power and Coolant Distribution Unit | 121,000 |
| Two 3089 Power Unit Model 3s | 76,000 |
| Two 3370 Direct Access Storage Model A2s | 70,960 |
| Two 3180 Display Station Model 145s | 4,790 |
| Automatic Calling Unit for 3864-2 Modem | 1,090 |
| 90 3278 Display Unit Model 2s | 176,850 |
| Three 3274-31A Communications Controllers | 49,950 |
| Nine 6901 Terminal Adapters | 8,262 |
| Three 3880 Controllers Model 3 | 180,810 |
| Three 3380-AE4 Direct Access Storage Devices (DASD) | 367,440 |
| Nine 3380-BE4 DASD Slave Units | 883,260 |
| Sixteen 3420 Model 8 | 318,080 |

| | |
|--|-----------------|
| Sixteen 6250/1600 bpi Dual Density Features | 35,280 |
| Two 3803-2 Tape Controllers Multiple Tape Control Switch; two tape control | 55,100 6,130 |
| Two 3480 Tape Cartridges A22 Control Units | 130,860 |
| Four B22 Cartridge Tape Units | 172,480 |
| Three 4248 Model 1 printers (3600 lpm) | 225,000 |
| One 3800 Model 3 laser printer; (20,040 lpm) | 330,750 |

TOTAL PURCHASE PRICE: \$ 8,209,092

LARGE CONFIGURATION:

| | |
|---|-----------------|
| 3090 Model 400 Processor Complex; 128 megabytes shared central storage, 64 integrated channels | \$ 7,944,000 |
| 128 megabytes of expanded storage; A side | 695,000 |
| 128 megabytes of expanded storage; B side (256 megabytes of expanded storage total) | 695,000 |
| 32 additional channels | 520,000 |
| One 3092 Processor Controller Model 2 | 235,000 |
| Two 3097-1 Power and Coolant Distribution Unit | 242,000 |
| Four 3089 Power Unit Model 3s | 152,000 |
| Two 3370 Direct Access Storage Model A2s | 70,960 |
| Three 3180 Display Station Model 145s | 7,185 |
| Two Automatic Calling Unit for 3864-2 Modem | 2,180 |
| 90 3278 Display Unit Model 2s | 176,850 |
| Three 3274-31A Communications Controllers | 49,950 |
| Nine 6901 Terminal Adapters | 8,262 |
| Six 3880 Controllers Model 3 | 361,620 |
| Six 3380-AE4 Direct Access Storage Devices (DASD) | 734,880 |
| Eighteen 3380-BE4 DASD Slave Units | 1,766,520 |
| Sixteen 3420 Model 8s | 318,080 |
| Sixteen 6250/1600 bpi Dual Density Features | 35,280 |
| Two 3803-2 Tape Controllers Multiple Tape Control Switch; two tape control | 55,100 6,130 |
| Two 3480 Tape Cartridges; A22 Control Units | 130,860 |
| Four B22 Cartridge Tape Units | 172,480 |
| Three 4248 Model 1 printers (3600 lpm) | 225,000 |
| One 3800 Model 3 laser printer; (20,040 lpm) | 330,750 |

TOTAL PURCHASE PRICE: \$14,935,087 ►

IBM 3090 Series

EQUIPMENT PRICES

| | | Purchase Price (\$) | Monthly Maint. (\$) | Monthly Rental Charge* (\$) | Monthly Charge (2-Year Lease)* (\$) |
|--|--|---------------------------|---------------------------|--------------------------------------|---|
| PROCESSORS & FEATURES | | | | | |
| Model 150 | Processor Complex consists of CPU, 32 megabytes of central storage, 64K-bytes of buffer memory, and 16 integrated channels; requires 3092-1 Processor Controller, 3097-1, or -2 Power and Coolant Distribution Unit, 3089-3 Power Unit, two 3180-145 System Consoles, and 3864-2 with Automatic Calling Unit | 1,300,000 | 2,400 | 108,350 | — |
| Model 180 | Processor Complex consists of CPU, 32 megabytes of central storage, 64K-bytes of buffer memory, and 16 integrated channels; requires 3092-1 Processor Controller, 3097-1 or -2 Power and Coolant Distribution Unit, 3089-3 Power Unit, two 3180-145 System Consoles, and 3864-2 with Automatic Calling Unit | 2,200,000 | 2,870 | 183,350 | — |
| 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 | 4,100,000 | 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 | 7,944,000 | 11,910 | 728,650 | — |
| Channel Groups: Model 150 | | | | | |
| 3848 | Eight additional channels | 130,000 | 145 | 10,830 | — |
| Channel Groups: Model 180 | | | | | |
| 3848 | First additional channel group | 130,000 | 145 | 10,830 | — |
| 3849 | Second additional channel group; requires 3848 | 130,000 | 145 | 10,830 | — |
| 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 | — |
| Additional Central Storage: Model 150 or Model 180 | | | | | |
| 4064 | Additional 32 megabytes | 270,000 | 250 | 22,500 | — |
| Expanded Storage: Model 180 | | | | | |
| 5064 | First 64 megabytes | 405,000 | 500 | 39,580 | — |
| 5128 | First 128 megabytes | 695,000 | 900 | 69,170 | — |
| 5192 | 192 megabytes | 985,000 | 900 | 68,740 | — |
| 5256 | 256 megabytes | 1,275,000 | 1,700 | 128,320 | — |
| 6128 | 64 megabytes to 128 megabytes; requires 5064 | 290,000 | 400 | 29,580 | — |
| 6192 | 64 megabytes to 192 megabytes; requires 5064 | 580,000 | 800 | 59,160 | — |
| 6256 | 64 megabytes to 256 megabytes; requires 5064 | 870,000 | 1,200 | 88,740 | — |
| 6193 | 128 megabytes to 192 megabytes; requires 5128 or 6128 | 290,000 | 400 | 29,580 | — |
| 6257 | 128 megabytes to 256 megabytes; requires 5128 or 6128 | 580,000 | 800 | 59,160 | — |
| 6258 | 192 megabytes to 256 megabytes; requires 5192, 6192, or 6193 | 290,000 | 400 | 29,580 | — |

*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)* (\$) |
|------------------------------------|---|---------------------|---------------------|-----------------------------|-------------------------------------|
| Expanded Storage: Model 200 | | | | | |
| 5064 | 64 megabytes | 405,000 | 500 | 39,580 | — |
| 5128 | 128 megabytes | 695,000 | 900 | 69,170 | — |
| 6128 | Expansion from 64 megabytes to 128 megabytes; requires 5064 | 290,000 | 400 | 29,580 | — |
| Expanded Storage: Model 400 | | | | | |
| 5064 | 64 megabytes for A side; 5064 and 7064 are corequisite or prerequisite | 405,000 | 500 | 39,580 | — |
| 7064 | 64 megabytes for B side; 5064 and 7064 are corequisite or prerequisite | 405,000 | 500 | 39,580 | — |
| 5128 | 128 megabytes for A side; 5128 or 7128 requires 128 megabytes on other side | 695,000 | 900 | 69,170 | — |
| 7128 | 128 megabytes for B side; 5128 or 7128 requires 128 megabytes on other side | 695,000 | 900 | 69,170 | — |
| 6128 | 64 megabytes to 128 megabytes for A side; 6128 or 8128 requires 128 megabytes on other side | 290,000 | 400 | 29,580 | — |
| 8128 | 64 megabytes to 128 megabytes for B side; 6128 or 8128 requires 128 megabytes on other side | 290,000 | 400 | 29,580 | — |
| VECTOR FACILITY | | | | | |
| 1545 | Vector Facility for the Model 150 or Model 180 | 370,000 | 350 | 30,830 | — |
| 1545 | First Vector Facility for 3090 Model 200 | 370,000 | 350 | 30,830 | — |
| 1550 | Second Vector Facility for 3090 Model 200; requires 1545 | 230,000 | 175 | 19,170 | — |
| 1545 | First Vector Facility on A side for 3090 Model 400 | 370,000 | 350 | 30,830 | — |
| 1550 | Second Vector Facility on A side for Model 400; requires 1545 | 230,000 | 175 | 19,170 | — |
| 1546 | First Vector Facility on B side | 370,000 | 350 | 30,830 | — |
| 1551 | Second Vector Facility on B side; requires 1546 | 230,000 | 175 | 19,170 | — |
| 3092-1 | Processor Controller for the 3090 Model 150, 180, or 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 Models 150, 180, 200 or 400 | 121,000 | 220 | 10,080 | — |
| 3097-2 | Power and Coolant Distribution Unit; has same distribution capabilities as 3097 Model 1, but does not have I/O power sequence control function | 111,000 | 200 | 9,250 | — |
| — | 3097 Model 2-to-Model 1 Upgrade | 10,000 | — | — | — |
| 4650 | I/O Power Sequence Control for the 3090 Models 150, 180, 200, or 400 | 8,000 | 50 | 667 | — |
| 3089-3 | Power Unit; 3090 Model 150 requires one 3089 Model 3, Model 180 configured with more than 128 megabytes of Expanded Storage and a Vector Facility requires two, the Model 200 requires two, and the Model 400 requires four | 38,000 | 90 | 3,165 | — |
| 3180-145 | Console Display Station; two required for the 3090 Models 150, 180, and, 200, and three for the Model 400 | 2,395 | 300 | — | — |
| 5801 | Automatic Call Unit for the 3864-2 Modem | 1,090 | 192 | — | — |
| SYSTEM UPGRADES | | | | | |
| | 3090 Model 150 to Model 180 | 900,000 | — | — | — |
| | 3090 Model 180 to Model 200; requires 3848, 3849, and 4064 | 1,370,000 | — | — | — |
| | 3090 Model 200 to Model 400 | 3,844,000 | — | — | — |
| MASS STORAGE | | | | | |
| 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 |

*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)* (\$) |
|---|---------------------|---------------------|-----------------------------|-------------------------------------|
| 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 | 122,480 | 295.00 | 7,030 | — |
| Model BE4; connects to a Model AE4 or AD4 unit | 98,140 | 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) | 129,400 | 575.00 | 8,305 | — |
| Model E21; same as D21, but with 16 megabytes | 165,400 | 600.00 | 10,470 | — |
| Model G21; same as D21, but with 32 megabytes | 237,400 | 650.00 | 14,800 | — |
| Model H21; same as D21, but with 48 megabytes | 309,400 | 700.00 | 19,130 | — |
| Model J21; same as D21, but with 64 megabytes | 381,400 | 750.00 | 23,460 | — |
| Model D23; connects to 3380 to form cache/DASD subsystem; 8 megabytes (requires 8170) | 129,400 | 575.00 | 8,305 | — |
| Model E23; same as D23, but with 16 megabytes | 165,400 | 600.00 | 10,470 | — |
| Model G23; same as D23, but with 32 megabytes | 237,400 | 650.00 | 14,800 | — |
| Model H23; same as D23, but with 48 megabytes | 309,400 | 700.00 | 19,130 | — |
| Model J23; same as D23, but with 64 megabytes | 381,400 | 750.00 | 23,460 | — |
| 3380 Model Upgrades: | | | | |
| Model AD4 to AE4 | 43,660 | — | — | — |
| Model BD4 to BE4 | 43,660 | — | — | — |
| 3880 Model Upgrades: | | | | |
| Model 1 to Model D21 | 69,130 | — | — | — |
| Model 1 to Model E21 | 105,130 | — | — | — |
| Model 1 to Model G21 | 177,130 | — | — | — |
| Model 1 to Model H21 | 249,130 | — | — | — |
| Model 1 to Model J21 | 321,130 | — | — | — |
| Model D11 to Model D21 | 69,130 | — | — | — |
| Model D11 to Model E21 | 105,130 | — | — | — |
| Model D11 to Model G21 | 177,130 | — | — | — |
| Model D11 to Model H21 | 249,130 | — | — | — |
| Model D11 to Model J21 | 321,130 | — | — | — |
| Model D21 to Model E21 | 49,500 | — | — | — |
| Model D21 to Model G21 | 121,500 | — | — | — |
| Model D21 to Model H21 | 193,500 | — | — | — |
| Model D21 to Model J21 | 265,500 | — | — | — |
| Model E21 to Model G21 | 72,000 | — | — | — |
| Model E21 to Model H21 | 144,000 | — | — | — |
| Model E21 to Model J21 | 216,000 | — | — | — |
| Model G21 to Model H21 | 72,000 | — | — | — |
| Model G21 to Model J21 | 144,000 | — | — | — |
| Model H21 to Model J21 | 72,000 | — | — | — |
| Model X21 to Model X23 | 2,745 | — | — | — |
| Model 3 to Model D23 | 83,480 | — | — | — |

*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)* (\$) |
|--|---------------------|---------------------|-----------------------------|-------------------------------------|
| 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 | 49,500 | — | — | — |
| Model D23 to Model G23 | 121,500 | — | — | — |
| Model D23 to Model H23 | 193,500 | — | — | — |
| Model D23 to Model J23 | 265,500 | — | — | — |
| Model E23 to Model G23 | 72,000 | — | — | — |
| Model E23 to Model H23 | 144,000 | — | — | — |
| Model E23 to Model J23 | 216,000 | — | — | — |
| Model G23 to Model H23 | 72,000 | — | — | — |
| Model G23 to Model J23 | 144,000 | — | — | — |
| Model H23 to Model J23 | 72,000 | — | — | — |
| 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 | — |
| 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 | — |

*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)* (\$) |
|-------------------------------|---|--|---|---|--|
| PUNCHED CARD EQUIPMENT | | | | | |
| 2501 | Card Reader (with control): Model B1; 600 cpm | 19,610 | 144.00 | 623 | — |
| | Model B2; 1000 cpm | 19,920 | 158.00 | 767 | — |
| 3505 | Card Reader: Model B1; 800 cpm | 36,030 | 293.00 | 1,350 | — |
| | Model B2; 1200 cpm | 37,270 | 400.00 | 1,595 | — |
| | 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 | — |
| 3525 | 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 | — |
| PRINTERS | | | | | |
| 3203 | Printer, Model 5; 1200 lpm, 132 print positions 1416 Interchangeable Train Cartridge (required) | 33,875 2,930 | 451.00 T&M | 2,155 178 | 1,835 — |
| 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 3751 Additional 36 Print Positions (plant installation) 3753 Additional 36 Print Positions (field installation) | 75,000 10,000 15,000 | 1,070.00 110.00 110.00 | 6,205 615 615 | — — — |
| 3820 | Page Printer; 20 pages/minute 3050 EIA Interface Attachment 3055 S/370 Channel Interface Attachment 3035 Control Storage Memory, 128KB 3005 Pattern Storage Memory, 256KB 3010 Pattern Storage Memory, 512KB 3020 Pattern Storage Memory, 1024KB 3025 Pattern Storage Memory, 2048KB 3030 Pattern Storage Memory, 3072KB 3065 Pattern Storage Memory, 4096KB | 28,350 500 2,600 750 1,050 1,700 3,000 6,000 9,000 12,000 | 310.00 10.00 40.00 10.00 10.00 20.00 40.00 80.00 120.00 160.00 | 1,680 34 164 46 61 102 184 368 552 736 | — — — — — — — — — — |
| 3800 | Printing Subsystem** Model 1; up to 20,040 lpm Model 3; up to 20,040 lpm; 240 x 250 picture elements | 215,000 330,750 | 1,080 719.00 | 14,880 13,910 | 11,450 — |
| | 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-Trimner-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 | — |

*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)* (\$) |
|---|--|---------------------|------------------------|-------------------------------------|
| TERMINALS | | | | |
| Cluster Controllers: | | | | |
| | 3274 Model 21A; local, SNA mode | 14,220 | 72.00 | 874 |
| | 3274 Model 21B; local, 3272 mode | 14,220 | 74.50 | 874 |
| | 3274 Model 21C; remote; requires 3701 | 9,900 | 55.50 | 613 |
| | 3274 Model 21D; local, 3272 mode | 14,220 | 79.50 | 674 |
| | 3274 Model 31A; local, SNA mode | 16,650 | 90.00 | 1,026 |
| | 3274 Model 31C; remote; requires 3701 | 12,420 | 73.50 | 764 |
| | 3274 Model 31D; local, 3272 mode | 16,650 | 97.50 | 1,026 |
| | 3274 Model 41A; local, SNA mode | 18,230 | 58.00 | 1,083 |
| | 3274 Model 41C; remote; requires 3701 | 13,840 | 40.00 | 820 |
| | 3274 Model 41D; local, 3272 mode | 18,230 | 58.00 | 1,083 |
| | 3274 Model 51C; remote; requires 3701 | 4,885 | 37.50 | 282 |
| | 3274 Model 61C; remote; requires 3701 | 7,600 | 27.00 | 434 |
| | Terminal Adapters (for Models -21X, -31X, and -51C only)— | | | |
| 6901 | Type A1; devices 9 through 16 | 918 | 2.00 | 52 |
| 6902 | Type A2; devices 17 through 24 | 918 | 2.00 | 52 |
| 6903 | Type A3; devices 25 through 32 | 918 | 2.00 | 52 |
| 7801 | Type B; requires 5550 | 986 | 4.00 | 60 |
| 7802 | Type B1; devices 1 through 4 | 986 | 4.00 | 60 |
| 7803 | Type B2; devices 5 through 8 | 831 | 2.50 | 52 |
| 7804 | Type B3; devices 9 through 12 | 831 | 2.50 | 52 |
| 7805 | Type B4; devices 13 through 16 | 831 | 2.50 | 52 |
| 1801 | Control Storage Expansion | 790 | 4.00 | 50 |
| 3701 | External Modem Interface; requires 6302 or 6303 | 337 | 3.00 | 16 |
| 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 |
| 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 |
| 8801 | Watertight Power Connector; -21A/B/D, -31A/D, and -41A/D | NC | NC | NC |
| 3680 | Encrypt/Decrypt; -1C, 3274 -21C, -31C, -41C, -51C, and -61C only | 1,780 | 2.00 | 85 |
| 5650 | Dataphone Digital Service; point-to-point; -21C, -31C, -41C, -51C, and -61C only | 840 | 1.50 | 36 |
| 5651 | Dataphone Digital Service; multipoint; -21C, -31C, or -51C only | 840 | 1.50 | 36 |
| 5655 | X.21 Adapter; nonswitched networks; -41C or -61C only | 800 | 1.50 | 33 |
| 5656 | X.21 Adapter; switched networks; -41C or -61C only | 800 | 2.00 | 41 |
| 3299 | Terminal Multiplexer | 1,175 | — | — |
| Note: IBM no longer accepts lease/rental orders for any model of the 3274 Control Unit. | | | | |
| Cluster Display Stations: | | | | |
| | 3278 Model 1; 960 char. | 1,855 | 10.00 | 99 |
| | 3278 Model 2; 1920 char. | 1,965 | 10.00 | 102 |
| | 3278 Model 3; 2560 char. | 2,145 | 10.50 | 123 |
| | 3278 Model 4; 3440 char. | 2,255 | 11.50 | 126 |
| | 3278 Model 5; 3564 char. | 2,575 | 12.50 | 148 |
| | 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 | — | — |

*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)* (\$) |
|---|---|---------------------------|---------------------------|--------------------------------------|---|
| Color Display Stations: | | | | | |
| | 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 |
| Keyboards: | | | | | |
| | 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 |
| 3278 Display Station Options: | | | | | |
| 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 |
| 3278/3279 Display Station Options: | | | | | |
| 5790 | Programmed Symbols (PS) | 853 | 2.50 | 36 | 31 |
| 8750 | Video output (3279 Model 3X only) | 702 | 1.00 | 25 | 21 |
| SYSTEM MANAGEMENT | | | | | |
| 3814 | Switching Management System (requires one Model A): | | | | |
| | Model A1; Controller; 4 x 4 switch | 47,480 | 145.00 | 2,438 | **1,950 |
| | Model A2; Controller; 4 x 8 switch | 60,420 | 189.00 | 3,106 | **2,485 |
| | Model A3; Controller; 8 x 4 switch | 64,740 | 185.00 | 3,331 | **2,665 |
| | Model A4; Controller; two 4 x 4 switches | 69,570 | 203.00 | 3,588 | **2,870 |
| | Model B1; Remote Unit; 4 x 4 switch | 39,710 | 98.00 | 2,044 | **1,635 |
| | Model B2; Remote Unit; 4 x 8 switch | 52,660 | 143.00 | 2,706 | **2,165 |
| | Model B3; Remote Unit; 8 x 4 switch | 56,970 | 138.00 | 2,931 | **2,345 |
| | Model B4; Remote Unit; two 4 x 4 switches | 61,800 | 156.00 | 3,181 | **2,545 |
| | Model C1; Expansion Unit; 4 x 4 switch | 37,980 | 95.00 | 1,950 | **1,560 |
| | Model C2; Expansion Unit; 4 x 8 switch | 50,930 | 139.00 | 2,613 | **2,090 |
| | Model C3; Expansion Unit; 8 x 4 switch | 55,240 | 134.00 | 2,838 | **2,270 |
| | Model C4; Expansion Unit; two 4 x 4 switches | 60,070 | 153.00 | 3,094 | **2,475 |
| | 3604 Keyboard/Display, Model 6, one required | 1,745 | 14.50 | 126 | ***98 |
| | 1520 Channel Expansion Internal—4 Control Unit Interfaces | 1,550 | 1.00 | 80 | **64 |
| | 1521 Channel Expansion Internal—8 Control Unit Interfaces | 3,100 | 1.00 | 156 | **125 |
| | 153X Channel Expansion External | 5,350 | 1.00 | 273 | **218 |
| | 181X Control Unit Power Sequencing | 518 | 1.00 | 25 | **20 |
| | 6010 Remote Two-Channel Switch Control—Basic | 5,180 | 19.50 | 263 | **210 |
| | 6011 Remote Two-Channel Switch Control—Additional | 2,415 | 14.50 | 124 | **99 |
| | 6350 System Power Sequencing—Additional | 207 | — | 8 | **6 |
| 3044-CO1 | 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.

IBM 3090 Series

| | Purchase Price (\$) | Monthly Maint. (\$) | Monthly Rental Charge* (\$) | Monthly Charge (2-Year Lease)* (\$) |
|---|---------------------------|---------------------|-----------------------------|-------------------------------------|
| COMMUNICATIONS EQUIPMENT | | | | |
| 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 Contoller: | | | |
| 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 |
| 3725 | Communications Contoller: | | | |
| 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 | 32,000 | 42.00 | 1,585 | — |
| 3727 | 2,390 | 27.00 | 182 | — |

*Includes equipment maintenance.

**Four-year lease.

***Five-year lease.

NC—No charge.

T&M—Time & material.

IBM 3090 Series

SOFTWARE PRICES

| | | Initial Charges | | Monthly Charge | | Monthly Licensed Program Support (\$) |
|----------------------------|---|--------------------|-----------|--------------------|-----------|---------------------------------------|
| | | Basic License (\$) | DSLO (\$) | Basic License (\$) | DSLO (\$) | |
| Operating System Software: | | | | | | |
| 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 |
| | Release 1.3 and 1.7 | 12,840 | 9,360 | 4,280 | 3,210 | 673 |
| 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 |
| | Release 1.3 and 1.7 | 14,430 | 10,821 | 4,810 | 3,607 | 1,335 |
| 5664-167 | VM/SP Releases 1, 2, 3, and 3.1 | — | — | 414 | 310 | 63 |
| 5664-169 | VM/XA Systems Facility Release 2 | 10,500 | 7,875 | 3,500 | 2,625 | 583 |
| | | 11,220 | 8,415 | 3,740 | 2,805 | 623 |
| 5664-173 | VM/SP High-Performance Option Release 3.0, -3.2, and 3.4 | 4,980 | 3,740 | 1,660 | 1,240 | 128 |
| 5664-173 | VM/SP High Performance Option Release 4.2 Support for Vector Facility | 5,325 | 3,993 | 1,775 | 1,331 | — |
| 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 |
| Languages and Compilers: | | | | | | |
| 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 | — | — | 372 | 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 |
| 5668-806 | VS Fortran Version 2 Compiler, Library, and Interactive Debug | — | — | 750 | 563 | — |
| 5668-805 | VS Fortran Version 2 Library | — | — | 200 | 150 | — |
| 5668-864 | IBM Fortran Language Conversion Program | *28,000 | — | — | — | — |
| 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 | — | — |
| Data Management: | | | | | | |
| 5740-XX2 | IMS/VS Version 1 Release 3 Data Communications Feature | — | — | 1,800 | 1,265 | 180 |
| | | — | — | 2,105 | — | 180 |
| 5665-332 | IMS/VS Version 2 Release 1 | — | — | 3,900 | 2,925 | 825 |
| 5665-319 | Interactive System Productivity Facility (ISPF) for MVS Version 2.1.2 | 690 | 450 | 190 | 142 | 30 |
| 5665-317 | Interactive System Productivity Facility/Program Development Facility (ISPF/PDF MVS) for MVS Version 2.1.2 | 4,025 | 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 |

*Onetime charge.

IBM 3090 Series

| | | Initial Charges | | Monthly Charge | | Monthly Licensed Program Support (\$) |
|--|--|--------------------|-----------|--------------------|-----------|---------------------------------------|
| | | Basic License (\$) | DSLO (\$) | Basic License (\$) | DSLO (\$) | |
| Data Communications: | | | | | | |
| 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 |
| 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 |
| 5748-XP1 | Remote Spooling Communication System/Systems Network Architecture (RSCS/SNA) Release 3 | — | — | 104 | 78 | 35 |
| 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 |
| Engineering/Scientific Support: | | | | | | |
| 5740-SM1 | DFSORT (Data Facility Sort) Release 7 | — | — | 231 | 173 | 18 |
| 5750-ESE | Engineering/Scientific Support System-Entry | — | — | 700 | 525 | — |
| 5668-863 | Engineering and Scientific Subroutine Library | — | — | — | — | — |
| 5665-368 | Vector Processing Subsystem/Vector Facility | *40,000 | *30,000 | — | — | — |

*Onetime charge. ■