IBM 4381 Series

MANAGEMENT SUMMARY

UPDATE: *The 4381, considered in some circles to have been made obsolete by the 9370, is more important than ever, serving now as bridge between the low end of IBM's System/370 family and the 30XX class mainframes at the top. Since Datapro's last update, four new models and enhanced software facilities have been added, providing greater strength in both conventional data processing and network computing. This special report focuses on this critical product.*

To paraphrase Mark Twain, rumors of the 4381's demise are greatly exaggerated. When IBM announced the 9370 Information System, many analysts (this one included) predicted the end of the line for the 4381, assuming that it would be replaced by increasingly larger high-end 9370s. IBM had been selling the 4381 as a departmental supermini. While it can be highly useful for distributed-site computing, the 4381 is a computer-room machine, lacking the office installability that marks the 9370. The advent of the smaller, office-installable 9370 seemed to signal curtains for the larger, more unwieldy 4381.

Speculating on the long-range direction of the 9370, however, caused many of us to overlook short-term reality, in

IBM's enhanced 4381 product line provides more firepower in the company's ongoing battle with Digital Equipment Corporation. Disadvantages in system price/performance and extended delivery schedules for critical connectivity facilities could blunt the 4381's impact, however.

The 4381 represents the midpoint in IBM's System/370 architecture family, serving as a bridge between the low-end, departmentally oriented 9370 Information System and the high-end, organizational 3090 mainframes. The 4381 is highly functional for both commercial and technical applications in distributed or centralized environments.

MODELS: 4381 Model Groups 11, 12, 13, 14, 21, 22, 23, and 24.
MEMORY: 2MB to 64MB.
DISK CAPACITY: 258MB to 12,800GB.
WORKSTATIONS: Up to 1,024.
PRICE: $175,000 to $1,130,000 (base processor complexes).

FOCUS

TARGET

Growing general-purpose and engineering/scientific users.

Features for Target Applications

Broad Software Base: **Although the 4381 is a supermini largely by virtue of its performance range and marketing orientation, its architecture is downward compatible with IBM 9370 and other System/370 (S/370) architectures and upward-compatible with Extended Architecture (XA) mainframe architectures. This means it has the largest mid-range (non-PC) software base in the world, especially when third-party offerings are added to what is sold by IBM. IBM offers seven primary operating system versions and four subordinate operating environments.**

Compute-Intensive Processing Facilities**: Features supporting high-speed calculations include fast processor, memory, and cache cycles; hardware and microcoded support for floating-point operations, including 128-bit extended precision; extensive mathematical libraries; and vector processing software.**

Powerful Networking**: IBM's Systems Network Architecture (SNA) is a mature, well developed network with extensive standardization efforts in process to allow communications with incompatible environments. There are a wide variety of compatible terminal types, including graphics stations and applications-oriented terminal clusters.**

SYSTEM SUMMARY

Models

Uniprocessor Model Groups 11, 12, 13, 21, 22, and 23 and dual processor Model Groups 14 and 24.

Memory Size Range

Memory ranges from 4MB on an entry-level 4381-11 to 64MB on the 4381-23 and -24. The 4381 S/370 addressing mode can handle up to 64MB and the XA addressing mode can handle up to 2GB.

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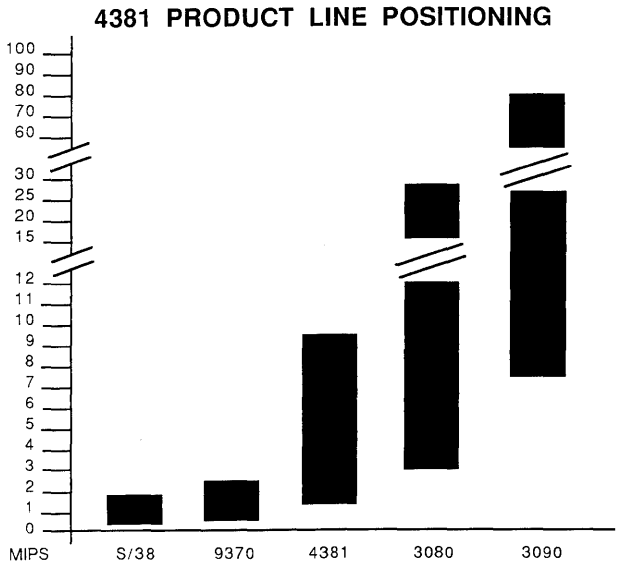

Figure 1. Although it serves as a bridge between IBM's smaller medium-scale systems and high-end mainframes, the 4381 overlaps and occasionally competes with both groups.

which the 4381 figures prominently—especially in light of the market pressures on IBM.

Regardless of the way it's deployed (whether departmentally or centrally), the 4381 is significant because it is the entry point to IBM's strategic, high-end MVS/XA operating environment (in which the 9370 does not participate). In that capacity, the 4381 provides a mid-range migration platform to IBM's high-end, 3090-class mainframes. (See the positioning chart in Figure 1.) Prior to May 1987, no new 4381 models had been added since February 1986—a dangerous stasis, considering that IBM's principal rival, Digital Equipment Corporation, made three major enhancements to its competing VAX 8000 line in the same time period. The lack of more powerful enhancements to the 4381 line through 1986 indisputably contributed to the decline IBM experienced in its medium-scale system revenues for the year (down 7 percent from 1985, according to International Data Corporation, of Framingham, Massachusetts).

COMPETITIVE POSITION

The enhancements IBM finally made to 4381 systems and software in the summer of 1987 were obviously introduced with Digital in mind. For example, the CPU power of the line now extends up to about 9.5 MIPS on the top-of-the-line, dual-processor 4381 Model Group 24, a 30 percent increase over the previous high of 7.3 on the predecessor 4381-14. That increase brings the upper ranges of 4381 power closer to the 12-MIPS mark of Digital's high-end dual processor, the VAX 8800.

In addition, the doubling of maximum 4381 main memory capacity from 32MB to 64MB partially closes the gap between the 4381 and comparable VAX 8000 machines, which provide up to 128MB of main storage. Higher mem-

Storage Capacity

12,800GB attachable, but only 2641GB addressable. These limits, the result of the all-purpose character of the channel ports, are far beyond the practical capacity of the system. Datapro's 1987 Computer Users Survey shows that over 60 percent of the 4381 users responding have less than 10GB on their systems.

Other Local I/O

Tape drives, printers, card equipment, plotters, MICR document reader/sorters, OCR, OEM devices, and a wide range of general-purpose and special-purpose terminals.

Communications Support

***Number of Ports*: The 3725 front end can be attached to any channel position in the system; there are 96 ports on all six uniprocessor models, 144 ports on the 4381-14, and 192 ports on the 4381-24. The terminal loads implied by these port configurations are far beyond the practical system limits, however.**

***Data Rates*: Peak speeds of 230.4K bps on synchronous lines and 19.2K bps on asynchronous lines.**

***Front-End Processors*: Models 3720 and 3725 are the primary actively marketed communications processors; older 3705 models are supported as well. All are channel attached. The Series/1 minicomputer can also be directly attached to an I/O channel and operate as a front end; this arrangement is most frequently used to attach ASCII terminals. There are no integrated communications adapters outside of the channel-attached I/O subsystem.**

***Remote Concentrators/Cluster Controllers*: The 3720 and 3725 front ends can be configured as remote concentrators as well as local front ends; the 3708 and 3710 are primarily oriented toward remote concentration.**

***Communications Gateways*: Two X.25 gateway programs run in the 372X front end processor under Network Control Program (NCP). The NCP Packet Switching Interface (NPSI) allows the 4381 to interface to an X.25 network as a terminal node (DTE). The XI Programming RPQ (PRPQ) allows the 4381 to operate as an X.25 networking node (DCE), which enables SNA networks to act as backbones for X.25 transmissions.**

***LAN Support*: The 3174, 3270, and 3275 all have configurations which can attach one or more IEEE 802.2/802.5-compatible Token-Ring LANs. All three of these controllers can be channel- attached locally, or can be remotely attached by means of a data link.**

Operating Systems

The native-mode system most capable of fully exploiting the 4381's capabilities is MVS/XA (Multiple Virtual Storage/Extended Architecture). Other primary operating systems are MVS/370, VM/IS (Virtual Machine/Integrated System), VM/SP (VM/System Product), VM/XA, DOS/VSE (Disk Operating System/Virtual Storage Extended), and OS/VS1/BPE (Operating System/Virtual Storage/Basic Programming Extensions). Secondary operating systems which have evolved from standalone operating systems into packages that must function in conjunction with one of the primary environments include TPF2 (Transaction Processing Facility 2), operating in conjunction with MVS, and IX/370 (Interactive Executive for System/370) and MUSIC/SP, operating in conjunction with VM/SP or VM/IS.

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ory capacity is an absolute requisite for the 4381 systems in the memory-intensive technical applications in which IBM claims to rival and even to better Digital.

Still, IBM's enhanced 4381 machines fall short of the performance marks attained by Digital's comparable compute engines. That shortfall in raw performance is mirrored by the disparity in price/performance, as well. For example, a base 4381-24 CPU complex with 64MB of main memory lists for $1,130,000—a cost of $118,900 per MIPS. Those cost figures suffer severely in comparison to the $72,700 per MIPS ($872,550 list) price of a comparable basic VAX 8800 package.

IBM's disadvantage in price/performance isn't confined only to the low end of the 4381 family. For instance, Digital's 4.2-MIPS VAX 8530, in a base configuration with 32MB of main store, retails for $301,350, or $71,700 per MIPS. A comparable 4381-22, rated at 4.6 MIPS, costs $430,000, or $93,500 per MIPS. Even though the price/performance disparity between IBM's and Digital's offerings decreases the lower one goes in the 4381 line, it is still quite significant.

However, IBM retains a clear advantage over Digital in disk (or, to use IBM's term, DASD) capacity and cost per megabyte of auxiliary storage. Simply on a per-drive basis, IBM's new triple-capacity 3380 drives (the 7.56GB Models AK4 and BK4) cost between $14 and $17 per megabyte. By contrast, Digital's most powerful offering, the 2.5GB SA482 Storage Array, is more than twice as expensive at $35 per megabyte. In fact, the SA482 is not really a single drive; it comprises four 622MB drives.

IBM generally retains the advantage over Digital in disk price/capacity even when one figures in the cost of controllers. For example, the SA482 and its associated HSC70 controller cost $145,530, a per-megabyte price of $58. A combination of IBM's 3380 AK4 and new 3990 storage controller with 32MB of cache memory costs only $43 per megabyte. IBM offers 3990 controllers with up to 256MB of cache; the high-end models cost close to $1 million, so the capacity/price curve theoretically diminishes when one hits the upper end of IBM's DASD range. However, the only systems likely to support such elaborate storage devices are 3090-class machines far beyond the realm of 4381/VAX competition.

While IBM may take the lead over Digital in DASD, IBM's recent software enhancements are essentially catchup moves in the ongoing battle between the two vendors. The addition of an Advanced Program-to-Program Communication (APPC) facility to the Application Program Interface (API) in IBM's ACF/VTAM communications product allows peer-to-peer networking of machines in disparate IBM operating environments (such as S/370-class and S/3X machines); intelligent nodes can communicate directly with each other without the resource overhead entailed in host-based networking.

Database Software

Two database products—IMS (Information Management System) for MVS and DL/1 (Data Language/1) for VM and VSE—are traditional hierarchical production databases. More significant for IBM's long-range plans these days, however, are DB2 (Database2) for MVS and SQL/DS (Structured Query Language/Data System) for VM and VSE; these relational databases are more suited to decision support and end-user computing. Stairs (Storage and Information Retrieval System) is a very old bibliographic database, really a precursor to more advanced types. TPF2 has its own transaction processing database.

Range of System Price

The if-sold value of basic configurations ranges from $175,000 to $1,130,000; the addition of a large remote terminal network can easily raise the price tag to more than $1,750,000.

Product History

The low end of the 4300 series was originally introduced in January 1979; the original 4381-1 and 4381-2 "Glendale" uniprocessors were announced in September 1983, filling a much-discussed performance gap between the high end of the then-extant 4341 and the low end of the original 3080 series. The 4381-3 dual processor soon followed. Those three models were withdrawn when 4381 Model Groups 11, 12, 13, and 14 were introduced in February 1986. The more powerful 4381 Model Groups 21, 22, 23, and 24 were added in May 1987, largely in response to Digital Equipment Corporation's continued enhancement of the upper range of its VAX 8000 family.

APPLICATION SUITABILITY

Departmental Computing

All of the important end-user and office support software that can run on the 9370 can also run on the 4381. The 4381

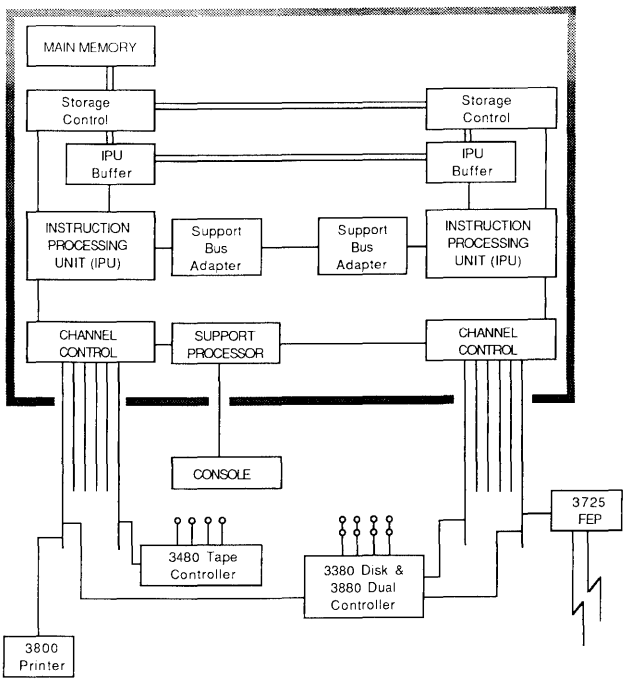

Figure 2. A small configuration showing the dual-processor architecture of the 4381 Model Groups 14 and 24.

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CHART A. 4381 MODEL COMPARISON

MODEL	4381 Model Group 11	4381 Model Group 12	4381 Model Group 13	4381 Model Group 14
PROCESSOR				
Estimated performance, MIPS	1.6	3.1	4.2	7.3
Number of main processors	1	1	1	2
Cycle time, nanoseconds	68	68	56	56
MEMORY CAPACITY				
Main memory				
Minimum, bytes	4M	8M	8M	16M
Maximum, bytes	16M	32M	32M	32M
Cache buffer, bytes per CPU	4K	32K	64K	64K (128K total)
INPUT/OUTPUT CONTROL				
Number of 8-port channels:				
Byte multiplexer	1 std., 1 opt.	1 std., 1 opt.	1 std., 1 opt.	2 std., 2 opt.
Block multiplexer	5 std., 6 opt.	5 std., 6 opt.	5 std., 6 opt.	10 std., 6 opt.
Combined total	12: 6 std., 6 opt.	12: 6 std., 6 opt.	12: 6 std., 6 opt.	18: 12 std., 6 opt.
Maximum ports	96	96	96	144
Additional device-specific ports	Console	Console	Console	Console
Maximum devices per system				
Attachable (32 per controller)	3072	3072	3072	4608
Currently addressable	2048	2048	2048	2048
Peak data transfer, bytes/sec.	22M	24M	30M	48M
SOFTWARE				
Protect key sizes	2KB, 4KB	2KB, 4KB	2KB, 4KB	4KB
Operating systems	DOS/VSE, MVS/SP, VM/SP, MVS/XA, VM/XA, IX/370, OS/VS1, MUSIC/SP, TPF2, SRTOS	DOS/VSE, MVS/370, VM/SP, MVS/XA, VM/XA, IX/370, OS/VS1, MUSIC/SP, TPF2, SRTOS	DOS/VSE, MVS/370, VM/SP, MVS/XA, VM/XA, IX/370, OS/VS1, MUSIC/SP, TPF2, SRTOS	MVS/370, VM/SP, MVS/XA, VM/XA
POSITIONING				
Date announced	February 1986	February 1986	February 1986	February 1986
Date first delivered	May 1986	April 1986	April 1986	April 1986
Field upgradable to	4381-12, -21, -22	4381-13, -23	4381-14, -23, -24	4381-24
Comparable predecessor	4381-1	4381-2	Not applicable	4381-3

Digital has been offering such a capability for its VAX machines for a number of years. Also, IBM's peer-to-peer functionality is not scheduled for availability until at least the third quarter of 1988, giving Digital additional time to demonstrate that it can currently deliver what IBM can only promise.

IBM's rollout of products conforming to the company's cross-environment Systems Application Architecture (SAA)—such as the enhanced members of its so-called Relational Productivity Family of database management systems—signals the vendor's commitment to developing a unified operating environment for its varying architectures. Such an attempt at uniformity has been a long time coming from IBM, particularly in light of Digital's highly touted, unified VAX/VMS environment. However, SAA will not be completely in place until a couple of years down the road, so 4381 users must continue to wait for the type of environmental symmetry that Digital is currently delivering.

Similarly, IBM's introduction of graduated, processor-dependent one-time charges for selected critical VM, MVS, **employs a special "impingement" air cooling technology that theoretically allows it to be housed in room-temperature air-conditioned offices without raised floors, as well as in computer rooms. That seeming environmental flexibility would appear to support its use as a very large departmental system. However, the 4381 uses IBM's 33XX series of disk drives as its primary storage devices. Those drives are large and expensive, and some have special environmental requirements that disqualify them for office installation and office-based departmental computing. The 4381s could be perfectly suitable for a large department, provided it has dedicated computer-room facilities.**

Engineering/Scientific Computing

Compute-intensive environments like those found in the engineering/scientific sector have been a primary market focus for the 4381. In addition to the hardware support for high-speed computation mentioned earlier, the 4381 can run key mathematical and manufacturing and graphics packages, like IBM's ACRITH (High-Accuracy Arithmetic Package) and popular graphics/design packages like CADAM, CAEDS, CIEDS, CBDS, and so on.

Timesharing

TSO (Time Sharing Option) in the MVS environments and CMS (Conversational Monitor System) in the VM environ-

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CHART A. 4381 MODEL COMPARISON (Continued)

MODEL	4381 Model Group 21	4381 Model Group 22	4381 Model Group 23	4381 Model Group 24
PROCESSOR				
Estimated performance, MIPS	2.1	4.6	5.5	9.5
Number of main processors	1	1	1	2
Cycle time, nanoseconds	68	68	52	52
MEMORY CAPACITY				
Main memory				
Minimum, bytes	8M	16M	16M	16M
Maximum, bytes	16M	32M	64M	64M
Cache buffer, bytes per CPU	8K	32K	64K	64K (128K total)
INPUT/OUTPUT CONTROL				
Number of 8-port channels:				
Byte multiplexer	1 std., 1 opt.	1 std., 1 opt.	1 std., 1 opt.	2 std., 2 opt.
Block multiplexer	5 std., 6 opt.	5 std., 6 opt.	5 std., 6 opt.	10 std., 12 opt.
Combined total	12: 6 std., 6 opt.	12: 6 std., 6 opt.	12: 6 std., 6 opt.	24: 12 std., 12 opt.
Maximum ports	96	96	96	192
Additional device-specific ports	Console	Console	Console	Console
Maximum devices per system				
Attachable (32 per controller)	3072	3072	3072	6144
Currently addressable	2048	2048	2048	2048
Peak data transfer, bytes/sec.	24M	24M	32M	64M
SOFTWARE				
Protect key sizes	2KB, 4KB	2KB, 4KB	2KB, 4KB	4KB
Operating systems	DOS/VSE, MVS/SP, VM/SP, MVS/XA, VM/XA, IX/370, OS/VS1, MUSIC/SP, TPF2, SRTOS	DOS/VSE, MVS/370, VM/SP, MVS/XA, VM/XA, IX/370, OS/VS1, MUSIC/SP, TPF2, SRTOS	DOS/VSE, MVS/370, VM/SP, MVS/XA, VM/XA, IX/370, OS/VS1, MUSIC/SP, TPF2, SRTOS	MVS/370, VM/SP, MVS/XA, VM/XA
POSITIONING				
Date announced	May 1987	May 1987	May 1987	May 1987
Date first delivered	1st qtr. 1988	1st qtr. 1988	1st qtr. 1988	1st qtr. 1988
Field upgradable to	4381-22	4381-23	4381-24	Not applicable
Comparable predecessor	4381-11	4381-12	4381-13	4381-14

VSE, and cross-system software products—enacted in stages from October 1986 through May 1987—emulates a scheme Digital introduced for VAX software almost a year earlier. This move is, of course, beneficial to IBM users for the most part. For example, smaller-system users purchasing software no longer have to pay the same hefty one-time charge as users with much larger systems. Still, IBM is only now implementing the sort of graduated price structure that Digital (as well as other competing vendors, like Data General) has had in effect for quite some time.

ADVANTAGES AND RESTRICTIONS

The greatest advantage of the 4381 is its versatility, which makes it desirable as both a migration target from the 9370 and a platform for movement upward to IBM's 3090 series of mainframes. The 4381 can run VM/SP and VM/IS, so it allows transfer of applications upward from the less powerful 9370, which is primarily a VM machine. Also, because it runs the more complex MVS/XA—IBM's strategic mainframe operating system—the 4381 provides a viable entry point into the higher-end S/370 environment for users who

ments are both mature timesharing systems that have been implemented in a wide variety of applications. CICS (Customer Information Control System), TPF, and IX/370 are all important transaction processing systems that do not have the round-robin timeslicing typical of timesharing.

Entry-Level User Computing

The 4381's overall performance levels, and particularly (as previously mentioned) the type of peripherals it attaches, put it beyond entry levels for almost all users except those who have a special need for intensive computations. The 4381 does support VM/IS, the primary entry-level operating system for the 9370, but it cannot attach the 9370's low-cost peripherals, such as the 9332 and 9335 disk drives.

ARCHITECTURE

The 4381 is a dual-personality, microcoded machine that allows a choice of two operating modes: S/370, with its 24-bit addressing base, and XA, with its 31-bit addressing base. Operating modes set at Initial Microprogram Load (IML) time determine which operating systems will be compatible and whether or not 31-bit addressing can be used.

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do not immediately require the power—or cannot afford the expense—of the generally more powerful 3090-class machines.

For those moving within the 4381 grouping, a solid migration path is offered. Any of the four newest model groups (21, 22, 23, and 24) can be field upgraded to the next highest in the line, so no box swap is required. In addition, the older Model Groups 11, 12, 13, and 14 are directly upgradble to more powerful models within the newer model groups, so users of the older systems who wish to move upward are spared the agony of a full reinstallation.

However, to get to the 3090 class of systems from the 4381, a box swap is required, with all attendant costs (including the environmental costs required by a move from air cooling to water cooling). The expensive 3380-class disk drives can be ported upward, however, as can their associated 3880 and 3990 controllers, so a major expense can be avoided.

A major disadvantage is the delayed availability of certain critical facilities for the 4381. For example, as previously noted, the full peer-to-peer version of the ACF/VTAM communications product is not scheduled for delivery until mid-1988 at the earliest (although IBM does have a habit of accelerating product deliveries). Similarly, full SAA functionality will not be available for several years. That doesn't help medium-scale users who need such facilities now.

Moreover, even the newer 4381 model groups are not slated for delivery until the first quarter of 1988—a lag of at least eight months after delivery. Upgrades from one new model group to the next will not come until the second quarter—nearly a year after rollout. To be fair, we must point out that IBM has enacted a special ordering scheme whereby users ordering a newer 4381 prior to November 30, 1987 will get a Model Group 11, 12, 13, or 14 machine prior to December 31, with an upgrade to the appropriate new model group following when available; this scheme, in fact, can provide a discount over the full list price of the new model group, giving potential users an incentive to order early.

The newly inaugurated graduated software charges we mentioned above have both advantages and disadvantages. The graduated charges allow users to save money on initial purchases. For example, a license for the ISPF/PDF application development facility for MVS/XA now costs $17,250, where it used to cost $27,600; that's a decrease of 38 percent. Moreover, quantity discounts ranging from 10 to 25 percent, depending upon volume, are available for purchases of three or more licenses; users with a large number of distributed sites can benefit from this scheme.

Still, upgrade charges are required for migration of software from version to version or for movement from one processor group to another. Thus, the cost benefit of the initial license purchase can be diminished somewhat in the course of subsequent software upgrades.

There are so many different operating systems that can run on the 4381 that at first it seems difficult to bring the essential character of the system into focus. However, MVS/XA is the strongest "native" operating environment, capable of fully exploiting all the capabilities of the 31-bit addressing scheme. VM/XA can also handle 31-bit addressing, but it has compatibility problems with other VM systems because it supports only a greatly reduced subset of VM/SP software. MVS/XA, on the other hand, was carefully designed both to exploit the XA architecture and to remain compatible with the System/370 architecture. It does this through its own internal dual mode addressing, which allows changing back and forth between 24-bit and 31-bit modes, based on the settings in the Processor Status Word (PSW). This is not to be confused with the setting of the essential machine mode at IML time. The implementation of these "modes within modes" allows MVS/XA to run in XA mode, using 31-bit-oriented system software to service 24-bit-oriented applications programs also running in XA.

PROCESSOR

The 4381 processors are all microcoded machines implemented with chip carrier packages designed to greatly shorten transmission paths and expedite cooling.
The compact implementation of the 4381 processors reduces the system footprint for all models to 14.33 square feet. When service clearances are added, the space required is 125.61 square feet.

Power consumption on the uniprocessor models is 4.7 kVA at 50 or 60 Hz; on the dual processor models it is 7.2 kVA at 50 or 60 Hz. Heat output on uniprocessor 4381s is 13,650 Btu per hour; the 4381-14 and -24 put out 22,500 Btu per hour. Noise levels are 54.2 dbA for uniprocessor models and 55.3 dbA for dual-processor models. Like other environmental restrictions in the 4381 systems, those high noise levels militate against the 4381s' being used for in-office departmental processing—a use for which IBM attempts to sell the systems.

The dual-processor 4381-14 and -24—whose architecture is shown in the block diagram in Figure 2—are tightly coupled processors incorporating two instruction processors (two instruction streams) operating under a single control program. Each processor has its own 64KB cache, its own set of channels, and its own storage control and support subsystem interfaces. Both processors share access to central storage and the support subsystem, although both of those subsystems are associated primarily with processor 0, and only secondarily with processor 1. Data paths between main storage and the instruction processor cache are 128 bits wide, and are shown in the diagram as double lines. Data paths between memory and I/O, and within the instruction processor, are 64 bits wide, and are depicted as single lines in the diagram. The system cannot be partitioned into two distinct uniprocessor systems, as larger 30XX mainframes can.

The single-processor models are outwardly the same as the dual-processor, since the same system cabinet was designed to house both versions. See Chart A for a comparison of the eight 4381 models.

The 4381 CPUs include a service processor, a service panel, a power-up microprocessor, a direct console attachment, diskette drives, a modem (which connects to the Remote Operator Console Facility and the Remote Service Facility), a direct instruction processor link, and a channel link for operator consoles.

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USER REACTION

Datapro's 1987 Computer Users Survey garnered responses from 335 users of the 4381. (Included in the systems surveyed were some models that IBM no longer actively markets.) The systems had an average installed life of a little under two years (22.5 months). Of the systems surveyed, 45.6 percent had been purchased, 19.1 percent were rented or leased from IBM, and 33.4 percent had been leased from a third party. The low percentage of purchased systems is somewhat paradoxical, given IBM's strenuous efforts in the last couple of years to encourage customers to buy their machines, rather than follow the rental/lease path.

Even though IBM has tried mightily to market the 4381 as a departmental system (particularly before the debut of the 9370), our survey shows that only 7.5 percent of the respondents employ their machines in that capacity. Such usage stands to reason; the 4381 employs high-performance DASD as primary disk storage devices, and those components require a computer room environment, rather than the office milieu for which most true departmental machines are geared.

Identifying sources of application programs, 92.2 percent of indicated that they employ in-house programmers. That's significantly above the 76-percent figure for in-house development cited by our medium-scale system respondents in general. It's an indication that the 4381 tends to be installed in organizations capable of sustaining the support staff required to develop a majority of applications in-house. Again, that's an indication of more centralized system usage, for only in the largest corporations can departments employ dedicated application development staffs.

Although IBM likes to tout the engineering/scientific performance of the 4381, only 11.9 percent of our respondents were using their systems for such applications. Our respondents' systems seem to be used largely for run-of-the-mill commercial applications, such as accounting/billing (74 percent), payroll/personnel administration (57.3 percent), order processing/inventory accounting (46.3 percent), and purchasing (42.4 percent). Another 26.9 percent are involved in manufacturing. Consistent with the commercial orientation of the systems, Cobol is the programming language favored by the largest number of users (77.5 percent).

Of the responding users, 96.4 percent indicated that the 4381 fulfilled their expectations; 95.2 percent said that they would recommend it to other users. That recommendation takes on additional luster when one considers that less than 1 percent of the respondents (0.6 and 0.9 percent, respectively) indicated that the 4381 had failed to satisfy expectations or that they would not recommend it to prospective users.

The following table shows how the 335 respondents rated their 4381s:

Processor Architecture

The differences in the two elements of the dual-mode architecture are highlighted by differences in the instruction set. Both the nonprivileged and the semiprivileged instructions used by applications programs are common to both sets; however, the privileged instructions used by the system software to handle the memory and I/O subsystems are different. XA systems implement not only increased memory capacity, but also increased I/O flexibility due to a dynamic pathing I/O subsystem particularly helpful to multiprocessing systems.

The instruction processing unit includes a shifter (to and from memory), a storage address register, an arithmetic logic unit, local storage, control storage, and an instruction buffer; it also includes a high-speed hardware multiplier in all models except the 4381-11 and -21.

Registers

There are 16 general-purpose registers and four floating-point registers in a special local memory.

Instruction Set

As mentioned earlier, the 4381 is a microcoded machine with two instruction sets, one for S/370 operating mode and one for XA operating mode. Both instruction sets are based on the System/370 Universal Instruction Set. Instructions are 2, 4, or 6 bytes in length, specifying 0, 1, or 2 memory addresses, respectively. Both instruction sets include complete arithmetic facilities for processing variable-length decimal and fixed-point binary operands, as well as instructions which handle loading, storing, comparing, branching, shifting, editing, radix conversion, code translation, logical operations, packing, and unpacking.

In addition, a group of privileged instructions, usable only by the operating system, handles input/output and various hardware control functions. Also standard are some instructions that were optional on some models of the System/370, including those for dynamic address translation, VTAM (Virtual Telecommunications Access Method) support, OS/VS support, and extended-precision floating-point computations.

Floating-point operations involve three levels of precision. "Short" format occupies one 32-bit word, consisting of a 24-bit fraction and a 7-bit hexadecimal exponent; "long" format occupies 64 bits, or two words, consisting of a 56-bit fraction and a 7-bit hexadecimal exponent, in "long" format; and "extended precision" format involves four words, or 128 bits. Fixed-point operands can range from 1 to 16 bytes (1 to 31 digits plus sign) in decimal mode; they occupy one halfword (16 bits) in binary mode.

Interrupt Handling

Classes of interrupts include I/O, external, program, supervisor call, machine check, and restart. Classes of interrupts are distinguished by the storage locations at which the old program status word (PSW) is stored and from which the new PSW is fetched.

INPUT/OUTPUT

Although data transfers are not routed through the CPU cache, but go directly to the storage controller, the channel subsystem does not operate independently; it is controlled by the instruction processing unit. However, it does have enough local intelligence to allow it to function with some

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CHART B. 4381 DISK DRIVES

Model Number	Capacity, per Model Unit/ per Actuator*	Actuators/Unit* × Units/String = Actuators/String	Strings per 3880/3990 Director	Average Access, Msec.	Peak Transfer, Bytes/Sec.
3350	635MB/317.5MB	2 × 4 = 8	4 per 3880	33.4	1.2M
3370	729.8MB/364.9MB	2 × 4 = 8	4 per 3880	29.1	1.86M
3375	819.7MB/409.8MB	2 × 4 = 8	4 per 3880	29.1	1.86M
3380-D	2.52GB/630MB	4 × 4 = 16	2 per 3880; 4 per 3990	24.3	3.0M
3380-E	5.04GB/1,260MB	4 × 4 = 16	2 per 3880; 4 per 3990	26.3	3.0M
3380-J	2.52GB/630MB	—	2 per 3880; 4 per 3990	— —	3.0M
3380-K	7.56GB/1,260MB	—	2 per 3880 4 per 3990	— —	3.0M
3380-CJ2	1.26GB/630MB	—	**	—	3.0M

**The actuator, or read/write head assembly, is the logical drive as perceived by the software. The 3350s have one actuator per drive, two drives per unit, whereas the 3370 and 3375 have two actuators per drive, one drive per unit. The 3380s combine both (two actuators per drive, two drives per unit) into a quad drive. Thus software sees four 3380s as if they were 16 drives.*
***Attaches directly to 3.0MB Block Multiplexer Channel; one subsystem supports up to 23.9GB.*
Note: A dash (—) for a entry indicates that the information is unavailable from the vendor.

	Excellent	Good	Fair	Poor	WA*
Ease of operation	101	203	25	1	3.2
Reliability of system	283	49	2	0	3.8
Reliability of peripherals	168	155	10	0	3.5
Maintenance service:					
Responsiveness	147	159	23	1	3.4
Effectiveness	141	164	17	1	3.4
Technical support:					
Troubleshooting	74	206	46	5	3.1
Education	55	206	61	4	3.0
Documentation	52	196	72	7	2.9
Manufacturers software:					
Operating system	94	205	29	3	3.2
Compiler & assemblers	102	215	14	0	3.3
Application programs	41	181	65	8	2.9
Ease of programming	39	223	60	3	2.9
Ease of conversion	37	173	91	10	2.8
Overall satisfaction	79	238	14	0	3.2

*Weighted Average on a scale of 4.0 for Excellent.

To supplement the ratings, we contacted two respondents by telephone in September 1987 and asked them to discuss their experiences with their 4381s.

The first user we contacted was Manager of Library Systems at a large university in the Midwest. Although his 4381 Model Group 13 is housed in the university computing center for reasons of space and economy, it is used as a departmental system in the sense that it is dedicated to a single application: cataloging (with circulation and acquisition accounting to be added, he hopes, in the not-too-distant future). In fact, the 4381 was purchased primarily

independence once I/O operations have been initiated. The channel subsystem does not have the same level of independence as the comparable subsystem on the high-end 30XX mainframes, which is based on a full-blown I/O processor.

The channel subsystem includes channel data buffers, a channel operation unit, and standard and optional channels. All basic systems have 6 channels standard on each processor (totalling 12 on the dual processor). Options can increase the overall system total to 12 on the uniprocessor models and 18 or 24 on the dual-processor Model Groups 14 and 24, respectively. See Chart A and the "System Description" section of this report for more details.

General-Purpose I/O Subsystems

The 4381 can support the full roster of channel-attached mainframe peripherals. Details on actively marketed disk drives, disk controllers and cache subsystems, tape drives, printers, and terminals are presented in Charts B through F, respectively. Also supported are a variety of special-purpose and industry-specific subsystems, including card equipment, plotters, MICR document reader/sorters, financial terminal systems, retail systems, manufacturing systems, graphics terminals, and modems.

COMMUNICATIONS

The 4381 is a host system in the IBM communications hierarchy, and this implies the same type of mainframe/front-end/terminal controller/terminal network relationships as are found on larger 3080 and 3090 systems. Terminals and remote systems communicate with the communications processor software, and that in turn communicates with the access method residing in the central processor, which in turn communicates directly or indirectly with the destination application.

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CHART C. 4381 DISK CONTROLLERS

Model Number	Number of Storage Directors	Cache Memory Capacity	Currently Marketed Drives Attachable
3880-1	2 independent	None	3350, 3370, 3375
3880-2	2 independent	None	3350, 3370, 3375; 3380 on second Storage Director
3380-3	2 independent	None	3380 only
3880-4	1 single	None	3370, 3375
3880-21	2 interconnected	16MB to 64MB	3350 only; paging cache
3880-23	2 interconnected	8MB to 64MB	3380 only; application data cache
3990-1	2	None	3380 only
3990-2	4	None	3380 only
3990-3	4	32MB to 256MB	3380 only

for its ability to run a specific library application package—Notis, from Notis Systems, Inc.

The system serves 135 stations wired over dedicated lines, more than 100 terminals, and PCs communicating over dial-in facilities. The 4381 communicates with a 3033, uploading catalog data to the larger machine and thus making it available to the entire university community.

This user praised the 4381, saying, "It handles our data more than adequately"; in that connection, he described the system's 3380 DASD storage devices as "state-of-the-art" and observed that they would allow him to double the disk capacity his system currently employs.

His only criticism concerned the inability of his 4381 to access powerful CDROM optical disk facilities attached to PCs in the university community; he sees it as wasteful that such devices serve only individual microcomputers.

Despite his rather glowing assessment of the 4381, this manager levelheadedly refuses to view it as a panacea. When asked what advice he would give prospective users, he opined that, in choosing a system, users should focus not on the hardware itself, but, rather, on "the hardware's ability to run [a specific] application."

The second user we interviewed is Assistant Director of Data Processing for a manufacturing concern in the South. His 4381 Model Group 14 is used to run all general business applications for the company, such as payables and receivables. Process control is handled by IBM Series/1's attached to the 4381.

This 4381 is an upgrade from a 4381 Model Group 2, and was acquired for the greater CPU power it offered. The hardware conversion was problematic, the user said, be-

The 3720 and 3725 Communications Processors and their predecessor, the 3705, are separate front-end processors that have their own operating software, the NCP. This facility directly controls SNA/SDLC networks, and has subsidiary programs: NSI (Non-SNA Interconnect), NTO (Network Terminal Option), and XI (X.25 Interconnect) for management of terminals using BSC, Start/Stop, or X.25/HDLC protocols. SNA usually handles non-SDLC protocols by embedding them in an envelope of SDLC code, treating the control code as another layer of data; the SDLC layer is stripped away at the receiving end, and the destination non-SDLC communications program receives the original nonSDLC protocol as if it had not passed through an SNA/SDLC network.

SYSTEM SOFTWARE

Operating Systems

Although MVS/XA is the native-mode system for the 4381, it is likely that it will be in the minority of installations because of the 4381's position as a transition system between low-end superminis and high-end mainframes. Both VM and VSE users migrating upwards from 9370 and 4300 systems, respectively, are likely first to make the hardware transition for greater processing power, and then to consider carefully before undertaking a software migration.

In the discussions that follow, operating systems which share a compatibility family have been grouped together wherever possible.

MVS/XA, MVS/370, OS/VS1/BPE: Those members of the MVS-compatible family of operating systems supported on the 4381 are three very distinct products: MVS/370, also known as MVS/SP Version 1; MVS/XA, also called MVS/SP Version 2; and OS/VS1/BPE. All evolved from the real-memory "OS" operating system developed in the 1960s; MVS/XA is upward compatible with MVS/SP, which is in turn upward compatible with OS/VS1/BPE. OS/VS1/BPE, a system with a single virtual storage area of up to 16MB and a real memory capacity of 8MB, was actively upgraded by IBM until about five years ago.

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cause IBM did not perform appropriate systems assurance. As a consequence, a major problem with the I/O subsystem occurred, requiring acquisition of more disk drives—at greater expense, of course. IBM's negligence in this case, he said, is atypical of the solid support the vendor usually provides; it was merely the fault of one branch that did not perform up to the company's normal standards of service.

On the other hand, porting applications from the Model Group 2 to the Model Group 14 was easy, the user said. It was a case of "just IPL and go"; not even recataloging was required.

When asked to single out special features of the system, he spoke highly of the 4381-14's dyadic processing capability. He said it works well for multiple CICS systems that are not integrated; for example, he uses three CICS to handle corporate applications. However, if the CICS must be broken up, the dyadic structure is not as desirable, he said. He did say that he feels the system provides a good growth path, permitting eventual upgrade to the 4381-24 and conversion from the MVS/SP environment his system currently employs to the higher-performance MVS/XA.

When asked what he would tell a prospective 4381-14 user, this respondent said he would neither praise nor condemn the system; he would recommend an objective approach to system selection, observing, "You just need to know where the rocks are so you can walk on the water." □

MVS/370, a system allowing multiple virtual storage areas of up to 16MB each, residing in a real memory space of up to 64MB, is still being actively developed. Both of these systems use 24-bit addressing, which can be stretched to 26 bits by MVS/370 through the annexation of two protect bits. MVS/XA, the extended-architecture system most capable of fully exploiting the 4381's 31-bit addressing mode, handles multiple virtual address spaces of 2GB each, residing in a real memory that theoretically could also be expanded to 2GB, but is constrained by the 4381's current 64MB memory ceiling. That ceiling provides at least some relief from the constraint that existed prior to May 1987, when the maximum memory capacity was 32MB.

The generic designation "MVS/SP" is one that, unhappily, refers to two quite distinct operating systems: a substantial migration effort and a complete new SYSGEN are required to move from Version 1 to Version 2. IBM has given Version 2 the distinctive "MVS/XA" appellation, but did not supply Version 1 with a mnemonic that refers only to itself. This report uses the MVS/370 name to refer only to MVS/SP Version 1, even though IBM usually applies it to both MVS/SP Version 1 and MVS/SE, an MVS version not supported on the 4381. Readers should keep in mind, however, that the characteristics described here for MVS/370 are only claimed for MVS/SP Version 1 and do not necessarily apply to MVS/SE.

The multiple virtual memory orientation of the MVS/370 and MVS/XA operating systems theoretically allows users to write programs as if there were little in the way of size restrictions; the operating systems just swap portions of the programs out to disk when they don't fit into the real space. Actually, MVS/370 has encountered capacity problems in the virtual space because of the addresses that need to be reserved for continuously growing operating system modules. The MVS/370 nucleus is located at the bottom of the address space, and the other system programs held in common are located at the top of the address space. The area left over in the middle is the "private" area, for the user's private programs. Obviously, as more and more system software is added, the common area expands, and the private area shrinks, leading to a condition known as virtual storage constraint. This tends to be a problem particularly in MVS/370 installations which have both IMS and CICS installed.

This is a humorous problem in some respects, since IBM sells real memory, not virtual memory. An IBM spokesperson once remarked that it was very annoying to run out of something the company was not even selling.

MVS/XA provides the means to relieve virtual storage constraint by moving the nucleus up to the 16MB boundary, with part of it residing above and part of it below the 16MB line. The basic common area lies just below the nucleus, while the private area is now at the bottom of memory. Both the common area and the private area have corresponding areas above the line for those programs which can fully utilize XA address space or don't need to directly contact 24-bit-oriented programs. As more and more XA-oriented systems software is moved all or in part above the line, the space left in the private area expands. Thus MVS/XA opens up the system not only for new programs written for the 31-bit architecture, but also makes more room for existing 24-bit-oriented applications.

Two Job Entry Subsystems for MVS environments, JES2 and JES3, have continued to evolve somewhat asynchronously with each of the operating systems. JES2 is descended from and compatible with S/360 HASP, while JES3 is descended from and compatible with S/360 ASP. MVS/370 and MVS/XA can be packaged with either of the JES products, so there are a total of four operating system packages available for the two environments. Either JES manages the entry of jobs through a series of Job Control Language (JCL) statements entered from local or remote job entry terminals, other computers, or other jobs. The statements are scanned for basic syntactical accuracy, translated to a more readily processed form, and then placed in a job queue to await execution.

JES2 scheduling procedures are usually based on a first-in-first-out (FIFO) basis, once a program's class priority structure has been established. JES3 also supports the definition of deadlines which ensure that a job will be scheduled by a specific time, regardless of time of entry and job priority, and can provide for the concurrent scheduling of independent job steps while maintaining dependency relationships and sequences within the job stream.

Although historically JES2 has been a simpler system than JES3, IBM has been changing this through a concerted development effort, probably motivated by the unwillingness of the JES2 user base to convert to JES3. Although both entry subsystems can be used in tightly coupled multiprocessors with shared memory, or in loosely coupled multiprocessors with shared DASD (Direct Access Storage Device) disk drives, JES3 has long been inherently more suited to these environments. JES2 requires a separate option, Multiaccess Spooling.

MVS/XA, MVS/370, and OS/VS1/BPE operating systems are licensed program products that require all or part of another no-charge System Control Program (SCP) in order to operate. The two MVS/SP systems both require

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CHART D. 4381 TAPE DRIVES

Model Number	Type: Reel or Cartridge	Number of Tracks	Recording Density, bits/inch	Peak Performance, Bytes per Second, Inches per Second	Drives per Subsystem, Single Controller or Master Drive Model
3420-4	Reel	9	1600/6250	470K, 75 ips	8 single per 3803 Controller
3420-6	Reel	9	1600/6250	780K, 125 ips	8 single per 3803 Controller
3420-8	Reel	9	1600/6250	1.2MB, 200 ips	8 single per 3803 Controller
3422	Reel	9	1600/6250	780K, 125 ips	8 single including 3422-A Master
3430	Reel	9	1600/6250	312.5K, 50 ips	4 single including 3430-A Master
3480	Cartridge	18	38,000	3M (buffered)	4 dual per 3480-A Controller

the MVS Release 3.8 SCP, while OS/VS1/BPE requires the OS/VS1 Release 1.7 SCP. Both of those SCP components used to be freestanding operating systems themselves—members of the OS/VS family—but neither SCP can run on the 4381 that way, so for our purposes they are merely sets of free utilities.

VM/SP, VM/IS, VM/XA: The VM environment currently embraces what are, in effect, three operating systems not entirely compatible with one another. The key product is VM/SP, which can run nearly all the programs available to the other two environments, VM/IS and VM/XA. VM/IS, a replacement for the earlier VM/Entry systems, is an entry-level system that incorporates special packaging and user interfaces to make it easy for entry-level users to install and operate.

VM/XA is a high-end system with marked environmental limitations arising from its origin; it was originally designed not to be an operating system, but to serve as a migration aid for MVS/370 users in the process of upgrading to MVS/XA. Enhancements announced in June 1987 (discussed in the "System Expansion and Migration" subsection of this report) make VM/XA more desirable as a product data base in its own right.

However, both VM/XA and VM/IS can select programs from a more limited software base than that available to VM/SP. Moreover, the two program subsets are different, reflecting differences in market orientation even in the basic languages supported. Since VM/SP is so much more versatile than its low-end and high-end subset environments, most of this report refers to the VM environment in terms of the VM/SP base.

Regardless of the diversity of implementations, there are broad areas of similarity in the basic VM architecture in all its operating system versions. All employ the essential concept of a "virtual machine." This concept is surprisingly contemporary even though it was developed more than 20 years ago: its principle of organization is reminiscent of structured programming and the Unix layered "shells." The basic VM control program (CP) is a "backbone" or "umbrella" which runs a number of subsidiary environments under it as "virtual machines." To VM, each of these is like an application program, but every one of those VM "applications" is either a full-blown operating system or an executive of a major subsystem with numbers of subordinate programs.

Although CP is the resource manager for the system, it provides only services for the virtual machines. Each individual operating system/virtual machine uses its own resources for access methods and user services, but executes in the problem state to allow CP, the only program in the supervisor state, to trap real machine calls. This system does not require that CP and the virtual machine directly interact with one another, but the layered architecture usually involves performance penalties unless steps are taken.

The CMS timesharing executive intimately associated with the VM core control program is handled the same way as any other virtual machine. The VM backbone keeps the environments separate from each other for the most part, but traps I/O or other system calls and translates them into its own code for execution. As a result, none of the environments needs to be compatible, and each one is protected from the other. This environmental translation activity is completely transparent to the various end users, who see themselves as operating in an MVS environment, a VSE environment, or a CMS environment, rather than in a VM environment.

DOS/VSE: DOS/VSE Version 2, the basis of both VSE/AF (Advanced Function) and VSE/SP Version 2 packages, is a descendant of real-memory DOS, and is upward compatible with virtual memory DOS/VS environments. VSE/SP, unlike MVS/SP and VM/SP, is not a new version of VSE/AF with different operating features; it is a pregenerated, ready-to-run packaged system with the same basic software combined with ease-of-installation benefits, and a special Interactive Interface.

VSE is a multiprogramming/multitasking operating system that maintains control over concurrently executing tasks through a virtual memory partitioning scheme. The system supervisor divides the virtual memory available for execution of programs into 2 to 12 partitions, usually of unequal length. Memory capacity is 16MB of real memory and 40MB of virtual memory in three virtual address spaces of up to 16MB each. Up to 31 VSE processors, including 4381 models, can share DASD, including large 3380 disks, but there is still no tightly coupled multiprocessing. Earlier VSE releases were limited to seven partitions with a combined total of 16MB of virtual memory residing in up to 8MB of real memory.

The supervisor, which resides outside the partitions, allocates the programs or tasks to the partitions, and the tasks

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assume the priority of the partition. Partition priorities are assigned at IPL, and are ordinarily not altered unless two or more partitions have been specifically designated for dynamic recalculation of priorities for purposes of processor load balancing. The partitions execute concurrently, with the highest priority partition retaining control until interrupted by an event that has not occurred, like the completion of an I/O request. Then control passes to the waiting partition with the highest priority. One task executes in each partition, but complex tasks can initiate up to 31 subtasks, as long as the system-wide ceiling of 208 subtasks has not been reached. Subtasks compete for processor time as if they were independent programs. In this case, when a running task or subtask is interrupted, control is transferred to another subtask in the same partition rather than to another partition, unless a partition with a higher priority is waiting to receive control.

VSE/AF network management relies primarily on programs in two partitions: ACF/VTAM (Advanced Communications Function/Virtual Telecommunications Access Method) and the PNET component of VSE/POWER. Management of local interactive terminals can be handled independently by the CICS partition, but as soon as remote interactive terminals are mixed in, the networking partitions have to be invoked for every remote terminal access. The partition-independent job queuing provided by VSE/POWER and the addition of the Shared Virtual Access (SVA) area are important elements of the system that have been devised to get around the problems of communications across partition boundaries.

The period between 1984 and 1987 has been a critical time in the history of the VSE environment. On the one hand the user base growth rate has been sufficient to maintain the combined DOS/VS and DOS/VSE operating environments in the lead as the environment with the largest number of mainframe installations in the world.

On the other hand, the growth rate of the VM environment has escalated to the point that it is realistic to assume that VM will overtake VSE in the not-so-distant future. No doubt with this in mind, IBM announced as early as 1984 that it intended to "functionally stabilize" VSE, and has continued to make remarks of this nature ever since. Users and industry observers alike periodically conjecture what the difference is between "functionally stabilize" and "no longer support." "Functionally stabilize" at least means that IBM wants to spend more development money on VM than on VSE, and that the company wants to encourage VM over VSE sales without exactly saying that it intends to leave its largest user base in the lurch.

Licensed programs for most strategic areas are VSE versions of products familiar to the MVS user: ACF/VTAM, CICS, and ISPF (Interactive System Productivity Facility) for communications, SQL/DS and DL/1 for databases, GDDM (Graphical Data Display Manager) for graphics, and so on. Like MVS, VSE predecessors began with a primarily batch production orientation, but the product of today is designed for mixed mode, batch, and interactive processing. Like MVS, VSE and its predecessors can run together with VM as a "virtual machine" to make use of VM's excellent timesharing facilities and upgrade umbrella. Unlike MVS, VSE has retained a fairly easy-to-manage profile, along with memory requirements consistent with a small-systems entry level.

IX/370: Interactive Executive for System/370 is an implementation of Unix System V (level 0.2), the operating system developed and licensed by AT&T. A multiuser, multitasking system, IX/370 runs as a separate virtual machine under VM/SP, with or without VM's High Performance Option (HPO).

Several images can co-reside in one VM virtual machine (sharing one or more Series/1s with an IX/370 ASCII Control feature), or can each occupy a separate virtual machine. The Bourne shell command language is used to customize applications or user needs. IX/370 also employs a true virtual memory system, rather than swapping, with 4KB pages, and an 8MB virtual address space for each process or application. The file system is hierarchical, and includes the ability to copy files to other Unix systems.

Other IX/370 facilities include a desk calculator package, text processing and document preparation, editors, Fortran and C compilers, and support for IBM and other full-duplex ASCII terminals. System V functions not included are games, programs oriented toward non-IBM hardware, RJE, crypt or callunix commands, and online manuals.

TPF2: The Transaction Processing Facility has symbiotic relationships with both VM/XA and MVS. There is, in fact, some argument as to whether TPF2 should be called a separate operating system or not. On the one hand, it is the primary control facility for very large installations, needing extremely high transaction processing rates of several hundred to more than a thousand transactions per second (tps). On the other hand, it requires MVS to do a SYSGEN or any batch processing, and so could be seen as a subsidiary of the MVS environment. At any rate, in the VM environment its position is clearly defined: it is a virtual machine. As we saw earlier, a virtual machine frequently is, but need not be, a full-blown operating system.

VM/XA is particularly important to TPF2 because the TPF2 Partitioned MultiProcessor (PMP) feature required to expand upwards into dyadic or quadratic XA multiprocessing environments cannot run except under VM/XA. The upward growth issue has become more critical since TPF2, after a slow but profitable beginning as an Airlines Control Program, has become strategic for IBM in a world that has suddenly become more and more interested in online transaction processing at high speeds. It is gaining favor in hospitals, hotel reservations, and other applications that require the critical timing and high volume characteristic of airline reservation systems.

MUSIC/SP: The Multi-User System for Interactive Computing is an interactive timesharing system able to support diverse activities like problem solving, program development, word processing, computer-aided instruction, file editing, and batch processing. It has been developing slowly from an ASCII-oriented system into one that can operate in XA environments and can efficiently handle both 3270 terminals and PCs. In 1986 IBM upgraded MUSIC into a fully warranted program product and included it as the foundation component of the Education Computing Support System, one of the SolutionPac series of packaged applications made available for S/370-based systems.

Databases

Historically, IMS, a hierarchical database, has been the most strategic DBMS product for IBM's MVS customers. It is still a primary production database offering suitable for customers with moderately high transaction processing rates. However, it has been superseded in importance by IBM's so-called "Relational Productivity Family." This group of relational DBMS products participates in IBM's Systems Application Architecture (SAA), a set of selected software interfaces, conventions, and protocols designed to permit development of applications compatible across all

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CHART E. 4381 PRINTERS

Model Number	Technology Type	Peak Speeds	Color, Speed Factors	Char./Line or Pels/In.	Interface Type
3262-3	Band	650 lpm, 252 lpm	48-char. set 128-char. set	132 char.	3270
3262-5	Band	650 lpm, 252 lpm	48-char. set 128-char. set	132 char.	Channel
3262-13	Band	650 lpm 252 lpm	48-char. set 128-char. set	132 char.	3270/8775
3268-2	Dot matrix	340 cps	—	132/168 char.	3270/8875
3268-2C	Dot matrix	340 cps	4-color	132/168 char.	3270
3287-1	Dot matrix	80 cps	—	132 char.	3270/8875
3287-1C	Dot matrix	80 cps	4-color	132 char.	3270/8875
3287-2	Dot matrix	120 cps	—	132 char.	3270/8875
3287-2C	Dot matrix	120 cps	4-color	132 char.	3270/8875
3800-3	Laser, page	526 ppm	Also APA mode	240 × 240 pels	Channel
3800-6	Electrophoto, page	134 ppm	Also APA mode	240 × 240 pels	Channel
3812	LED, page	12 ppm	NLQ; APA mode	240 × 240 pels	3270
3820	Laser, page	20 ppm	NLQ; APA mode	240 × 240 pels	Link, Chan.
3852-2	Inkjet	10-50 cps	7-color; APA	66/132/166 char.	3279
4234	Dot band	410 lpm 300 lpm 120 lpm	Draft quality Data processing NLQ	132/168 char.	3270
4245-12	Band	1200 lpm	48-char. set	132 char.	Channel
4245-D12	Band	1200 lpm	48-char. set	132 char.	3270
4245-20	Band	2000 lpm	48-char. set	132 char.	Channel
4245-D20	Band	2000 lpm	48-char. set	132 char.	3270
4248-2	Band	4000 lpm 3200 lpm 2200 lpm	Draft Data processing NLQ	132/168 char.	Channel
4250	Electroerosion	NA	Repro master	600 × 600 pels	3270
5210-61	Daisywheel	40 cps	Bidirectional	Proportional	3270/8775
5210-62	Daisywheel	60 cps	Bidirectional	Proportional	3270/8775

Note: A dash (—) indicates that the information is unavailable from the vendor.

major IBM computing environments: System/370, System/3X, and Personal Computing (including the new Personal System/2). The Relational Productivity Family includes DB2 and SQL/DS (discussed in the following paragraphs), along with OS/2 Extended Edition Version 1.1, the operating system for the PS/2. The Relational Productivity Family products provide Common Programming Interface, Database Interface, and Query Interface elements of SAA.

DB2, the Database 2 relational database for MVS environments, is a relatively new strategic product. Even though it has fewer users than IMS at this point, it is extremely important in that it is the wave of the future, and can supply many functions not available in IMS—at the price, admittedly, of a slower transaction processing rate. It is a full-function relational database system with integrated report writing and query language features. Its table-oriented relational data structures make it particularly useful for end-user applications such as planning, prototyping, design work, and similar activities relying on data and application structures subject to frequent change.

IBM makes DB2 and IMS files accessible to each other (and both IMS and DB2 databases can be accessed by CICS or TSO), thus inviting a dual database strategy.

VSE and VM environments mirror MVS database offerings with somewhat compatible subset databases. The DL/1 database is the traditional hierarchical system, and gets its name from the Data Language/1 component it has in common with IMS. In the past, VM environments usually acquired database facilities by running the VSE operating system as a virtual machine in combination with DL/1. However, SQL/DS, which is the equivalent of DB2, can run efficiently in native mode under VM, as well as under VSE. SQL/DS is marketed as the primary, strategic database system for VM environments, and there is not the same level of tension in a dual database strategy as there is for MVS and VSE users already committed to older databases.

The most common file access method in IBM environments is the Virtual Storage Access Method (VSAM). VSAM's key-sequenced file structures allow files to be distributed across multiple locations, instead of requiring contiguous disk space. The separate VSE/VSAM program product provided for VSE file access runs on VM systems and is compatible with the VSAM access method integral to the MVS operating systems.

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File management and automatic file backup utilities have been extensively developed for MVS environments and are moderately well developed for VM. The Data Facility Hierarchical Storage Manager (DFHSM) for MVS provides automatic storage space management functions for memory, disk, tape, and disk cache subsystem management. DFHSM, together with several optional disk management programs, manages 3420, 3430, and 3480 tape subsystems; 3330, 3350, 3375, and 3380 DASD subsystems; the 3850 mass storage subsystem; and 3880 and 3990 disk cache devices. The 3330 and 3850 are older systems no longer actively supported by IBM, but there are still users who have not converted to their more modern equivalents.

COMMUNICATIONS

The 4381 is a host system in the IBM communications hierarchy. (In 1988, it will be able to function as a peer.) When the 4381 serves as a host, terminals and remote systems communicate with the communications processor's NCP software, and that in turn communicates with the access method—usually VTAM—which communicates directly or indirectly with the destination application. This basic path can be impacted by several layers of code that may supply routing through the network, establish sessions between sending and receiving programs, check for errors or other problems, and translate protocols and formats, among other functions.

IBM's SNA defines these basic levels of communications and the structure of these interactions in a standardized way, which paves the way for communications across the various environments. The primary pieces of software for implementing SNA are the ACF/VTAM access method and the host-resident ACF/SSP (System Support Program) facility, which generates and provides supporting functions for ACF/NCP, the network control workhorse that resides in the front-end communications processor. NCP primarily supports communications using the SNA/SDLC protocol, but has subsidiary programs allowing BSC and X.25/HDLC synchronous communications, as well as asynchronous ASCII interfaces.

Version 3 Release 2 of ACF/VTAM—announced in June 1987 and scheduled for release throughout 1988 (third quarter for MVS/XA, MVS/370, and VM/SP; fourth quarter for VSE)—promises to be one of the most significant communications products IBM has ever provided. Working in conjunction with NCP, this version of VTAM is the vehicle for delivery of true peer-to-peer networking in the SNA environment. Any network node conforming to Physical Unit Type 2.1 (PU2.1) can communicate with any other node without having to go through a host, thus saving central system resources and associated overhead costs.

VTAM's Application Program Interface (API) allows Advanced Program to Program Communications (APPC) between applications using Logical Unit Type 6.2 (LU6.2) sessions. Thus, an APPC application running in the ACF/VTAM environment on a System/370 machine can directly access an APPC application in a differently architected IBM system, such as a System/3X, RT PC, IBM PC, or PS/2. VTAM is responsible for session initiation and termination management under APPC.

This APPC capability in ACF/VTAM reduces the need for separate communications lines and provides more connectivity options among hosts, distributed and departmental processors, and end-user workstations.

ACF/VTAM participates in IBM's SAA, supporting IBM's Token-Ring LAN and X.25, as well as Type 2.1 nodes and LU Type 6.2 as part of SAA's Common Communications Support element.

In addition to peer-to-peer connectivity, ACF/VTAM Version 3 Release 2 provides dynamic path updating facilities. These features enable the tables that define network topology to be updated without requiring inactiviation or regeneration of the NCP. Thus, nodes can be added to the network without bringing it down.

One of IBM's new standardized architectures, developed in 1986, involves network management and control of this basic pathway. Previously, control functions were divided among a number of programs which were not implemented in all of the operating environments; these functions are now consolidated into a single package, NetView, with versions supplied for MVS/370, MVS/XA, VSE, and VM/SP.

NetView allows establishment of a single control center to manage both SNA and non-SNA networks. NetView can run unattended in distributed VM and VSE environments; network management and alert information can be forwarded to a central site host. For example, restarting of data lines can be handled without operator intervention through predefined system responses to specific events and messages.

An adjunct product, Inter-System Control Facility (ISCF), runs as a NetView application and allows control and monitoring of multiple target computers from a centralized controlling system. ISCF works in conjunction with a facility called ISCF/PC, which runs in stations attached to the target systems. Through these products, functions such as initial microcode load (IML), initial program load (IPL), and time-of-day clock setting at the remote sites can be handled by operators at the central site.

The centralized management provided by NetView and its associated products represents a significant cost saving for large, dispersed system configurations, for it reduces the amount of support required at remote sites.

Five key transaction-oriented and timesharing subsystems intimately involved with SNA are TSO (MVS only), CMS (VM only), TPF, IX/370, and CICS (MVS, VSE, and VM). TPF, which has evolved into a subsidiary of MVS, and IX/370 are both arguably considered separate operating environments, so they were discussed in the "Operating Systems" subsection, above. Details on all the other key communications products are presented later, in the "System Description" section.

Two different file exchange architectures—DSX (Distributed System Executive) and DDM (Distributed Data Management)—are available on the 4381. DSX is a network management system for a layered distributed processing network with multiple types of node computers managed by a central host. It currently supports the following systems as DDP nodes: System/36, Series/1 (running under CPS, EDX, or RPS), 8100 (running under DPPX or DPCX), System/88, and mainframes running under VSE or SSX. DDM is a more recent architecture that provides peer-to-peer exchanges between systems that may operate as sources of requests, targets of requests, or both. The 4381 operates only as a source, that is, as a file server. Other DDM systems are S/36 and S/38, which can operate as both source and target, and PCs, which are only sources (i.e., requesters).

The Screen Definition Facility (SDF) is the primary application development aid for programmers who want to define or edit basic CICS maps or map sets.

LANGUAGES & UTILITIES

Fifteen different languages are actively marketed for the 4381: Ada, Algol, APL2, Assembler H, Basic, C, Cobol,

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CHART F. 4381 DISPLAY TERMINALS

Model Number	Terminal Interface	Capacity, Characters	Colors Displayed	APA Graphics	Compatible Predecessors; Microcoded Emulator
3151	ASCII	1920, 2200, 3168, 3300,	Monochrome	NA	IBM 3161; IBM 3101, DEC, Wyse, ADDS, Hazeltine, Televideo, Lear-Siegler
3161	ASCII/RS-232	1920	Monochrome	NA	IBM 3101-881; ADDS, Hazeltine, Televideo, Lear Siegler
3162	ASCII/RS-232	1920	Monochrome	NA	IBM 3101-881; DEC, Hazeltine, ADDS, Televideo, Lear Siegler
3163	ASCII/RS-232	1920	Monochrome	NA	IBM 3101-881; DEC, Televideo
3164	ASCII/RS-232	1920	4-color	NA	IBM 3101-881; two special ALA-compatible submodels
3178	3270	1920	Monochrome	NA	3278
3179	3270	1920	7-color	NA	3279
3179-G	3270	1920, 2560	8-color	APA	3279
3180	3270	1920, 2560, 3440, 3564	Monochrome	NA	3278
3191	3270	1920, 2560	Monochrome	NA	3278-2
3192-C	3270	1920, 2560	7-color	NA	3279
3192-D	3270	1920, 2560, 3440, 3564	7-color	NA	3279
3192-F	3270	1920, 2560, 3440, 3564	7-color	NA	3279
3192-G	3270	1920, 2560	8-color	APA	3279
3192-L	3270	1920, 2560	7-color	NA	3279
3193	3270	3840 (880 × 1200 dots)	Monochrome	APA	Split-screen can emulate 3278
3194	3270	1920, 2560, 3440, 3564	7-color, Monochrome	NA	3279
3278-1	3270	960	Monochrome	NA	NA
3278-2	3270	1920	Monochrome	NA	NA
3278-3	3270	2560	Monochrome	NA	NA
3278-4	3270	3440	Monochrome	NA	NA
3278-5	3270	3564	Monochrome	NA	NA
3279-S2A	3270	1920	4-color	NA	NA
3279-S2B	3270	1920	7-color	NA	NA
3279-S3G	3270	2560	7-color	Prog. symbol	NA
3279-02X	3270	1920	4-color	NA	NA
3279-03X	3270	2560	4-color	NA	NA
3290	3270	9920; large slim panel	Monochrome	NA	Split-screen can emulate 3278
6580-A	Displaywriter	2000	Monochrome	NA	NA
6580-B	Displaywriter	6600; 66 lines	Monochrome	NA	NA
8875-11	8875 (3270-like)	960, 1920, 2560	Monochrome	NA	NA
8875-12	8875 (3270-like)	960, 1920, 2560, 3440	Monochrome	NA	NA

DSL/VS, Fortran, Intellect, Lisp/VM, VS Pascal (replacing the older Pascal/VS), PL/1, Prolog, and RPG II. Many of these have evolved over several generations, so more than one version is available. Cobol II, for example, is an enhanced version of VS Cobol. In addition to the standard PL/1 compiler, there is an optimizing PL/1 compiler.

IBM has designated three languages as being particularly important to its new cross-product SAA: Cobol II, ANS Version X.323-1985; Fortran 77; and the C language, based on the ANS X3J11 proposal. The individual operating system environments vary widely as to which languages are supported. VM has the widest range, since it supports several artificial intelligence languages as well as the stan-

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dard business-oriented languages. This is explained in more detail in the "System Description" section of this report.

Common Programming Interface is the term for a group of new and existing products that form one of the major classes of IBM's new SAA. In addition to the three languages mentioned above, this group includes the Cross System Product (CSP) set as the primary Applications Generator and the venerable GDDM as the primary Presentation Interface.

CSP/Application Development (CSP/AD) and CSP/Application Execution (CSP/AE) programs are application generators designed to develop highly portable applications. Programs can be developed, tested, and generated using CSP/AD running under VM/CMS, DOS/VSE with CICS/VS, or MVS with TSO or CICS/VS. Program development and testing can also be done with similar CSP/AD products that run on PCs under PC-DOS or on the 8100 under either DPCX or DPPX. The resulting application program, from whatever source, is designed to operate with the CSP/AE program in any of those environments. During the application generation process, the defined application is translated into a set of tables, placed in an execution library, and then generated into whichever environment(s) the user specifies. It was originally expected that most applications would run under CICS (MVS or VSE) or perhaps the 8100 operating systems; runtime compatibility with VM/CMS, MVS/TSO, and the PCs has been provided mostly with the expectation that it will be used mostly for testing. Recent changes in operating system and product line relationships suggest that VM environments will also be key targets for CSP applications.

GDDM has been IBM's primary mainframe general-purpose graphics processing package for years, and consequently has a lot of support from third-party vendors and users who have programs related to it. Since it has been a strategic product for scientific and engineering applications, as well as for business graphics, it has been undergoing a lot of development. It can operate in context with TSO, CICS, IMS, or MVS batch environments. Graphical Display and Query Facility (GDQF) is associated with graphics for CAD/CAM applications rather than for business graphics, but GDDM has been expanded to include both. GDDM can communicate with the Initial Graphics Exchange Specification (IGES), GDDM/graPHIGS, and a number of other subsidiary programs, thus defining a coherent subenvironment. IGES is designed to transfer engineering data from one CAD/CAM system to another, according to a subset of the ANSI graphics exchange specifications. GDDM/graPHIGS is a programming interface based on the proposed ANSI PHIGS (Programmer's Hierarchical Interactive Graphics System) standard for simplifying CAD/CAM and similar types of graphics applications.

The various Common User Access levels of IBM's new SAA have not yet been spelled out, but two products, Interactive System Productivity Facility (ISPF) and DisplayWrite/370, are very likely to be specified as core products. They are both already supported across several environments and have been informally identified as important by IBM spokespersons making off-the-cuff, unofficial comments.

DisplayWrite/370 is a word processing program common to MVS, VM, and VSE environments; it is designed for professional end users who need advanced text functions on a terminal or PC attached to a mainframe. It is a glorified emulator based on IBM's popular DisplayWriter word processing system; versions of this "emulator" have been implemented for PCs and System/36. Both revisable and final form documents—the RFTDCA and FFTDCA standards specified by IBM's Document Content Architecture (DCA)—can be processed. DisplayWrite/370 can be called by a CICS 1.6.0 application program to create, view or print a document; to transform a document into a 1403 or 3800-1 data stream; or to transfer it to the Document Composition Facility, which can, in turn, return the transformed document to the calling application via the DW interface.

ISPF provides enhanced editing support and special operator utilities that significantly reduce system load when extensive program development is taking place. Many users consider it a requirement for MVS/TSO environments with these characteristics. There are also versions of ISPF for VSE and VM; the latter provides a common user interface for users who are moving TSO-like applications to VM in native mode. There are actually two products collectively referred to as ISPF: the "bare" ISPF program, which provides the dialog function, and ISPF/PDF, for editing and library utilities.

Operating system utilities are highly specific to each of the environments, but certain elements have been implemented with a great deal of cross-environment compatibility. Most of the printer control programs for the all points addressable (APA) Advanced Function 38XX printers, for example, are permutations of a basic program set. The DITTO (Data Interfile Transfer Test and Operations) utility, originally developed for the DOS environment, now has VM and MVS versions. The MVS RACF (Resource Access and Control Facility) has been adapted for the VM environment.

Three operating system utilities are important enough components of their respective systems to be treated more like operating systems extensions. They are DFP (Data Facility Product) for MVS and RSCS (Remote Spooling Communications Subsystem) and VM Batch Subsystem for VM. The timesharing TSO and CMS systems also fall into this category (see the "Transaction Processing" subsection of this report).

DFP is the required data facility product for MVS/370 (MVS/SP Version 1) and MVS/XA. It provides key data management, device support, program library management, and utilities. It combines in a single, separate licensed program certain facilities found in portions of MVS 3.8 plus five program products that were previously optional. DFP allows up to 4,096 devices, 256 channel paths with up to 8 paths per device, and 31-bit real and virtual storage addressing of I/O devices. There are separate versions for MVS/370 and MVS/XA.

RSCS is a key program for VM systems and is usually considered one of the components of the basic operating system complex, rather than an optional systems program. As a separate virtual machine under VM, it is like a single-purpose operating system for accepting spooling files and either spooling them to a local user or transmitting them to the designated destination. It can operate as a host for both intelligent and dumb terminals, and as a peer system for NJI/NJE job networking systems. It can invoke application programs resident in another system and transport programs as well as data to other systems that have required data, special configurations, special devices, or a shorter work queue.

VM Batch Subsystem is based on a program developed by Intel Corporation. It has become an important IBM-supported program for VM-only users. It schedules, initializes, and monitors batch jobs in a VM/CMS environment. This

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CHART G. 4381 COMMUNICATIONS PROCESSORS

Processor Model	3708	3710	3720	3725-1 (with 3726)	3725-2
Functions					
Network front end	No	No	Yes	Yes	Yes
Remote network node	No	Yes	Yes	Yes	Yes
Concentration	Yes	Yes	Yes	Yes	Yes
Token/Ring LANs attachable	None	None	2	8	4
Line support					
Maximum number (without LANs)	10	60	28-60	256	80
Peak synchronous speed, bps	19.2K	19.2K	230.4K	230.4K	230.4K
Peak asynchronous speed, bps	19.2K	19.2K	19.2K	19.2K	19.2K
Gateways	ASCII	ASCII	X.25	X.25	X.25

subsystem is a separate supervisory batch virtual machine that can be used instead of a VSE, VS1, or MVS guest for batch operations.

SYSTEM EXPANSION AND MIGRATION

The 4381 hardware, positioned as it is between two compatible product lines, is designed for easy migration through the system by means of field-upgradable processors. Even expansion to the dual-processor model does not require an additional box; the uniprocessor box has room in it for the second processor. I/O channels provide all-purpose attachment positions, so there are no problems in changing the positions or relationships of various I/O subsystems.

The software situation is quite another story. Because the 9370 and low-end 4300s migrating upward to the 4381 are going to be either VSE or VM systems, and the XA mainframes that are the target of the 4381's own growth path are primarily MVS systems, the 4381 is the most likely arena for a software conversion effort to be required. The likelihood of a required conversion's occurring is greatly increased by IBM's declared intention to "stabilize" its huge DOS/VS-DOS/VSE user base and put its development efforts primarily into the strategic MVS, VM, and, to a lesser extent, TPF2 operating environments. The attractiveness of the added power and memory capacities are, as it were, carrots attracting the VSE user base; however, the stick that is likely to drive them into conversion is this stabilization announcement.

There are significant deterrents to converting from VSE to MVS, in addition to the well-known difficulties of performing the conversion itself. The advantages VSE users enjoy over MVS users in ease of use and management make VSE users less than enthralled about the prospect of having to upgrade to the far more complicated MVS.

Creating a standalone, easy-to-use, low-end version of MVS to replace VSE would be no mean feat, if it were possible at all. One current solution to this growth path problem is to run VSE in conjunction with VM on a larger processor, and gradually change growing applications over to a VM installation. The XA version of VM is problematic because of its general lack of software compatibility with VM/SP; the upgrade path for VM/SP systems is thus limited. Moreover, recent enhancements to VM/XA have done nothing to alleviate this compatibility problem. Loosely coupling multiple VSE systems together into a file-sharing configuration is only a stopgap measure; sooner or later growing DOS/VS and VSE users are going to have to go *somewhere.*

To ease the migration from VSE to MVS/XA, IBM is marketing a product called SolutionPac VSE/MVS Migration Assistant. Among other programs, this package contains IBM's MVS Migration System (MVS-MS) licensed program, which automates many of the tasks required to convert VSE applications to their MVS equivalents; facilities for source code conversion, JCL generation, and file transfer are included. The SolutionPac also includes a number of on-site services, including education, conversion plan development, pilot and customization assistance, and dummy conversion assistance. Actual switchover assistance is optional.

The second software conversion effort that can occur on growing 4381 systems is conversion from MVS/370 to MVS/XA. This is a genuine conversion, not an upgrade; for the first time in MVS history, a complete new SYSGEN is required. It is less likely to occur on the 4381 than on larger processors, because the 4381 is at the low end of the MVS growth path. Even though changes of this magnitude are bound to be complex, it is significant that by the beginning of 1986 more than half of the MVS licenses worldwide were XA licenses. That indicates that there must have been a lot of users hurting for more memory.

IBM has done an excellent job of designing and documenting the MVS/370-to-MVS/XA migration path. Outside of the three core programs, there are only a few XA-oriented programs which *must* run on XA; most can also run on MVS/370, allowing users to gradually position most of the system software at XA-compatible release levels before the actual conversion of the operating system proper.

VM/CMS has been used for program development and testing, as well as for timesharing, since it was allowed on the open market; native VM/CMS and its more recent entry-level packaged systems have been specifically directed toward scientific end users for more than five years. About half of existing VM installations have guest operating systems and half are native VM/CMS-only.

A surprisingly large number of native systems are at the high end of the market. At the 4381 level, it is fairly common to find VM in combination with DOS/VS or DOS/VSE. Now that VSE development has been squelched, this combination is likely to grow by leaps and bounds, providing users with a means to ease out of VSE over a long period of years, while moving new work to native VM wherever possible.

The addition of dual-mode CMS to the VM environment with the new VM/XA System Product (VM/XA SP) in June 1987 (for March 1988 availability) will make CMS more attractive to users in interactive application environments. It not only enables application programs to take advantage of 31-bit 370-XA addressing, but also allows attachment of greater numbers of users. (For further de-

tails on VM/XA SP, see the "Evolution and Direction" subsection of this report, which follows.)

One very obvious correlation between the ease-of-use and ease-of-management characteristics of all of the 4381 operating systems is the number of people required to maintain the system. Given comparable workloads and system sizes, the number of support personnel needed for VSE would be somewhat larger than for VM, but nowhere near the number needed to maintain the complexities of MVS, even though the "comparable system" idea would mean that the MVS installation was functioning at entry level. The advantage VSE enjoys in this regard points out that an upgrade from VSE to MVS would be far more than a problem of paying more for the software and going through a conversion; it would mean that VSE personnel would either have to be replaced or retrained and new staff added. This factor will probably encourage many VSE users to opt for a VM-VSE combination.

Disk subsystem growth is eating up an increasingly large percentage of the data processing hardware dollar, especially in installations with growing online applications. Changes in user demands, improved technologies, and the intimate relationship between CPU and disk subsystem performance mean that disk buying decisions are getting more complicated. In the last few years, as the growth rate of online and end-user-oriented applications has been increasing, many users have discovered that disk expansion needs are exceeding projected growth rates, and, furthermore, are likely to continue to do so for some time. In 1985 alone, IBM sold five times as many 3380s as it is reported to have originally projected for the entire life of the product.

ANALYSIS

EVOLUTION AND DIRECTION

The 4381 hardware architecture has proven to be a very successful design—so successful that it is likely to be sold for a number of years yet, even though the rest of the 4300 series has been replaced. The existing systems are put together in such a way that they can take advantage of changes in memory density without requiring a processor model change. Moreover, the addressing schemes of both MVS/370 and MVS/XA are amenable to ceilings of at least 64MB—the maximum configurable on a 4381. However, IBM's increases in peak channel speeds on the new 4381s strain already burdened I/O facilities.

The software arena presents quite another picture. IBM is undergoing a vast reorganization of its operating environment, and expects its new development effort, the SAA, to be as significant and as far-ranging as the development of SNA. In fact, this architecture treats SNA as just one of four major components of the overall picture.

Even though both VM and DOS/VS-DOS/VSE operating system families each have almost three times as many licenses as MVS, the MVS environment continues to be the leading-edge strategic operating system for the upper end of IBM's S/370 computing spectrum because of the nature of the user base it supports. Large-systems users dominate the business market in many ways through their networks and generate more revenue, so IBM is willing to spend more money on them—it's as simple as that. Large systems require more supporting software and far more expensive hardware than small ones do. Their installations are growing at increasing rates. And, as the icing on the cake, they still require proportionally lower overhead for IBM in sales and marketing costs, in spite of the complexity of their environments.

The last two years have seen some marked changes in IBM's other development priorities in system software. Both VM, which IBM has done its best to ignore in the past, and TPF2, which still has under 100 licenses, are perceived as the other strategic operating systems for the future. The principal cause of this change in priorities is the ability of each of the environments to handle rapidly growing online applications, and, particularly, transaction processing.

VM, in particular, has emerged as the principal low-end S/370 environment. For example, the load-and-go VM/IS incarnation of VM/SP is the one touted for the department-oriented 9370. In effect, VM is the principal compatibility vehicle between the lower- and upper-end S/370 machines, for the 9370 does not support MVS/XA. VM, in fact, is the only single operating environment that spans IBM's entire product range, from the 370 PC to the small, mid-range, and high-end S/370 machines.

As a result of this new emphasis on VM, IBM has consciously boosted the functionality of VM/XA to handle interactive applications. This move was stimulated in no small way by the inroads made at mid-range—frequently at the expense of the 4381—by Digital Equipment Corporation, whose VAX machines have gained wide acceptance for high-performance interactive computing.

The aforementioned VM/XA SP, replacing the older VM/XA System Facility (VM/XA SF), includes dual-mode CMS, which supports both 24- and 31-bit applications and accommodates larger numbers of users in complex interactive applications, such as simulation—in short, the types of applications that have caused IBM customers to defect to Digital.

VM/XA SP and its CMS component endow systems formerly used primarily for batch applications with formidable interactive facilities; they open new vistas for use of applications like graphics or IBM's PROFS office automation system.

By allowing development of software that fully exploits the XA architecture of the 4381 and other, higher-end S/370 machines, VM/XA SP provides a more logical and functional upgrade path to MVS/XA for users with strong growth needs.

Since past attempts to merge the DOS/VS and MVS operating environments themselves proved unworkable because of the vast differences in the architectures, IBM's direction has been to eventually create a development path that is not so operating-system visible by means of standardized user interfaces. The increasing number of IBM-developed programs that provide common interfaces and common file and data structures across multiple operating environments points to a future where users can change the manufacturer's system software from, say, VSE and the VSE version of ACF/VTAM to MVS and the MVS version of ACF/VTAM, and can continue to run their existing applications without a great deal of conversion of application programs or retraining of the user base.

In a sense, the operating system software becomes virtually transparent. Most major IBM-developed subsystems have already been adapted to multiple environments, although compatibility is not always perfect. For example, the same VSE/VSAM program runs under both VSE and VM, and provides file structures compatible with those of MVS IMS for the most part. SQL/DS/DB2 and QMF database software; ACF/VTAM, CICS, ISPF and NPDA (Network Problem Determination Application) communications software; GDDM graphics software; and CSP information de-

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velopment software are all strategic subsystems common to MVS, VSE, and/or VM environments. It is no accident that these common subsystems have been named as key components of the new architecture.

VM's relative user-friendliness and excellence for interactive timesharing may be the primary reasons for its current rise to prominence, but that does not mean it is entirely ready for what mid-range and larger users suddenly want in their interactive systems. VM/SP, for instance, has database problems which need to be ironed out before an unequivocal endorsement can be made for this system to operate as the hub of an Information Center.

The SQL/DS relational database does run under native-mode CMS, but these types of databases are all slow performers, with typical rates of around 15 transactions per second because of the complexity of the typical transactions they support and the nature of the process required to assemble the answer to a query. IBM's so-called "production" (primarily batch-updated) databases perform at much better speeds—in excess of 100 transactions per second—but in the VM environment, they cannot run in native mode. Both require a guest operating system with its attendant professional support. The extra layer always exacts a performance penalty.

The most common operating system/DBMS combination is VM/VSE with the DL/1 (DOS) subset of the IMS database, although IMS can also be run under MVS or VS1. In all three cases, the relative isolation of CMS users from each other—due to the "single-user" virtual machine state each one has—presents problems when users want to share data, particularly when multiple users need to be able to update data in online mode. On the other hand many security problems cease to exist in this architecture; others are just now being resolved by new software introductions—primarily via RACF (Resource Access Control Facility) borrowing from MVS—because previous typical applications did not need the levels of security that today's Information Center needs.

APPLICATIONS

As a highly versatile general purpose system, the 4381 is targeted at a wide variety of applications. Three key areas currently undergoing a great deal of development are applications for office systems, for departmental computing, for graphics, and for compute-intensive environments, including engineering, scientific, and manufacturing applications.

Office Automation

As a native MVS/XA system, the 4381 has access to the full capabilities of DISOSS, the office automation package that is the foundation of IBM's Document Interchange and Document Content Architectures (DIA/DCA). Many future 4381 environments, however, will be VM upgrades. Office automation has been a problem area in VM environments, in spite of the sophisticated PROFS environment that IBM has developed to such an extent that it is the one used internally within the company. The problem area has to do with compatibility with DISOSS, the MVS-based office system. The two were sufficiently different that the first steps in building bridges were monumental tasks. IBM has indicated that its future direction is an office environment in which the full capabilities of both PROFS and DISOSS are available to all users, and that they would be accessed through a common interface, regardless of what software is actually running on the system. In addition to the comprehensive PROFS and DISOSS systems, 4381 users have access to a variety of other packages—for voice transmission and electronic mail, for example.

Departmental Computing

Departmental computing is in many respects a branch of office automation. The 4381 has excellent software support of every sort for support of office automation and professional computing. However, the 4381 is more powerful (and more expensive) than most of the systems targeted for this market: it would be suitable only for the largest departments that wanted to combine support of professional workstations and local area networks with some in-house data processing that might involve compute-intensive operations. Although IBM touts the 4381 as environmentally flexible, its size, weight, and heat output are such that it would probably be more comfortable in a computer room with a raised floor. Furthermore, its peripheral complement would prefer the computer room, too. It is definitely not the kind of system you could fit into a corner.

Graphics

Existing graphics for MVS, VM, and VSE users are largely built around the same set of strategic GDDM packages that have evolved out of the MVS environment. This provides a commonality of user interface that is a prized goal for all IBM environments. It is not surprising that GDDM has been named as one of the key components of IBM's new SAA. Some non-GDDM-compatible software, which can be highly focussed towards a particular type of graphics, is also provided. The large variety of packages available reflects the interest in VM and MVS as the bases of scientific, manufacturing, and design systems. Graphics is important not only to business users, but also to scientific users and designers of electrical and electronic circuit boards, as well as of other three-dimensional structures.

Compute-Intensive Applications

The 4381 includes many features designed to enhance functionality in engineering/scientific applications. All models have 64-bit arithmetic logic units capable of handling 128-bit precision floating-point operations. All Model Groups except 11 and 21 include a high-speed hardware multiplier. In addition, the Engineering/Scientific Assist on each model reportedly reduces processor busy time by as much as 65 percent for the assisted functions in mathematical computations such as matrix inversion, decomposition, and multiplication.

Among the assistance facilities are a Multiply and Add Facility that provides vector/scalar capability for all models; a Square Root Facility for all models; and a Mathematical Function Facility on Model Groups 12, 13, 14, 22, 23, and 24 that includes short- and long-precision versions of exponentiation, common logarithm, and natural logarithm.

Several separate program products are of use to scientific users, regardless of the size of the installation; a prime example is ACRITH, which affects the users' knowlege of the accuracy of calculations. ACRITH is a set of subroutines for solving and verifying the accuracy of certain types of numerical analysis problems, especially those involving complex numbers that occur frequently in electrical engineering and physics.

The VM-based and MVS-based computer-aided design and manufacturing marketplaces are growing by leaps and bounds, as we noted earlier. The packages described in the following paragraph, for the most part, are only one or two core packages that define extensive subsystems. To those core packages can be added a varying number of supporting auxiliary packages:

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- CADAM (Computer-Graphics Augmented Design and Manufacturing-Interactive Design) is, as the name implies, an interactive graphics system for CAD/CAM applications that was originally developed by Lockheed. CADAM has proved itself over fifteen years of development in many IBM installations. There are eleven different supporting program facilities.

- CAEDS Frame Analysis System provides a quick and easy evaluation of alternative structural concepts through representation of interconnected beams and shells. It can analyze up to 10,000 elements and 1,000 degrees of freedom. It is associated with three other programs: System Analysis, Modeler, and Graphics System.

- CATIA (Computer-Graphics Aided Three-Dimensional Interactive Application) is an advanced CAD/CAM design system with an integrated environment and database for drafting, two- and three-dimensional wire frame design, surface modeling, solids modeling, and other advanced applications. There are nine additional supporting programs.

- CBDS2 (Circuit Board Design System Design Verification) is a computer-aided system for designing and testing circuit boards. It has one auxiliary program.

- Data Communication Services is designed to control and manage dissimilar CAD/CAM data types in a single central relational database system (either DB2 or SQL/DS), and to communicate (distribute) that data among the applications. Certain batch processes, like data transformations, can be grouped together. Applicaton programs and data can come from CADAM, CATIA, CBDS, IGES, and so on. In this context, "Data Communications" does not primarily refer to remote transmissions, although those can be accommodated.

ALTERNATIVES

Internal Competition

The 4381 faces competition not only from outside competitors—particularly Digital Equipment Corporation (as discussed in the "Management Summary" portion of this report)—but also from its own product lines. As the product positioning graph in Figure 2 shows, the low end of the 4381 series overlaps with System/38 and the 9370 series in processing power, while the high end extends into the 3090 series. The low-end overlap is an advantage for upgrading 9370 users; however, the 4381 does not provide much competition to those systems, not only because the 9370s have significantly better price/performance ratios, but also because the two sets of systems are employed in somewhat different environments (the 9370 in departments, the 4381 in computer rooms).

The shoe is definitely on the other foot with regard to the older 3080 series, however. The four newest models of the 4381 cut into the competition that the 4381s have received from vendors of remarketed 3081 and 3083 systems. The latter two machines, delivering up to 8 MIPS, have been priced by their resellers in the $700,000 to $1,000,000 price range; IBM can now match that with the upper-end 4381s.

The principal competition for the high-end 4381s now comes from the low-end 3090-120E, rated at 7.4 MIPS by International Data Corporation, of Framingham, MA. This machine overlaps the performance of the 4381-24, and provides a strategic alternative to the 4381 for users who envision more rapid short-term growth in data processing requirements, necessitating expansion upward into the 3090 mainframe class.

Alternative System Approaches

Some of the applications described for the 4381 could be handled by multiprocessing of a smaller system. Since the advent of the 9370, with its S/370 architecture, very attractive price/performance ratio, and low-cost peripherals, there are undoubtedly some users who will link multiple 9370s together, perhaps on a Token-Ring LAN, rather than buy a single system of 4381 power. Where this will not happen is in compute-intensive environments requiring greater degrees of precision than the 9370 can offer. Some of these types of long-running applications benefit from improved cycle times and larger memories, because they cannot be broken up into pieces and run on separate processors.

IBM itself may use some alternative system approaches in the future. The existence of the two-plus-processor 3090 series suggests that multiprocessing beyond two processors will not occur in the 4381; instead, users will be encouraged to upgrade. However, IBM's SNA is one of the heavy users of system resources. One of the major reasons is the splitting of network control between an access method which resides in the mainframe and a network controller residing in the communications processor. Why not move the access method out to the communications processor and cut back on unnecessary I/O? Other manufacturers have done it successfully. Since this weakness in SNA is very obvious, and so is the solution, we can only conjecture that IBM fears the onslaught of plug-compatible competition if the interface were eased in this manner. As it stands now, there is a considerable amount of traffic between the access method and the network controller, as well as between the controller's host system support program and NCP. Whether VTAM will be moved out to the front end or not depends on tradeoffs among a great many market factors.

SYSTEM DESCRIPTION

CPU & PROGRAMMING

This subsection provides specific details on 4381 processors, along with information on the system software supported under each 4381 operating environment.

Operating Systems

The following show the earliest versions of each operating system supported on the 4381. The most current version is listed in the price list. There is frequently more than one version of an operating system, and, occasionally, important packaged combinations. For example, MVS/370 (MVS/SP Version 1) and MVS/XA (MVS/SP Version 2) are really separate operating systems in spite of the similarity in names; the VSE/SP system, however, is just a special way of packaging VSE/AF. See the "Architecture" section of this report for more details on operating systems versions and packages. Three operating systems on this list evolved from standalone operating systems, but the only version supported on the 4381 is subordinate to another environment. One is an MVS adjunct, and two run under VM as virtual machines. Also listed below are those primary operating system versions supported under VM/SP and VM/XA as virtual machines.

Primary Operating Systems

- MVS/370 (MVS/SP Version 1) Release 3.3 and up.

- MVS/XA (MVS/SP Version 2) Releases 1.2 and up.

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- OS/VS1/BPE Release 4.0 with 5652-VS1 OS/VS1 Version 1.7 SCP.
- VM/IS Base Release 4.0 and up.
- VM/SP Base Release 3.0 and up.
- VM/SP HPO Release 3.2 and up.
- VM/XA System Product Release 1.0 and up.
- VSE/AF Version 1 Release 3.5 and up.
- VSE/SP Version 1 Release 1.0 and up.

OS Requiring MVS as Co-Requisite

- TPF2 Transaction Processing Facility Version 2 Release 3.

OS Supported as VM Virtual Machines

- IX/370
- MUSIC/SP Release 1
- MVS/SP Version 1 Release 3.0 and up (MVS/370).
- MVS/SP Version 2 Release 1.1 and up (MVS/XA); VM/XA support only.
- OS/VS1/BPE Release 4.0 with 5652-VS1 OS/VS1 Version 1.7 SCP.
- VM/IS Base Release 4.0 and up.
- VM/SP Base Release 2.0 and up (2.1 and up for VM/XA).
- VM/SP HPO Release 3.2 and up.
- VSE/AF Version 1 Release 3.5 and up.
- VSE/SP Version 1.0 Release 1.0 and up.

Utilities

MVS/SP AND MVS/XA ENVIRONMENTS: Over 30 utilities are available for the MVS/SP and MVS/XA environments, including a DASD Migration Aid; Data Facility (DF) Sort; Data Facility Product (DF), providing data management, device support, and other system services; DITTO; the Info series of data management and retrieval utilities; JCL Conversion Aid; MVS Migration System MVS-MS for VSE-to-MVS conversion; and RACF.

VM/IS, VM/SP, AND VM/XA ENVIRONMENTS: The complement of utilities for the VM environment exceeds 30 programs. The DITTO, RACF, and Info products supported under MVS are also available for VM. Additional VM utilities include Sort/Merge for VM/SP; VM/Batch Subsystem for VM/SP; VM/RTM (Real Time Monitor); VMMAP Performance Monitor Analysis Program; and a group of VM/IS utilities, including a Performance Monitor and a Graphics Support feature.

VSE ENVIRONMENT: Over 15 utilities are available in the VSE environment. Included are DITTO; Sort/Merge; JCL Conversion Aid; VSE/Access Control for security logging; and VSE/Power spooling system.

Languages and Related Programming Aids

Fifteen different languages run on the 4381, and support for each varies widely between individual environments. A list of all the languages and language-specific programming aids follows; environmental support is explained in the "Evaluation of Programming Support" subsection:

- Ada (including a Development System).
- Algol.
- APL2.
- Assembler H.
- Basic.
- C for System/370.
- Cobol; programming aids include Structuring Facility, Report Writer Precompiler and Library, Prompter (TSO), Interactive Debug, CICS/VS-to-Cobol II Command Level Conversion Aid, and DSL/VS (Dynamic Simulation Language/VS).
- Fortran (VS); programming aids include Execution Analyzer, Utilities, Prompter (TSO), and Language Conversion Program.
- Intellect (end-user-oriented relational query language); programming aids include a graphics facility.
- Lisp/VM.
- VS Pascal.
- PL/1; programming aids include Optimizing and Checkout Compilers.
- Prolog.
- RPG II.

General-Purpose Programming Aids

MVS/370 AND MVS/XA ENVIRONMENTS: Available programming aids include APE (Application Prototype Environment), CSP/AD (Cross System Product/Application Development), and CSP/AE (Application Execution). CSP/AD is a highly strategic application development tool. Also available are ISPF and ISPF/PDF (Program Development Facility) for development of menu-driven interactive applications.

VM/IS, VM/SP, AND VM/XA ENVIRONMENTS: The facilities identified for the MVS environment are also available, among others, for VM. CSP/AD and AE run under VM/SP, along with a CSP/Query facility. ISPF and ISPF/PDF run under VM/SP, VM/IS, and VM/XA. There is also a Productivity Facility specifically for VM/IS.

VSE ENVIRONMENTS: Programming aids for VSE include CSP/AE, DISPF/VSE (Decision and Information Productivity Facility), ISPF, and ISPF/PDF, among others.

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Evaluation of Programming Support

Because each operating environment is so unique, the languages available on the 4381 are discussed in the context of the operating environments under which they run.

Some of the languages have special strategic significance for IBM, because they have been designated as standard components in the company's forthcoming SAA. Those SAA languages are C (in conformity with ANS draft proposal K3J11), Cobol (ANS X3.23-1985), and Fortran (ANS Fortran 77).

Not every language is supported in each of the different operating environments, or even in all the variations of an environment. For example, MVS/370 and MVS/XA support all languages but Algol and RPG II, but there is a considerable difference in the language rosters of VM/IS, VM/SP, and VM/XA. An analysis of the language support in each major environment follows:

IX/370: Supports an Assembler and the C language, in keeping with its origin as a Unix operating system.

MVS/370: Supports Ada, Algol, APL2, Assembler H, Basic, C, Cobol, Fortran (supporting vector and scalar compilation and scalar execution), Intellect, VS Pascal, PL/1, and RPG II. This offering is equalled in breadth only by that of VM/SP. Algol Version 2 runs under MVS/370 only in conjunction with SRTOS (Special Real Time Operating System), a plant management system. This is the only 4381 environment in which Algol is implemented.

MVS/XA: Supports Ada, APL2, Assembler H (required), Basic, C, Cobol, Fortran (supporting vector and scalar compilation and scalar execution), Intellect, VS Pascal, and PL/1. RPG II is not supported, as it is for MVS/370, because it is intended for much smaller environments than that afforded by MVS/XA.

MUSIC/SP: Has language interfaces for APL, Basic, Cobol, Fortran, VS Pascal, PL/1, and RPG II programs, the core languages for general-purpose commercial processing, as well as for educational users' needs.

OS/VS1/BPE: Supports Assembler H, Cobol, Fortran, VS Pascal, PL/1, and RPG II, the core languages for general-purpose commercial processing.

TPF2: Supports only Assembler H (required) and PL/1. TPF is a highly focused environment oriented more toward servicing high-volume transaction processing applications than toward providing wide-ranging diversity in product development efforts. The associated MVS environment can be used for program development as well as for batch functions, so MVS languages could be considered as adjuncts to languages supported by TPF2.

VM/IS: Supports APL2, Basic, Cobol, Fortran, VS Pascal, and PL/1, representing most of the essential languages for multipurpose, entry-level installations. A surprising omission is RPG II, which is usually included in systems aimed at entry-level or departmental computer applications.

VM/SP: Supports Ada, APL2, Assembler H, Basic, C, Cobol, Fortran (supporting vector and scalar compilation and scalar execution under VM/SP with HPO), Intellect, Lisp/VM, VS Pascal, PL/1, and Prolog, a roster equal in range to that supported by MVS. Several of the artificial intelligence languages, such as Lisp and Prolog, are available only in this environment.

VM/XA: Supports Assembler H (required), C, Cobol, Fortran, and PL/1. It is not surprising that languages like Basic and RPG II are not supported, since these were designed for inexperienced users. It *is* surprising, however, that not one of the many VM artificial intelligence languages has made its way up to VM/XA.

VSE: Supports Cobol, Fortran, Intellect, and PL/1—a narrow range compared to the other operating environments, but suggestive of the primary focus of the VSE environment on traditional batch-oriented commercial processing.

MEMORY, MULTIUSER, AND MULTITASKING SUPPORT

One secondary operating system, TPF2, is a real memory-oriented operating system, but all of the others use virtual memory management schemes, employing an address translation facility that allows users to write programs as if they had a larger memory than is really physically available on the processor.

Virtual Memory

In all virtual memory systems, the operating system automatically breaks the program up into pages, moves pages back and forth from the real memory to the disk as needed to service current needs, and maintains page and segment tables that reflect the real memory allocation of each user, or, in the case of VM, each virtual machine. Translation between the virtual and real addresses is accomplished by a hardware-implemented table-lookup procedure that accesses tables in main storage which are created and maintained by the operating system. The translation process is sped up by a group of high-speed registers (called the translation lookaside buffer) that hold recently referenced virtual storage addresses and their real storage equivalents.

Model Groups 11, 12, 13, 21, 22, and 23 support system control programs with either 2KB or 4KB virtual page sizes, with automatic switching between the two under microcode control. However, only half of the high-speed buffer is employed when 2KB virtual pages are used. The 4381 Model Group 14 and 24 dual-processor systems support only 4KB virtual pages. Protection schemes can involve either pages or multipage "segments." For example, the VM virtual memory allocation scheme is based on 4KB pages and 64K-page segments; MVS/370 handles both 2KB pages and 1MB segments, and MVS/XA handles 4KB pages and 1MB segments.

DOS/VSE Version 1 is a single virtual system; the entire addressable virtual storage area of 16MB must be divided among the program partitions. With Version 2, however, the architecture has been restructured into a modified multiple virtual system architecture, defining three virtual memory spaces, each of which can be up to 16MB, within the confines of the system ceiling.

MVS virtual memory addressing is organized differently in MVS/XA and MVS/370. In MVS/370, as in prior versions of MVS, the nucleus is located at the bottom of the address space, and the other system programs and application data held "in common" are located at the top of the address space. The area left over in the middle is the "private" area for the user's private programs. Obviously, as more and more system software is added, the common area expands and the private area shrinks, leading to virtual storage constraint. MVS/XA systems move much of the nucleus, and all or part of other system programs, above the 16MB addressing boundary line between the

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24-bit and 31-bit addressing schemes. This frees up space for 24-bit-oriented programs that must reside below the line.

IX/370 also employs a true virtual memory system, with 4KB pages, and an 8MB virtual address space for each processor application. The file system is hierarchical and includes the ability to copy files to other Unix systems.

Evaluation of Memory Architecture

Because swapping pages back and forth between main memory and disk storage is a constant activity with all virtual memory systems, problems in the performance and management of disk storage are intimately related to overall system performance. The impact of this factor on individual programs will depend on the extent to which the program can efficiently use the processor cache, and the complexity of the job lot in which it is running. The storing of system volumes on one of the newer high-technology 3380 disks and the addition of disk caches can improve system response times over those provided through older techonlogies. Of course, increases in the system memory size reduce the need for paging and improve performance over prior levels.

Determining a practical real memory size for virtual memory systems can be complex. Both MVS/370 and MVS/XA can run on 4MB systems, but the practical minimum for MVS/370 installations has traditionally been at least 8MB. With MVS/XA, the originally anticipated system performance improvements over an MVS/370 running on the same processor were expected to occur in 16MB installations, but turned out to require 24MB.

Compare these numbers with the requirements for DOS/VSE. The ceiling for VSE installations was lifted above 8MB only a few years ago. Practical real memory requirements of entry-level systems are competitive with those for personal computers: as small as 256KB, with 1MB and 2MB more common for packaged VSE/SP systems.

Multiuser and Multitasking Implications

All of the 4381 operating systems are multiuser and multitasking systems. The larger systems are constantly seeking to balance the danger of loss of integrity or security against the need to communicate with other programs.

In VSE, for example, very little communication across partitions was presumed necessary; the idea of partitioning was to keep programs from inadvertently communicating (interfering) with each other in a primarily local batch production orientation. Today's complex database/data communications and file-sharing multiprocessing environments require easier interfacing between programs without compromising security. Cross-partition communications for VSE control programs and applications are supplied partly by a fairly recent introduced Shared Virtual Area (SVA) and the much more venerable VSE/Power program, which provides a partition-independent I/O queuing facility, as well as spooling, RJE, and other facilities.

Cross Memory Services, which are standard features of both versions of MVS/SP, are important additions to the efficiency of data movement and the passing of control between two programs in MVS environments. Previously, passing of control had to be communicated through the common area, and, in addition, there was no provision for direct data movement between address spaces. Cross Memory Services control both system software and user program access to "auxiliary address spaces" set up in the private area; previously they had to be placed in common. This shrinks the common area and improves security by allowing the system software to place some tasks in private program areas. Cross Memory Services particularly reduce common storage demands made by JES3 by allowing buffer staging areas to be placed in the private area and supply distinct improvements in the functioning of global resource serialization in loosely coupled system complexes.

VM has many of the same problems, only more so, because the boundaries separating one virtual machine from another represent a type of partitioning that separates whole environments, not just programs ("tasks"). Virtual storage segments can be shared in read-only mode, providing they are part of an operating system that does not control virtual storage; the segments need not be within the virtual address space allocated to virtual machine.

Furthermore, any VM environment that includes guest operating systems has immediate concerns about system performance relative to the previous environment—first because of the double-layered nature of the architecture, and secondly because now there may be multiple operating systems contending for the same resources. Over the years IBM has developed a number of ways to deal with this very real problem. First, the Virtual Machine Assist adds emulation (rather than software simulation) for certain privileged instruction codes, for handling SVC interrupts, and for updating the shadow page table. The Extended Control Program Support (ECPS) feature adds hardware implementation of some of those features. Some programs are helped by a hardware floating-point feature.

These features help the performance of all programs on the machine. Individual operating systems can be helped by assigning higher priorities, by designating one as "favored execution" (with percentage specified), by reserving "n" 4K-page frames of real storage for exclusive use of one virtual machine, and by designating one machine as V=R (virtual = real) to eliminate paging and to cut down on control overhead. The most efficient overhead saver, available primarily to MVS, is the "Preferred Guest" status, where certain channels are assigned to the non-VM system and are allowed to be operated directly with a minimum of VM intervention.

INPUT/OUTPUT AND DATABASE SUPPORT

The 4381 channel subsystem includes channel data buffers, a channel operation unit, and standard and optional channels.

The basic Model Group 11, 12, 13, 21, 22, and 23 systems come equipped with six channels that are usually configured as one byte multiplexer and five block multiplexer channels. Four of the block multiplexer channels can operate as data streaming channels with data rates of up to 3 megabytes per second. The fifth block multiplexer channel has a data rate of up to 2 megabytes per second; this channel may alternatively be selected as a byte multiplexer channel.

Each processor on the dual processor Model Groups 14 and 24 comes equipped with its own 6-channel set, for a basic system total of 12 standard channels. The 4381-14 includes two byte multiplexer channels and ten 3MB data streaming block multiplexer channels. The 4381-24 includes two byte multiplexer channels, eight 3MB data streaming block multiplexer channels, and two 2MB block multiplexer channels on each processor. Here again, one channel on each of the sets can alternatively be configured as a byte multiplexer channel, for a basic system total of four byte multiplexer and eight block multiplexer channels.

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An additional group of block multiplexer channels may be installed as an option on each of the model groups. On all models except Model Group 24, up to six channels can be added. (On Model Group 14, three channels are dedicated to each processor.) Model Group 24 allows configuration of up to 12 more block mux channels (six per processor). The addition of any of these options is subject to performance limitations in the I/O subsystems, however.

Data rates for the additional six-channel set have to be adjusted on each model, because the peak data transfer rate differs for each model. Maximum aggregate data rates are as follows:

- 22MB per second on the 4381-11.
- 24MB per second on the 4381-12, -21, and -22.
- 30MB per second on the 4381-13.
- 32MB per second on the 4381-23.
- 48MB per second (24MB per processor) on the 4381-14.
- 60MB per second (30MB per processor) on the 4381-24.

Additional block multiplexer channel configurations allowed on each model are as follows:

- Two 2MB and four 1MB channels on the 4381-11.
- Two 3MB and four 1MB channels on the 4381-12, -21, and -22.
- Five 3MB and one 1MB channels on the 4381-13.
- Six 3MB channels on the 4381-23 and -14 (three channels per processor on the 4381-14).
- Twelve 3MB channels on the 4381-24.

Addition of the Channel-to-Channel Adapter allows the interconnection of two channels, which may be on a 4341, 4381, 30XX, or any other System/360- or System/370-compatible system. Only one of the interconnected processors needs to be equipped with this feature. The 3088 Multisystem Channel Contro Unit is a standalone I/O control unit that provides channel-to-channel communications facilities for multiple IBM 303X, 308X, 3090, 4361, 4341, or 4381 processors. The 3088 permits interconnection of four to eight processor channels.

The 4381 processors allow attachment of most peripheral devices supported by IBM's System/370 and 303X, 308X, and 3090 Series computers, including 3350, 3370, 3375, and 3380 DASD; the 3830, 3880, and 3990 Storage Control Devices; the 3420, 3430, and 3480 Magnetic Tape Units; and the 4245, 4248, and 3820 Printers. See the peripheral charts (B through F) in this report for a full list of devices and their primary characteristics.

All 4381 processors require a 3278-2A, 3279-2C color, or 3205 display console as an operator console. Up to three additional consoles or 3287 printers (for a total of four devices) can be attached to the 4381 processors.

COMMUNICATIONS AND TRANSACTION PROCESSING SUPPORT

Network Architectures

IBM's SNA defines the basic levels of communications and the structure of the interactions among host systems and their peers, front ends, and terminals in a standardized fashion, paving the way for communications across the various environments. Connected with SNA are a variety of standards, sometimes associated with a single program and sometimes implemented across several programs.

IBM's new SAA treats SNA as the primary element of the Common Communications Support component, one of the four basic divisions of the architecture. Associated standards are those for data streams, Application Services, Session Services, Network Services, and Data Link Controls. Data stream standards include the 3270 and Intelligent Printer (IPDS), as well as the Document Content Architecture. Applications Services currently includes SNA Distribution Services (SNADS), the Document Interchange Architecture (DIA), and the new SNA Management Architecture. Session Services includes the LU Type 6.2 program-to-program communications protocol, commonly referred to as APPC. Network Services includes Low-Entry Networking (LEN) Node (Type 2.1) services, and X.25 support. Data Link Controls refers to the foundation SDLC protocol. Of all these elements, only LEN does not apply to the 4381.

Notably missing from IBM's initial description of SAA are the DSX and DDM architectures, both programs that run on the 4381 and communicate with other systems in defined ways that are clearly attempts to standardize the exchange of files between systems.

The primary pieces of software for implementing SNA are the ACF/VTAM access method and the host-resident ACF/SSP program, which generates and provides supporting functions for ACF/NCP, the network control workhorse that resides in the front-end communications processor. NCP primarily supports communications using the SNA/SDLC protocol, but has subsidiary programs allowing BSC and X.25/HDLC synchronous communications, as well as asynchronous ASCII interfaces.

ACF/NCP resides in the 3705/3725 network controllers and manages the physical resources of the attached network. Primary functions are to manage lines and terminals, perform error recovery, and route data through the network. NCP is generated by the ACF/SSP program, and implements communications sessions that have been established by the VTAM access method programs.

Non-SNA Interconnect (NSI) is an extension of ACF/NCP Version 2 that allows users of certain BSC protocol RJE and NRJE devices to connect into an SNA network. BSC attachments used to be handled by the 270X Emulator Program (EP). Although both NCP and EP could run in the same (partitioned) front end, 270X units formerly could not transmit over SNA networks. NSI solves that problem by embedding the 270X-type transmission in an envelope of SDLC code, and treats the 270X control code as data. The procedure is reversed at the receiving end, and the destination program never knows the difference.

The Network Terminal Option (NTO) extends NCP access to certain non-SNA terminals (2740/41, TWX, WTTY, and nonswitched 3780, among others) and to VM/VTAM and VM/VNCA software.

NPSI and XI, two X.25 gateway programs, also run under NCP.

ACF/VTAM is the telecommunications access method that determines the full capabilities of SNA networks. The TCAM access method, which resides in a separate program, can also support SNA. However, certain features are supported only by VTAM, such as extended network ad-

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dressing, SNA network interconnection, use of the NCP for network definition, dynamic allocation for channel-attached devices, and channel-to-channel adapter support, among others. TCAM users can now gain access to those capabilities by upgrading to Release 3, which can run as an application program under VTAM Version 2 Release 2. The advent of this arrangement suggests that independent development of TCAM has come to a dead end. The Basic Telecommunications Access Method/System Product (BTAM/SP) is not an SNA protocol, but provides basic tools for writing telecommunications programs for devices using BSC or asynchronous protocols.

ACF/VTAM Version 2 Release 2 can operate with either MVS/370 or MVS/XA in S/370 compatibility mode; hence it is the major positioning product for VTAM users readying for a conversion to XA. ACF/VTAM Version 3 is the primary vehicle for implementing native-mode SNA networks in a VM/SP Release 4 environment. With this version installed, no guest operating system is needed to install, maintain, and run SNA networking facilities at Release levels comparable to OS/VS (MVS) VTAM Version 2 Release 1. VM VTAM is a separate "virtual machine"; it acts like a subsidiary operating system that handles the resource allocation and user requests for the network attached to the system. With appropriate support software at suitable release levels, it allows participation in networks with multiple hosts that need not all have the same operating system. VM VTAM supports the concurrent execution of multiple communications applications and establishes sessions between applications programs and terminals, as well as between two applications (in the same or different hosts). It thus performs very important interprogram communications functions within the VM operating environment itself. All versions of VTAM interface to subsidiary programs—such as NetView, NCCF (Network Communications Control Facility), NPDA (Network Problem Determination Application), and NLDM (Network Logical Data Manager)—particularly for network management and control functions.

The Operator Console Communications Facility (OCCF) is the primary set of programs for controlling remote MVS or VM systems operated by a host console instead of a local one. The program resides in the remote system as well as in the host; it sends commands from the host to the remote MVS or VM system for execution, intercepts messages and routes them to the host, and generates a series of command lists, among other functions.

Chart G provides information on front-end processors for the 4381 systems.

Gateways to Foreign Networks

Two X.25 gateway programs run in the 372X front-end processor under NCP. NPSI allows the 4381 to interface to an X.25 network as a terminal node (DTE). The XI PRPQ allows the 4381 to operate as an X.25 networking node (DCE), which enables SNA networks to act as backbones for X.25 transmissions.

TCP/IP for VM, a software facility, allows 4381 systems running under VM/SP, VM/SP HPO, or VM/XA SP to participate in multivendor networks. It requires a Series/1 or 7170 Device Attachment Control Unit (DACU) attached through a System/370 channel. Network protocols supported under TCP/IP for VM include IBM Token-Ring (IEEE 802.5), Ethernet (IEEE802.3), Proteon Pronet, and DDN X.25. An optional version of the TCP/IP product for PCs allows microcomputer users on IBM's Token-Ring or Ethernet to communicate with VM systems.

LAN Support

The 3174 and the 3270/3725 front ends all have configurations that can attach one or more IEEE 802.2/802.5-compatible Token-Ring LANs. All three of these controllers can be channel attached locally or can be remotely attached by means of a data link.

Terminal Support

Specifications for general-purpose terminals that can be attached to the 4381 are given in Chart F. In addition, there are a variety of special-purpose terminals that are actively marketed for financial, graphics, retail and manufacturing applications. PCs and other remote systems usually establish communications with the 4381 mainframe by means of an emulation program.

Host Transaction and Communications Support

Five key transaction-oriented and timesharing subsystems intimately involved with SNA are TSO (MVS only), CMS (VM only), TPF, IX/370, and CICS (MVS and VSE; it also runs under VM in a limited form). Each is the focus of a number of subsidiary programs. TPF and IX/370 are arguably considered separate operating environments, and so have been discussed in the "Operating Systems" portion of the "Architecture" section of this report. Details on the three other key transaction processing/timesharing products follow.

CICS is a strategic teleprocessing monitor for interactive applications. It controls the interface between terminal-entered applications and the operating system, often providing a functional link among applications, the operating system, and IMS. Since many programs run under CICS, it creates, in effect, a separate, unified operating subenvironment with its own unique characteristics.

CICS applications do not get involved with terminal handling, but rely completely on VTAM PUs, simplifying compatibility with new terminals. Since equivalent versions of CICS run under MVS and VSE operating systems, a degree of cross-system compatibility is provided for those programs which primarily use CICS as an interface. Although IMS has its own data communications subsystem option, about two-thirds of IMS users choose to couple it with CICS instead. CICS/CMS for VM/CMS is a single-user system designed specifically for using VM to develop programs that will be run on MVS or VSE CICS installations.

CICS Multiregion Operation (MRO) allows multiple connected CICS/VS regions to run within a system while sharing terminals, transactions, and other resources. In addition, the Intersystem Communications (ISC) facility allows connection of CICS/VS systems through ACF/VTAM or ACF/TCAM so that a transaction running in one system can access files and DL/1 data bases, initiate transactions, queue messages, or communicate directly with another transaction running in a connected CICS/VS system.

Next to the Control Program, CMS is the single most important element in defining a "native" VM system environment. Unlike a full-blown operating system, CMS is a separate virtual machine that cannot run by itself on another processor; however, it is like an operating system in that it contains its own facilities for interfacing interactive timesharing users; for file management; for developing, testing, debugging, and executing programs; and for controlling certain other virtual machines.

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The System Product Interpreter macro processor, a separate program under CMS but part of the basic system software, supports CMS by providing macro definition, symbolic debugging, CMS command tailoring, mathematical calculation, text manipulation, and call and subroutine support facilities. Other basic CMS programs included in VM/SP are the System Product Editor and a VM/370 Assembler.

TSO, although labelled an option, is included in the core MVS 3.8 program amalgamated with both versions of MVS/SP, but with some differences. The Test facility included with the MVS/370 version is removed from MVS 3.8 when XA is installed, so users who need this facility in an XA environment must add the truly optional TSO/Extended (TSO/E) program product. TSO is normally used to provide program development and information center support for MVS, while IBM's other major communications environment, CICS, is more apt to be used for network communications to data entry, inquiry, transaction processing, and similar applications.

TSO generally uses a greater number of instruction cycles in disk access than CICS or IMS, so it is wise to monitor performance for different applications separately to determine the best locations for the each one's data. Most MVS/370 users have found that the basic TSO facilities are too simplistic for full development center support, so they enhance them with ISPF and ISPF/PDF).

SUPPORT

HARDWARE SUPPORT

Several types of hardware maintenance contracts are available, as explained below. In addition, a no-charge Problem Analysis Feature allows 4381 users to identify valid hardware problems as the cause of system interruptions. Screen-prompted instructions lead the user through the steps required to solve the problem. Using the Remote Support Facility, service information can be sent to and received from IBM Field Engineering. The Remote Operator Console Facility (ROCF) is used to run a subset of the Problem Analysis Feature from the user installation.

Warranties

The length of warranties varies from three months to three years, depending on the equipment type. The 4381 processors and most peripherals are warranted for one year. Some terminals are available with alternative purchase arrangements, depending on whether the warranty extends for one year or three years.

Maintenance Contracts

Users may obtain a separate maintenance contract for purchased 4381 systems; the 4300 processors are all classified as maintenance Group D, and are charged a fixed monthly rate for the duration of the contract. The same Group D contract is an integral component of rental agreements; there is no separate maintenance charge. The minimum period of maintenance service is 9 consecutive hours between 7 a.m. and 6 p.m., Monday through Friday. Charges for maintenance coverage outside this period are higher; they are based upon set percentages of the minimum monthly maintenance charge (MMC) added to the MMC.

Although most peripheral devices and many terminals are likely to be maintained under the same type of contract as the processors, an increasing number—particularly in the communications and terminal equipment sectors—involve contracts of widely different styles. Some involve a yearly charge instead of a monthly charge; a few involve both yearly and monthly charges. For a number of terminals there are up to five different types of contracts covering on-site or customer carry-in service or exchange.

When a user does not want a maintenance contract, the 4381 Series can be maintained on a per-call basis; the main processor is classified as Class 3 equipment for charging purposes. The per-call charge for this equipment class is $218 per hour during regular hours; during off hours the charge is $250 per hour. Peripheral and terminal equipment are charged at different rates, depending on their classes.

SOFTWARE SUPPORT

Local programming support is available on two levels. The Monthly Licensed Program Support Charge provides local support for a single licensed program; however, many programs are not associated with standard support contracts. An alternative to contracted software maintenance is per-call service, charged at the applicable hourly rate. Program service/programming assistance costs $218 per hour during regular hours and $250 per hour at other times. The initial—and principal—interface for software problems and their solution is the IBM Support Center, described below.

The centralized IBM Support Center provides 24-hour, seven-day customer access by telephone; an 800 number is provided. The Support Center uses 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.

Retain is a database that serves as the heart of software service support. It is available to 4381 customers as an online service. It is scanned for existing solutions to a problem as the problem occurs. Retain is also used as a place to store solutions to new problems so that others will not rediscover the same problems. If the Support Center 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 user finds that the problem still cannot be resolved, the PSR (Program Support Representative) from the customer's local office is dispatched to assist. Under the support plan, many of the facilities previously provided by IBM support personnel at no charge have become billable activities.

PRICING

HARDWARE PRICING

IBM offers purchase or rental agreements for the 4381 series processors, but not leases; users who want to lease their systems must contact IBM Credit Corporation or a third-party lessor. Leases are still available for some peripheral components. Since leasing directly from IBM has been on its way out for a number of years, lease prices have not been included in the following price list.

The standard rental contract entails monthly charges that include equipment maintenance and entitle the customer to

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unlimited usage each month. The purchase option accrual equals 40 percent of the monthly charge, up to 50 percent of the purchase price. The Agreement for Lease or Rental of IBM Machines provides users with a single contract on which they can specify mixtures of rental and leased equipment, each with various terms. CPUs rented under the plan can be terminated or downgraded on 90 days' notice, and all other rented equipment can be terminated or downgraded on 30 days' notice.

Volume discounts are given for purchase of multiple 4381 systems or their peripherals; discounts vary from one model group to another.

SOFTWARE PRICING

Charges for most licensed systems and application software products are based on a continuous monthly charge, but this charge is usually delayed until a period of acceptance is over. The period is usually just one month, sometimes three months, and very rarely longer than three months. Occasionally charges are levied annually. In addition to the monthly charge, an upfront initial charge is levied for some programs.

A onetime license fee is available for an increasing number of programs. In some cases this is offered as an alternative to monthly licensing; in others it is the only license arrangement possible. At this time, one-time charges are available for about two-thirds of IBM's actively marketed software.

A recently implemented charge structure provides graduated onetime charges for selected VM and MVS/XA programs, in which the price of the software depends on the model group to which a processor belongs. The four groups defined (10, 20, 30, and 40) thus allow a four-tier pricing structure for each applicable product, so that entry-level users with smaller systems and smaller budgets do not have to pay the same amount for exactly the same product that runs on a larger system.

4381 Model Groups 11 and 21 belong to processor Group 20; Model Groups 12, 13, 14, 22, 23, and 24 are in Group 30.

As the user migrates upward into a different model group, there is an upgrade charge for the software. This introduces some interesting considerations into software licensing, because this arrangement does not apply to ongoing monthly licenses and complicates calculation of the cost benefits of going with IBM plug-compatible vendors.

Volume discounts are available for many software packages. In addition, users who have multiple systems controlled from a central site can obtain a lower-cost Distributed Systems License Option (DSLO) contract with lower license charges for all locations running additional copies of a central-site program, providing there are facilities for transmitting the outlying copies for consolidated maintenance at the central site. In this case, Central Service, including the IBM Support Center, is provided through the customer location designated for the Basic License, and service to outlying, lower-cost programs requires that they be transmitted to the central site. DSLO prices apply to all license charges, including monthly, initial, and onetime charges. Contact your local IBM representative for details on DSLO pricing.

IBM provides further discounts for so-called "enterprise" customers. Under this plan, customers pay for an evaluation of the management of their site(s), and if IBM concludes that the sites are (as IBM puts it) "well managed," the customer qualifies for the extra discount.

Detailed hardware and software price lists follow.

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EQUIPMENT PRICES

		Purch. Price ($)	Monthly Maint. ($)	Monthly Rental ($)
PROCESSORS				
Model Group 11				
4381 L11	Processor with 4-kilobyte buffer and 4 megabytes of main memory	175,000	450.00	20,650
4381 M11	Same as L11, but with 8 megabytes of main memory	195,000	475.00	23,790
4381 P11	Same as L11, but with 16 megabytes of main memory	235,000	525.00	30,060
Model Group 12				
4381 M12	Processor with 32-kilobyte buffer and 8 megabytes of main memory	300,000	550.00	42,360
4381 P12	Same as M12, but with 16 megabytes of main memory	340,000	600.00	48,630
4381 Q12	Same as M12, but with 24 megabytes of main memory	380,000	650.00	54,900
4381 R12	Same as M12, but with 32 megabytes of main memory	420,000	700.00	61,170
Model Group 13				
4381 M13	Processor with 64-kilobyte buffer and 8 megabytes of main memory	405,000	640.00	48,200
4381 P13	Same as M13, but with 16 megabytes of main memory	445,000	690.00	54,470
4381 Q13	Same as M13, but with 24 megabytes of main memory	485,000	740.00	60,740
4381 R13	Same as M13, but with 32 megabytes of main memory	525,000	790.00	67,010
Model Group 14				
4381 P14	Dual-processor system; 64-kilobyte buffer per processor and 16 megabytes of shared main memory	680,000	740.00	82,630
4381 Q14	Same as P14, but with 24 megabytes of main memory	720,000	790.00	88,900
4381 R14	Same as P14, but with 32 megabytes of main memory	760,000	840.00	86,525
Model Group 21				
4381 M21	Processor with eight megabytes of main memory and eight-kilobyte buffer	225,000	450.00	26,785
4381 P21	Same as M21, but with 16 megabytes of main memory	265,000	462.00	32,485
Model Group 22				
4381 P22	Processor with 16 megabytes of main memory and 32-kilobyte buffer	350,000	550.00	41,665
4381 R22	Same as P22, but with 32 megabytes of main memory	430,000	574.00	53,065
Model Group 23				
4381 P23	Processor with 16 megabytes of main memory and 64-kilobyte buffer	530,000	640.00	63,095
4381 R23	Same as P23, but with 32 megabytes of main memory	610,000	644.00	74,495
4381 S23	Same as P23, but with 48 megabytes of main memory	690,000	688.00	85,895
4381 T23	Same as P23, but with 64 megabytes of main memory	770,000	712.00	97,295
Model Group 24				
4381 P24	Processor with 16 megabytes of shared main memory and a 128-kilobyte buffer	890,000	810.00	105,950
4381 R24	Same as P24, but with 32 megabytes of main memory	970,000	834.00	117,350
4381 S24	Same as P24, but with 48 megabytes of main memory	1,050,000	858.00	128,750
4381 T24	Same as P24, but with 64 megabytes of main memory	1,130,000	882.00	140,150
Additional 4381 Features and Options				
3205	Model 1 Console; 1920 characters, 122-key keyboard, 4 colors	2,895	320	—
1850	Channel-to-Channel Adapter	23,150	31.00	1,650
1870	Additional Block Multiplexers Channels for single-processor models	35,580	12.50	2,535
1871	Additional Block Multiplexers Channels for dual-processor models	35,580	12.50	2,535
1872	Second Additional Block Multiplexer Channels for Model Group 24 only	35,580	12.50	2,535

NA—Not applicable.
NC—No charge.
**Includes equipment maintenance.*
***Four-year lease.*

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SYSTEM UPGRADES	Purch. Price ($)	Monthly Maint. ($)	Monthly Rental ($)
Model Group 1 Upgrades			
4381 L1 to 4381 P22	190,000	NA	NA
4381 L1 to 4381 R22	270,000	—	—
4381 M1 to 4381 P22	170,000	—	—
4381 M1 to 4381 R22	250,000	—	—
4381 P1 to 4381 P22	130,000	—	—
4381 P1 to 4381 R22	210,000	—	—
Model Group 2 Upgrades			
4381 L2 to 4381 P23	310,000	—	—
4381 L2 to 4381 R23	390,000	—	—
4381 L2 to 4381 S23	470,000	—	—
4381 L2 to 4381 T23	550,000	—	—
4381 M2 to 4381 P23	290,000	—	—
4381 M2 to 4381 R23	370,000	—	—
4381 M2 to 4381 S23	450,000	—	—
4381 M2 to 4381 T23	530,000	—	—
4381 P2 to 4381 P23	250,000	—	—
4381 P2 to 4381 R23	330,000	—	—
4381 P2 to 4381 S23	410,000	—	—
4391 P2 to 4381 T23	490,000	—	—
4381 Q2 to 4381 P23	—	—	—
4381 Q2 to 4381 R23	290,000	—	—
4381 Q2 to 4381 S23	370,000	—	—
4381 Q2 to 4381 T23	450,000	—	—
4381 R2 to 4381 P23	—	—	—
4381 R2 to 4381 R23	250,000	—	—
4381 R2 to 4381 S23	330,000	—	—
4381 R2 to 4381 T23	410,000	—	—
Model Group 3 Upgrades			
4381 M3 to 4381 P24	525,000	—	—
4381 M3 to 4381 R24	605,000	—	—
4381 M3 to 4381 S24	685,000	—	—
4381 M3 to 4381 T24	765,000	—	—
4381 P3 to 4381 P24	485,000	—	—
4381 P3 to 4381 R24	565,000	—	—
4381 P3 to 4381 S24	645,000	—	—
4381 P3 to 4381 T24	725,000	—	—
4381 Q3 to 4381 P24	—	—	—
4381 Q3 to 4381 R24	525,000	—	—
4381 Q3 to 4381 S24	605,000	—	—
4381 Q3 to 4381 T24	685,000	—	—
4381 R3 to 4381 R24	485,000	—	—
4381 R3 to 4381 S24	565,000	—	—
4381 R3 to 4381 T24	645,000	—	—
Model Group 11 Upgrades			
4381 L11 to 4381 M11	20,000	—	—
4381 L11 to 4381 P11	60,000	—	—
4381 L11 to 4381 M12	125,000	—	—
4381 L11 to 4381 P12	165,000	—	—
4381 L11 to 4381 Q12	205,000	—	—
4381 L11 to 4381 R12	245,000	—	—
4381 L11 to 4381 M21	60,000	—	—
4381 L11 to 4381 P21	100,000	—	—
4381 L11 to 4381 P22	175,000	—	—
4381 L11 to 4381 R22	255,000	—	—
4381 M11 to 4381 P11	40,000	—	—
4381 M11 to 4381 M12	105,000	—	—
4381 M11 to 4381 P12	145,000	—	—
4381 M11 to 4381 Q12	185,000	—	—
4381 M11 to 4381 R12	225,000	—	—
4381 M11 to 4381 P21	80,000	—	—
4381 M11 to 4381 P22	155,000	—	—
4381 M11 to 4381 R22	235,000	—	—

NA—Not applicable.
NC—No charge.
**Includes equipment maintenance.*
***Four-year lease.*

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Model Group 11 Upgrades (Continued)	Purch. Price ($)	Monthly Maint. ($)	Monthly Rental ($)
4381 P11 to 4381 P12	105,000	—	—
4381 P11 to 4381 Q12	145,000	—	—
4381 P11 to 4381 R12	185,000	—	—
4381 P11 to 4381 P21	40,000	—	—
4381 P11 to 4381 P22	115,000	—	—
4381 P11 to 4381 R22	195,000	—	—
Model Group 12 Upgrades			
4381 M12 to 4381 P12	40,000	—	—
4381 M12 to 4381 Q12	80,000	—	—
4381 M12 to 4381 R12	120,000	—	—
4381 M12 to 4381 M13	105,000	—	—
4381 M12 to 4381 P13	145,000	—	—
4381 M12 to 4381 Q13	185,000	—	—
4381 M12 to 4381 R13	225,000	—	—
4381 M12 to 4381 P23	230,000	—	—
4381 M12 to 4381 R23	310,000	—	—
4381 M12 to 4381 S23	390,000	—	—
4381 M12 to 4381 T23	470,000	—	—
4381 P12 to 4381 Q12	40,000	—	—
4381 P12 to 4381 R12	80,000	—	—
4381 P12 to 4381 P13	105,000	—	—
4381 P12 to 4381 Q13	145,000	—	—
4381 P12 to 4381 R13	185,000	—	—
4381 P12 to 4381 P23	190,000	—	—
4381 P12 to 4381 R23	270,000	—	—
4381 P12 to 4381 S23	350,000	—	—
4381 P12 to 4381 T23	430,000	—	—
4381 Q12 to 4381 R12	40,000	—	—
4381 Q12 to 4381 Q13	105,000	—	—
4381 Q12 to 4381 R13	145,000	—	—
4381 Q12 to 4381 R23	230,000	—	—
4381 Q12 to 4381 S23	310,000	—	—
4381 Q12 to 4381 T23	390,000	—	—
4381 R12 to 4381 R13	105,000	—	—
4381 R12 to 4381 R23	190,000	—	—
4381 R12 to 4381 S23	270,000	—	—
4381 R12 to 4381 T23	350,000	—	—
Model Group 13 Upgrades			
4381 M13 to 4381 P13	40,000	—	—
4381 M13 to 4381 Q13	80,000	—	—
4381 M13 to 4381 R13	120,000	—	—
4381 M13 to 4381 P14 with feature 1870	239,420	—	—
4381 M13 to 4381 P14 without feature 1870	275,000	—	—
4381 M13 to 4381 Q14 with feature 1870	279,420	—	—
4381 M13 to 4381 Q14 without feature 1870	315,000	—	—
4381 M13 to 4381 R14 with feature 1870	319,420	—	—
4381 M13 to 4381 R14 without feature 1870	355,000	—	—
4381 M13 to 4381 P23	180,000	—	—
4381 M13 to 4381 R23	260,000	—	—
4381 M13 to 4381 S23	340,000	—	—
4381 M13 to 4381 T23	420,000	—	—
4381 M13 to 4381 P24 with Feature 1870	449,420	—	—
4381 M13 to 4381 R24 with Feature 1870	529,420	—	—
4381 M13 to 4381 S24 with Feature 1870	609,420	—	—
4381 M13 to 4381 T24 with Feature 1870	689,420	—	—
4381 M13 to 4381 P24 without Feature 1870	485,000	—	—
4381 M13 to 4381 R24 without Feature 1870	565,000	—	—
4381 M13 to 4381 S24 without Feature 1870	645,000	—	—
4381 M13 to 4381 T24 without Feature 1870	725,000	—	—
4381 P13 to 4381 Q13	40,000	—	—
4381 P13 to 4381 R13	80,000	—	—
4381 P13 to 4381 P14 with feature 1870	199,420	—	—
4381 P13 to 4381 P14 without feature 1870	235,000	—	—
4381 P13 to 4381 Q14 with feature 1870	239,420	—	—
4381 P13 to 4381 Q14 without feature 1870	275,000	—	—
4381 P13 to 4381 R14 with feature 1870	279,420	—	—

NA—Not applicable.
NC—No charge.
**Includes equipment maintenance.*
***Four-year lease.*

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Model Group 13 Upgrades (Continued)	Purch. Price ($)	Monthly Maint. ($)	Monthly Rental ($)
4381 P13 to 4381 R14 without feature 1870	315,000	—	—
4381 P13 to 4381 P23	140,000	—	—
4381 P13 to 4381 R23	220,000	—	—
4381 P13 to 4381 S23	300,000	—	—
4381 P13 to 4381 T23	380,000	—	—
4381 P13 to 4381 P24 with Feature 1870	409,420	—	—
4381 P13 to 4381 R24 with Feature 1870	489,420	—	—
4381 P13 to 4381 S24 with Feature 1870	569,420	—	—
4381 P13 to 4381 T24 with Feature 1870	649,420	—	—
4381 P13 to 4381 P24 without Feature 1870	445,000	—	—
4381 P13 to 4381 T24 without Feature 1870	685,000	—	—
4381 Q13 to 4381 R13	40,000	—	—
4381 Q13 to 4381 Q14 with feature 1870	199,420	—	—
4381 Q13 to 4381 Q14 without feature 1870	235,000	—	—
4381 Q13 to 4381 R14 with feature 1870	239,420	—	—
4381 Q13 to 4381 R14 without feature 1870	275,000	—	—
4381 Q13 to 4381 R23	180,000	—	—
4381 Q13 to 4381 S23	260,000	—	—
4381 Q13 to 4381 T23	340,000	—	—
4381 Q13 to 4381 S24 with Feature 1870	529,420	—	—
4381 Q13 to 4381 T24 with Feature 1870	609,420	—	—
4381 Q13 to 4381 R24 without Feature 1870	485,000	—	—
4381 Q13 to 4381 S24 without Feature 1870	565,000	—	—
4381 Q13 to 4381 T24 without Feature 1870	645,000	—	—
4381 Q13 to 4381 R24 with Feature 1870	449,420	—	—
4381 R13 to 4381 R14 with feature 1870	199,420	—	—
4381 R13 to 4381 R14 without feature 1870	235,000	—	—
4381 R13 to 4381 R23	140,000	—	—
4381 R13 to 4381 S23	220,000	—	—
4381 R13 to 4381 T23	300,000	—	—
4381 R13 to 4381 R24 with Feature 1870	409,420	—	—
4381 R13 to 4381 S24 with Feature 1870	489,420	—	—
4381 R13 to 4381 T24 with Feature 1870	569,420	—	—
4381 R13 to 4381 R24 without Feature 1870	445,000	—	—
4381 R13 to 4381 S24 without Feature 1870	525,000	—	—
4381 R13 to 4381 T24 without Feature 1870	605,000	—	—
Model Group 14 Upgrades			
4381 P14 to 4381 P24	260,000	—	—
4381 P14 to 4381 R24	340,000	—	—
4381 P14 to 4381 S24	420,000	—	—
4381 P14 to 4381 T24	500,000	—	—
4381 Q14 to 4381 R24	300,000	—	—
4381 Q14 to 4381 S24	380,000	—	—
4381 Q14 to 4381 T24	460,000	—	—
4381 R14 to 4381 R24	260,000	—	—
4381 R14 to 4381 S24	340,000	—	—
4381 R14 to 4381 T24	420,000	—	—
Model Group 21 Upgrades			
4381 M21 to 4381 P21	40,000	—	—
4381 M21 to 4381 P22	125,000	—	—
4381 M21 to 4381 R22	205,000	—	—
4381 P21 to 4381 P22	85,000	—	—
4381 P21 to 4381 R22	165,000	—	—
Model Group 22 Upgrades			
4381 P22 to 4381 R22	80,000	—	—
4381 P22 to 4381 P23	180,000	—	—
4381 P22 to 4381 R23	260,000	—	—
4381 P22 to 4381 S23	340,000	—	—
4381 P22 to 4381 T23	420,000	—	—
4381 R22 to 4381 R23	180,000	—	—
4381 R22 to 4381 S23	260,000	—	—
4381 R22 to 4381 T23	340,000	—	—

NA—Not applicable.
NC—No charge.
**Includes equipment maintenance.*
***Four-year lease.*

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Model Group 23 Upgrades	Purch. Price ($)	Monthly Maint. ($)	Monthly Rental ($)
4381 P23 to 4381 R23	80,000	—	—
4381 P23 to 4381 S23	160,000	—	—
4381 P23 to 4381 T23	240,000	—	—
4381 R23 to 4381 S23	80,000	—	—
4381 R23 to 4381 T23	160,000	—	—
4381 S23 to 4381 T23	80,000	—	—
4381 P23 to 4381 P24 with Feature 1870	324,420	—	—
4381 P23 to 4381 R24 with Feature 1870	404,420	—	—
4381 P23 to 4381 S24 with Feature 1870	484,420	—	—
4381 P23 to 4381 T24 with Feature 1870	564,420	—	—
4381 R23 to 4381 R24 with Feature 1870	324,420	—	—
4381 R23 to 4381 S24 with Feature 1870	404,420	—	—
4381 R23 to 4381 T24 with Feature 1870	484,420	—	—
4381 S23 to 4381 S24 with Feature 1870	324,420	—	—
4381 S23 to 4381 T24 with Feature 1870	404,420	—	—
4381 T23 to 4381 T24 with Feature 1870	324,420	—	—
4381 P23 to 4381 P24 without Feature 1870	360,000	—	—
4381 P23 to 4381 R24 without Feature 1870	440,000	—	—
4381 P23 to 4381 S24 without Feature 1870	520,000	—	—
4381 P23 to 4381 T24 without Feature 1870	600,000	—	—
4381 R23 to 4381 R24 without Feature 1870	360,000	—	—
4381 R23 to 4381 S24 without Feature 1870	440,000	—	—
4381 R23 to 4381 T24 without Feature 1870	520,000	—	—
4381 S23 to 4381 S24 without Feature 1870	360,000	—	—
4381 S23 to 4381 T24 without Feature 1870	440,000	—	—
4381 T23 to 4381 T24 without Feature 1870	360,000	—	—
4381 P24 to 4381 R24	80,000	—	—
4381 P24 to 4381 S24	160,000	—	—
4381 P24 to 4381 T24	240,000	—	—
4381 R24 to 4381 S24	80,000	—	—
4381 R24 to 4381 T24	160,000	—	—
4381 S24 to 4381 T24	80,000	—	—

MASS STORAGE		Purchase Price ($)	Monthly Maint. ($)	Monthly Rental Charge* ($)	Monthly Charge (2-Year Lease)* ($)
3350	Direct Access Storage; 317.5MB per drive:				
	Model A2; Dual Disk Drive	32,030	190.00	2,491	2,120
	Model A2F; Dual Disk Drive with 2MB fixed-head storage	39,970	246.00	3,108	2,645
	Model B2; Add-on Dual Disk Drive	25,360	143.00	1,980	1,685
	Model B2F; Add-on Dual Disk Drive for 2MB fixed-head storage per drive	33,300	200.00	2,597	2,210
	Model C2; Two-drive disk storage and associated control	33,130	200.00	2,597	2,210
	Model C2F; Two-drive disk storage and associated control	41,070	257.00	3,208	2,730
	1320 Primary Controller Adapter (permits selection of A2/AF controller as on-line controller via manual switch on the C2/C2F)	220	1.50	18	15
	8150 String Switch for 3350 A2, A2F, C2, C2F	3,690	9.50	304	259
3370	Direct Access Storage:				
	Model A1; Single Disk Drive; 571.3MB	35,480	173.00	1,851	1,575
	Model B1; Add-on Single Disk Drive for attachment to Model A1	26,600	129.00	1,387	1,180
	Model A2; 729.8MB; contains logic and power for up to three Model B2 units	35,480	134.00	2,190	—
	Model B2; connects to a 3370 Model A2	26,600	101.00	1,640	—
	8150 String Switch for 3370 A1	3,830	1.50	181	154
3375	Direct Access Storage; 819.7MB per drive:				
	Model A1; contains logic and power for up to three Model B1 units	24,730	144.00	1,851	1,575
	Model B1; connects to a 3375 Model A1	18,700	109.00	1,486	1,265
	Model D1; provides dual controller function in a 3375 string; requires one Model A1 and two Model B1s	23,590	133.00	1,763	1,500
	4951 Model D1 Attachment for Model A1	2,590	6.00	112	95
	4952 Model D1 Attachment for Model B1	NC	NC	NC	NC
	8150 String Switch Feature for 3375 A1	3,795	1.50	199	169
	3375 Model B1 to D1 Upgrade	7,520	—	—	—

NA—Not applicable.
NC—No charge.
**Includes equipment maintenance.*
***Four-year lease.*

IBM 4381 Series

MASS STORAGE (Continued)

		Purchase Price ($)	Monthly Maint. ($)	Monthly Rental Charge* ($)	Monthly Charge (2-Year Lease)* ($)
3380	Direct Access Storage:				
	Model A4; 2.52 billion bytes of storage; connects to one 3880 storage director	77,680	285.00	5,305	4,515
	Model AA4; 2.52 billion bytes of storage; connects to two 3880 storage directors	88,780	325.00	6,057	5,155
	Model B4; connects to a Model A4 or AA4 unit	64,440	240.00	4,400	3,745
	Model AD4; 2.52 billion bytes per unit; connects to two 3880 storage directors	88,780	295.00	5,105	—
	Model BD4; connects to a Model AD4 or AE4 unit	64,440	215.00	3,715	—
	Model AE4; 5.04 billion bytes per unit; connects to two 3880 storage directors	122,480	295.00	7,590	—
	Model BE4; connects to a Model AE4 or AD4 unit	98,140	215.00	6,190	—
	Model AJ4; 2.52GB	82,000	225.00	4,325	—
	Model BJ4; 2.52GB; attaches to Model AJ4	59,000	165.00	3,115	—
	Model AK4; triple-capacity 7.56GB drive	128,000	225.00	6,625	—
	Model BK4; triple-capacity 7.56GB drive; attaches to Model AK4	105,000	165.00	5,415	—
	Model CJ2 Direct Channel Attach; 1.6GB	70,000	230.00	3,730	—
	3380 Model Upgrades:	43,660	—	—	—
	Model AD4 to AE4	43,660	—	—	—
	Model BD4 to BE4	43,660	—	—	—
	Model AJ4 to Model AK4	60,000	—	—	—
	Model BJ4 to Model BK4	60,000	—	—	—
3990	Storage Control:				
	Model 1; two-path, no cache	60,000	185.00	3,185	—
	Model 2; four-path, no cache	110,000	370.00	5,870	—
	Model G3; four-path, 32MB cache	200,000	800.00	10,800	—
	Model J3; four-path, 64MB cache	312,000	875.00	16,475	—
	Model L3; four-path, 128MB cache	536,000	1,025.00	27,825	—
	Model Q3; four-path, 256MB cache	984,000	1,325.00	50,525	—
	Feature 8172; additional four-channel switch	18,000	40.00	940	—
3880	Storage Control; includes two storage directors:				
	Model 1; each storage director can attach up to four 3350 A2/A2F, or 3375 1 or D1 in any combination	60,270	176.00	4,124	3,510
	Model 2; provides one storage director for 3350 or 3375 storage and one for 3380 storage	60,270	176.00	4,124	3,510
	Model 3; provides two storage directors for 3380 storage	60,270	176.00	4,124	3,510
	Feature 3005; allows attachment of 3380 Models AJ4 and AK4	5,000	NA	5,000	—
	Model 4; provides one storage director which can attach up to four 3375 Model A1s	30,000	82.50	2,370	—
	Model E21; same as D21, but with 16 megabytes	165,400	600.00	11,300	—
	Model G21; same as D21, but with 32 megabytes	237,400	650.00	15,970	—
	Model H21; same as D21, but with 48 megabytes	309,400	700.00	20,640	—
	Model J21; same as D21, but with 64 megabytes	381,400	750.00	25,310	—
	Model D23; connects to 3380 to form cache/DASD subsystem; 8 megabytes (requires 8170)	129,400	575.00	8,965	—
	Model E23; same as D23, but with 16 megabytes	165,400	600.00	11,300	—
	Model G23; same as D23, but with 32 megabytes	237,400	650.00	15,970	—
	Model H23; same as D23, but with 48 megabytes	309,400	700.00	20,640	—
	Model J23; same as D23, but with 64 megabytes	381,400	750.00	25,310	—
	Feature 3010; allows attachment of 3380 Model AK4 to 3880 Model 23 controller	5,000	NA	5,000	—
	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 G21 to Model H21	72,000	—	—	—
	Model G21 to Model J21	144,000	—	—	—
	Model H21 to Model J21	72,000	—	—	—
	Model 3 to Model D23	69,130	—	—	—
	Model 3 to Model E23	105,130	—	—	—
	Model 3 to Model G23	177,130	—	—	—
	Model 3 to Model H23	249,130	—	—	—
	Model 3 to Model J23	321,130	—	—	—
	Model E23 to Model G23	72,000	—	—	—
	Model E23 to Model H23	144,000	—	—	—
	Model E23 to Model J23	216,000	—	—	—

NA—Not applicable.
NC—No charge.
**Includes equipment maintenance.*
***Four-year lease.*

IBM 4381 Series

MASS STORAGE (Continued)

		Purchase Price ($)	Monthly Maint. ($)	Monthly Rental Charge* ($)	Monthly Charge (2-Year Lease)* ($)
	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	597	508
	6560 Speed Matching Buffer	11,420	40	518	441
	8160 Two Channel Switch	3,580	5	241	—
	8170 Two-Channel Switch Pair	6,225	11.00	421	358
	8171 Two-Channel Switch Pair, Additional	16,610	38.50	1,136	967
	8172 Eight-Channel Switch	22,850	53.50	1,563	1,330
	3990 Model Upgrades:				
	Model 1 to Model 2	50,000	NA	NA	—
	Model 1 to Model G3	170,000	NA	NA	—
	Model 1 to Model J3	282,000	NA	NA	—
	Model 1 to Model L3	506,000	NA	NA	—
	Model 1 to Model Q3	954,000	NA	NA	—
	Model 2 to Model G3	120,000	NA	NA	—
	Model 2 to Model J3	232,000	NA	NA	—
	Model 2 to Model L3	456,000	NA	NA	—
	Model 2 to Model Q3	904,000	NA	NA	—
	Model G3 to Model J3	112,000	NA	NA	—
	Model G3 to Model L3	336,000	NA	NA	—
	Model G3 to Model Q3	784,000	NA	NA	—
	Model J3 to Model L3	224,000	NA	NA	—
	Model J3 to Model Q3	672,000	NA	NA	—
	Model L3 to Model Q3	448,000	NA	NA	—
MAGNETIC TAPE EQUIPMENT					
3420	Magnetic Tape Units:				
	Model 3; 120,000 bytes/sec. at 1600 bpi; 75 ips	11,930	248.00	768	645
	Model 4; 470,000 bytes/sec. at 6250 bpi; 75 ips	15,340	248.00	1,075	903
	Model 5; 200,000 bytes/sec. at 1600 bpi; 125 ips	16,000	272.00	1,035	869
	Model 6; 780,000 bytes/sec. at 6250 bpi; 125 ips	17,920	272.00	1,235	1,037
	Model 7; 320,000 bytes/sec. at 1600 bpi; 200 ips	17,920	326.00	1,225	1,029
	Model 8; 1250 bytes/sec. at 6250 bpi; 200 ips	19,880	401.00	1,465	1,231
	6420 6250 bpi Density Feature (for 3420 Models 4, 6, and 8)	1,600	74.00	103	87
	6425 6250/1600 bpi Density Feature (for 3420 Models 4, 6, and 8)	2,205	99.00	151	127
	6631 Single Density Feature (for Models 3, 5, and 7)	2,870	74.00	177	149
	3550 Dual Density Feature (for Models 3, 5, and 7)	3,705	124.00	231	194
	6407 7-Track Feature (for Models 3, 5, and 7)	2,870	107.00	177	149
3803	Tape Controller:				
	Model 1; for 3420 Model 3, 5, and 7 drives	20,680	158.00	1,335	1,121
	Model 2; for 3420 Model 3 through 8 drives	27,550	218.00	1,945	1,634
	5310 9-Track NRZI Feature (permits connection of 800-bpi drives to 3803-2)	3,080	2.00	186	156
	6320 7-Track NRZI Feature (permits connection of 800-bpi drives to 3803-2; 5310 is prerequisite)	1,515	2.00	92	77
	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	15.00	388	326
	1793 For 3 Tape Controls	7,820	25.00	504	423
	1794 For 4 Tape Controls	9,195	25.00	590	496
	3551 Dual Density Feature (for 3803-1)	2,300	3.50	139	117
	6148 Remote Switch Attachment	910	—	55	46
	6408 7-Track Feature (for 3803-1)	2,300	3.50	139	117
	8100 Two-Channel Switch	4,600	6.50	288	242

NA—Not applicable.
NC—No charge.
**Includes equipment maintenance.*
***Four-year lease.*

IBM 4381 Series

MAGNETIC TAPE EQUIPMENT (Continued)

		Purchase Price ($)	Monthly Maint. ($)	Monthly Rental Charge* ($)	Monthly Charge (2-Year Lease)* ($)
3422	Magnetic Tape Subsystem				
	Model A1 Control Unit	36,800	440.00	2,460	—
	Model B1 Magnetic Tape Unit	17,900	181.00	1,165	—
	3005 Two Channel Switch	3,250	4.00	183	—
	3010 Two-Control Unit Switch; primary	7,350	20.00	425	—
	3015 Two-Control Unit Switch, Secondary	5,250	20.00	310	—
	3020 Data Streaming	1,575	35.00	122	—
3430	Magnetic Tape Subsystem				
	Model A1; Tape Unit and Control	33,400	251.00	2,575	—
	Model B1; Tape Unit Only	16,900	176.00	1,365	—
4991	Multi-drive Attachment	600	5.00	46	—
3480	Model A11 Tape Controller	49,080	355.00	2,810	—
	Model B11 Tape Unit	38,810	220.00	2,160	—
	Model A22 Tape Controller	65,430	423.00	4,605	—
	Model B22 Magnetic Tape Unit	43,120	264.00	3,015	—
	1511 Channel Attachment, First	5,785	21.00	357	—
	1512 Channel Attachment, Second	5,785	21.00	357	—
	1513 Channel Attachment, Third	5,785	21.00	357	—
	2511 Automatic Cartridge Loader	8,900	40	485	—
	3211 A11/A22 Control Unit Coupler	4,045	—	—	—
	3480 Upgrades:				
	Model A11 to Model A22; 3201 required for conversion to Model A22	14,000	—	—	—
	Model B11 to Model B22	11,000	—	—	—

PUNCHED CARD EQUIPMENT

3505	Card Reader:				
	Model B1; 800 cpm	36,030	328.00	1,600	—
	Model B2; 1200 cpm	37,270	449.00	1,890	—
	3921 51/80-Column Interchange	6,370	130.00	316	—
	5450 Optical Mark Read	10,130	120.00	473	—
	6555 Selective Stacker	2,845	16.00	119	—
	8103 3525 Punch Adapter	6,370	8.00	279	—
	8105 3525 Read/Punch Adapter	7,010	11.00	350	—
	8100 3525 Card Print Control	3,810	11.00	152	—
3525	Card Punch:				
	Model P1; 100 cpm	25,520	222.00	1,135	—
	Model P2; 200 cpm	26,520	301.00	1,435	—
	Model P3; 300 cpm	27,520	376.00	1,725	—
	1533 Card Read Feature	7,645	56.00	335	—
	1421 Basic Card Print	16,750	221.00	737	—
	5273 Multi-Line Card Print	1,365	64.00	196	—
	8339 Two-Line Card Print	874	8.00	29	—

PRINTERS

3262	Model 3; band printer; 252 to 650 lpm	15,040	202.50	806	686
	Model 5; band printer; 252 to 650 lpm	17,000	202.50	1,117	951
	Model 13; band printer; 325 lpm	12,620	148.00	592	504
	5450 OCR Feature	3,990	42.00	149	127
	1090 Audible Alarm	201	—	6	5
3268	Model 2	7,500	76.00	498	424
	Model 2C	8,990	102.00	677	—
3287	Serial Printer:				
	Model 1; 80 cps	4,830	41.00	348	296
	Model 2; 120 cps	5,150	52.00	426	362
	Model 1C; 4 colors; 80 cps	5,210	46.00	431	367
	Model 2C; 4 colors; 120 cps	5,530	57.00	506	431

NA—Not applicable.
NC—No charge.
**Includes equipment maintenance.*
***Four-year lease.*

IBM 4381 Series

PRINTERS (Continued)

		Purchase Price ($)	Monthly Maint. ($)	Monthly Rental Charge* ($)	Monthly Charge (2-Year Lease)* ($)
	1120 APL/Text	165	0.50	6	5
	3610 Extended Character Set Adapter	429	3.00	25	22
	3880 Extended Print Buffer	198	0.50	7	6
	4110 Friction Feed Paper Handling	151	0.50	6	5
	8330 3271/3272 Attachment for Models 1 and 2	860	2.50	60	51
	8331 3274/3276 Attachment for Models 1 and 2	165	0.50	6	5
	8700 Variable-Width Forms Tractor	151	0.50	6	5
3800	Model 3; high-speed laser printer; prints up to 215 pages per minute (ppm)	330,750	776	16,520	—
	Model 6; High-speed laser printer; prints up to 134 ppm	175,000			
	1010 Accumulator	21,250	138	1,060	—
	1021 Accumulator Expansion	5,445	42	270	—
	1490 Burster-Trimmer-Stacker	52,500	372	2,630	2,020
	5401 127 Writable Character Generator Storage Positions (Additional)	4,695	29	174	135
	5410 Raster Pattern Storage (Additional)	8,655	8	431	—
	7810 Tape-to-Printing Subsystem Feature (Model 1)	12,630	57	699	537
	8170 Two-Channel Switch (Model 1)	10,270	23	469	363
	8180 Two-Channel Switch (Model 3)	10,270	23	469	—
3812	Nonimpact tabletop page printer Model 1	8,235	126.00	—	—
	3060 bisync communication feature for VM attachment	250	—	—	—
3820	Model 1; Page Printer; laser-based machine prints up to 20 pages per minute	28,350	310	1,845	—
	3005 Pattern Storage Memory, 256KB	1,050	10	67	—
	3010 Pattern Storage Memory, 512KB	1,700	20	112	—
	3020 Pattern Storage Memory, 1024KB	3,000	40	202	—
	3025 Pattern Storage Memory, 2048KB	6,000	80	404	—
	3030 Pattern Storage Memory, 3072KB	9,000	120	607	—
	3040 EIA Interface Cable 12m	125	—	—	—
	3045 EIA Interface Cable 6m	90	—	—	—
	3050 EIA Interface Attachment	500	10	37	—
	3055 S/370 Channel Interface Attachment	2,600	40	180	—
	3065 Pattern Storage Memory, 4096KB	12,000	160	809	—
4245	Model 12/D12 Band printers; 1200 lpm. Model 12 attaches to IBM byte, block, or selector channels. The Model D12 attaches via 3274, or 4700 controllers.	31,000	250	2,050	—
	Model 20/D20 Band printers; 2000 lpm. Model 20 attaches to IBM byte, block, or selector channels. The Model D20 attaches via 3274, or 4700 controllers.	35,000	400	2,340	—
	4245 Upgrades:				
	Model 12/D12/T12 to Model 20/D20/T20	10,000	—	—	—
4248	Model 2; Variable-speed band printer; 2200, 3200, and 4000 lpm	75,000	800	6,205	—
	3751 36 additional print positions; plant installed	10,000	110	615	—
	3753 36 additional print positions; field installed	15,000	110	615	—

TERMINALS

Cluster Controllers:

3174	Nonprogrammable Control Unit for 3270 Subsystems; includes one megabyte of control storage, expandable to three megabytes, diskette drive, microcode equivalent of 3274-41A/C/D with Configuration Support D				
	Model 1L Control Unit with Channel Interface; supports 4 to 32 terminals or PCs with appropriate emulation features; attaches to byte or block multiplexer channel, 4381/9370 SOEMI interface, 3814 Switching Management System; supports Token Ring via optional feature	12,950	264.00	—	—
	Model 1R Control Unit with RS-232-C Remote Link Attachment; supports 4 to 32 terminals or PCs with appropriate emulation features; attaches to SNA or X.25 networks; 64K bps data rate	9,950	240.00	—	—
	Model 2R Control Unit with X.21 Remote Link Attachment; supports 4 to 32 terminals or PCs with appropriate emulation features; attaches to SNA or X.25 networks; 64K bps data rate		240.00	—	—
	Model 3R Control Unit with Interface for Token-Ring Attachment; supports 4 to 32 terminals or those PCs with appropriate emulation features; standard attachment interface is for IEEE 802.5/802.2 standard baseband Token Ring; can also attach to 3174 1L with 3025 feature	11,450	300.00	—	—

NA—Not applicable.
NC—No charge.
**Includes equipment maintenance.*
***Four-year lease.*

IBM 4381 Series

Cluster Controllers: (Continued)

		Purchase Price ($)	Monthly Maint. ($)	Monthly Rental Charge* ($)	Monthly Charge (2-Year Lease)* ($)
	Model 81R Small Cluster Control Unit with RS-232-C Remote Link Attachment; supports up to eight terminals; for SNA or X.25 networks	3,500	168.00	—	—
	Model 82R Small Cluster Control Unit with X.21 Remote Link Attachment; supports up to eight terminals; for SNA or X.25 networks	3,500	168.00	—	—
1011	Storage Expansion; 512 kilobytes	1,300	40.00	—	—
1012	Storage Expansion; 1 megabyte	2,300	80.00	—	—
1046	Diskette Drive; 1.2 megabytes	650	120.00	—	—
3020	Asynchronous Emulation Adapter (2-way); microprocessor-based; allows attachment of or emulation of IBM 3101, Digital Equipment VT100, other ASCII terminals and ASCII pass-through	2,250	144.00	—	—
3025	Token-Ring Network 3270 Gateway; for 3174 1L, supports up to 140 ring-attached PU Type 2.0 cluster controllers (LUs are transparent); downstream devices can be PCs, 3174 3Rs, or S/36s	5,000	162.00	—	—
3103	Terminal Multiplexer Adapter; 8 ports; maximum of 4 attachable	500	20.00	—	—
3680	Encrypt/Decrypt Adapter	1,780	24.00	—	—
3274					
	Model 21A; local, SNA mode	14,220	77.00	1,038	883
	Model 21B; local, 3272 mode	14,200	80.00	1,038	883
	Model 21C; remote; requires 3701	9,990	59.00	727	619
	Model 21D; local, 3272 mode	14,220	85.00	1,038	883
	Model 31A; local, SNA mode	16,650	97.00	1,216	1,035
	Model 31C; remote; requires 3701	12,420	79.00	907	772
	Model 31D; local, 3272 mode	16,650	105.00	1,216	1,035
	Model 41A; local, SNA mode	18,230	62.00	1,281	1,090
	Model 41C; remote; requires 3701	13,840	43.00	973	828
	Model 41D; local, 3272 mode	18,230	62.00	1,281	1,090
	Model 51C; remote; requires 3701	4,885	40.00	334	284
	Model 61C; remote; requires 3701	7,600	29.00	513	437
1550	CCITT V.35 Interface	525	1.50	25	22
1800	Extended Function Storage, D2 CSE	2,430	20.00	166	141
1801	Control Storage Expansion	790	4.00	59	50
3101	Internal Disk Drive Enhancement	1,620	15.00	117	100
3622	Extended Function Storage, Ty C1	950	8.50	97	83
3623	Extended Function Storage, Ty C2	1,265	10.50	127	108
3625	Extended Function Storage, Ty C3	950	8.50	97	83
3627	Extended Function Storage, Ty D1	950	8.50	97	83
3631	Extended Function Storage, Ty D3	820	7.00	59	50
3650	Extended Function Storage, Ty C1	1,640	15.00	117	100
3660	Extended Function Storage, DS	1,550	2.00	100	85
3680	Encrypt/Decrypt; -1C, 3274 -21C, -31C, -41C, -51C, and -61C only	1,780	2.00	99	84
3701	External Modem Interface; requires 6302 or 6303	337	3.00	18	16
5101	Internal Disk Drive Enhancement	1,530	14.00	109	93
5550	Power Expansion	341	1.50	18	16
5650	Dataphone Digital Service; point-to-point; -21C, -31C, -41C, -51C, and -61C only	840	1.50	41	36
5651	Dataphone Digital Service; multipoint; -21C, -31C, or -51C only	840	1.50	41	36
5655	X.21 Adapter; nonswitched networks; -41C or -61C only	800	1.50	38	33
5656	X.21 Adapter; switched networks; -41C or -61C only	800	2.00	47	40
	Terminal Adapters (for Models -21X, -31X, and -51C only)—				
6901	Type A1; devices 9 through 16	918	2.00	60	51
6902	Type A2; devices 17 through 24	918	2.00	60	51
6903	Type A3; devices 25 through 32	918	2.00	60	51
7801	Type B; requires 5550	986	4.00	71	60
7802	Type B1; devices 1 through 4	986	4.00	71	60
7803	Type B2; devices 5 through 8	831	2.50	60	51
7804	Type B3; devices 9 through 12	831	2.50	60	51
7805	Type B4; devices 13 through 16	831	2.50	60	51
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	15	13
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	67	57
8801	Watertight Power Connector; -21A/B/D, -31A/D, and -41A/D	NC	NC	NC	NC

Note: IBM no longer accepts lease/rental orders for any model of the 3274 Control Unit. Listed lease/rental prices apply to hardware installed prior to 8/24/84.

NA—Not applicable.
NC—No charge.
**Includes equipment maintenance.*
***Four-year lease.*

IBM 4381 Series

		Purchase Price ($)	Monthly Maint. ($)	Monthly Rental Charge* ($)	Monthly Charge (2-Year Lease)* ($)
Display Stations					
	Model 316X Display Stations:				
3161	Model 1 ASCII Display Station; 1920 characters, emulates 3101-881; emulates additional non-IBM models through added features	695	35	—	—
8001	Additional Read Command	15	—	—	—
8501	Extended Emulation, including ADDS Viewpoint, Hazeltine 1500, TeleVideo 910, and Lear Siegler ADM-3A and ADM-5	35	—	—	—
8901	Five TeleVideo Emulation, includes 910, 912, 920, 925, and 925E	35	—	—	—
3162	Model 110 Microcoded Display; full keyboard, green, RS-232-C interface	610	35	—	—
	Model 120 Microcoded Display; full keyboard, green, RS-232-C and RS-422-A interfaces	724	35	—	—
	Model 210 Microcoded Display; full keyboard, amber, RS-232-C interface	645	35	—	—
	Model 220 Microcoded Display; full keyboard, amber, RS-232-C and RS-422-A interfaces	724	35	—	—
	Model 310 Microcoded Display; short keyboard, green, RS-232-C interface	645	35	—	—
	Model 320 Microcoded Display; short keyboard, green, RS-232-C and RS-422-A interfaces	724	35	—	—
	Model 410 Microcoded Display; short keyboard, amber, RS-232-C interface	645	35	—	—
	Model 420 Microcoded Display; short keyboard, green, RS-232-C and RS-422-A interfaces	724	35	—	—
8222	Digital Equipment VT220 Emulation	—	—	—	—
8232	Digital Equipment VT220 Emulation with hot key/3708	—	—	—	—
8502	TeleVideo 950 Emulation	—	—	—	—
8922	10 ASCII Terminal Emulation	—	—	—	—
3163	Model 1 Standard Microcoded Display	895	45	—	—
860	ALA Display; displays diacritic characters in separate position	976	45	—	—
861	ALA Display; displays diacritic characters combined with letters	985	45	—	—
8103	Digital Equipment VT100/52 Emulation	50	—	—	—
8953	TeleVideo 950 Emulation	38	—	—	—
3164	Model 1 Standard Microcoded Display	1,295	55	—	—
860	ALA Display; displays diacritic characters in separate position	1,376	75	—	—
861	ALA Display; displays diacritic characters combined with letters	1,385	75	—	—
3180	Monochrome Display for 3270 Subsystems; attaches to 3174, 3274, or 3276				
	Model 110 Display with 4 user selectable screen formats; up to 3564 characters	2,095	95	—	—
	Model 120 Display with 4 user selectable screen formats; up to 3564 characters	2,095	95	—	—
	Model 130 APL Display with 4 user selectable screen formats; up to 3564 characters	2,095	95	—	—
8191	Switch Control Unit; permits switching operation between two control units	168	—	—	—
3191	Monochrome Display for 3270 Subsystems; attaches to 3174, 3274, or 3276				
	Model A10 Display with 122-key typewriter keyboard; 1920 characters; green	1,295	40	—	—
	Model A20 Display with 102-key enhanced keyboard; 1920 characters; green	1,295	40	—	—
	Model A30 Display with 104-key typewriter keyboard; 1920 characters; green	1,295	40	—	—
	Model B10 Display with 122-key keyboard; 1920 characters; amber	1,295	40	—	—
	Model B20 Display with 102-key keyboard; 1920 characters; amber	1,295	40	—	—
	Model B30 Display; with 104-key typewriter keyboard; 1920 characters; amber	1,295	40	—	—
3192	Color Display for 3270 Subsystem; attaches to 3174, 3274, or 3276				
	Model C10 Display with 122-key typewriter keyboard; 1920 or 2560 characters	1,895	85	—	—
	Model C20 Display with 102-key enhanced keyboard; 1920 or 2560 characters	1,895	85	—	—
	Model C30 Display with 104-key typewriter keyboard; 1920 characters; 7 colors	1,895	85	—	—
	Model CDO Display with 122-key typewriter keyboard; 1920 or 2560 characters; 7 colors; 3-year guarantee	2,045	85	—	—
	Model CEO Display with 102-key enhanced keyboard; 1920 or 2560 characters; 7 colors; 3-year warranty	2,045	85	—	—
	Model CFO Display with 104-key typewriter keyboard; 1920 or 2560 characters; 3-year warranty				
	Model D10 Display with 122-key typewriter keyboard; 1920, 2560, 3440, or 3560 characters; 7 colors	1,795	60	—	—
	Model D20 Display with 102-key enhanced keyboard; 1920, 2560, 3440, or 3564 characters; 7 colors	1,795	60	—	—
	Model D30 Display with 104-key typewriter keyboard; 1920, 2560, 3440, or 3564 characters; 7 colors	1,795	60	—	—
	Model DDO Display with 122-key typewriter keyboard; 1920, 2560, 3440, or 3564 characters; 7 colors; 3-year warranty	1,895	60	—	—

NA—Not applicable.
NC—No charge.
**Includes equipment maintenance.*
***Four-year lease.*

IBM 4381 Series

Display Stations (Continued)

		Purchase Price ($)	Monthly Maint. ($)	Monthly Rental Charge* ($)	Monthly Charge (2-Year Lease)* ($)
	Model DEO Display with 102-key enhanced keyboard; 1920, 2560, 3440, or 3564 characters; 7 colors; 3-year warranty	1,895	60	—	—
	Model DFO Display with 104-key typewriter keyboard; 1920, 2560, 3440, or 3564 characters; 7 colors; 3-year warranty	1,895	60	—	—
	Model G10 Color Graphics Display with 122-key typewriter keyboard; 1920 or 2560 characters, 8 colors	2,795	110	—	—
	Model G20 Color Graphics Display with 122-key/APL typewriter keyboard; 89 colors; 2560 characters	2,795	110	—	—
	Model G30 Color Graphics Display with 104-key enhanced keyboard; 1920 or 2560 characters; 8 colors	2,795	110	—	—
	Model G40 Color Graphics Display with 104-key/APL enhanced keyboard; 2560 characters; 8 colors	2795	110	—	—
	Model GDO Color Graphics Display with 122-key typewriter keyboard; 2560 characters; 8 colors; 3-year warranty	2,995	110	—	—
	Model GEO Color Graphics Display with 122-key/APL typewrtier keyboard; 1920 or 2560 characters; 8 colors; 3-year warranty	2,995	110	—	—
	Model GFO Color Graphics Display with 104-key enhanced keyboard; 1920 or 2560 characters; 8 colors	2,995	110	—	—
	Model GGO Color Graphics Display with 104-key/APL typewriter keyboard; 1920 or 2560 characters, 8 colors; 3-year warranty	2,995	110	—	—
3193	Advanced Monochrome Displays for 3270 Subsystems; attaches to 3174, 3274, 8 partitions, 2 logical terminals, combines characters and images; 880 x 1200 dots				
	Model 10 Display with 122-key keyboard; 3840 characters; 100 pels	2,495	75	—	—
	Model 10 Display with 102-key enhanced keyboard; 3840 characters; 100 pels	2,495	75	—	—
3194	Color Display for 3270 Subsystems; attaches to 3174, or 3274				
	Model 10 Display with 122-key keyboard; 1920 characters; 7 colors	2,895	—	—	—
	Model 20 Display with 102-key keyboard; 1920 characters; 7 colors	2,895	—	—	—
3178	Model C10; 1920 char., w/75-key Data Entry keyboard	1,040	—	—	—
	Model C20; 1920 char., w/87-key Typewriter keyboard	1,095	—	—	—
	Model C30; 1920 char., w/87-key Typewriter keyboard and numeric pad	1,095	—	—	—
	Model C40; 1920 char., w/87-key Typewriter keyboard and numeric pad	1,095	—	—	—
3276	Integrated Display/Control Unit; can support additional 3270-type displays				
	Model 1; 960-character display; for BSC transmissions	5,380	36.00	348	296
	Model 2; 1920-character display; for BSC transmissions	5,535	37.00	356	303
	Model 3; 2560-character display; for BSC transmissions	5,680	38.00	361	307
	Model 4; 3440-character display; for BSC transmissions	5,830	39.00	377	321
	Model 11; 960-character display; for SNA/SDLC transmissions	5,380	32.00	348	296
	Model 12; 1920-character display; for SNA/SDLC transmissions	5,535	33.00	356	303
	Model 13; 2560-character display; for SNA/SDLC transmissions	5,680	34.00	361	307
	Model 14; 3440-character display; for SNA/SDLC transmissions	5,830	34.00	377	321
1009	Address Keylock	56	—	62	—
1067	APL/Text Control	950	1.00	55	47
1068	Extended Function Base; allows attachment of features 1067, 5656, or 1950	190	1.00	6	5
1950	Color Display Attachment	758	0.50	46	39
3255	Terminal Adapter 1; allows attachment of 2 terminals	530	1.50	26	23
3256	Terminal Adapter 2; allows attachment of 2 terminals above 3255	530	1.50	26	23
3257	Terminal Adapter 3; allows attachment of 2 terminals above 3256	530	1.50	26	23
3620	Character Set Extension; allows display of APL/Text 222-character set, which includes the 94-character EBCDIC set	644	3.00	29	25
3680	Encrypt/Decrypt	1,600	2.00	94	80
3701	External Modem Interface	337	3.00	18	16
4621	75-Key EBCDIC Typewriter Keyboard	463	2.00	22	19
4622	75-key EBCDIC Data Entry Keyboard	463	3.00	22	19
4623	75-Key EBCDIC Data Entry Keyboard; keypunch layout	463	3.00	22	19
4624	75-Key ASCII Typewriter Keyboard	463	2.00	22	19
4626	87-Key EBCDIC Typewriter/APL Keyboard	632	2.50	27	24
4627	87-Key EBCDIC Typewriter Keyboard	632	2.50	27	24
4628	87-Key ASCII Typewriter Keyboard	632	2.50	27	24
4629	87-Key EBCDIC Typewriter/Text Keyboard	632	2.50	27	24
4999	Magnetic Reader Control	379	3.50	17	15
5500	Integrated 1200 bps Modem; nonswitched	535	5.50	34	29

NA—Not applicable.
NC—No charge.
**Includes equipment maintenance.*
***Four-year lease.*

IBM 4381 Series

Display Stations (Continued)

		Purchase Price ($)	Monthly Maint. ($)	Monthly Rental Charge* ($)	Monthly Charge (2-Year Lease)* ($)
5501	Integrated 1200 bps Modem; switched, auto answer	714	2.50	46	39
5502	Integrated 1200 bps Modem; manual answer	535	3.00	34	29
5507	Integrated 1200 bps Modem; nonswitched with SNBU	766	5.50	49	42
5508	Integrated 1200 bps Modem; nonswitched with SNBU and auto answer	855	3.00	55	47
5650	DDS Adapter for point-to-point operations	840	1.50	41	36
5651	DDS Adapter; multipoint operation	840	1.50	41	36
5655	X.21 Adapter; for nonswitched networks	800	1.50	38	33
5656	X.21 Adapter; for switched networks	884	2.00	47	40
6302	Communications Adapter without clock	365	2.00	15	13
6315	SDLC/BSC Switch	682	3.00	36	31
6360	Light Pen	548	0.50	24	20
3278	Model 1; 960 char.	1,484	10.00	115	98
	Model 2; 1920 char.	1,572	10.00	119	102
	Model 3; 2560 char.	1,716	10.50	146	124
	Model 4; 3440 char.	1,804	11.50	149	127
	Model 5; 3564 char.	2,060	13.00	175	149
3610	Extended Character Set Adapter	—	—	17	15
3620	Character Set Extension	464	2.50	30	26
4621	Keyboard; 75 Key EBCDIC Ty	334	2.00	22	19
4622	Keyboard; 75 Key EBCDIC De	334	3.00	22	19
4623	Keyboard; 75 Key EBCDIC De/Kp	334	3.00	22	19
4624	Keyboard; 75 Key ASCII Ty	334	2.00	22	19
4626	Keyboard; 87 Key EBCDIC Typ/APL	455	2.50	27	24
4627	Keyboard; 87 Key EBCDIC Ty	455	2.50	27	24
4628	Keyboard; 87 Key ASCII Ty	455	2.50	27	24
4629	Keyboard; 87 Key EBCDIC Typ/Text	455	2.50	27	24
3620	Character Set Extension	464	2.50	30	26
6360	Selector Light Pen	394	0.50	24	20
4999	Magnetic Reader Control	273	3.50	17	15
3279	Model S2A; base color; 1920 char.	2,190	19.00	201	171
	Model S2B; extended color; 1920 char.	2,415	19.00	204	174
	Model S3G; extended color; 2560 char.	3,115	25.00	310	264
	Model 2X; base/extended color; 1920 char.	2,190	19.00	206	176
	Model 3X; base/extended color; 2560 char.	2,235	19.00	227	193
3850	Extended Function (Model 2X or 3X)	210	2.00	15	13
4621	75-Key EBCDIC Typewriter	417	1.50	22	19
4622	75-Key EBCDIC Data Entry	417	2.50	22	19
4623	75-Key EBCDIC Data Entry, keypunch layout	417	2.50	22	19
4624	75-Key ASCII Typewriter	417	1.50	22	19
4626	87-Key EBCDIC Typewriter/Text; 3278 only	569	2.00	27	24
4627	87-Key EBCDIC Typewriter; 3278/3274 only	569	2.00	27	24
4628	87-Key ASCII Typewriter; 3278/3274 only	569	2.00	27	24
4629	87-Key EBCDIC Typewriter/Text; 3278 only	569	2.00	27	24
4640	87-Key EBCDIC Typewriter Overlay	569	2.00	27	24
4651	87-Key EBCDIC Attribute Select Typewriter	569	2.00	27	24
4652	87-Key EBCDIC Attribute Select Typewriter/APL	569	2.00	27	24
3290	Information Panel Display For 3270 Subsystems; plasma panel technology				
	Model 220 Slim Profile Display; 9920 characters; data/typewriter keyboards; multiple screens/windows, optional 5300 large character format	6,500	288	—	—
	Model 230 Slim Profile Display; 9920 characters; modifiable data/typewriter keyboard with integrated numeric pad; similar to 3179; 3180; multiple screens/windows, optional 5300 large character format	6,500	288	—	—
	Model T30 TEMPEST Specification Display; similar to 230, but not modifiable	9,300	360	—	—
8775	Display Terminal with control logic for standalone remote operation; highly compatible with 3270 cluster datastreams				
	Model 11 Display; 960, 1920, or 2560 characters in 9 x 16 format	3,070	27.00	147	125
	Model 12 Display; 3440 characters in 9 x 12 format as well as 960, 1920, or 2560 characters in 9 x 16 format	3,450	27.00	165	140
1009	Setup Keylock	63	—	63	—
1090	Audible Alarm	93	—	2	2

NA—Not applicable.
NC—No charge.
**Includes equipment maintenance.*
***Four-year lease.*

IBM 4381 Series

Display Stations (Continued)

		Purchase Price ($)	Monthly Maint. ($)	Monthly Rental Charge* ($)	Monthly Charge (2-Year Lease)* ($)
1488	Business Machine Clock	234	1.50	6	5
3623	Extended Feature Storage; needed for 3624, 3626, 5110, or IDIF	848	4.00	44	35
3701	External Modem Interface	374	3.50	17	15
3905	Feature Adapter; provides logic to perform 3624, 3626, or IDPF	424	2.00	17	15
4621	75-Key EBCDIC Typewriter Keyboard	417	2.00	21	18
4622	75-Key EBCDIC Data Entry Keyboard	417	3.00	21	18
4623	75-Key EBCDIC Data Entry Keyboard; keypunch layout	417	3.00	21	18
4626	87-Key EBCDIC Typewriter/APL Keyboard	569	2.50	26	23
4627	87-Key EBCDIC Typewriter Keyboard	569	2.50	26	23
4640	87-Key EBCDIC Typewriter Overlay Keyboard	569	2.50	26	23
4670	87-Key EBCDIC Typewriter/Text Entry and Edit Keyboard	632	3.50	25	22
4999	Magnetic Reader Control	364	2.00	17	15
5500	Integrated 1200 bps Modem	563	6.50	30	26
5580	Printer Adapter	1,440	4.50	56	48
5650	DDS Adapter; for point-to-point operations	840	1.50	39	34
5651	DDS Adapter; multipoint operation	840	1.50	36	31
5655	X.21 Adapter; for nonswitched networks	800	1.50	35	30
5781	Programmed Symbols; two 190-symbol sets	202	1.50	6	5
5782	Programmed Symbols; adds four 190-symbol sets to 5781	324	2.50	16	14
6340	Security Keylock	40	—	40	—

SYSTEM MANAGEMENT

IBM 3814 Switching Management System, Models:

A1	Controller Unit (4 x 4)	47,480	159	2,630	**2,105
A2	Controller Unit (4 x 8)	60,420	207	3,350	**2,680
A3	Controller Unit (8 x 4)	64,740	203	3,595	**2,875
A4	Controller Unit (two 4 x 4s)	69,570	223	3,875	**3,095
B1	Remote Unit (4 x 4)	39,710	107	2,205	**1,765
B2	Remote Unit (4 x 8)	52,660	157	2,920	**2,335
B3	Remote Unit (8 x 4)	56,970	151	3,165	**2,530
B4	Remote Unit (two 4 x 4s)	61,800	171	3,435	**2,745
C1	Expansion Unit (4 x 4)	37,980	104	2,105	**1,680
C2	Expansion Unit (4 x 8)	50,930	152	2,820	**2,255
C3	Expansion Unit (8 x 4)	55,240	147	3,065	**2,450
C4	Expansion Unit (two 4 x 4s)	60,070	168	3,340	**2,670

Additional Hardware and Options

Upgrades	Model A1 to A4, Model B1 to B4, or Model C1 to C4	22,090	—	—	—
3178-C20	Display Station	1,095	—	—	—
3278-2	Display Station	1,572	10.00	119	102
3287-1	Hard Copy Printer	4,830	41.00	348	296
3287-2	Hard Copy Printer	5,150	52.00	426	362
1410	Expanded Storage Unit	4,800	23.00	246	**196
1420	Printer and Display Station Attachment	1,990	3.00	103	**83
1430	Alternate Controller	1,990	3.00	103	**83
1440	System Attachment Feature	5,700	16.00	307	**248
1520	Internal Channel Expansion; four controller unit interfaces	1,550	1.00	86	**69
1521	Internal Channel Expansion; eight controller unit interfaces	3,100	1.00	168	**135
1531	External Channel Expansion; first 4 x 4 interface	5,350	1.00	294	**235
1532	External Channel Expansion; second 4 x 4 interface	5,350	1.00	294	**235
1811	Control Unit Power Sequencing; provides sequencing for first group of control units	518	1.00	27	**21
1812	Control Unit Power Sequencing; provides sequencing for second group of control units	518	1.00	27	**21
1813	Control Unit Power Sequencing; provides sequencing for third group of control units	518	1.00	27	**21
1814	Control Unit Power Sequencing; provides sequencing for fourth group of control units	518	1.00	27	**21
6350	Additional System Power Sequencing	207	—	8	**6
6010	Remote Two-Channel Switch Control—Basic	5,180	21.00	284	**226
6011	Additional Remote Two-Channel Switch Control	2,415	15.00	133	**106
6012	Second Additional Remote Two-Channel Switch Control	2,415	15.00	133	**106
6013	Third Additional Remote Two-Channel Switch Control	2,415	15.00	133	**106

NA—Not applicable.
NC—No charge.
**Includes equipment maintenance.*
***Four-year lease.*

IBM 4381 Series

		Purchase Price ($)	Monthly Maint. ($)	Monthly Rental Charge* ($)	Monthly Charge (2-Year Lease)* ($)
CHANNEL EXTENSION					
3044-C01	Fiber-Optic Channel Extender Link; channel unit	8,500	27	—	—
3044-D01	Fiber-Optic Channel Extender Link; downstream unit	8,500	27	—	—
COMMUNICATIONS EQUIPMENT					
3720	Communications Controller:				
	Model 1 Communications Controller; local base	36,500	175.00	2,605	—
	Model 2 Communications Controller; remote base	26,000	142.00	1,855	—
	Model 11 Communications Controller	42,500	178.00	3,035	—
	Model 12 Communications Controller	33,000	146.00	2,285	—
3725	Communications Controller:				
	Model 1; up to six channel adapters and from 512K to 1024K bytes of main storage capacity	75,000	232.00	4,420	—
	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	208.00	3,330	—
	1561 Channel Adapter	6,750	8.50	399	—
	4666 Internal Clock Control	1,500	2.00	85	—
	4771 Line Attachment Base Type A	19,000	17.00	1,115	—
	4772 Line Attachment Base Type B	26,400	30.00	1,560	—
	4911 Line Interface Coupler Type 1	2,600	2.00	155	—
	4921 Line Interface Coupler Type 2	3,000	2.00	174	—
	4931 Line Interface Coupler Type 3	3,000	2.00	174	—
	4941 Line Interface Coupler Type 4A	2,600	2.00	155	—
	4942 Line Interface Coupler Type 4B	3,000	2.00	174	—
	7100 Storage Increment 256K	4,375	20.00	257	—
	8320 Two Processor Switch	4,000	3.00	237	—
3726	Communications Controller Expansion	32,000	43.00	1,880	—
3727	Operator Console	2,390	28.00	215	—

NA—Not applicable.
NC—No charge.
**Includes equipment maintenance.*
***Four-year lease.*

SOFTWARE PRICES

		Initial Basic License Charge ($)	Monthly Basic* License Charge ($)	Graduated Onetime Charge ($)	Licensed Program Support Charge ($)
Operating Systems					
5662-257	OS/VS1/BPE Release 4 with 5652-VS1 OS/VS1 Release 7 SCP	NA	259	NA	48
5664-167	VM/SP Releases 3 through 5 and up				
	Graduated Charge: Processor Group 20	NA	500	13,540	69
	Graduated Charge: Processor Group 30	NA	500	19,345	69
5664-169	VM/XA Systems Facility Release 1 and up	11,220	4,110	NA	623
5664-308	VM/XA System Product Release 1; available March 1988; Multiple Preferred Guest component will be available Third Quarter 1988				
	Graduated Charge: Processor Group 20	NA	4,500	NA	—
	Graduated Charge: Processor Group 30	NA	4,500	112,500	—
5664-308	VM/XA System Product Release 2				
	Graduated Charge: Processor Group 20	NA	4,500	NA	—
	Graduated Charge: Processor Group 30	NA	4,500	112,500	—
5664-173	VM/SP HPO High Performance Option Releases 3.2 through 5.0 and up; optional on 4381, but really needed if VM/SP is to fully utilize 4381 characteristics				
	Graduated Charge: Processor Group 20	5,325	1,775	NA	136
	Graduated Charge: Processor Group 30	5,325	1,775	57,665	136
5664-197	MUSIC/SP System Product; this version of MUSIC requires VM/SP	NA	850	NA	NA
5664-301	VM/IS BASE Release 4 and up				
	Graduated Charge: Processor Group 20	NA	2,000	23,765	NA
	Graduated Charge: Processor Group 30	NA	2,000	33,100	NA
5665-291	MVS/SP Version 2 Releases 1.2 through 1.7 and up (MVS/XA with JES3)				
	Graduated Charge: Processor Group 20	14,430	4,810	177,165	1,335
	Graduated Charge: Processor Group 30	14,430	4,810	177,165	1,335

IBM 4381 Series

Operating Systems (Continued)

		Initial Basic License Charge ($)	Monthly Basic* License Charge ($)	Graduated Onetime Charge ($)	Licensed Program Support Charge ($)
5665-432	SRTOS Special Realtime Operating System Version 2; Version 2 requires MVS/SP or MVS/XA				
	Graduated Charge: Processor Group 20	NA	NA	40,000	NA
	Graduated Charge: Processor Group 30	NA	NA	40,000	NA
5666-301	VSE/AF Version 2 Release 1 and up				
	Graduated Charge: Processor Group 20	NA	438	8,000	108
	Graduated Charge: Processor Group 30	NA	438	11,430	108
5666-316	VSE/SP Version 2 Release 1.6				
	Graduated Charge: Processor Group 20	NA	2,160	40,440	433
	Graduated Charge: Processor Group 30	NA	2,160	57,805	433
5666-345	VSE/SP Version 3 Release 1.0 and up				
	Graduated Charge: Processor Group 20	NA	2,608	51,305	NA
	Graduated Charge: Processor Group 30	NA	2,608	51,305	NA
5667-126	IX/370 Interactive Executive Version 1 Release 1.3 requires VM/SP Release 3.0 or up				
	4506 pricing feature for IX/370: asset assignment, to 16 CSTUS				
	Graduated Charge: Processor Group 20	NA	NA	10,000	495
	Graduated Charge: Processor Group 30	NA	NA	10,000	495
	4507 pricing feature for IX/370: supports up to 32 currently signed-on terminal users (CSTUs); requires 4506				
	Graduated Charge: Processor Group 20	NA	NA	10,000	NA
	Graduated Charge: Processor Group 30	NA	NA	10,000	NA
	4508 pricing feature for IX/370: supports up to 64 CSTUs; requires 4506 and 4507				
	Graduated Charge: Processor Group 20	NA	NA	20,000	NA
	Graduated Charge: Processor Group 30	NA	NA	20,000	NA
	4509 pricing feature for IX/370: supports more than 65 CSTUs; requires 4506, 4507, and 4508				
	Graduated Charge: Processor Group 20	NA	NA	35,000	NA
	Graduated Charge: Processor Group 30	NA	NA	35,000	NA
5740-XC6	MVS/SP Version 2 Releases 1.2 through 1.7, Release 2.0 and up (MVS/XA with JES2)	12,840	4,280	NA	673
5740-XYN	MVS/SP Version 1 Releases 3 through 6 and up (MVS/370 with JES3)	NA	2,150	NA	117
5740-XYS	MVS/SP Version 1 Releases 3 through 6 and up (MVS/370 with JES2)	NA	2,150	NA	240
5748-T12	TPF2.3 Transaction Processing Facility Version 2 Release 3; Version 2 requires MVS/SP or MVS/XA for batch facilities	32,100	13,540	NA	NA

Utilities, Installation Management, Performance Analysis

5664-179	VMPPF Performance Planning Facility; for VM/SP				
	Graduated Charge: Processor Group 20	NA	2,000	30,000	NA
	Graduated Charge: Processor Group 30	NA	2,000	30,000	NA
5664-191	VMMAP Performance Monitor Analysis Program Release 1.1; for VM/SP				
	Graduated Charge: Processor Group 20	NA	270	2,800	NA
	Graduated Charge: Processor Group 30	NA	270	4,000	NA
5664-301F	VM/IS Performance Reporting Feature ("UMMAP")				
	Graduated Charge: Processor Group 20	NA	270	2,800	NA
	Graduated Charge: Processor Group 30	NA	270	4,000	NA
5664-301F	VM/IS Shared User Files Feature ("FSF")				
	Graduated Charge: Processor Group 20	NA	44	770	NA
	Graduated Charge: Processor Group 30	NA	44	1,100	NA
5664-301F	VM/IS Performance Monitor Feature ("Real Time Monitor")				
	Graduated Charge: Processor Group 20	NA	50	700	NA
	Graduated Charge: Processor Group 30	NA	50	1,000	NA
5664-301F	VM/IS Background Execution Feature ("Batch")				
	Graduated Charge: Processor Group 20	NA	44	770	NA
	Graduated Charge: Processor Group 30	NA	44	1,100	NA
5664-301F	VM/IS Graphics Support Feature ("GDDM/PGF)				
	Graduated Charge: Processor Group 20	NA	413	8,670	NA
	Graduated Charge: Processor Group 30	NA	413	12,390	NA
5664-301F	VM/IS Text Formatter Feature ("DCF/FEF")				
	Graduated Charge: Processor Group 20	NA	417	8,735	NA
	Graduated Charge: Processor Group 30	NA	417	12,480	NA
5664-301F	VM/IS General Language Support Routines ("PL/1")				
	Graduated Charge: Processor Group 20	NA	37	775	NA
	Graduated Charge: Processor Group 30	NA	37	1,100	NA
5664-322	INFO/Mgt Information/Management Version 3; for VM/SP				
	Graduated Charge: Processor Group 20	NA	500	7,700	44
	Graduated Charge: Processor Group 30	NA	500	11,000	44
5664-323	INFO/Sys Information/System Version 3; for VM/SP				
	Graduated Charge: Processor Group 20	NA	450	7,000	52
	Graduated Charge: Processor Group 30	NA	450	10,000	52

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Utilities, Installation Management, Performance Analysis (Continued)

		Initial Basic License Charge ($)	Monthly Basic* License Charge ($)	Graduated Onetime Charge ($)	Licensed Program Support Charge ($)
5664-364	VM Batch Facility				
	Graduated Charge: Processor Group 20	NA	150	3,150	NA
	Graduated Charge: Processor Group 30	NA	150	4,500	NA
5665-XA2	Data Facility Product Version 2 Release 3; for MVS/XA				
	Graduated Charge: Processor Group 20	NA	1,025	30,750	342
	Graduated Charge: Processor Group 30	NA	1,025	30,750	342
5665-266	INFO/Access Information Access Version 3; for MVS/370, MVS/XA				
	Graduated Charge: Processor Group 20	NA	800	24,000	NA
	Graduated Charge: Processor Group 30	NA	800	24,000	NA
5665-274	RMF Resource Measurement Facility Version 3 Release 5; for MVS/370, MVS/XA				
	Graduated Charge: Processor Group 20	2,250	750	24,375	67
	Graduated Charge: Processor Group 30	2,250	750	24,375	67
5665-294	Library/MVS; for MVS/370, MVS/XA	399	146	NA	NA
5665-295	DFP Data Facilities Product Version 1 Release 1.0; for MVS/370, MVS/XA	1,590	600	NA	186
5665-371	OPC/A Operations Planning and Control/Advanced Event Manager Subsystem Version 1; for MVS/370, MVS/XA				
	Graduated Charge: Processor Group 20	NA	820	18,000	NA
	Graduated Charge: Processor Group 30	NA	820	18,000	NA
5665-372	OPC/A Operations Planning and Control/Advanced Production Control System Version 1; for MVS/370, MVS/XA				
	Graduated Charge: Processor Group 20	NA	2,270	50,000	NA
	Graduated Charge: Processor Group 30	NA	2,270	50,000	NA
5665-373	OPC/A Operations Planning and Control/Advanced Network Event Communicator Version 1; for MVS/370, MVS/XA				
	Graduated Charge: Processor Group 20	NA	980	21,600	NA
	Graduated Charge: Processor Group 30	NA	980	21,600	NA
5665-383	INFO/Mgt Information/Management Version 3; for MVS/370, MVS/XA				
	Graduated Charge: Processor Group 20	NA	500	11,000	58
	Graduated Charge: Processor Group 30	NA	500	11,000	58
5665-384	INFO/Sys Information/System Version 3; for MVS/370, MVS/XA				
	Graduated Charge: Processor Group 20	NA	450	10,000	49
	Graduated Charge: Processor Group 30	NA	450	10,000	49
5665-397	Service Level Reporter Version 3; for MVS/370, MVS/XA				
	Graduated Charge: Processor Group 20	2,000	100	3,265	120
	Graduated Charge: Processor Group 30	2,000	100	3,265	120
5665-950	INFO/Access; for MVS/370, MVS/XA	3,300	362	NA	28
5666-273	VSE/POWER Version 2 Release 3; for VSE				
	Graduated Charge: Processor Group 20	498	166	2,710	33
	Graduated Charge: Processor Group 30	498	166	3,875	33
5668-002	DASD Migration Aid Release 1.1; for MVS/370, MVS/XA, VS1				
	Graduated Charge: Processor Group 20	NA	NA	1,450	19
	Graduated Charge: Processor Group 30	NA	NA	1,450	19
5668-006	Downstream Load Utility/8775; for VSE, VS1, MVS/370, MVS/XA	NA	124	NA	7
5668-722	DITTO Data Interfile Transfer, Testing, and Operations Utility Version 2 Release 1; for VSE, VM/SP				
	Graduated Charge: Processor Group 20	NA	82	1,720	NA
	Graduated Charge: Processor Group 30	NA	82	1,720	NA
5668-897	INFO Center/1 Release 1.1; for VM/SP, MVS/370, MVS/XA				
	Graduated Charge: Processor Group 20	NA	1,390	15,400	NA
	Graduated Charge: Processor Group 30	NA	1,390	22,000	NA
5668-917	DITTO Data Interfile Transfer Test and Operations Utility; for VSE, VM/SP				
	Graduated Charge: Processor Group 20	231	94	935	7
	Graduated Charge: Processor Group 30	231	94	1,340	7
5668-919	INFO/VM-VSE Information/MVS; for VM/SP, MVS/370, MVS/XA, VSE	NA	150	NA	91
5668-949	SMP/E System Modification Program/Extended; for VS1, MVS/370, MVS/XA	1,920	380	NA	97
5668-966	SLR Service Level Reporter; for VS1, MVS/370, MVS/XA				
	Graduated Charge: Processor Group 20	2,130	815	NA	99
	Graduated Charge: Processor Group 30	2,130	815	99	99
5668-997	CDPF Composed Document Printing Facility; for VM/SP, MVS/370, MVS/XA, VSE				
	Graduated Charge: Processor Group 20	NA	342	NA	49
	Graduated Charge: Processor Group 30	NA	342	49	49
5740-SM1	DF SORT Data Facility Sort; for MVS/370, MVS/XA, VS1	NA	247	NA	19
5740-XT9	OPC Installation Management/Operations Planning and Control; for MVS/370, MVS/XA, VS1				
	Graduated Charge: Processor Group 20	NA	1,745	38,390	NA
	Graduated Charge: Processor Group 30	NA	1,745	38,390	NA
5740-XXH	RACF Resource Access Control Facility Version 1 Release 7; for MVS/370, MVS/XA, VM/SP (with 5767 VM/RACF PRPQ)				
	Graduated Charge: Processor Group 20	NA	841	25,230	43
	Graduated Charge: Processor Group 30	NA	841	25,230	43
5740-XXH	RACF Resource Access Control Facility Version 1 Release 7; for VM only				
	Graduated Charge: Processor Group 20	—	—	14,595	—
	Graduated Charge: Processor Group 30	—	—	20,850	—

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	Utilities, Installation Management, Performance Analysis (Continued)	Initial Basic License Charge ($)	Monthly Basic* License Charge ($)	Graduated Onetime Charge ($)	Licensed Program Support Charge ($)
5740-XY4	RMF Resource Measurement Facility Version 2 Release 4; for MVS/370	NA	406	NA	17
5746-SM2	Sort/Merge Version 2 Release 5; for VSE, VM/SP	NA	108	NA	14
5746-XE7	VSE/Access Control Logging and Reporting; for VSE				
	Graduated Charge: Processor Group 20	NA	63	2,360	24
	Graduated Charge: Processor Group 30	NA	63	2,360	24
5787-MVS	MVS Migration System (from VSE); for MVS/370, MVS/XA				
	Graduated Charge: Processor Group 20	NA	NA	65,000	NA
	Graduated Charge: Processor Group 30	NA	NA	65,000	NA
5796-PLQ	VSE/PT Performance Tool; for VSE				
	Graduated Charge: Processor Group 20	NA	285	6,300	NA
	Graduated Charge: Processor Group 30	NA	285	6,300	NA
5796-PNA	VM/RTM Real Time Monitor; for VM/SP				
	Graduated Charge: Processor Group 20	NA	50	700	NA
	Graduated Charge: Processor Group 30	NA	50	1,000	NA
5798-BDW	CMS SORT and Extensions; for VM/SP				
	Graduated Charge: Processor Group 20	NA	NA	1,025	NA
	Graduated Charge: Processor Group 30	NA	NA	1,025	NA
5798-CQQ	GTFPARS Generalized Trace Facility/Performance Analysis; for VS1, MVS/370, MVS/XA				
	Graduated Charge: Processor Group 20	NA	94	2,310	NA
	Graduated Charge: Processor Group 30	NA	94	2,310	NA
5798-DAA	DOS/GPAR Generalized Performance Analysis Reporting; for VSE				
	Graduated Charge: Processor Group 20	NA	66	1,365	NA
	Graduated Charge: Processor Group 30	NA	66	1,365	NA
5798-DPH	JCL Conversion Aid; for VSE, MVS/370, MVS/XA				
	Graduated Charge: Processor Group 20	NA	500	11,000	NA
	Graduated Charge: Processor Group 30	NA	500	11,000	NA
5798-DWD	VM/XA RTM/SF Realtime Monitor/Systems Facility Version 2; for VM/XA				
	Graduated Charge: Processor Group 20	NA	NA	7,500	NA
	Graduated Charge: Processor Group 30	NA	NA	7,500	NA
	Languages and Language-Specific Programming Aids				
5665-433	Algorithm Generation Language Version 2; for MVS/370, SRTOS				
	Graduated Charge: Processor Group 20	NA	NA	11,000	NA
	Graduated Charge: Processor Group 30	NA	NA	11,000	NA
5665-948	BASIC; for MVS/370, MVS/XA	4,170	695	NA	42
5668-786	COBOL Structuring Facility; for MVS/370, MVS/XA, VS1, VM/SP				
	Graduated Charge: Processor Group 20	NA	12,500	125,000	NA
	Graduated Charge: Processor Group 30	NA	12,500	125,000	NA
5668-805	FORTRAN (VS) Library only Version 2 Release 2; for MVS/370, MVS/XA, VM/XA, VM/SP				
	Graduated Charge: Processor Group 20	NA	200	4,200	NA
	Graduated Charge: Processor Group 30	NA	200	6,000	NA
5668-806	FORTRAN (VS) Compiler, Library and Debug Version 2 Release 2; for MVS/370, MVS/XA, VM/SP, VM/XA				
	Graduated Charge: Processor Group 20	NA	750	15,750	NA
	Graduated Charge: Processor Group 30	NA	750	22,500	NA
5668-864	FORTRAN Language Conversion Program; for MVS/370, MVS/XA, VM/SP, VM/XA				
	Graduated Charge: Processor Group 20	NA	NA	28,000	NA
	Graduated Charge: Processor Group 30	NA	NA	28,000	NA
5668-899	APL2 Release 2.0; for MVS/370, VS1, MVS/XA, VM/IS, VM/SP				
	Graduated Charge: Processor Group 20	4,170	695	9,800	37
	Graduated Charge: Processor Group 30	4,170	695	14,000	37
5668-903	FORTRAN IAD Interactive Debug Release 2; for VM/IS, VM/SP, VM/XA, MVS/370, MVS/XA				
	Graduated Charge: Processor Group 20	1,920	320	7,835	26
	Graduated Charge: Processor Group 30	1,920	320	11,195	26
5668-940	COBOL II (VS) Library only Version 1 Release 2; for MVS/370, MVS/XA, VS1, VM/SP, VM/XA				
	Graduated Charge: Processor Group 20	2,550	425	10,410	53
	Graduated Charge: Processor Group 30	2.550	425	14,870	53
5668-958	COBOL II (VS) Compiler and Library Version 1 Release 2; for MVS/370, VS1, MVS/XA, VM/SP, VM/XA				
	Graduated Charge: Processor Group 20	6,420	1,070	26,210	53
	Graduated Charge: Processor Group 30	6,420	1,070	37,445	53
5668-962	Assembler H Version 2 Release 1; for VM/SP, VM/XA, VS1, MVS/370, MVS/XA, TPF2	465	155	NA	7
5668-996	BASIC/VM Release 2; for VM/IS, VM/SP				
	Graduated Charge: Processor Group 20	1,125	375	4,900	38
	Graduated Charge: Processor Group 30	1,125	375	7,000	38

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Language and Language-Specific Programming Aids (Continued)		Initial Basic License Charge ($)	Monthly Basic* License Charge ($)	Graduated Onetime Charge ($)	Licensed Program Support Charge ($)
5713-AAG	C for System/370; for MVS/370, MVS/XA				
	Graduated Charge: Processor Group 20	NA	313	5,000	NA
	Graduated Charge: Processor Group 30	NA	313	5,000	NA
5713-AAH	C for System/370; for VM/SP, VM/XA				
	Graduated Charge: Processor Group 20	NA	313	5,000	NA
	Graduated Charge: Processor Group 30	NA	313	5,000	NA
5713-AAR	Development System for the Ada Language; for MVS/370, MVS/XA				
	Graduated Charge: Processor Group 20	NA	1,875	30,000	NA
	Graduated Charge: Processor Group 30	NA	1,875	30,000	NA
5713-AAT	Development System for the Ada Language; for VM/SP				
	Graduated Charge: Processor Group 20	NA	1,565	25,000	NA
	Graduated Charge: Processor Group 30	NA	1,565	25,000	NA
5734-CB4	COBOL Interactive Debug; for MVS/370, MVS/XA, VS1, VM/SP				
	Graduated Charge: Processor Group 20	NA	375	7,875	NA
	Graduated Charge: Processor Group 30	NA	375	11,250	NA
5734-CP1	COBOL Prompter (TSO); for MVS/370, MVS/XA, TSO	NA	38	NA	7
5734-CP2	Assembler Prompter (TSO); for MVS/370, MVS/XA, TSO				
	Graduated Charge: Processor Group 20	NA	29	1,200	NA
	Graduated Charge: Processor Group 30	NA	29	1,200	NA
5734-CP3	FORTRAN Prompter (TSO); for MVS/370, TSO, MVS/XA				
	Graduated Charge: Processor Group 20	NA	32	1,200	NA
	Graduated Charge: Processor Group 30	NA	32	1,200	NA
5734-LM4	PL/I Resident Library Only Release 5.1; for VM/IS, VM/SP, VM/XA, MVS/370, VS1, MVS/XA				
	Graduated Charge: Processor Group 20	NA	64	1,340	7
	Graduated Charge: Processor Group 30	NA	64	1,920	7
5734-LM5	PL/I Transient Library Only Release 5.1; for VM/SP, VM/XA, MVS/370, VS1, MVS/XA				
	Graduated Charge: Processor Group 20	NA	37	775	7
	Graduated Charge: Processor Group 30	NA	37	1,110	7
5734-PL1	PL/I Optimizing Compiler and Libraries, R.5.1; for VM/SP, VM/XA, MVS/370, VS1, MVS/XA				
	Graduated Charge: Processor Group 20	NA	296	6,215	39
	Graduated Charge: Processor Group 30	NA	296	8,880	39
5734-PL2	PL/I Checkout Compiler; for VM/SP, VS1, MVS/370	NA	575	NA	7
5734-PL3	PL/I Optimizing Compiler Only R.5.1; for VM/SP, VM/XA, MVS/370, VS1, MVS/XA, TPF2				
	Graduated Charge: Processor Group 20	NA	398	8,355	53
	Graduated Charge: Processor Group 30	NA	398	11,940	53
5736-LM4	PL/I Resident Library Only Release 5.1; for VM/SP, VSE				
	Graduated Charge: Processor Group 20	NA	58	1,215	7
	Graduated Charge: Processor Group 30	NA	58	1,740	7
5736-LM5	PL/I Transient Library Only Release 5.1; for VM/SP, VSE				
	Graduated Charge: Processor Group 20	NA	34	710	7
	Graduated Charge: Processor Group 30	NA	34	1,020	7
5736-PL1	PL/I Optimizing Compiler and Libraries; for VM/SP, VSE				
	Graduated Charge: Processor Group 20	NA	251	5,270	39
	Graduated Charge: Processor Group 30	NA	251	7,530	39
5736-PL3	PL/I Optimizing Compiler Only; for VM/SP, VSE				
	Graduated Charge: Processor Group 20	NA	344	7,220	53
	Graduated Charge: Processor Group 30	NA	344	10,320	53
5740-CB1	COBOL (VS) Compiler and Library; for MVS/370, MVS/XA, VS1, VM/SP				
	Graduated Charge: Processor Group 20	NA	365	7,665	15
	Graduated Charge: Processor Group 30	NA	365	10,950	15
5740-LM1	COBOL (VS) Library Only; for MVS/370, MVS/XA, VS1, VM/SP				
	Graduated Charge: Processor Group 20	NA	118	2,475	7
	Graduated Charge: Processor Group 30	NA	118	3,540	7
5740-RG1	RPG II Report Program Generator; for MVS/370, VS1	663	221	NA	13
5746-CB1	COBOL (DOS/VS) Compiler and Library; for VSE, VM/SP				
	Graduated Charge: Processor Group 20	NA	184	3,860	15
	Graduated Charge: Processor Group 30	NA	184	5,520	15
5746-LM4	COBOL (DOS/VS) Library Only; for VSE, VM/SP				
	Graduated Charge: Processor Group 20	NA	33	690	7
	Graduated Charge: Processor Group 30	NA	33	990	7
5746-RG1	RPG II Report Program Generator; for VSE				
	Graduated Charge: Processor Group 20	NA	160	3,360	7
	Graduated Charge: Processor Group 30	NA	160	4,800	7
5748-F03	FORTRAN (VS) Compiler, Library Release 4.1; for VSE, VS1, MVS/370, MVS/XA, VM/IS, VM/SP				
	Graduated Charge: Processor Group 20	747	249	5,660	18
	Graduated Charge: Processor Group 30	747	249	8,090	18

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Language and Language-Specific Programming Aids (Continued)		Initial Basic License Charge ($)	Monthly Basic* License Charge ($)	Graduated Onetime Charge ($)	Licensed Program Support Charge ($)
5785-ABH	PROLOG Programming In Logic; for VM/SP				
	Graduated Charge: Processor Group 20	NA	NA	8,000	NA
	Graduated Charge: Processor Group 30	NA	NA	8,000	NA
5785-ABJ	COBOL/CICS/VS to COBOL II Command Level Conversion Aid; for MVS/370, MVS/XA				
	Graduated Charge: Processor Group 20	NA	350	7,000	NA
	Graduated Charge: Processor Group 30	NA	350	7,000	NA
5796-PNQ	Pascal/VS Release 2.2; for VM/IS, VM/SP, MVS/370, VS1				
	Graduated Charge: Processor Group 20	NA	247	4,410	NA
	Graduated Charge: Processor Group 30	NA	247	6,300	NA
5796-PWA	INTELLECT for DOS/CICS-SQL/DS; for VSE				
	Graduated Charge: Processor Group 20	NA	2,245	42,000	NA
	Graduated Charge: Processor Group 30	NA	2,245	42,000	NA
5796-PWC	INTELLECT for MVS/VSAM; for MVS/370, MVS/XA				
	Graduated Charge: Processor Group 20	NA	3,050	57,000	NA
	Graduated Charge: Processor Group 30	NA	3,050	57,000	NA
5796-PWE	INTELLECT for VM-VSAM; for VM/SP				
	Graduated Charge: Processor Group 20	NA	3,050	57,000	NA
	Graduated Charge: Processor Group 30	NA	3,050	57,000	NA
5796-PWJ	General CICS/VS ADA				
	Graduated Charge: Processor Group 20	NA	NA	12,100	NA
	Graduated Charge: Processor Group 30	NA	NA	12,100	NA
5796-PYH	INTELLECT for VM-SQL/DS; for VM/SP				
	Graduated Charge: Processor Group 20	NA	3,050	57,000	NA
	Graduated Charge: Processor Group 30	NA	3,050	57,000	NA
5798-DFH	FORTRAN Utilities Version 2.2.; for VM/IS, VM/SP, VM/XA				
	Graduated Charge: Processor Group 20	NA	NA	1,100	NA
	Graduated Charge: Processor Group 30	NA	NA	1,575	NA
5798-DQZ	LISP/VM List Processing; for VM/SP				
	Graduated Charge: Processor Group 20	NA	325	7,150	NA
	Graduated Charge: Processor Group 30	NA	325	7,150	NA
5798-DXJ	FORTRAN (VS) Execution Analyzer; for MVS/370, MVS/XA, VM/SP				
	Graduated Charge: Processor Group 20	NA	NA	12,500	NA
	Graduated Charge: Processor Group 30	NA	NA	12,500	NA
5798-RWP	Expert System Consultation Environment/VM; for VM/SP				
	Graduated Charge: Processor Group 20	NA	1,250	25,000	NA
	Graduated Charge: Processor Group 30	NA	1,250	25,000	NA
5798-RWQ	Expert System Development Environment/VM; for VM/SP				
	Graduated Charge: Processor Group 20	NA	1,750	35,000	NA
	Graduated Charge: Processor Group 30	NA	1,750	35,000	NA
Data Base Management and File Handling					
5664-189	STAIRS Storage and Information Retrieval System; for VM/SP	1,650	575	NA	NA
5664-327	CMS Servers; for VM/SP				
	Graduated Charge: Processor Group 20	NA	850	17,850	NA
	Graduated Charge: Processor Group 30	NA	850	25,500	NA
5664-329	Contextual File Search/370; for VM/SP				
	Graduated Charge: Processor Group 20	NA	295	6,500	NA
	Graduated Charge: Processor Group 30	NA	295	6,500	NA
5665-292	QMF Query Management Facility; for MVS/370, MVS/XA				
	Graduated Charge: Processor Group 20	NA	NA	25,000	23
	Graduated Charge: Processor Group 30	NA	NA	25,000	23
5665-327	DFDSS Data Facility/Data Set Services Version 2 Release 2; for MVS/370, MVS/XA				
	Graduated Charge: Processor Group 20	NA	215	6,450	38
	Graduated Charge: Processor Group 30	NA	215	6,450	38
5665-329	DFHSM Data Facility Hierarchical Storage Manager Version 2 Release 2.1; for MVS/370, MVS/XA				
	Graduated Charge: Processor Group 20	NA	800	24,000	141
	Graduated Charge: Processor Group 30	NA	800	24,000	141
5665-332	IMS/VS Information Management System Version 2 Release 2; for MVS/370, MVS/XA				
	Graduated Charge: Processor Group 20	NA	3,900	117,000	825
	Graduated Charge: Processor Group 30	NA	3,900	117,000	825
5665-348	IMSADF II IMS Application Development Facility; for MVS/370, MVS/XA				
	Graduated Charge: Processor Group 20	NA	2,750	54,890	200
	Graduated Charge: Processor Group 30	NA	2,750	54,890	200
5665-354	DB2 Performance Monitor; for MVS/370, MVS/XA				
	Graduated Charge: Processor Group 20	NA	975	29,000	NA
	Graduated Charge: Processor Group 30	NA	975	29,000	NA

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Data Base Management and File Handling (Continued)

		Initial Basic License Charge ($)	Monthly Basic* License Charge ($)	Graduated Onetime Charge ($)	Licensed Program Support Charge ($)
5665-396	TSO/E Servers; for MVS/370, MVS/XA				
	Graduated Charge: Processor Group 20	NA	1,350	40,500	NA
	Graduated Charge: Processor Group 30	NA	1,350	40,500	NA
5668-788	DXT Data Extract Version 2 Release 1; for MVS/370, MVS/XA, VM/SP				
	Graduated Charge: Processor Group 20	NA	300	6,300	NA
	Graduated Charge: Processor Group 30	NA	300	9,000	NA
5668-937	IMS ADF II Application Development Facility; for MVS/370, MVS/XA	3,950	1,315	NA	214
5740-UT3	DFDSS Data Facility/Data Set Services Version 1 Release 2.0; for MVS/370, MVS/XA, VS1	NA	88	NA	40
5740-XR1	STAIRS Storage and Information Retrieval System; for MVS/370, MVS/XA, VS1				
	Graduated Charge: Processor Group 20	NA	1,280	28,160	NA
	Graduated Charge: Processor Group 30	NA	1,280	28,160	NA
5740-XXF	DB/DC Data Dictionary Release 6; for VS1, MSV/370, MVS/XA				
	Graduated Charge: Processor Group 20	NA	1,110	15,000	115
	Graduated Charge: Processor Group 30	NA	1,110	15,000	115
5740-XX2	IMS/VS Information Management System Version 1 Release 3.0; for MVS/370, MVS/XA, VS1				
	Graduated Charge: Processor Group 20	NA	2,593	77,790	240
	Graduated Charge: Processor Group 30	NA	2,593	77,790	240
5740-XYF	DB/DC Dictionary; for MVS/370, MVS/XA, VS1				
	Graduated Charge: Processor Group 20	NA	349	7,675	50
	Graduated Charge: Processor Group 30	NA	349	7,675	50
5740-XYR	DB2 Database 2; for MVS/XA, MVS/370				
	Graduated Charge: Processor Group 20	16,050	2,675	93,625	374
	Graduated Charge: Processor Group 30	16,050	2,675	93,625	374
5746-AM2	VSE/VSAM Virtual Sequential Access Method Release 3.0; for VM/SP, VSE				
	Graduated Charge: Processor Group 20	NA	82	1,215	24
	Graduated Charge: Processor Group 30	NA	82	1,735	24
5746-XR4	STAIRS Storage and Information Retrieval System; for VSE				
	Graduated Charge: Processor Group 20	NA	1,045	22,990	NA
	Graduated Charge: Processor Group 30	NA	1,045	22,990	NA
5746-XX1	DL/I Data Language I Version 1 Release 7; for VSE	NA	459	NA	149
5748-XXC	VM/IFS Interactive File Sharing; for VM/SP	NA	52	NA	16
5748-XXJ	SQL/DS Structured Query Language/Data System Release 3.5; for VM/IS, VM/SP, VSE				
	Graduated Charge: Processor Group 20	NA	464	9,740	144
	Graduated Charge: Processor Group 30	NA	464	13,920	144
5796-ATP	IMS Message Requeueing; for MVS/370, MVS/XA				
	Graduated Charge: Processor Group 20	NA	154	4,950	NA
	Graduated Charge: Processor Group 30	NA	154	4,950	NA
5798-CHJ	IMSASAP II; for MVS/370, MVS/XA, VS1				
	Graduated Charge: Processor Group 20	NA	165	3,675	NA
	Graduated Charge: Processor Group 30	NA	165	3,675	NA
5798-CQP	IMSPARS; for MVS/370, MVS/XA, VS1				
	Graduated Charge: Processor Group 20	NA	203	4,155	NA
	Graduated Charge: Processor Group 30	NA	203	4,155	NA
5798-DLL	Data Base Edit Facility; for VM/IS, VM/SP, MVS/370, MVS/XA				
	Graduated Charge: Processor Group 20	NA	NA	4,235	NA
	Graduated Charge: Processor Group 30	NA	NA	6,050	NA
5798-DQL	Relational Design Tool; for VM/SP, VSE				
	Graduated Charge: Processor Group 20	NA	NA	4,400	NA
	Graduated Charge: Processor Group 30	NA	NA	4,400	NA
5798-DZP	DXTA Data Extract Assist Tool				
	Graduated Charge: Processor Group 20	NA	NA	7,000	NA
	Graduated Charge: Processor Group 30	NA	NA	7,000	NA

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5662-262	TPNS Teleprocessing Network Simulator Version 2 Release 3.0; for VM/SP, MVS/XA, MVS/370	NA	1,875	NA	NA
5664-175	NCCF Network Comm. Control Facility Version 2; for VM/SP	1,920	320	NA	33
5664-183	3270 Display Option; for VM/XA	2,400	800	NA	42
5664-188	RSCS Networking Version 2 Release 2; for VM/IS, VM/SP				
	Graduated Charge: Processor Group 20	NA	337	6,300	38
	Graduated Charge: Processor Group 30	NA	337	6,300	38
5664-190	NPDA Network Problem Determination Application Version 3 Release 2.0; for VM/SP	1,350	225	NA	20
5664-202	NETDA Network Design and Analysis; for VM/SP				
	Graduated Charge: Processor Group 20	NA	750	15,000	NA
	Graduated Charge: Processor Group 30	NA	750	15,000	NA

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		Initial Basic License Charge ($)	Monthly Basic* License Charge ($)	Graduated Onetime Charge ($)	Licensed Program Support Charge ($)
5664-204	NetView; for VM/SP				
	Graduated Charge: Processor Group 20	NA	940	19,740	90
	Graduated Charge: Processor Group 30	NA	940	28,200	90
5664-280	ACF/VTAM Virtual Telecomm. Access Method Version 3 Release 2; for VM/SP				
	Graduated Charge: Processor Group 20	3,525	1,175	19,660	247
	Graduated Charge: Processor Group 30	3,525	1,175	28,090	247
5664-281	3270 PC File Transfer Version 1.0 for VM/IS, VM/SP				
	Graduated Charge: Processor Group 20	NA	NA	600	NA
	Graduated Charge: Processor Group 30	NA	NA	600	NA
5664-289	ACF/SSP System Support Program Version 3 Release 1.0; for VM/IS, VM/SP	960	320	NA	44
5664-298	PC Bond: PC Connectivity to VM, Release 2.0; for VM/IS, VM/SP				
	Graduated Charge: Processor Group 20	NA	107	2,000	NA
	Graduated Charge: Processor Group 30	NA	107	NA	NA
5664-315	FTP File Transfer Program Version 2 Release 2.0; for VM/SP only				
	Graduated Charge: Processor Group 20	NA	450	7,875	NA
	Graduated Charge: Processor Group 30	NA	450	11,250	NA
5664-319	VM/PC Host Server for VM/IS, VM/SP				
	Graduated Charge: Processor Group 20	NA	135	2,000	NA
	Graduated Charge: Processor Group 30	NA	135	2,000	NA
5665-279	BTAM/SP Basic Telecommunications Access Method/System Product; for MVS/XA, MVS/370				
	Graduated Charge: Processor Group 20	NA	NA	5,950	13
	Graduated Charge: Processor Group 30	NA	NA	5,950	13
5665-285	TSO/E TSO Extensions Release 3				
	For MVS/370				
	Graduated Charge: Processor Group 20	1,500	500	17,900	87
	Graduated Charge: Processor Group 30	1,500	500	17,900	87
	For MVS/XA				
	Graduated Charge: Processor Group 20	1,500	555	17,900	108
	Graduated Charge: Processor Group 30	1,500	555	17,900	108
5665-288	OCCF/MVS Operator Console Communications Facility; for MVS/370, MVS/XA	1,050	350	NA	8
5665-289	ACF/VTAM Virtual Telecomm. Access Method Version 3 Release 2; for MVS/XA				
	Graduated Charge: Processor Group 20	6,255	2,085	67,760	302
	Graduated Charge: Processor Group 30	6,255	2,085	67,760	302
5665-313	ACF/VTAM Virtual Telecomm. Access Method Version 3 Release 2; for MVS/370	5,130	1,710	NA	275
5665-314	ACF/TCAM Telecommunications Access Method Version 3; for MVS/370, MVS/XA only	8,025	2,675	NA	330
5665-316	NCCF Network Comm. Control Facility Version 2 Release 2.0; for MVS/XA (31-bit mode)	2,730	455	NA	66
5665-321	NPDA Network Problem Determination Application Version 3 Release 2; for MVS/XA (31-bit)	2,040	340	NA	30
5665-333	NPM NetView Performance Monitor; for MVS/370, MVS/XA	3,210	615	NA	57
5665-338	ACF/SSP System Support Program Version 3 Release 3.0; for MVS/370, MVS/XA	1,605	535	NA	71
5665-345	SAMON SNA Applications Monitor; for MVS/370, MVS/XA				
	Graduated Charge: Processor Group 20	NA	NA	9,000	NA
	Graduated Charge: Processor Group 30	NA	NA	9,000	NA
5665-361	NetView; for MVS/370	NA	1,060	NA	124
5665-362	NetView; for MVS/XA				
	Graduated Charge: Processor Group 20	NA	1,255	37,650	128
	Graduated Charge: Processor Group 30	NA	1,255	37,650	128
5665-403	CICS/MVS Version 2 Release 1; for MVS/XA				
	Graduated Charge: Processor Group 20	NA	2,485	74,550	NA
	Graduated Charge: Processor Group 30	NA	2,485	74,550	NA
5665-411	DTNL Direct Telecommunication Network Link/CICS; for MVS/370, MVS/XA				
	Graduated Charge: Processor Group 20	NA	1,250	25,000	NA
	Graduated Charge: Processor Group 30	NA	1,250	25,000	NA
5665-412	DTNL Direct Telecommunication Network Link/IMS; for MVS/370, MVS/XA				
	Graduated Charge: Processor Group 20	NA	1,500	30,000	NA
	Graduated Charge: Processor Group 30	NA	1,500	30,000	NA
5665-463	CICS/DDM Distributed Data Management Target; for MVS/370, MVS/XA				
	Graduated Charge: Processor Group 20	NA	NA	4,000	NA
	Graduated Charge: Processor Group 30	NA	NA	4,000	NA
5666-280	ACF/VTAM Virtual Telecomm. Access Method Version 3 Release 2; for VSE				
	Graduated Charge: Processor Group 20	963	321	7,300	59
	Graduated Charge: Processor Group 30	963	321	10,430	59
5666-284	VSE/DSNX Distributed Systems Node Executive Version 1 Release 2; for VSE				
	Graduated Charge: Processor Group 20	NA	253	3,800	41
	Graduated Charge: Processor Group 30	NA	253	3,800	41

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		Initial Basic License Charge ($)	Monthly Basic* License Charge ($)	Graduated Onetime Charge ($)	Licensed Program Support Charge ($)
5666-285	NCCF Network Comm. Control Facility Version 2 Release 2.0; for VSE				
	Graduated Charge: Processor Group 20	1,110	185	4,530	22
	Graduated Charge: Processor Group 30	1,110	185	6,470	22
5666-295	NPDA Network Problem Determination Application Version 3 Release 2; for VSE				
	Graduated Charge: Processor Group 20	825	132	3,250	16
	Graduated Charge: Processor Group 30	825	132	4,645	16
5666-322	ACF/SSP System Support Program Version 3 Release 2; for VSE	321	107	NA	27
5666-344	DTNL Direct Telecommunication Network Link; for VSE/CICS				
	Graduated Charge: Processor Group 20	NA	950	19,000	NA
	Graduated Charge: Processor Group 30	NA	950	19,000	NA
5668-754	ACF/NCP Network Control Program Subset, Version 4; for VM/SP, MVS/370, MVS/XA, VSE	NA	275	NA	48
5668-795	CICS/CMS Customer Information Control System; for VM/SP				
	Graduated Charge: Processor Group 20	NA	835	15,000	NA
	Graduated Charge: Processor Group 30	NA	835	15,000	NA
5668-815	Routing Table Generator; for MVS/370, MVS/XA, VM/SP				
	Graduated Charge: Processor Group 20	NA	300	6,600	NA
	Graduated Charge: Processor Group 30	NA	300	6,600	NA
5668-854	ACF/NCP Network Control Program Version 4 Release 2; for MVS/370, MVS/XA, VM/SP, VSE, VS1				
	Graduated Charge: Processor Group 20	NA	695	2,085	148
	Graduated Charge: Processor Group 30	NA	695	2,085	148
5668-915	DSX Distributed System Executive Version 3 Release 2.0; for MVS/370, MVS/XA, VSE	2,700	1,035	NA	88
5668-920	NPDA Network Problem Determination Application Version 3 Release 2.0; for MVS/370, MVS/XA	1,650	264	NA	22
5668-932	FTP File Transfer Program Version 2 Release 2.0; for MVS/370, MVS/XA, VM/SP, VSE				
	Graduated Charge: Processor Group 20	1,500	310	7,385	90
	Graduated Charge: Processor Group 30	1,500	310	10,550	90
5668-947	NCCF Network Comm. Control Facility Version 2 Release 2.0; for MVS/370, MVS/XA	2,250	375	NA	55
5668-948	BTS Batch Terminal Simulator; for MVS/370, MVS/XA, VS1	1,030	394	NA	28
5668-951	NSI Non-SNA Interconnect Release 4.0; for MVS/370, MVS/XA, VS1	1,605	465	NA	40
5668 963	NRF Network Routing Facility Release 2; for VS1, MVS/370, MVS/XA	3,525	1,175	NA	248
5668-971	NLDM Network Logical Data Manager Release 3.0; for MVS/370, MVS/XA	1,305	207	NA	24
5668-981	NPSI NCP X.25 Packet Switching Interface, Release 4.3; for MVS/370, MVS/XA, VS1, VSE	770	269	NA	40
5735-RC3	ACF/TCAM Telecommunications Access Method Version 2 Release 4.0; for VS1 as well as MVS/370, MVS/XA	2,420	874	NA	91
5735-XX7	NTO Network Terminal Option Release 3.0; for MVS/370, MVS/XA, VM/SP, VSE, VS1	660	206	NA	12
5735-XXB	EP Emulation Program Release 4.0; for VSE, MVS/370, VS1, VM/IS, VM/SP, MVS/XA	1,365	256	NA	40
5740-XX1	CICS/OS/VS Customer Information Control, Release 7.0; for MVS/370, MVS/XA				
	Graduated Charge: Processor Group 20	5,730	1,910	62,075	160
	Graduated Charge: Processor Group 30	5,730	1,910	62,075	160
5740-XYF	SDF/CICS Screen Definition Release 3.0; for MVS/370, MVS/XA	NA	349	7,675	50
5746-XC5	VSE/QCCF Operator Communications Control Facility; for VSE				
	Graduated Charge: Processor Group 20	NA	155	5,800	13
	Graduated Charge: Processor Group 30	NA	155	5,800	13
5746-XX3	CICS/DOS/VS Customr Information Control System Version 1 Release 7; for VSE				
	Graduated Charge: Processor Group 20	NA	686	14,405	149
	Graduated Charge: Processor Group 30	NA	686	20,580	149
5746-XXT	SDF/CICS VSE Screen Definition Facility Version 1 Release 5; for VSE				
	Graduated Charge: Processor Group 20	NA	243	5,345	44
	Graduated Charge: Processor Group 30	NA	243	5,345	44
5748-RC1	PVS VM Pass-Through Facility Release 3; for VM/IS, VM/SP, VM/XA				
	Graduated Charge: Processor Group 20	NA	185	3,000	90
	Graduated Charge: Processor Group 30	NA	185	3,000	90
5748-XP1	RSCS Networking Version 1 Release 3; for VM/SP, VM/XA	NA	111	NA	38
5798-DAB	CICSPARS Performance Analysis Reporting System; for VSE, MVS/370, MVS/XA				
	Graduated Charge: Processor Group 20	NA	94	1,785	NA
	Graduated Charge: Processor Group 30	NA	94	1,785	NA
5798-DFE	VTAMPARS II Performance Analysis Reporting System II; for VM/370, MVS/370, MVS/XA				
	Graduated Charge: Processor Group 20	504	198	5,570	NA
	Graduated Charge: Processor Group 30	504	198	5,570	NA
5798-DMJ	RSCS/SNA Extension to VM/SP Version 1 Release 3.0; for VM/SP				
	Graduated Charge: Processor Group 20	NA	NA	4,950	NA
	Graduated Charge: Processor Group 30	NA	NA	4,950	NA

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		Initial Basic License Charge ($)	Monthly Basic* License Charge ($)	Graduated Onetime Charge ($)	Licensed Program Support Charge ($)
5799-BZJ	XI X.25 SNA Interconnection PRPQ; for MVS/370, MVS.XA				
	Graduated Charge: Processor Group 20	NA	NA	37,200	NA
	Graduated Charge: Processor Group 30	NA	NA	37,200	NA
5799-CDX	NEF Network Extension Facility Version 2; for TPF2				
	Graduated Charge: Processor Group 20	NA	NA	70,000	NA
	Graduated Charge: Processor Group 30	NA	NA	70,000	NA

Departmental/Office System

5664-176	PROFS Professional Office System Version 1 Release 2.3; for VM/SP				
	Graduated Charge: Processor Group 20	5,000	895	22,000	NA
	Graduated Charge: Processor Group 30	5,000	895	22,000	NA
5664-309	PROFS with Applications Support Feature, Version 2 Release 2 for VM/IS, VM/SP				
	4574/4599 pricing features for PROFS: support up to 100 currently signed-on terminal users (CSTUs)				
	Graduated Charge: Processor Group 20	NA	995	22,400	NA
	Graduated Charge: Processor Group 30	NA	995	32,000	NA
	4630/4631 pricing features for PROFS: support more than 100 CSTUs; requires 4574/4599				
	Graduated Charge: Processor Group 20	NA	200	400	NA
	Graduated Charge: Processor Group 30	NA	200	10,000	NA
5664-370	DisplayWrite/370 Version 1 Release 1.1; for VM/IS, VM/SP				
	Graduated Charge: Processor Group 20	NA	665	9,800	42
	Graduated Charge: Processor Group 30	NA	665	14,000	42
5665-290	DISOSS Distributed Office Support System Version 3 Release 3; for MVS/370, MVS/XA				
	Graduated Charge: Processor Group 20	4,570	1,485	52,705	223
	Graduated Charge: Processor Group 30	4,570	1,485	52,705	223
5665-330	Personal Services/370 Release 2; for MVS/370, MVS/XA				
	Graduated Charge: Processor Group 20	2,400	800	28,400	132
	Graduated Charge: Processor Group 30	2,400	800	28,400	132
5665-346	Personal Services/TSO; for MVS/370, MVS/XA				
	Graduated Charge: Processor Group 20	NA	1,200	36,000	NA
	Graduated Charge: Processor Group 30	NA	1,200	36,000	NA
5665-382	DisplayWrite/370 Version 1 Release 1.1; for MVS/370, MVS/XA				
	Graduated Charge: Processor Group 20	NA	665	14,000	42
	Graduated Charge: Processor Group 30	NA	665	14,000	42
5666-270	DISOSS Distributed Office Support System Version 3 Release 3; for VSE	1,710	570	NA	176
5666-318	Personal Services/370 Release 2; for VSE	1,125	375	NA	99
5666-338	DisplayWrite/370 Version 1 Release 1.1; for VSE				
	Graduated Charge: Processor Group 20	NA	285	4,200	42
	Graduated Charge: Processor Group 30	NA	285	6,000	42
5666-339	Document Management Release 1.1; for VSE				
	Graduated Charge: Processor Group 20	NA	158	2,850	28
	Graduated Charge: Processor Group 30	NA	158	2,850	28
5740-XYL	ATMS Advanced Text Management System III; for MVS/370, MVS/XA, VS1				
	Graduated Charge: Processor Group 20	NA	1,155	25,410	NA
	Graduated Charge: Processor Group 30	NA	1,155	25,410	NA
5746-XXU	ATMS III Advanced Text Management System III; for VSE				
	Graduated Charge: Processor Group 20	NA	567	12,470	NA
	Graduated Charge: Processor Group 30	NA	567	12,470	NA
5748-XXE	DLF Document Library Facility; for VS1, VSE, MVS/370, MVS/XA	480	160	NA	NA
5748-XX9	DCF Document Composition Facility (SCRIPT/VS) Release 3.1; for VM/SP, VM/XA, VSE, MVS/370, MVS/XA				
	Graduated Charge: Processor Group 20	972	324	7,370	NA
	Graduated Charge: Processor Group 30	972	324	10,530	NA
5799-BKE	HDDI Host to Displaywriter Document Interchange Release 2.0 PRPQ; for VM/IS, VM/SP				
	Graduated Charge: Processor Group 20	1,165	265	6,240	NA
	Graduated Charge: Processor Group 30	1,165	265	8,920	NA ■