NAS AS/VL Series

MANAGEMENT SUMMARY

UPDATE: *National Advanced Systems (NAS) began delivering the first models of its new AS/VL Series of intermediate mainframes toward the end of last year. The product line, which features three single-processor systems and a dual-processor model, competes against the IBM 4381 Series of intermediate mainframes and the low end of the IBM 3090 Series of large-scale mainframes. Shortly after initial shipment, NAS announced the first round of product line enhancements. The IBM plug-compatible mainframe (PCM) vendor increased maximum real storage on all single processors, introduced an Expanded Memory option, and increased channel capacity. Maximum main memory limit on single processors went from 128 megabytes to 256 megabytes. Users can also configure systems with up to 192 megabytes of Expanded Memory and up to 32 channels.*

In the peripheral area, NAS has announced new disk technology that in some respects surpasses the new IBM 3380 triple-density product. In October 1987, NAS introduced the 7980 family of storage controllers and new 7380 Direct Access Storage Devices (DASDs) featuring a maximum triple-density capacity of 7.5 gigabytes, the same as the latest IBM offering.

To increase its presence within the growing engineering/scientific market, NAS introduced products that connect System/370-based NAS mainframes to VAX systems from Digital Equipment Corporation. In related areas, NAS is currently working with Sun Microsystems to develop a new operating system for NAS mainframes based on AT&T's UNIX.

The four-processor NAS AS/VL Series, which replaces the NAS AS/66X0 Series and AS/80X3 Series, is an intermediate processor line offered as a price/performance alternative to the IBM 4381 line of medium-scale mainframes.

MODELS: AS/VL 40, AS/VL 50, AS/VL 60, all single-processor models, and the AS/VL 80, a dyadic processor.
CONFIGURATION: One or two processors, 32 megabytes to 256 megabytes of main memory, and 8 to 32 channels.
COMPETITION: Amdahl 580 Series and low end of the Amdahl 5890 Series, Control Data 960 Series, Honeywell Bull DPS 8000, IBM 4381 Series and low end of the IBM 3090 Series, and Unisys A 10, A 12.
PRICE: Prices range from $638,000 for the entry-level AS/VL 40 to $2,156,00 for the dual-processor AS/VL 80.

CHARACTERISTICS

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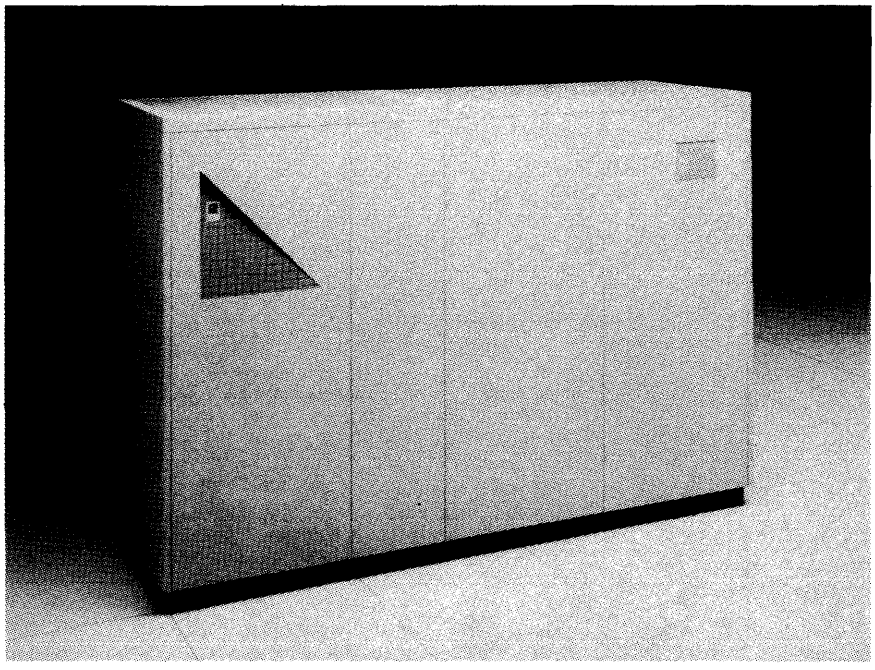
MODELS: AS/VL 40, AS/VL 50, AS/VL 60, all single-processor models, and the AS/VL 80, a dyadic processor.



The NAS AS/VL Series of intermediate mainframes features 32 to 256 megabytes of main memory and 8 to 32 channels. They are marketed as plug-compatible replacements for the IBM 4381 Series.

NAS AS/VL Series

NAS and its PCM rival, Amdahl Corporation, market hardware that is compatible with all the major IBM mainframe operating environments. For the last decade, PCMs have been trying to erode IBM market share by offering systems that have a 15 to 20 percent price/performance advantage over comparable IBM hardware. AS/VL Series intermediate-scale mainframes, obtained from Hitachi of Japan, were introduced in July 1987 in response to the introduction of new IBM 4381 systems earlier last year.

The NAS AS/VL Series consists of four models, the AS/VL 40, 50, and 60, all single-processor systems, and the AS/VL 80, a dyadic system. The processors are all field upgradable to the next largest processor in the series. NAS single-processor systems became available during the third quarter of 1987 while the top-end Model 80 became available during the fourth quarter. To date, the company has installed 10 systems in the U.S. and 50 systems internationally. More systems have been installed internationally because the systems were available earlier to overseas customers. The new models use 1-megabit, dynamic random access memory components and, except for the AS/VL 40, make use of high-speed Dynamic Work Storage (DWS), a memory facility positioned between buffer storage and main memory.

The NAS AS/VL Series replaces the medium-range NAS AS/66X0 Series and the NAS AS/80X3 Series, two model lines that competed against older models of the IBM 4381 Series, as well as the defunct IBM 308X Series. Both NAS systems are now out of production, but upgrades are still available. For 66X0 users, however, upgrades are limited.

The latest NAS product line has greater performance than the 66X0 Series and overlaps the performance of the 80X3 Series as well. The AS/VL 60 has 3.5 to 4.2 times the internal execution rate of an AS/6660 equipped with the High-Speed Arithmetic feature. The AS/VL 50 has 0.65 to 0.75 times the internal execution rate of the AS/VL 60 and the AS/VL 40 has 0.45 to 0.60 times the internal execution rate of the AS/VL 60. The AS/VL 80 has 1.7 to 1.9 times the performance of the AS/VL 60.

The new AS/VL line strengthens NAS' medium-scale product range and makes it more competitive with current IBM 4381 mainframes and the low end of the 3090 mainframe line. Performance now ranges from 5 million instructions per second (MIPS) for the AS/VL 40 to 17 MIPS for the AS/VL 80. This performance range overlaps the performance range of IBM 3090 Model 120E and 180E uniprocessors.

To regain an edge in the competitive PCM storage market, NAS plans to deliver its 7380K triple-density DASD during the third quarter of this year. The company first announced the NAS 7980 Controller and the Models 7380J and 7380K DASDs in October. These products are roughly equivalent to IBM's newest generation of controllers and DASDs, the 3990 storage controller and the 3380 Models J and K DASDs.

DATA FORMATS

All data formats, instruction formats, and other architectural features of the National Advanced Systems (NAS) processors have evolved from the IBM System/370 architecture, although the implementation may be different in ways that are transparent to the software. The most important element in defining the predominant personality of a series—and the range of operating systems it can support—is the processor mode microcode loaded at Initial Microprogram Load (IMPL or IML) time.

The AS/VL Series can support two modes, System/370 or 370 Extended Architecture (XA) modes. Both modes differ in the instruction set they support, in their address translation algorithms and associated virtual memory paging logic and capacity, and in their channel loading and channel addressing methods. Like the System/370, NAS AS/VL computers can operate in either the Basic Control (BC) mode or Extended Control (EC) mode. The BC mode maintains general upward compatibility with the System/360 architecture and programming, although changes in error recovery mean that S/360 operating systems can no longer run standalone, but must run under VM. In the EC mode, the Program Status Word (PSW) and the layout of the permanently assigned main storage area are altered to support Dynamic Address Translation and other system control functions; therefore, the virtual storage-oriented operating systems must be used.

BASIC UNIT: Eight-bit byte, due to byte-oriented instructions. However, the basic word orientation of the instruction set means there is a performance penalty if a byte is not on a word boundary. Each byte can represent one alphanumeric character, two BCD digits, or eight binary bits. Two consecutive bytes form a halfword of 16 bits, while four consecutive bytes form a 32-bit word.

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

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

INSTRUCTIONS: 2, 4, or 6 bytes in length, which usually specify zero, one, or two memory addresses, respectively. The basic System/370 mode in the low-end IBM and NAS architectures implements the 183 instructions of the System/370 Universal Instruction Set and adds instructions for handling extended precision (28 hexadecimal digits) floating-point operands on the AS/VL Series. The instruction sets for the 370 XA processor mode is a modified form of this core instruction set. Additional XA instructions are included, which substitute for and augment certain 370 instructions and which are primarily needed to fully exploit the redesigned I/O subsystem. Some of the standard and optional microcode assists in 370 mode, such as S/370 Extended Facility and ECPS:VM, also add microcoded instructions to the base set, but these just build on the personality that is established by the processor-mode microcode.

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

NAS AS/VL Series

TABLE 1. SYSTEM COMPARISON

MODEL	AS/VL 40	AS/VL 50	AS/VL 60	AS/VL 80
SYSTEM CHARACTERISTICS				
Date announced	July 1987	July 1987	July 1987	July 1987
Date first delivered	Third quarter 1987	Third quarter 1987	Third quarter 1987	Fourth quarter 1987
Field upgradable to	AS/VL 50	AS/VL 60	AS/VL 80	Not applicable
Relative performance	—	—	—	—
Number of processors	1	1	1	2
Cycle time, nanoseconds	NA	NA	NA	NA
Word size, bits	32	32	32	32
Operating systems	MVS/SP, MVS/XA, VM/SP, VM/SF, VM/XA	MVS/SP, MVS/XA, VM/SP, VM/SF, VM/XA	MVS/SP, MVS/XA, VM/SP, VM/SF, VM/XA	MVS/SP, MVS/XA, VM/SP, VM/SF, VM/XA
MAIN MEMORY				
Type	1-megabit MOS	1-megabit MOS	1-megabit MOS	1-megabit MOS
Minimum capacity, bytes	32M	32M	32M	32M
Maximum capacity, bytes	256M	256M	256M	256M
Increment size, bytes	32M	32M	32M	32M
Cycle time, nanoseconds	120	120	120	120
BUFFER STORAGE				
Minimum capacity	32KB	32KB	64KB	128KB
Maximum capacity	32KB	32KB	64KB	128KB
Increment size	—	—	—	—
INPUT/OUTPUT CONTROL				
Number of channels:				
Byte multiplexer	4 to 8	4 to 8	4 to 8	4 to 8
Block multiplexer	8 to 32	8 to 32	8 to 32	8 to 32
Word	0	0	0	0
Other	0	0	0	0

NA—Information not available from vendor.

The NAS 7380 Model K disk storage unit contains eight Head Disk Assemblies (HDAs) per cabinet, compared to four HDAs for competing products in this class. Storage capacity per HDA is now 1.89 gigabytes and total capacity per cabinet is now 7.5 gigabytes. Average seek time is 12.5 milliseconds, compared to 17.6 milliseconds for older NAS DASDs. NAS revealed in March that it was able to improve access time by using 9.5-inch platters rather than the industry-standard 14-inch platters. The NAS Model J features up to 2.5 gigabytes of storage and is field-upgradable to the Model K. NAS has thus far released few other details about the new DASDs.

The NAS 7980 Controller, introduced with the new DASDs, comes in three field-upgradable models, the 7980-1, the 7980-2, and the 7980-3C. Similar to IBM and Amdahl models, the NAS controller family features a maximum data transfer rate of 4.5 megabytes per second and quad port support, which provides four data paths to each device to improve performance. The top-end Model 3C features up to 256 megabytes of cache memory, 4 megabytes of nonvolatile storage, and extended support for DASD fast write and dual copy. Controller Models 1 and 2 will be available during the first half of 1989, while the Model 3C will be available during the second half of 1989.

AS/VL models can transfer data at 6 megabytes per second when attached to the NAS 7900 Semiconductor Disk Subsystem or the NAS 7480 Cartridge Tape Subsystem. The AS/VL models are the first such intermediate systems that feature this transfer capability.

COMPETITIVE POSITION

The 1987 introduction of the new AS/VL Series featuring the latest semiconductor technologies and price/

MAIN MEMORY

STORAGE TYPE: See Table 1.

CAPACITY: See Table 1.

CYCLE TIME: NAS does not release information on cycle time.

CHECKING: Error detection and recovery capabilities are implemented through hardware and software. Error detection and correction occurs within the Instruction Processor, system memory, and the Input/Output Processor (IOP). Error detection within the instruction processor and IOP are handled through parity checking, while arithmetic units use special residue checking logic.

When an error is detected, information about the error is stored on a console disk for analysis and problem determination. System recovery is then attempted using hardware instruction retry (HIR). If a failure is detected during instruction execution, the instruction can be reexecuted automatically by HIR. An instruction can be retried up to seven times before the failure is considered permanent. HIR will not be invoked in cases when data and system integrity might be threatened; however, software error recovery logic can still recover partially, and in some cases fully, from a machine check interrupt. When an error is detected at the IOP level, the I/O device control unit can request that the channel reissue the I/O command.

Data held in main storage and dynamic work storage have an associated Hamming code placed in storage in parallel with the data. When data is retrieved from storage, the code is also fetched. Special error correction circuits (ECCs) use the data and code to permit any single-bit error to be corrected. Additionally, any error consisting of one solid bit and one intermittent error bit can also be corrected using ECC logic.

RESERVED STORAGE: The AS/VL Series features four storage-protection types to protect information in virtual and real storage; these are key-controlled protection, low-address protection, segment protection, and page protection. Segment protection is only used in System/370 mode

NAS AS/VL Series

performance features improves NAS' standing in the competitive mid-range market and positions the company well against current and future IBM mid-range offerings.

In addition to offering a price/performance alternative to the IBM 4381 Series, NAS is improving its position in other areas to increase market share, particularly the high-performance storage market and the engineering/scientific market.

The delivery of the 7380 triple-density disk is expected to improve NAS' position in the high-capacity PCM disk market and cut into IBM's market share. In March 1988, NAS revealed that the K model features faster access times than the comparable IBM Model K. The NAS Model K has an average access time of 12.5 milliseconds, compared to 16 milliseconds for the IBM version. The use of a smaller 9.5-inch platter rather than the industry-standard 14-inch platter, means that actuator arms have less space to cover when accessing data. This makes the NAS K models 22 to 50 percent faster than the comparable IBM product, NAS claims.

In May, Amdahl brought out its own response to the IBM storage products. These include the triple-density 6380 Model K, the single-density Model J, and the 6100 controller family.

NAS will be the first to bring its triple-density product to market if the company is able to deliver the Model K by the third quarter as promised. IBM plans to deliver the 3380 Models J and K in October. The Amdahl Models K and J will be available during the first quarter of 1989.

Like IBM and Amdahl, NAS wants to capture a larger share of the growing engineering/scientific market, which is growing at a faster rate than the traditional data processing market as a whole. NAS already offers vector processing versions of its AS/XL mainframes for the high end of the market. Last year, NAS turned its attention to technical users at the departmental level who run engineering/scientific applications on Digital Equipment VAX systems. Digital clearly dominates the mid-range market with its successful VAX line. With thousands of VAXs installed, a number of vendors including NAS have been trying to exploit this market with new products directly appealing to VAX users. In December 1987, NAS announced four products that let VAX users connect their systems to NAS AS/VL and AS/XL mainframes. NAS*NET is a front-end communications processor that connects the two environments; NAS*LINK makes an NAS mainframe look like a node on a DECnet network. NAS*COMPUTE lets end users process VAX/VMS Fortran jobs in an NAS environment. NAS*LIB integrates new and existing software into a high-performance math subroutine library.

The new connectivity products, part of the NAS Cross Systems Series, let VAX technical users access the NAS mainframe to run applications that would otherwise overwhelm the smaller, less powerful VAXs. Additionally,

and page protection is only used in System/370-XA mode. Key-controlled protection is implemented using one or two storage keys for every four-kilobyte block of main storage. Every time a storage access is made, the key of the associated four-kilobyte block is checked against the access key of the requesting instruction processor or channel to check the validity of the store and fetch request.

Low-address protection safeguards the first 512 bytes of the prefix storage area—containing data critical to system operation—from being destroyed. Real addresses from 0 to 511 of each active prefix area are protected whenever bit three of control register zero has been set to one.

Segment protection stops data from being stored anywhere within a segment of virtual storage. Page protection stops data from being stored anywhere within a page of virtual storage.

The Hardware System Area (HSA) is a special section of main memory held in reserve for use by the system hardware. HSA is not accessible to user programs. HSA consists of a single contiguous area of storage below the highest absolute storage address configured in the system. HSA usually requires from 384 kilobytes to 768 kilobytes of space, depending on the number of I/O devices, the complexity of the I/O device path, and the mode of system operation. If an I/O maintenance trace has been selected from the system console at IMPL time, HSA size will be expanded by an additional 512 kilobytes.

HSA space is reserved for communications between AS/VL system components; for storing data related to internal hardware functions and locks; for storing unit control words representing I/O device configuration; for storing the management tables and queues used to control the dynamic channel subsystem; as a common area for internal AS/VL system directories; and as an expanded area to hold a special additional subarea for the I/O trace data when an I/O trace has been selected.

CENTRAL PROCESSORS

CENTRAL PROCESSOR AND MEMORY: The AS/VL Series uses very large scale integration (VLSI) circuitry, making the systems technologically competitive with other System/370-compatible systems in its class. Each model within the AS/VL line is composed of five functional units: an Instruction Processor (IP), a Storage Control Unit (SCU), a Main Storage (MS) unit, an Input/Output Processor (IOP), and a Multifunctional Service Processor (MSP). Models 40, 50, and 60 use one Instruction Processor, while the dyadic Model 80 uses two IPs.

The Model 80 is configured as a tightly coupled system that shares a common main storage area and shares one copy of the operating system. The Model 80 cannot be partitioned to operate as two separate uniprocessors; however, the system offers a degree of fault tolerance. Should an IP or IOP fail, system operation can continue by disconnecting the failing IP or IOP.

The IP uses emitter coupled logic (ECL) components, featuring 2,000 and 5,000 gates per chip. Switching speed can reach a maximum of 200 to 250 trillionths of a second (picoseconds). The IP contains a government unit (GU), a service unit (SU), an execution unit (EU), an instruction unit (IU), and a buffer control unit (BCU). The GU, which provides overall processor control, contains control storage and local storage. It maintains control of instruction execution and interruption of microprograms that are stored in

NAS AS/VL Series

VAX users are not forced to give up their VAX systems and migrate to an unfamiliar non-VAX environment.

To further enhance its appeal among technical users, NAS also plans to offer a native implementation of AT&T's UNIX operating system within the next year or two. In July 1987, NAS and Sun Microsystems signed an agreement to develop a UNIX product based on the SunOS operating system. Amdahl already offers UTS/580, a native implementation of UNIX, and also announced plans to include components of SunOS in UTS. During the last year, most other mainframe vendors have announced support for UNIX. In March, IBM introduced Advanced Interactive Executive (AIX)/370, an implementation of UNIX that runs on IBM System/370-based systems under VM. NAS users who want to run IBM's AIX/370 when it becomes available in March 1989 should have no problem running it on NAS mainframes under VM, according to the company.

In pursuing a VAX/UNIX strategy, NAS is attempting to fill the performance gap between a supermini and a full-scale supercomputer. Minisuper vendors, such as Alliant, Convex, and Elxsi, have been pursuing an identical strategy since the mid-1980s. Similar to NAS, these particular vendors offer VAX emulation products and software conversion aids to ease the migration to their systems. Minisupers sell for the price of a VAX, but offer near-supercomputer performance. With more than a dozen minisuper vendors and traditional mainframe vendors offering high-performance systems for the technical market, this scientific niche market has already become crowded.

Interestingly, neither NAS nor IBM offer integrated, vector processing at the mid-range level to compete directly against minisupers. NAS AS/VL machines feature an integrated, high-speed arithmetic facility, which NAS believes satisfies the needs of most mid-range customers who run some compute-intense applications. IBM is expected to offer a scientific processing capability at the mid-range level sometime next year.

Of course, NAS' primary market continues to be System/370 environment-compatible commercial data processing. In addition to DP and engineering/scientific computing, AS/VL systems are marketed to customers implementing remote-site computing and to users migrating from older IBM operating systems to MVS, or customers migrating to the IBM world from a non-IBM operating environment.

Customers using an AS/VL system to migrate to MVS are typically running applications originally written for IBM's older DOS/VSE operating system. Many of these customers running VSE on 4381 mainframes or compatible NAS systems will eventually have to convert their applications to MVS if they want to migrate to a larger, more powerful 3090 system. However, moving applications to MVS and a 3090 environment is no mean undertaking. For many users, the move will be costly, time consuming, and labor intensive. From a hardware standpoint, users must also

control storage. The EU sequentially executes fixed, decimal, logical, and floating-point operations according to instructions received from the IU. The IU processes instructions using a pipelined architecture. The IU prefetches and decodes instructions, generates operand addresses, prefetches instruction operands, and performs other setups and control functions. The unit works in parallel with the EU and other system units. The BCU contains a high-speed cache memory, addressing arrays, and the dynamic address translation facility and associated translation lookaside buffer (TLB). The TLB contains up to 1,024 of the most recently used virtual-to-real translated address pairs. The SU handles maintenance and operational functions of the multifunctional service processor. An SU stage tracer function maintains a chronological status record of various hardware parts for maintenance purposes.

To complement the processor component of the AS/VL line and enhance overall throughput, NAS implements a three-level hierarchical storage organization. It's composed of main storage at the top, Dynamic Work Storage (DWS) in the middle, and buffer storage (BS) at the bottom. The hardware uses a three-level organization to speed up apparent main storage access time and to keep pace with internal processing speed and high-speed I/O data transfer requirements. As an option, users can also set aside up to 192 megabytes of main memory as expanded storage, an area set aside to ease the paging and swapping load by reducing accesses to disk storage.

Main memory uses 1-megabit CMOS memory chips, while DWS uses 64K-bit Bi-CMOS chips. Four-kilobyte chips are used in buffer storage and control storage. Main memory ranges from 32 megabytes to 256 megabytes on all the models, including the top-end Model 80 dual processor. Additionally, the Model 50 contains 256 kilobytes of DWS and the Models 60 and 80 contain 512 kilobytes of DWS. DWS is not available on the entry-level Model 40.

DWS is part of the SCU. In addition to work storage, the SCU contains addressing arrays and the storage protection facility. (See RESERVED STORAGE for more information about storage protection.) The IOP, IPs (which contain buffer storage), and main memory interface with the SCU. Data is transferred between main storage and DWS in 128-byte blocks. Information is transferred from DWS to buffer memory in 64-byte blocks. If a data request from the IP is not found in BS or DWS, then the DWS initiates a 128-byte transfer from main memory. Similar to an IP request, the channel subsystem also fetches and stores data through the DWS.

AS/VL 80 models use two IPs, which each have their own buffer storage. The IPs and IOP share a common SCU. When two or more requests for main storage occur at the same time from different IPs and IOP, only one request is processed at a time.

For a description of the IOP, please refer to the INPUT/OUTPUT CONTROL section.

The Multifunctional Service Processor (MSP), the fifth functional unit, controls the operation of AS/VL systems, performs maintenance functions, and provides support for communication between the operator and the operating system. The MSP includes a service processor (SP), a systems console, and optional second console that let operators interface with the system. The SP contains other MSP components and acts as a control unit for all MSP interface functions. The SP contains a microprocessor, 2 megabytes of MSP main storage, two 20-megabyte Winchester disks,

NAS AS/VL Series

TABLE 2. MASS STORAGE

MODEL	7380-AD, BD	7380-AE, BE	7380-AJ, BJ	7380-AK, BK
Cabinets per subsystem	1 to 8	1 to 8	1 to 4	1 to 4
Disk packs/HDAs per cabinet	2 (4 logical)	2 (4 logical)	NA	8
Capacity	2.521GB	5.042GB	2.5GB	7.5GB
Tracks/segments per drive unit	13,275	26,650	NA	NA
Average seek time, msec.	9.3	9.3	NA	NA
Average access time, msec.	17.6	17.6	NA	12.5
Average rotational delay, msec.	8.3	8.3	NA	NA
Data transfer rate	3.0MB/sec	3.0MB/sec	4.5MB/sec	4.5MB/sec
Controller model(s)	7880-3, 7880-3C	7880-3, 7880-3C	7880-3, -3C, 7980-1, -2, -3C	7880-3, -3C, 7980-1, -2, -3C
Comments	Single-density 3380-type drive upgradable to E models.	Double-density 3380-type drive	Single-density 3380-type drive; AJ master controls up to three BJ add-on drives; the J model is field-upgradable to the K model	Triple-density 3380-type drive; AK master controls up to three BK add-on drives

NA—Information not available from vendor. When this report went to press, NAS had not released complete specifications for the Models J and K.

move from air-cooled, mid-range systems to much more expensive water-cooled 3090 systems. Rather than move to the 3090 to meet power requirements, many users prefer just adding another 4381 to meet short-term needs.

For users in this predicament, NAS has come to the rescue. The four AS/VL systems overlap the performance of low-end 3090 mainframes. An AS/VL 50, rated at 7.5 MIPS, matches the performance of the high-end 4381 Model 24 and entry-level 3090 Model 120E. The top-end AS/VL Model 80, rated at 17 MIPS, exceeds the performance of a 3090 Model 180E, rated at 15.6 MIPS. By delivering 3090 performance in a less expensive, AS/VL air-cooled mainframe, NAS provides VSE users with more powerful systems and lets them delay moving to the 3090 a little while longer.

IBM, meanwhile, has been pulling out all the stops to make its 3090 Series more attractive to 4381 users. Last year, IBM introduced the 3090 Model 120E, the first 3090 to sell for less than $1 million. Rated at 7.5 MIPS, it overlaps the performance of the 4381 Model 24. The new model erases the performance gap between the 3090 line and 4381 line and provides one of the smoothest transitions ever offered between IBM medium- and large-scale systems.

The new IBM 4381 models became available early in 1988, while the NAS systems became available during the last half of 1987.

ADVANTAGES AND RESTRICTIONS

The primary advantage of buying any PCM system is obtaining full IBM compatibility and equal or better reliability, but at a lower price/performance ratio. NAS consequently offers mid-range performance, exceeding comparable IBM offerings, at a lower price.

NAS processors have a number of secondary advantages that can weigh heavily in individual buying decisions. NAS processors are air-cooled and are manufactured with

and a 1-megabyte diskette. Other components include interface logic to support a standard I/O attachment for consoles and console printers, console adapters, and interface logic for a remote maintenance link.

The main system console and optional secondary console display up to seven colors on a 2,160-character screen. The alphanumeric keyboard features program function and processor control keys. Additionally, the main console only features an operator control panel. The panel contains a power on/off control, control program load, remote maintenance link, and automatic initial program load.

System consoles activate and monitor the systems; load the system's internal microcode and control tables; control processor complex configuration including main storage; control program initiation and execution; record and display events; and display and alter the contents of storage locations and registers. Service functions include the display and alteration of internal storage and registers; gathering and displaying of logout data; diagnosing system malfunctions; and supporting remote maintenance capabilities.

SPECIAL FEATURES: A high-speed arithmetic (HSA) facility is standard on all AS/VL processors. The HSA, composed of separate hardware logic units, speeds up arithmetic processing. High-speed multiplication and division units make use of algorithmic methods to achieve maximum performance.

PHYSICAL SPECIFICATIONS: AS/VL models are air cooled and operate within 50 to 89 degrees Fahrenheit at a relative humidity of between 8 and 80 percent. In standby mode, they operate within a temperature range of from 39 to 109 degrees Fahrenheit. Heat output is rated at 27,800 Btu per hour. Power consumption is rated at 9.5 kVA. Each system CPU measures 84 inches wide, 29 inches deep, and 58 inches high and weighs 2,094 pounds.

CONFIGURATION RULES

The AS/VL Series features three single-processor models and a top-end, dyadic-processor model. The single-processor models come with one Instruction Processor (IP), one Storage Control Unit (SCU), one Main Storage (MS) unit, one Input/Output Processor (IOP), and one Multifunctional Service Processor (MSP). The MSP features a

NAS AS/VL Series

TABLE 3. INPUT/OUTPUT UNITS

Magnetic Tape Units	Number of Tracks	Recording Density, Bits/Inch	Encoding	Tape Speed, Inches/Sec.	Transfer Rate, Bytes/Sec.
7480 Model B22	18	38,000 (bytes)	NA	79	3M or 6M
Printers	**Printing Speed**	**Print Positions**	**Horizontal Spacing, Chars./Inch**	**Vertical Spacing, Lines/Inch**	**Form Size, Inches**

NA—Information not available from vendor.

fewer components than their IBM counterparts. This enables the processors to operate using less power, floor space, and maintenance, while producing less heat. The compact size of NAS mainframes and storage peripherals can be an especially significant advantage for a company that suddenly finds itself running out of space and needing another building unless it can consolidate. The AS/VL air-cooled technology is also significant to users who have been running IBM air-cooled systems and find that an upgrade to the next larger IBM system, namely the 3090 Series, involves the addition of a plumbing network. Such a change requires a large financial outlay and condemns future CPUs to the same location because of the need to connect to the plumbing.

Users new to PCM products may worry about the stability of the vendor, particularly in view of ongoing maintenance and support. Because of this, the vendor's reputation assumes a considerable importance. In the past, IBM sales reps attempted to cast doubt on the ongoing stability of PCMs and their ability to keep up with new technology and remain compatible with the IBM world. During the last few years, these fears have subsided. NAS and Amdahl, working through their Japanese partners, have shown they can consistently respond to IBM product upgrades and changes with reasonable promptness, while continuing to maintain the traditional 15 to 20 percent price/performance edge. Previous NAS/Hitachi machines have also lived up to a reputation for reliability.

One of the biggest challenges for PCMs is maintaining compatibility with the most current IBM operating environments. Both NAS and Amdahl have been assuring customers that there should be no problem responding to IBM's two newest operating environments announced earlier this year, ESA/370 and AIX/370. NAS systems, of course, continue to be compatible with current MVS/SP, MVS/XA, and VM environments.

The new AS/VL replacement products deliver more power, use the latest chip technologies, and feature greater maximum memory and channel capacities than the mid-range systems they replace. The new processors, for instance, use 1-megabit memory chip technologies, while the previous model lines used a combination of 64K-bit and 256K-bit chips. Up to 256 megabytes of main memory are now available on the AS/VL Series, compared to

standard main console display and an optional second display. The dual-processor Model 80 comes with all these components plus an additional IP.

Main memory for all models ranges from 32 megabytes to 256 megabytes. (Please refer to Table 1.) Single-processor models also come with a buffer memory, while the dual-processor model features two buffers, one for each IP. The Model 40 features buffer storage, but does not come with Dynamic Work Storage (DWS). The Model 50 features 256 kilobytes of DWS, and the Models 60 and 80 feature 512 kilobytes of DWS. In addition to main memory, users can allocate up to 192 megabytes of Expanded Storage. Channel capacity ranges from 8 to 32 channels for each model.

INPUT/OUTPUT CONTROL

The AS/VL channel subsystem consists of three major system components: the I/O control logic inside the IP; the HSA, which provides the communications path for all I/O-related functions; and the IOP, which actually carries out I/O operations. The channel subsystem can operate in either System/370 mode or System/370-XA mode. In System/370 mode, the operating system manages all channel paths for each I/O device and keeps track of each I/O request. In System/370-XA mode, channel path selection is performed dynamically and more I/O functions are handled by the channel subsystem rather than the operating system. In this mode, the operation system only needs to be aware of logical I/O device configurations since all multipath queuing is carried out by the channel subsystem. Since this mode recognizes logical devices, there is no longer a need for a fixed association between an I/O device and channel and a specific instruction processor.

On dyadic Model 80 systems operating in S/370 mode, each channel set and associated channels communicate with a specific IP. In S/370-XA mode, however, channel groups are not assigned to a specific IP. Any I/O interrupt that the IOP generates can be handled by either Model 80 IP, regardless of which processor initiated an I/O operation.

The input/output processor uses high-density, complementary metal-oxide silicon (CMOS), VLSI circuits containing 24,000 and 40,000 gates per chip in addition to the 2,000 and 5,000 ECL gate chips mentioned above.

The channel subsystem works in conjunction with the IP attached to the central processor. Programs control individual I/O devices through instructions coming from the IP. In addition to controlling the channel subsystem, the IP sends commands appropriate for a given program to each individual device. This is done through channel command words (CCWs).

NAS AS/VL Series

the 16 megabytes of maximum memory available with the 66X0 Series and the 128 megabytes of maximum memory available with the 80X3 Series. The 66X0 family can be configured with up to 10 channels, while the 80X3 family can be configured with up to 32 channels, the same channel capacity as the AS/VL line.

In addition to greater performance and larger memory and channel capacities, NAS offers several fault-tolerant capabilities on the Model 80 dyadic processor. The model uses two Instruction Processors (IPs) that can interact dynamically with the Input/Output Processor (IOP) when operating in System/370-XA mode. Processors are not assigned to a fixed set of channel paths. If one IP fails or if the IOP fails, system operation can continue by disabling the failing IP or IOP.

To achieve greater power and throughput, the Model 80's two IPs are tightly coupled, sharing a single copy of the operating system and sharing a common memory. The Model 80, however, cannot be partitioned to run as two separate processors.

In the peripheral area, NAS offers single-, double-, and triple-capacity high-performance DASDs and cartridge tape products that are comparable to products from IBM and other PCMs. But NAS does not offer its own line of display terminals, printers, or communications controllers. Similarly, Amdahl offers IBM-compatible mainframes, disks products, and communications controllers, but does not offer terminals, tape drives, or printers. Users must obtain these devices from IBM or other peripheral suppliers. This can be an inconvenience to users looking for a full complement of plug-compatible equipment from a single source. □

The IP contains special hardware paths to allow communication with the channel subsystem. Communications is handled primarily using control blocks in the HSA. As described in the RESERVED STORAGE section, the HSA, a section reserved in main memory, is the primary location for control blocks, locks, and request queuing files used to control the operation of the channel subsystem.

The IOP handles most of the work required to handle I/O operations in the channel subsystem. Each AS/VL model is configured with one IOP, which has a capacity ranging from 8 to 32 channels. I/O devices and controllers are attached to each channel interface. Individual channels are grouped into sets of eight. Channel controllers contained in the IOP each control up to 16 channels, the equivalent of two channel groups. Channel processors, a third element in an IOP, control up to two channel controllers in a time-shared manner.

Channels can be configured for either byte multiplexer or block multiplexer operation. Byte multiplexer channels are reserved for slower speed peripherals working in byte multiplex or burst mode.

Up to 4 channels can be configured as byte multiplexer channels in each group of 16 channels. Up to eight I/O control units can be attached to each byte multiplexer channel. Each channel has its own data buffers and transfers data eight bytes at a time between the channel and DWS.

Block multiplexer channels support high-speed devices such as disks and tape devices. Each block multiplexer channel supports DC interlock, offset interlock, and datastreaming channel protocols. In datastreaming mode, block channels can operate at a data transfer rate of either 3 or 6 megabytes per second. Up to eight I/O control units can be attached to each block channel. Users can obtain a maximum data transfer rate of 6 megabytes per second when channels are attached to an NAS 7900 Semiconductor Disk Subsystem or an NAS 7480 Cartridge Tape Subsystem. Up to 15 block channels can be used to transfer data at 6 megabytes per second.

MASS STORAGE

Please refer to Table 2 for information about disk devices. In addition to the standard disk devices that are presented in the table, NAS offers the 7900 Series add-on semiconductor memory, which emulates IBM 3330, 3350, or 3380 disks or the 3880-21 disk cache. Older models ranged from 32 to 128 megabytes. Recently, the range was expanded from 128 to 512 megabytes.

INPUT/OUTPUT UNITS

Please refer to Table 3 for information about the NAS 7480 Cartridge Tape Subsystem.

TERMINALS

NAS does not offer terminals, but users can configure AS/VL processors with any IBM or IBM plug-compatible terminal.

COMMUNICATIONS CONTROL

Since NAS neither manufactures nor markets communications hardware or software, users can configure AS/VL Series processors with an IBM 3720, 3725, or an IBM plug-compatible 3720 or 3725-type communications controller. Additionally, any IBM communications product (i.e., CICS or TSO) can be used.

SOFTWARE

OPERATING SYSTEMS: The AS/VL Series is compatible with the major IBM System/370 operating systems. These include MVS/SP, MVS/XA, VM/SP, and VM/XA. All AS/VL Series processors are IBM plug compatible and can run any IBM-compatible software, providing the processor implements the operating mode (System/370 or 370-XA) required by that software. For detailed information on IBM software, see the Characteristics section of Datapro's IBM 3090 product report (Report 70C-504MK-701) in this volume.

The AS/VL Series offers complete functional compatibility with IBM's MVS/XA operating system software. Older OS/VS1, MVS versions, VM versions, DOS/VS, and DOS/VSE operating systems cannot run standalone, but they can run under an IBM-compatible version of VM. NAS supports users of current IBM system software by supplying software support services for its customers. In addition, AS/VL systems include firmware that supports the following IBM operating system enhancements in the form of microcode assists: System/370 Extended Facility (370 EF), which allows the use of the MVS/System Extensions (MVS/SE) and MVS/System Product (MVS/SP); Enhanced Virtual Machine Assist (EVMA); Segment Protection; Preferred Machine Assist; ECPS:VM system facility,

NAS AS/VL Series

which reduces operating system overhead to improve efficiency; SIE; and the High-Speed Arithmetic (HSA) feature, which speeds up the processing of floating-point and fixed-point arithmetic instructions. Other standard features include S/370 XA, DF Sort Assist, 3033 Extension, ROCF, and Extended Real Addressing.

All of these enhancements improve system throughput by implementing a number of frequently used system routines in microcode. AS/VL processors in 370 XA mode fully support MVS/SP Version 2, its associated products (collectively known as MVS/XA), and the VM/XA Systems Facility, which is a cross between an operating system and a Migration Aid. They provide every feature of the comparable IBM processors in 370 XA mode.

PROGRAMMING LANGUAGES: Programming languages available for the AS/VL Series include Pascal/VS, Cobol VS II, Fortran, PL/1, Basic, APL/VS, and Assembler, plus any other special-purpose languages implemented for XA processor environments.

DATA BASE MANAGEMENT: NAS does not offer products in this area, but users can run any IBM or IBM-compatible data base manager that can run on the 3090 Series.

DATA MANAGEMENT: NAS does not offer products in this area, but users can run any IBM or IBM-compatible data manager that can run on the 3090 Series.

DATA COMMUNICATIONS: The Cross Systems Series includes products designed to connect computer systems with dissimilar operating systems. Specific products announced to date make it possible to connect Digital Equipment VAX systems with NAS AS/XL and AS/VL mainframes.

*NAS*NET* is a front-end communications module that provides the physical connection between a NAS mainframe and a DECnet network through Ethernet.

*NAS*LINK* integrates the dissimilar NAS and Digital environments by making the NAS processor look to the end user as if it were a node on a DECnet network.

*NAS*COMPUTE* lets end users process VAX/VMS Fortran jobs in a NAS environment.

*NAS*LIB* integrates new and existing software into a high-performance math subroutine library.

PROGRAM DEVELOPMENT: The Advanced Conversational Editing and Programming System (ACEP) is an on-line programming system that permits programmers to create, modify, and maintain programs and systems. It can be used with IBM or IBM plug-compatible processors running under OS/VS1 or MVS. ACEP has an on-line reference manual and a TSO-like language. It builds and edits all programming languages, output files, JCL, and test data. In addition, ACEP can support more than 100 programmers, has full- and split-screen capability, and can dynamically allocate data sets.

An optional System Productivity Facility (SPF) lets users work with easy-to-understand screens and menus to arrive at programming decisions. The ACEP/SPF system includes capabilities for entering, editing, compiling, and saving source programs.

In addition to the above, any IBM or IBM-compatible program development tool that can run on IBM System/370 systems can be used.

UTILITIES: Along with all the IBM utilities available for AS/VL Series processors, NAS offers the following utility systems to its users.

The *DP Technician* is a DASD management utility. Capabilities include volume configuration/dump/restore, catalog management, file management, file record retrieval, and DASD management. DP Technician can be used with all OS and OS/VS operating systems and supports IBM 3330, 3344, 3350, 3375, and 3380 disk subsystems. The IBM 3420 magnetic tape units are also supported.

Discern is a VS1 system monitor designed to improve performance by graphically illustrating the system's performance. It aids in locating and analyzing system problems and provides system statistics on page faults, I/O activity, system data sets, DASD cylinder maps, 3270 response time, and link pack usage by virtual page number.

Extend is an MVS performance product designed to be used with IBM's MVS/System Extended Facility Function. It boosts performance by 12 to 20 percent without the delay and expense of ordering additional hardware.

Extend simulates the System/370 Extended Facility by substituting standard System/370 instruction set sequences for the machine instructions in the Extended Facility. It is designed to let System/370 users take advantage of MVS/SP 1.3 without making hardware modifications. According to NAS, Extend offers a 12 to 20 percent improvement in performance when used in conjunction with IBM's MVS/SE or MVS/SP operating systems.

The NAS Performance Monitor comprises three program products designed to track any event that occurs within and between the components of the user's NAS, IBM, or IBM plug-compatible processor running MVS, MVS/XA, OS/VS1, or VM/370 operating systems. Each of the three program products uses a common Event Accumulator that identifies, counts, and measures the duration of realtime events and periodically logs the data to disk storage.

- *System Performance Interrogator (SPI)* is a direct, interactive, on-line, realtime system monitoring and evaluation tool. SPI also allows the user to establish operating threshold parameters for the system. When these parameters are exceeded, SPI will notify the user to take corrective action before system degradation takes place.

- *System Performance Module (SPM)* comprises four program routines that use the data stored in the Event Accumulator to generate analysis of CPU usage, channel utilization, control unit activity, device utilization, I/O activity, and system degradation by task. SPM can also display or print (in the form of graphs, charts, tables, or calendar reports) realtime conditions from data accumulated since the last *n* period.

- *Job Analysis and Billing (JAB)* is a job accounting and work load analysis program that identifies who used the system, for how long, and for what purpose. JAB can issue user invoices, identify exceptional performance (good or bad), and establish either a break-even or profit-center philosophy.

PRICING AND SUPPORT

POLICY: Purchase prices and maintenance charges are listed in the price list that follows. Maintenance charges

NAS AS/VL Series

appearing in the price list cover a 24-hour period, 7 days a week under the Optional Periods of Maintenance plan. Hardware leases are available through the National Systems Finance Company, a subsidiary of National Semiconductor. Lease terms for three, four, and five years are determined through lease-rate factors. To derive individual lease rates, multiply hardware purchase price by the appropriate factor. Since lease-rate factors change on a monthly basis, NAS recommends that customers contact their NAS sales representative to obtain the latest rates. AS/VL Series lease rate factors released in May 1988 were 0.02571 for a three-year lease; 0.02231 for a four-year lease; and 0.01990 for a five-year lease.

Information about MVS and VM software licenses and fees should be obtained from IBM. Also refer to the IBM price lists at the end of the IBM 3090 and 4381 reports in this volume. Since October 1986, IBM has been moving most of its strategic software products over to a onetime graduated charge structure. Under this approach, the price of the software depends on the size of the central processor and the model group to which a processor belongs. The four groups defined (10, 20, 30, and 40) allow for a four-tier processing structure for each applicable product. Users who upgrade to larger model groups will have to pay an upgrade charge for the software.

SUPPORT: NAS offers two levels of software support. The Central Program Support Centers in Mountain View and San Diego, California provide a Central Program Support Service. This includes telephone assistance 24 hours a day, 7 days a week; customer guidance in Incident Program Analysis Report (IPAR) preparation; problem diagnosis advice; temporary fix or bypass service; and PTF selection and application assistance. The Local Program Support Service at the customer site includes problem diagnosis, IPAR preparation and submission assistance, local fix or bypass development and assistance, and PTF/PUT application problem assistance. The Local Program Support Service is available as an option. Customers can elect to pay a monthly program support charge or to pay hourly rates.

NAS has a Support Agency service for selected IBM Licensed Programs. Under the terms of an agreement between NAS and IBM, licensed users can select NAS as their support agent. The agreement permits NAS to use the IBM support centers on behalf of the users. NAS is offering a combined Central and Local Program Support Service for the designated IBM programs. A remote, first-level interface is provided via a toll-free telephone number, and local support is provided via local NAS Systems Support Representatives. The Support Agency service provides support for the following licensed programs: MVS/SP Version 1, VM/SP Release 1 and up, DOS/VSE Advanced Functions Release 3 and up, Data Facility/Device Support, Data Facility/Extended Function, Data Facility/Data Set Services, RMF, SAM-E, ACF/VTAM, ACF/NCP, SPF, Information System, VSE/VSAM, VSE/POWER, VSE/OCCF, VSE/IPCS, VSE/IPF, VSE/ICCF, VSE/Fast Copy, VSE/DITTO, BTAM-ES, VM/IPCS, RSCS, SPF/CMS, and IPF.

EDUCATION: NAS offers a number of software educational courses designed to meet the needs of both experienced and novice data processing personnel. The software application curriculum includes courses on operating systems and facilities and data base/data communications applications techniques. In addition, general course work covering subjects such as capacity planning, DP management, project management, office automation, computer literacy, and management of microcomputers are also available. NAS offers these courses in a number of U.S. and Canadian cities and maintains an Education Center in Washington, DC.

For additional information, contact National Advanced Systems, 4621-C Boston Way, Lanham, Maryland 20706-4393. Attn: Software Education Coordinator. Telephone (301) 459-2666 or (800) 638-8931.

TYPICAL CONFIGURATION: Because NAS does not offer a full line of operating system software or peripheral equipment (communications controllers, terminals, printers, etc.), a typical configuration cost is not possible.

EQUIPMENT PRICES

		Purchase Price ($)	Maint.* Price ($)
PROCESSORS			
AS/VL 40	Single-processor system; features one Instruction Processor (IP), 32 megabytes of main storage, 32 kilobytes of buffer storage, one Storage Control Unit (SCU), one Input/Output Processor (IOP) with 8 channels, and one Multifunctional Service Processor (MSP), which includes one system console	638,000	712
AS/VL 50	Single-processor system; features one IP, 32 megabytes of main memory, 32 kilobytes of buffer storage, one SCU, one IOP with 8 channels, and one MSP, which includes one system console	891,000	1,511
AS/VL 60	Single-processor system; features one IP, 32 megabytes of main memory, 64 kilobytes of buffer storage, one SCU, one IOP with 8 channels, and one MSP, which includes one system console	1,276,000	3,056
AS/VL 80	Dyadic-processor system; features two IPs, 32 megabytes of main memory, 128 kilobytes of buffer storage, one SCU, one IOP with 8 channels, and one MSP, which includes one system console	2,156,000	3,408
PROCESSOR UPGRADES			
	AS/VL 40 to AS/VL 50	253,000	799
	AS/VL 50 to AS/VL 60	385,000	1,545
	AS/VL 60 to AS/VL 80	880,000	1,897

**Complete service for 24 hours/day, 7 days/week.*

NA—Not applicable.
NC—No charge.

NAS AS/VL Series

		Purchase Price ($)	Maint.* Price ($)
PROCESSOR OPTIONS			
	Additional 32 megabytes of main memory	207,000	225
	Additional eight-channel group	117,000	145
	Six megabyte-per-second channel feature	NC	NA
	Additional Console Display	29,000	215
	Channel-to-Channel Adaptor	14,000	40
MASS STORAGE			
7380	Model AD single-density 3380-type upgradable master disk drive with dual port	77,900	295
	Model BD single-density 3380-type upgradable add-on disk drive with dual port	56,050	215
	Model AE dual-capacity disk drive with dual port	107,350	295
	Model BE dual-capacity disk drive with dual port	85,500	215
	Model AJ single-capacity master disk drive with quad port	77,900	225
	Model BJ single-capacity add-on disk drive with quad port	56,050	165
	Model AK triple-capacity master disk drive with quad port	121,600	225
	Model BK triple-capacity add-on disk drive with quad port	99,750	165
	7380 Upgrades:		
	Model AD to Model AE	38,000	NC
	Model AJ to Model AK	57,000	NC
Controllers			
7880-3	Disk controller	48,450	176
7880-3C	Disk controller with 8-megabyte cache and two channel switch	109,525	575
	7880 features:		
	Two-channel switch	5,025	11
	Additional two-channel switch	10,800	39
	Eight-channel switch	18,450	54
	Additional 8 megabytes of cache memory for Model 3C	34,200	25
	Additional 16 megabytes of cache memory for Model 3C	68,400	50
	Model D to Model E Support Controller Upgrade	NC	NC
	Model J to Model K Support Controller Upgrade	NA	NC
	4.5 megabyte-per-second upgrade for Model 3C	NA	NC
7980	Model 1 Controller	57,000	185
	Model 2 Controller	104,500	370
	Model 3C Controller; 32 megabytes	190,000	800
	7980 features:		
	Four-channel switch	17,100	40
	Additional 32-megabyte cache memory for Model 3C	106,400	75
7900	Semiconductor Disk Subsystem		
7970-2	Controller	78,600	187
7970-3	Controller	87,750	187
7990-1X	Storage Unit; 32 megabytes are standard	128,100	747
7990-2X	Storage Unit; 128 megabytes are standard	382,800	1,113
	7990-1X features:		
	Two-channel switch, additional pair	11,500	39
	32-megabyte increment; upgrade to 7990-1X	84,900	122
	128-megabyte increment; upgrade to 7990-2X	339,600	488
	Quad port	20,100	NA
MAGNETIC TAPE EQUIPMENT			
7480	Model B22 Drive Unit	41,000	264
	Model A22 Controller	62,000	423
	Model B22 Controller	41,000	264
	Additional Channel Attachment	5,495	20
	Data Compression	12,200	67
	Dual Control Coupler	3,845	NC
	Auto Cartridge Magazine Loader	8,455	40

**Complete service for 24 hours/day, 7 days/week.*

NA—Not applicable.
NC—No charge.

NAS AS/VL Series

SOFTWARE PRICES

	Onetime License Fee ($)
Advanced Conversational Editing and Programming System (ACEP)	
VS1 Version	24,000
MVS Version	24,000
VS1 to MVS conversion feature	4,000
System Productivity Facility (SPF) feature	4,000
Extend/SP System/370 Extended Facility Simulator	3,500 to 20,000
Discern/VS1 Performance Analyzer	6,500
Discern/VM Data Analyzer; off-line	3,450
Discern/VM; on-line	4,450
Discern/VM; off-line and on-line if purchased together	7,450
Billing Data Base Facility (BDBF)	15,000
IMS Data Option	2,000
CICS Data Option	2,000
VM Data Option	2,000
QCM Performance Monitor	14,000
Performance Data Base Facility (PDBF)	12,000
IMS Data Option	2,000
CICS Data Option	2,000
VM Data Option	2,000
QCM Systems Performance Interrogator (SPI); requires QCM Performance Monitor	8,000
Elapsed Time Analyzer Option (ELTAN)	2,000
JESTUNE Option	2,000
System Performance Module (SPM); requires QCM Performance Monitor	6,000■