NAS AS/XL Series

MANAGEMENT SUMMARY

UPDATE: *Since delivering the first models of its top-end AS/XL Series of IBM plug-compatible mainframes, National Advanced Systems (NAS) has increased its market share and further strengthened its position as an IBM plug-compatible mainframe (PCM) vendor. Recent NAS successes can be attributed to the timely introduction of product innovations and enhancements. Enhancements announced this year include the introduction of integrated optical channels; multiprocessor models and logical partitioning; and remote networking support. Earlier AS/XL enhancements include main-memory and channel-capacity expansions and the use of denser memory chips. NAS mainframes can now be configured with up to 2 gigabytes of main memory and up to 128 channels. Additionally, NAS processors can now handle data transfer rates of up to 6 megabytes per second, depending on attached peripheral device. In the software area, NAS has announced it will support IBM's Enterprise Systems Architecture/370 (ESA/370) and Advanced Interactive Executive (AIX/370), IBM's implementation of AT&T's UNIX operating system. In the peripheral storage area, NAS has introduced its own line of triple-density direct access storage devices that feature faster access times than comparable IBM models.*

NAS first introduced its Hitachi-based line of top-end Alliance AS/XL mainframes in early 1985. The ultrahigh-speed model line now consists of the uniprocessor Models 50 and 60, the dyadic Models 70 and 80, the triple-processor Model 90, and the quad-processor Model 100. Additionally, NAS markets corresponding "V" series models for each of the base models; these include integrated vector processors. In June 1988, NAS introduced multiprocessor versions of the Models 50, 60, and 70, ▷

The National Advanced Systems (NAS) AS/XL family currently consists of 15 models that are plug compatible with the IBM 3090 mainframe line. Additionally, the AS/XL Series of processors is functionally compatible with IBM software, firmware, and peripheral equipment.

MODELS: AS/XL 50, AS/XL V50, AS/XL 50M; AS/XL 60, AS/XL V60, AS/XL 60M; AS/XL 70, AS/XL V70 AS/XL 70M; AS/XL 80, AS/XL V80; AS/XL 90, AS/XL V90; and AS/XL 100 and AS/XL V100.

CONFIGURATION: One to four CPUs; 32 megabytes to 2 gigabytes of main memory, 128 kilobytes to 256 kilobytes of buffer storage per processor, and 16 to 128 I/O channels. A vector processor is integrated into the CPU on the V models. The M processors combine two of the same model to create configurations that have greater performance and that can be partitioned.

COMPETITION: IBM 3090 Series and Amdahl 5890 Series.

PRICING: Purchase prices range from $3,050,000 to $13,046,000.

CHARACTERISTICS

MANUFACTURER: National Advanced Systems, 750 Central Expressway, P.O. Box 54996, Santa Clara, California 95054-0996. Telephone (408) 970-1000. Canadian address: NAS, 155 Gordon Baker Road, Willowdale, Ontario M2H 3N7. Telephone (416) 494-4114. ▶
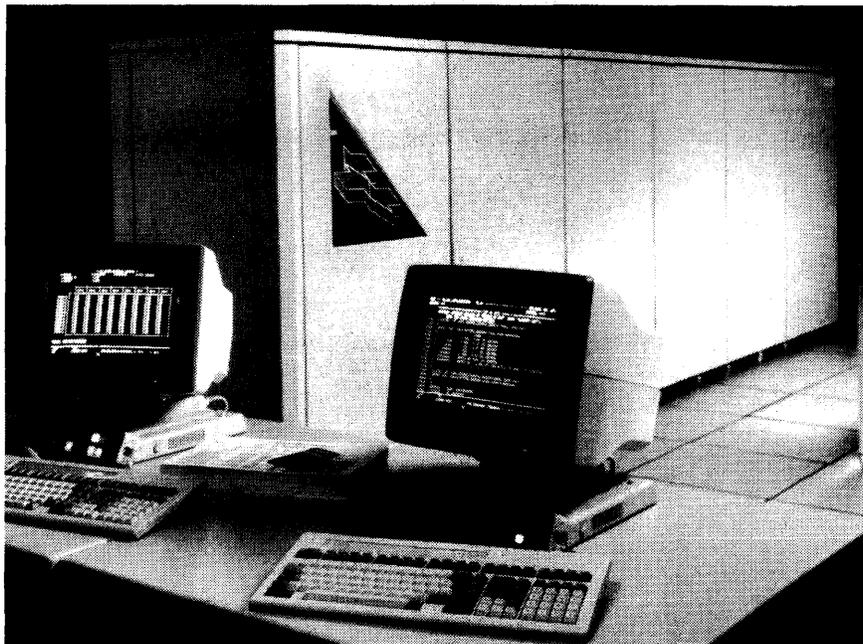
The top-of-the-line AS/XL Series is available in single-, dual-, triple- and quad-processor models. Memory ranges from 32 megabytes to 2 gigabytes; 16 to 128 channels can be attached. A three-level memory system features a large, 12-nanosecond Dynamic Working Storage (DWS) buffer that sits between main memory and an ultra-fast 4.5-nanosecond CPU cache. DWS, which ranges from 512 kilobytes to 2 megabytes in size, can also be accessed by the I/O subsystem.

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TABLE 1. SYSTEM COMPARISON

MODEL	AS/XL 50, AS/XL V50	AS/XL 50M	AS/XL 60, AS/XL V60	AS/XL 60M	AS/XL 70, AS/XL V70	AS/XL 70M
SYSTEM CHARACTERISTICS						
Date announced	May 1986 (XL 50) Aug. 1986 (XL V50)	June 1988	March 1985 (XL 60) Aug. 1986 (XL V50)	June 1988	January 1987	June 1988
Date first delivered	1Q '87 (XL 50) 1Q '87 (XL V50)	August 1988	July 1986 (XL 60) Oct. 1986 (XL V60)	August 1988	3Q '87	August 1988
Field upgradable to	AS/XL V50, AS/XL 60, 70	AS/XL 60M	AS/XL V60, AS/XL 80	AS/XL 70M	AS/XL 80	—
Relative performance	0.65 to 0.80	NA	1.0	NA	1.2 to 1.4	NA
Number of processors	1*	2*	1*	2*	2*	4*
Cycle time, nanoseconds	Classified	Classified	Classified	Classified	Classified	Classified
Word size, bits	32	32	32	32	32	32
Operating systems	MVS/SP V.1, MVS/XA, ESA/370, VM/ SP, VM/XA	MVS/SP V.1, MVS/XA, ESA/370, VM/ SP, VM/XA	MVS/SP V.1, MVS/XA, ESA/370, VM/ SP, VM/XA	MVS/SP V.1, MVS/XA, ESA/370, VM/ SP, VM/XA	MVS/SP V.1, MVS/XA, ESA/370, VM/ SP, VM/XA	MVS/SP V.1, MVS/XA, ESA/370, VM/ SP, VM/XA
MAIN MEMORY						
Type	256K-bit NMOS, 1M-bit DRAM	256K-bit NMOS, 1M-bit DRAM	256K-bit NMOS, 1M-bit DRAM	256K-bit NMOS, 1M-bit DRAM	256K-bit NMOS, 1M-bit DRAM	256K-bit NMOS, 1M-bit DRAM
Minimum capacity, bytes	32M	256M	64M	256M	64M	384M
Maximum capacity, bytes	1G	1G	1G	1G	1G	2G
Increment size, bytes	32M	64M	64M	64M	64M	64M
Cycle time, nanoseconds	Classified	Classified	Classified	Classified	Classified	Classified
BUFFER STORAGE						
Minimum capacity, bytes	—	—	—	—	—	—
Maximum capacity, bytes	128K plus 512K DWS**	128K/CPU plus 512K DWS**	256K plus 1M DWS**	256K/CPU plus 1M DWS**	128K/CPU plus 512K DWS**	256K/CPU plus 2M DWS**
Increment size	—	—	—	—	—	—
INPUT/OUTPUT CONTROL						
Number of channels:						
Byte multiplexer	0 to 12	0 to 16	0 to 16	0 to 16	0 to 16	0 to 32
Block multiplexer	16 to 48	32 to 64	32 to 64	64	32 to 64	64 to 128
Word	—	—	—	—	—	—
Other	—	—	—	—	—	—

A dash (—) indicates "Not applicable."
*An equal number of vector processors can be added to make "V" models.
**Dynamic Working Storage (DWS) is a system cache available to I/O as well as CPU.
NA—Not available.

▷ referred to as Models 50M, 60M, and 70M. All the various models and versions are IBM plug-compatible systems. AS/XL machines are sold to large corporate users who typically experience annual data processing growth of 60 percent or better.

NAS, a subsidiary of National Semiconductor Corp., no longer manufactures any of the product lines it is now selling. Current systems are altered versions of the Hitachi M 680H Series marketed in Japan. These systems have their own operating system and are somewhat incompatible with IBM. The degree of incompatibility between M Series machines and IBM-compatible machines, however, is small enough to make it worthwhile for Hitachi to design for both markets and sometimes even to announce comparable new models simultaneously in both countries. NAS markets, sells, and services the Hitachi-based mainframes in the U.S. and Canada and in many countries outside North America.

NAS, like all PCMs, brings customers to the PCM fold primarily by providing a machine with better performance than a comparably priced IBM machine or by offering lower prices for a machine of comparable performance; at times a more compact design, lower power or cooling requirements, and a record of reliability will affect the buyer's decision. ▷

▶ **MODELS:** Base models are the AS/XL 50, AS/XL 60, single processors; AS/XL 70 and AS/XL 80, dyadic processors; AS/XL 90, three-way processor; and AS/XL 100, quad processor. Each of these models has V Series equivalents. V Series models include integrated vector processing. Additionally, Models 50, 60, and 70 come in special multiprocessor configurations that are partitionable. Please refer to the CONFIGURATION RULES section for more details.

DATA FORMATS

All data formats, instruction formats, and other architectural features of the 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/XL Series can support two modes: System/370 or 370 XA. 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, the NAS AS/XL computers can operate in 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 ▶

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TABLE 1. SYSTEM COMPARISON (Continued)

MODEL	AS/XL 80, AS/XL V80	AS/XL 90, AS/XL V90	AS/XL 100, AS/XL V100
SYSTEM CHARACTERISTICS			
Date announced	March 1985 (XL 80) Aug. 1986 (XL V80)	May 1986 (XL 90) Aug. 1986 (XL V90)	May 1986 (XL 100) Aug. 1986 (XL V100)
Date first delivered	3Q '86 (XL 80) Oct. 1986 (XL V80)	2Q '87 (XL 90) 3Q '87 (XL V90)	2Q '87 (XL 100) 3Q '87 (XL V100)
Field upgradable to	AS/XL V80, AS/XL 90	AS/XL V90, AS/XL 100	AS/XL V100
Relative performance	1.7 to 1.9	2.4 to 2.7	2.9 to 3.4
Number of processors	2*	3*	4*
Cycle time, nanoseconds	Classified	Classified	Classified
Word size, bits	32	32	32
Operating systems	MVS/SP V.1, MVS/XA, ESA/370, VM/SP, VM/XA	MVS/SP V.1, MVS/XA, ESA/370, VM/SP, VM/XA	MVS/SP V.1, MVS/XA, ESA/370, VM/SP, VM/XA
MAIN MEMORY			
Type	256K-bit NMOS, 1M-bit DRAM	256K-bit NMOS, 1M-bit DRAM	256K-bit NMOS, 1M-bit DRAM
Minimum capacity, bytes	64M	128M	128M
Maximum capacity, bytes	1G	2G	2G
Increment size, bytes	64M	64M	64M
Cycle time, nanoseconds	Classified	Classified	Classified
BUFFER STORAGE			
Minimum capacity, bytes	—	—	—
Maximum capacity, bytes	256K/CPU plus 1M DWS**	256K/CPU plus 2M DWS**	256K/CPU plus 2M DWS**
Increment size	—	—	—
INPUT/OUTPUT CONTROL			
Number of channels:			
Byte multiplexer	0 to 16	0 to 32	0 to 32
Block multiplexer	32 to 64	48 to 128	48 to 128
Word	—	—	—
Other	—	—	—

A dash (—) indicates "Not applicable."
*An equal number of vector processors can be added to make "V" models.
**Dynamic Working Storage (DWS) is a system cache available to I/O as well as CPU.

▷ In 1986, NAS brought out the AS/XL Vector Processing Series. The AS/XL V versions integrate a vector processor together with an AS/XL Series scalar processor in the same enclosure as two integral parts of the same CPU complex. As an option, AS/XL customers may upgrade to the vector series. The V models offers customers a general-purpose mainframe that can handle traditional data processing applications together with some numeric-intensive computing applications. The vector processor is not an I/O device as a channel-attached array processor is. The AS/XL V Series models, and their IBM and Amdahl counterparts, are new types of entry-level supercomputers that combine IBM compatibility with efficient processing of data arrays. This high-speed computing is intended for applications such as medical, scientific, aerospace, and defense research; automotive manufacturing; and semiconductor design. Such application areas represent new NAS market opportunities.

In June, NAS made the three multiprocessor configurations—the Models 50M, 60M, and 70M—part of its standard product line. Previously, customers could only order these configurations on a special-order basis. The multiprocessor Models 50M, 60M, and 70M consist of two Model 50s, two Model 60s, and two Model 70Ms, respectively. The Models 50M and 60M can be physically partitioned as two uniprocessors, offering performance roughly equivalent to an AS/XL 70 and an AS/XL 80, ▷

▶ 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; one halfword (16 bits) or two 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: Two, four, or six bytes in length, which usually specify 0, 1, or 2 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/XL Series. The instruction set for the 370 XA processor mode is a modified ▶

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▷ respectively. The Model 70M complex can be physically partitioned as two dyadic processor complexes, with each complex offering performance equivalent to a Model 70. Model 70M performance in single-image mode is roughly equivalent to a Model 90. Multiprocessor models can be partitioned to run two different operating systems or two copies of the same operating system. When running two copies of the same software, users only have to pay one software license fee.

To complement the multiprocessor versions, in June NAS introduced a logical partitioning facility that lets users run multiple operating systems on AS/XL and AS/VL mainframes. When implementing the facility, users can logically partition processor complexes running in single-image mode into multiple-image configurations, eliminating the need to use VM software. Users can establish logical partitions to set up separate testing and development environments and to facilitate conversions to ESA/370 and to new releases of IMS, CICS, and DB2. The product is similar to Amdahl's Multiple Domain Facility and IBM's Processor Resource/System Manager (PR/SM). NAS logical partitioning will be available by the fourth quarter of 1989.

To augment its channel subsystem, NAS also introduced in June an integrated Optical Channel Subsystem (OCS), which allows high-speed storage units to be located up to 1.25 miles (2 kilometers) from the host AS/XL or AS/VL mainframe. OCS includes a group of optical channels, a remote optical channel interface unit, and an optical fiber cable. Up to 48 channels on an AS/XL 100 mainframe can be configured as optical channels.

The optical channel option lets users configure hardware over several floors or buildings. Without the optical channel feature, equipment must be kept within the same room because of cable length restrictions. Solidstate devices such as the NAS 7900 Semiconductor Disk Subsystem can be installed up to 2 kilometers from the CPU, and direct access storage devices (DASDs) such as the NAS 7380 can be extended up to 1 kilometer. IBM introduced a similar product for its mainframe line in 1985. Unlike the NAS version, IBM's is offered as a separate nonintegrated product. NAS' OCS will be available by the first quarter of 1989.

COMPETITIVE POSITION

For the major players that market IBM-compatible mainframes and peripherals, namely NAS and Amdahl, these have indeed been the best of times. Both NAS and Amdahl have managed to increase market share and sales revenues at the expense of IBM. In a mainframe market experiencing only single-digit growth, PCM success has had to come at IBM's expense.

Worldwide mainframe shipments went up by roughly 3 percent in 1987, according to International Data Corp. (IDC), the Framingham, Massachusetts market research firm. Worldwide shipment value within the IBM base ▷

▶ 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).

MAIN MEMORY

Whether a product line is oriented toward 24-bit or 31-bit memory addressing is a primary element of its identity, because it determines the capacity of the system and the kind of operating system compatibility problems it must face. The AS/XL Series can handle both types of addressing, but whether the 31-bit XA "native" mode can function depends on which basic processor mode microcode is loaded at IMPL time.

The System/370 microcode, common to all the NAS processors, has a dual-level virtual memory addressing algorithm that is not only suited to MVS and VM systems but can also handle the simpler single-level memory addressing for operating systems like VSE. The 370 mode in its simplest form can address up to 16 megabytes of real memory and 16 megabytes of virtual memory per user (given the proper operating system at the proper release level). An additional Extended Facility microcode assist allows addressing of more than 16 megabytes of real memory in 370 mode, but with no change to virtual memory limits. The Extended Facility for 370 mode should not be confused with the Extended Architecture microcode that provides the base for 370 XA mode.

The 370 XA (Extended Architecture) microcode expands and revises System/370 addressing in such a way as to allow 31-bit addressing (up to 2G bytes) and yet permit almost all 24-bit-based application programs to run without requiring a change of processor mode. The change in both real and virtual memory ceilings requires "XA" operating systems and the XA mode to be fully exploited; auxiliary microcode assists for the 370 mode, like the Extended Facility, allow operating systems originally designed for the 16-megabyte ceiling to handle larger memories (64 megabytes for MVS/SP V.1) but cannot change the virtual memory ceiling without affecting compatibility.

In addition to 370 mode and XA mode, NAS machines will also support IBM Enterprise Systems Architecture/370 (ESA/370), the latest IBM operating environment. ESA/370 separates data from the application code, providing multiple 2-gigabyte areas of storage just for data. This leaves more room for code in the address space.

To reduce system bottlenecks related to paging and swapping, NAS implements Expanded Memory on all of its AS/XL systems. Users can configure any amount of Expanded Memory up to operating system limits. The memory option is configured through the multifunctional service processor. Users can configure up to 960 megabytes of Expanded Memory on Models 50, 60, 70, and 80 and up to 1.92 gigabytes on Models 90 and 100.

STORAGE TYPE: Main memory modules for all AS/XL Series models use 256-kilobit NMOS chips and 1-megabit dynamic random access memory (DRAM) chips. Memory is interleaved 16 ways to reduce intersystem contention in highly interactive environments. ▶

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(which includes IBM and the PCMs) climbed about 1 percent to 82 percent of the total. IBM's share within the IBM base decreased by almost 2 percent to 73 percent of the total, IDC reported.

NAS' market share went from 2.6 percent in 1986 to 3.2 percent in 1987. The value of NAS shipments increased from $450 million in 1986 to $600 million in 1987. Amdahl has managed to increase its market share from 4.3 percent in 1986 to 6.1 percent in 1987.

Because of its recent successes, NAS has become a rising star within National Semiconductor, a diversified corporation plagued by loses in recent years. National Semiconductor's core business, of course, continues to be semiconductors. Because of a recession in the semiconductor industry, National reported net loses of 24.6 million for fiscal 1987 and 91.5 million for fiscal 1986. For fiscal 1988, however, National reported net earnings of $62.7 million, a result that reflects improved conditions within the semiconductor industry.

In 1986, National Semiconductor reorganized into two operational groups. National's systems-related companies, which includes NAS, became part of its Information Systems Group (ISG). National's semiconductor operations became part of its Semiconductor Group. By the end of fiscal 1987, ISG accounted for $891.0 million, or 48 percent, of total company sales. NAS is the largest member of ISG. Separate ISG financial data for fiscal 1988 was not yet available when this report went to press.

PCMs have done well by continuing to maintain the traditional 20 percent price/performance edge over comparable IBM systems. NAS and Amdahl have also been responding to IBM products within a reasonable time. In a number of instances, PCMs have matched or exceeded IBM delivery dates. Amdahl, for instance, orchestrated a marketing coup with the announcement of the 5990 mainframe series, a new product line positioned well above the maximum performance level of the flagship IBM 3090 series. IBM is expected to respond to the Amdahl announcement soon with the introduction of higher performance 3090 "F" models. When IBM does announce F models, NAS is expected to respond in kind within a month or two.

To add to their appeal, PCMs have been delivering product innovations of their own, such as NAS' logical partitioning feature and Amdahl's multiple domain feature. IBM was forced to respond this year with PR/SM, its own logical partitioning feature.

To stimulate sluggish 3090 sales, in 1987 IBM boosted mainframe performance from top to bottom with the introduction of 3090 "E" models. Amdahl responded with its own higher performing 5890 E models. NAS, on the other hand, simply added new features and pushed up delivery dates of its two most powerful mainframes, the Models 90 and 100. NAS delivered the systems during the second quarter of last year rather than the third quarter.

CAPACITY: See Table 1.

CYCLE TIME: NAS does not release information about cycle times.

CHECKING: Error checking and correction (ECC) circuitry in main memory performs automatic correction of all single-bit errors and detection of all double-bit and most other multiple-bit memory errors.

A reconfiguration capability is standard with all AS/XL models. In the event of an unrecoverable error, or any other problem with a memory module, the operator can "dial out" the problem module (0.5 million, 1 million, or 2 million bytes) and reconfigure the remaining memory for continuous operation.

The Store and Fetch Protection features, which guard against inadvertent overwriting or unauthorized reading of data, have an important role in circumscribing compatibility. Both XA and 370 modes implement key-oriented storage protection features, but most IBM XA systems use 4K protect keys, while non-XA systems use 2K keys. On the AS/XL Series, only 4K keys are supported. This is logical, because the performance benefits of the faster, higher capacity system are reduced if it is bogged down with moving the smaller pages. In addition, the 370 Extended Facility feature provides protection for the first 512 bytes of storage for MVS/SP Version 1 users in System/370 mode. The PLPA segment protection feature protects portions of the MVS/SP Version 1 pagable length packed area and CMS for VM/HPO users. In Extended Architecture mode, any 4K page can be protected.

RESERVED STORAGE: Not supplied by vendor.

CENTRAL PROCESSORS

The implementation of all NAS Central Processing Units (CPUs) is fundamentally similar. Primary functional units consist of the Storage Control Unit (SCU), the Instruction Unit (IU), and the Execution Unit (EU). The SCU processes all fetch and store requests to main storage and translates real addresses to absolute addresses prior to accessing main storage. Included in the SCU is a High-Speed Buffer that reduces the apparent fetch time of main storage; a Dynamic Address Translation Facility carries out all virtual-to-real address translations. The Storage Protection Facility uses seven-bit-long keys to protect against unauthorized access or alteration of data during store or fetch operations.

The IU fetches and prepares instructions and operands for execution by the EU. It also tests for address exceptions prior to execution and buffers the current instruction stream and branch target stream. The IU is composed of two sets of instruction buffers, one instruction register, three instruction queuing registers, an adder, three operand address registers, and a length incrementer for computing the end of addresses.

The EU is divided into two independently operable subunits: the floating-point execution unit (FEU) for executing floating-point instructions and the general execution unit (GEU) for executing instructions other than those mentioned above.

All models feature 16-way interleaving to reduce memory contention. In addition, the AS/XL Series uses 4-kilobyte ECL RAM devices for a 256 kilobyte, extremely high speed, 4.5-nanosecond cache buffer that is implemented in

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TABLE 2. MASS STORAGE

MODEL	7380-AD, BD	7380-AE, BE	7380-AJ, BJ	7380-AJX, BJX	7380-AK, BK
Cabinets per subsystem	1 to 8	1 to 8	1 to 4	NA	1 to 4
Disk packs/HDAs per cabinet	2 (4 logical)	2 (4 logical)	NA	8	8
Capacity	2.521GB	5.042GB	2.5GB	5GB	7.5GB
Tracks/segments per drive unit	13,275	26,650	NA	NA	NA
Average seek time, msec.	9.3	9.3	NA	NA	NA
Average access time, msec.	17.6	17.6	11	13	12.5
Average rotational delay, msec.	8.3	8.3	NA	NA	NA
Data transfer rate	3.0MB/sec	3.0MB/sec	4.5MB/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	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	Double-density 3380-type drive	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, K, and JX.

▷ The company also expanded maximum main memory capacity to 2 gigabytes, the maximum limit under MVS/XA, and began using 1-megabit memory chips. Additionally, NAS expanded maximum channel capacity to 128 channels and increased maximum data transfer rates from 3 megabytes to 6 megabytes per second.

The newest challenge facing PCMs is ESA/370, IBM's new mainframe operating system. Shortly after IBM unveiled ESA/370 in February 1988, NAS and Amdahl were assuring customers and industry watchers they would have little problem implementing ESA on their systems. The benefits of ESA/370, such as a virtual address space of 16 trillion bytes, will initially serve the needs of IBM's largest customers. Many IBM customers are continuing to migrate to MVS/XA. Because there appears to be little compelling need for ESA among most IBM customers for the time being, PCMs have plenty of time to plan for the latest operating environment transition. NAS, for instance, won't introduce ESA compatibility until the fourth quarter of 1989.

While NAS is committed to maintaining IBM compatibility, the company doesn't want to limit itself strictly to this market. During the last few years, NAS has been focusing on two fast growing markets—network communications and engineering/scientific.

In the communications area, NAS offers SBeX-3370, an SNA micro-to-mainframe link. Additionally, the company introduced, in June, AS/Control Facility (AS/CF), which lets users control NAS mainframes from a remote location.

Similar to IBM and Amdahl, NAS also 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 at the high end of the market. The vector versions are directed at mainframe users who need to process vectorizable code, but who don't need the power of a full-scale supercomputer. To further support its numeric-intensive computing ▷

▶ each instruction processor. An additional Reloadable Control Store (RCS) provides fast storage for microcode control programs. In addition, the 512-kilobyte-to-2-megabyte Dynamic Working Storage (DWS), located between the cache buffer and main storage, decreases the access times for the I/O processors as well as the instruction processors. The DWS is built with 16-kilobyte ECL RAM devices which are capable of switching at 12 billionths of a second (12 picoseconds).

Aside from the key differences in cycle times and cache buffer sizes, there are three CPU architectural features that significantly affect the differences in performance range. The first is the word length used in the Reloadable Control Storage, the second is the degree of pipelining implemented, and the third is the presence or absence of a vector processor.

The AS/XL instruction prefetch facility, located in the Instruction Unit, operates in parallel with the instruction pipeline. This facility prefetches instructions, updates program counters, and provides associated units with instruction fields to be executed. It has multiple buffers, which allow prefetching of both of the possible follow-on instructions for a branch instruction. The logic for handling branches has been improved, and techniques have been added for multiple plural operand handling, for pretesting and alignment of instruction operands, and for special handling of storage-to-storage instructions in order to overlap operand processing more extensively.

The instruction pipeline for the AS/XL Series is a sophisticated multilevel pipeline that can simultaneously perform the four basic operations needed to execute an instruction after it has been fetched. It decodes the instruction to obtain the appropriate microinstruction and operand addresses, requests the operand and microword, loads the operand and microword into the appropriate execution unit (general purpose or floating point), and executes them. This allows at least four instructions to be in process at the same time. One instruction can be decoded in each cycle, but even with the greater sophistication of the pipeline design, it is unlikely that the more complex instructions can be executed at one per cycle because the cycle is so fast; NAS/Hitachi do not indicate what portion of the instruction set can execute at the highest possible speed.

SPECIAL FEATURES: The *AS/XL V Series Vector Processor* enhances the AS/XL processors by adding an internal vector processor that gives them the capability to perform array processing. Field upgradable from existing AS/XL Series models, the AS/XL V Series is designed to ▶

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TABLE 3. INPUT/OUTPUT UNITS

Magnetic Tape Units	Number of Tracks	Recording Density, Bits/Inch	Encoding	Tape Speed, Inches/Sec.	Transfer Rate, Bytes/Sec.
7480 Model B22	18	38,000 (bytes)	NA	79	3M or 6M

NA—Information not available from vendor.

▷ efforts, NAS opened an Atlanta, Georgia Systems Software Development Center to develop software for the engineering/scientific market.

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 AIX/370, an implementation of UNIX that runs on IBM System/370-based systems under VM.

The delivery of the 7380 triple-density DASD is expected to improve NAS' position in the high-capacity PCM disk market and cut into IBM's market share. In 1987, NAS announced its triple-density Model K. In March 1988, NAS further revealed its K model which 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 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 can 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.

ADVANTAGES AND RESTRICTIONS

NAS systems, like any competitive PCM system, must attain full IBM compatibility and equal or better reliability, but at a lower price/performance ratio. They cannot remain competitive with IBM otherwise. NAS consequently offers comparable performance at a lower price or better performance at a comparable price than IBM does. ▷

▶ accelerate vector processing at a rate that is up to eight times faster than other large-scale mainframes that do not have internal vector processors or attached array processors. With the architectural expansion of the AS/XL V Series, a vector instruction with 46 order codes processes data and stores the results in the central processor. A parallel processing execution element is added to the execution unit of each instruction processor to implement vector processing functions. Vector Address Generation elements, Vector Data elements, and a microcoded engine perform parallel arithmetic operations which provide the performance increase. The AS/XL V processors use a Fortran preprocessor called VAST (Vector and Array Syntax Translator) which lets the systems execute vectorized Fortran programs, yet remain compatible with IBM architecture. All existing 370 business-oriented software can be run without modification, and the entire series supports appropriate release levels of both MVS and VM operating systems. Also available is a software library of mathematical subroutines called Math Advantage from Quantitative Technology Corp.

All the *Timing Features* of the System/370 architecture are included in the AS/XL central processors. These include a CPU Timer and a Clock Comparator; the latter provides a means for causing an interrupt when the standard Time-of-Day Clock reaches a program-specified value. Additional instructions are provided to set and store the Time-of-Day Clock, Clock Comparator, and CPU Timer.

The *Direct Control Feature* provides six external interrupt lines which operate independently of the normal data channels, plus the Read Direct and Write Direct Instructions which provide for single-byte data transfers between an external device and main storage. Direct Control is optional.

The optional *Preferred Machine Assist* feature is a hardware/microcode assist that is used in conjunction with the VM High Performance Option (VM/HPO) to provide a high-performance "preferred" capability for one MVS/SP guest machine achieving near native performance.

The *Virtual Machine Assist* feature is a microcode enhancement that is designed to improve the performance of operating systems running under the control of VM/370. VMA handles system interrupts caused by privileged instruction execution and supervisor calls.

The *Floating-Point Arithmetic* standard feature provides instructions to perform floating-point arithmetic operations on both short (one word) and long (two word) operands.

The *Extended Precision Floating-Point* standard feature provides seven instructions for performing floating-point arithmetic on four-word (16 byte) operands that provide a precision of up to 28 hexadecimal or 34 decimal digits. ▶

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▷ To enhance its favorable reputation among IBM users, the people PCMs need to convert, NAS has long stressed better price/performance, reliability, system compactness, and air-cooling. PCMs have also managed to maintain compatibility with IBM operating environments, allaying fears that PCMs could not keep up with IBM product changes and introductions. Additionally, PCMs have shown they can originate and introduce product innovations and advantages of their own that may not be available from IBM. In some cases, IBM has adopted product ideas that PCMs originated.

On a pure performance level, NAS continues to offer one of the fastest uniprocessors available. The AS/XL 60 uniprocessor can perform at 28 million instructions per second (MIPS) compared to the IBM 3090 Model 180E uniprocessor which is rated at 15.6 MIPS. Subsequently, using fewer CPUs per configuration, NAS can offer multiprocessor configurations more powerful than comparable IBM systems. A four-processor AS/XL Model 100 is rated at about 81 MIPS. To achieve comparable performance, the IBM top-end Model 600E needs to use six CPUs.

The use of fewer, more compact, air-cooled processors presents users with several obvious advantages. The air-cooled processors are manufactured with fewer components than their IBM counterparts. This means the processors require less power, floor space, and maintenance and produce less heat. Compact size also saves valuable floor space. This feature benefits companies running out of space and in need of another building unless they can consolidate. The exclusive use of very large scale integration (VLSI) technology in the CPU and main memory make the systems faster while also reducing the system footprint over previous mainframe generations. The majority of the high-speed functions are built with bipolar ECL gate array logic. ECL devices feature 2,000 and 5,000 logic gates per chip, operating at switching speeds as fast as 200 trillionths of a second. Other logic circuitry includes 40,000-gate CMOS components in the associated I/O processors. On a CPU-for-CPU basis, the AS/XL uniprocessors occupy 30 percent less space than the previous NAS AS/90X0 Series, and half that of the IBM 3090. The difference in footprint is even more striking, however, when considering systems of comparable performance. The NAS single processor, for instance, is comparable to an IBM dyadic processor. But in size the NAS system is about one quarter the footprint of the IBM system of comparable power.

The air-cooled technology is also significant to users who have been running IBM 4381 air-cooled systems and find that an upgrade to the IBM 3090 system involves the addition of a plumbing network that not only requires a large financial outlay but also condemns future CPUs to the same location because of the need to connect to the plumbing.

To further enhance system performance, NAS introduced an innovative buffering feature. All AS/XL Series systems ▷

▶ The *High-Speed Arithmetic* standard feature provides faster execution of fixed- and floating-point arithmetic instructions as well as certain packed decimal instructions on AS/XL Series systems. Designed to improve system performance by up to 50 percent, this feature is suited for engineering and scientific applications.

The *Channel-to-Channel Adapter* permits direct communications between an AS/XL processor and a System/370 via a standard I/O channel. It can be attached to either a selector channel or a block multiplexer channel and uses one control unit position on either channel. Either system can be equipped with the optional Channel-to-Channel Adapter, and it is required on only one of the interconnected channels.

Dynamic Address Translation for calculating virtual memory addresses is standard on all AS/XL processor models. Instruction retry, command retry, and channel retry are also standard on all models. The AS/XL Series also features enhanced I/O logout and a stage tracer for fault logging. A Log-Out Analyzer further speeds fault diagnosis and verification. In addition to the error-logging facility supported by the operating system, up to 9 kilobytes of status information are logged to the console diskette whenever there is a CPU or channel malfunction. The status information can be recalled and analyzed by a field engineer without affecting normal system operation. The AS/XL Series also has a remote support capability that allows information from a failing CPU to be accessed by a remote support site through a telecommunications link. This capability lets the remote support site receive logout information from, and assume control of, the service processor of the failing CPU. The remote facility can then process the information to diagnose the problem.

A *logical partitioning facility* lets users run multiple operating systems on AS/XL mainframes. When implementing the facility, users can logically partition a single-image processor into multiple-image configurations, while eliminating the need to use VM software. Users can establish logical partitions to set up separate testing and development environments and to facilitate conversions to ESA/370 and to new releases of IMS, CICS, and DB2.

PHYSICAL SPECIFICATIONS: The dimensions and weights of NAS' AS/XL processor models are as follows:

	Width (in.)	Ht. (in.)	Depth (in.)	Wt. (lb.)
AS/XL Series:				
Model 50, 60	35	68	173	7,960
Model 80	35	68	207	10,522

The specifications given above are for the CPU and memory only. Additional floor space and loading requirements must be considered for the console display station(s), power distribution unit(s), and the input/output unit(s). Weights and dimensions of specific hardware configurations will vary with the amount of main memory, number of I/O channels, type and number of peripheral devices, and optional features that are added. Datapro suggests that the user work closely with the NAS customer engineer to assure that sufficient floor space is available and that the load rating of the floor is not exceeded. ▶

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▷ use a three-level memory subsystem. A large, 12-nanosecond dynamic working storage (DWS) subsystem serves as a system cache that sits between the main memory and the 4.5-nanosecond CPU cache buffer. The DWS significantly reduces memory access time not only for the CPU but also for the machine's I/O processors.

The AS/XL Vector Processor Series provides an upgrade path for those AS/XL users who have applications with significant segments of vectorizable code. The AS/XL models can be field upgraded to the V versions by the addition of a vector processor that is integrated into the CPU.

The AS/XL Series also features a 3090 VF Extend "millicode" that allows object code developed for the 3090 to run on the NAS processors. A key software program, the Vector and Array Syntax Translator (VAST) developed by Pacific-Sierra Research, operates as a Fortran preprocessor. VAST locates operations it can vectorize and inserts the appropriate code, which activates the vector processing hardware. It alleviates the necessity to recode existing programs in order to use the system's vector processing capabilities. VAST lets users upgrading to these processors retain their current base of IBM 370 software. In addition to VAST and a number of other vector-oriented programs, NAS has acquired rights to Math Advantage from Quantitative Technology Corp. Math Advantage is a library of mathematical subroutines used for numerically intensive engineering studies.

Users new to PCM products may worry about the stability of a vendor, particularly in view of ongoing maintenance and support requirements. In this light vendor reputation assumes 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 to 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 PCM challenges is maintaining compatibility with the most current IBM operating environments. Both NAS and Amdahl have been assuring customers they should have no problem responding to IBM's two newest operating environments, ESA/370 and AIX/370, new products IBM announced earlier this year. NAS systems, of course, continue to be compatible with current MVS/SP, MVS/XA, and VM environments.

To make it possible for users to set up multiple processing environments on a uniprocessor, NAS has become the latest vendor to market a logical partitioning feature. The feature lets users logically partition a processor into separate processing environments without the need to run ▷

▷ **CONFIGURATION RULES**

The basic configuration for any of the single-processor AS/XL Series complexes (Models AS/XL 50 and AS/XL 60) includes a single CPU, a Main Storage Unit (MSU), an Input/Output Processor (IOP), a Power Distribution Unit (PDU), one or two system consoles, and a Multifunction Service Processor (MSP). In addition to these basic components, system software usually requires disk storage, a magnetic tape drive, a printer, and sometimes either a card reader or a device emulating a card reader. For descriptions of the CPU and the MSU, see the MAIN MEMORY and CENTRAL PROCESSOR sections. The IOP handles all I/O operations to and from main storage and the I/O devices. The MSP is an independent processor that is linked to the CPU and controls the console display. The MSP also enables communications between the computer operator and the central processor for system maintenance and operator command functions.

For multiprocessor configurations (Models AS/XL 70/80, AS/XL 90, AS/XL 100, and their V model counterparts), each complex consists of two, three, or four independent processors, respectively, that share a common main memory, and the appropriate number of IOPs, MSUs, PDUs, system consoles, and MSPs. All AS/XL multiprocessor models are capable of running as a single-system image or in a partitioned two-system mode. If one processor fails, the system can be reconfigured as a uniprocessor system through the operator console or the operating system commands. A Channel Cross-Call feature allows control of input/output operations to be switched to the available processor.

Additionally, multiprocessor versions of these models include the AS/XL 50M, 60M, and 70M. The Model 50M consists of two Model 50s; the Model 60M consists of two Model 60s; and the Model 70M consists of two dyadic Model 70s. The Models 50M and 60M can be physically partitioned as two uniprocessors, offering performance roughly equivalent to an AS/XL 70 and an AS/XL 80, respectively. The Model 70M complex can be physically partitioned as two dyadic processor complexes, with each complex offering performance equivalent to a Model 70. Model 70M performance in single-image mode is roughly equivalent to a Model 90. The multiprocessor models can be partitioned to run two different operating systems or two copies of the same operating system. When running two copies of the same software, users only have to pay one software license fee.

INPUT/OUTPUT CONTROL

All I/O transfers in 370 mode must use some cycle stealing to gain control of the CPU execution unit and perform I/O operations. This is because a high proportion of the logic needed for I/O resides in CPU microcode and programs, and relatively little in the channel control units or subsystem controllers. In XA mode, the amount of this cycle-stealing activity has been greatly reduced because many of the operations performed by the central processor in 370 mode are performed in the I/O processor in XA mode. There are other significant differences in the way that I/O channels are handled in two operational modes.

In System/370 mode, even though the I/O operation is largely handled by the CPU execution unit, the channels do not use the dual-level dynamic address translation facility used by CPU programs. Therefore, all virtual storage addresses have to be translated to real addresses before execution. System/370 mode is capable of addressing sets of up to 16 channels per CPU (two channel groups), but in ▷

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▷ VM/XA SP. The facility lets users run separate test and development environments, eliminating the need to run testing on a separate dedicated system. Additionally, the multiprocessor versions of the Models 50, 60, and 70 can be partitioned to run two different operating systems or two copies of the same operating system. This capability reduces the software license costs associated with running two separate processor complexes. A partitioned AS/XL multiprocessor requires only one software license fee when running two copies of the same software.

The addition of reliable, cost-effective PCM DASD and tape drives has added to NAS' aura of reliability and solid growth, as well as providing more possibilities for future CPU sales. Whether it is logical or not, users tend to lump all of a manufacturer's equipment together in their minds when asked about reliability and service. If they own reliable disk and tape drives, they are more favorably inclined towards purchasing a CPU. If they have owned one satisfactory CPU, most are inclined to buy the next one the manufacturer produces, even if its reliability is an untried quantity.

NAS currently 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, disk 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 may be an inconvenience to users looking for a full complement of plug-compatible equipment from a single source.

USER REACTION

Two users responded to Datapro's 1987 survey of large-scale systems. One respondent installed an AS/XL 60 in July 1986, and the other installed an AS/XL 50 in February 1987. The Model 50 site converted from an IBM 4381 Model Group 14. The Model 50 user purchased the system from NAS while the Model 60 user leases from a third party.

Respondents at both sites said their computer centers support retail/wholesale businesses. Principal applications included payroll processing, order processing/inventory, accounting/billing, and sales/distribution.

Both sites have migrated to IBM's MVS/XA. The Model 50 site programs primarily in Cobol while the other programs in Assembler.

The two NAS systems are configured with from 32 megabytes to 64 megabytes of main memory and more than 10 gigabytes of total disk storage. They also support more ▷

▷ multiprocessor configurations, a specific channel is always seen as part of one set or the other.

In 370 XA mode, the dynamic channel subsystem is activated and controlled by the CPU, but it otherwise processes I/O requests with a great deal of independence. Although the maximum number of channels possible on an AS/XL 100 is currently limited to 128, XA mode is inherently capable of handling up to 256 independent channels. Furthermore, XA-mode channels are not organized into sets related to a specific processor in multiprocessor configurations. Potentially, up to 4,096 devices can be handled concurrently, with eight paths to each device.

The operator communicates with the system via the main console, which also serves as a diagnostic tool for maintenance purposes. The AS/XL systems include two or more seven-color display units, a service processor console (two 20-inch, four-color display units), and two diskette drives. Additionally, a remote diagnostic capability and up to four service processor consoles are provided as standard.

The AS/XL Series has a dynamic channel subsystem (DCS) on the IOP(s). The DCS controls input/output queuing and channel path selection. The AS/XL 50 supports from 16 to 48 I/O channels. There are 32 standard channel paths expandable to 64 on Models AS/XL 60, AS/XL 70, and AS/XL 80. Models AS/XL 90 and AS/XL 100 support from 48 to 128 channels. Block multiplexer channels can support 3-, 4.5-, and 6-megabyte-per-second channels in the datastreaming mode. Up to half the available channels may be configured as 6-megabyte channels. 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. The data transfer rate for byte multiplexer channels is 100 kilobytes per second for all processor models. (See Table 1 for the channel capacity of each processor model.)

Datastreaming support is standard on all AS/XL models. Each I/O channel implements the standard IBM interface and is provided with 256 Unit Control Words.

The aggregate data rate at 3 megabytes per second for the combined maximum channels on a system varies, as follows:

• AS/XL 50: 144 megabytes per second

• AS/XL 60: 192 megabytes per second

• AS/XL 70: 192 megabytes per second

• AS/XL 80: 192 megabytes per second

• AS/XL 90: 384 megabytes per second

• AS/XL 100: 384 megabytes per second

To augment its channel subsystem, NAS features an integrated Optical Channel Subsystem (OCS), which allows high-speed storage units to be located up to 1.25 miles (2 kilometers) from the host AS/XL or AS/VL mainframe. OCS includes a group of optical channels, a remote optical channel interface unit, and an optical fiber cable. Up to 48 channels on an AS/XL 100 mainframe can be configured as optical channels.

The optical channel option lets users configure hardware over several floors or buildings. Without the optical channel feature, equipment must be kept within the same room ▷

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▷ than 60 terminals. Additionally, the Model 50 site supports 16 to 30 remote terminals.

When asked about future purchasing plans, the Model 60 respondent said his company plans to acquire additional software from NAS or IBM and from other suppliers. The user also plans to acquire additional hardware and communications facilities. The company produces most of its applications software through in-house personnel. The Model 50 respondent also plans to acquire proprietary software from third parties, expand communications facilities, and install a laser printer and power conditioning equipment. The Model 50 respondent acquires applications software from in-house personnel, contract programming, and independent suppliers.

The users were asked to rate NAS and its equipment as Excellent, Good, Fair, or Poor in a number of respects. Specifically, they were asked to rate hardware ease of operation, hardware reliability, maintenance, education, documentation, operating system, and applications software. Both users rated their NAS mainframes and software in the various categories as either excellent or good. The only low grade came from the Model 50 user who rated NAS documentation as only fair.

When asked to rate overall satisfaction, the Model 50 user rated NAS as excellent and the other rated the vendor as good. Both users said the systems did what they expected and would recommend the systems to another user. □

▶ because of cable length restrictions. Solidstate devices such as the NAS 7900 Semiconductor Disk Subsystem can be installed up to 2 kilometers from the CPU, and hard disk devices such as the NAS 7380 can be extended up to 1 kilometer.

MASS STORAGE

See Table 2 and Datapro's report "NAS 7380 Disk Storage Subsystems" (Report 70D6-638XM-101) in Volume 2 for details. In addition, any IBM or IBM plug-compatible 3380-type disk storage device may be used in support of AS/XL Series processors.

In addition to the standard disk devices that are presented in the table, NAS offers the 7900 series add-on semiconductor memory that emulates the 3330, 3350, or 3380 disks or the 3880-21 disk cache. Older models ranged from 32 to 128 megabytes. Recently the range has been expanded from 128 to 512 megabytes.

INPUT/OUTPUT UNITS

See Table 3 and the report on the NAS 7803/7420 tape subsystem (Report 70D6-638XM-201) in Volume 2 for details. In addition, any IBM or IBM plug-compatible tape storage device may be used in support of AS/XL Series processors.

TERMINALS

Terminals are not available from NAS, but any IBM or IBM plug-compatible terminal may be used in support of AS/XL Series processors.

COMMUNICATIONS

Since NAS neither manufactures nor markets communications processors and related software, an IBM 3720, 3725, or an IBM plug-compatible 3720- or 3725-type communications controller can be used in support of AS/XL Series processors. Additionally, any IBM communications product (i.e., CICS or TSO) may also be used.

To permit remote operation of AS/XL and AS/VL machines, NAS offers AS/Control Facility (AS/CF). AS/CF allows control of all standard console functions, including power on/off and initial microcode load (IML). The facility also allows for local and remote attachment of both IBM and IBM-compatible PCs and ASCII terminals. AS/CF hardware includes a proprietary protocol control board based on National Semiconductor 32000 microprocessors. Control software provides a user-friendly interface. Terminal devices that may be attached include NAS console devices, Teletype terminals, VT100 mode terminals or PCs emulating these terminals, and 3270-type terminals. AS/CF supports VTAM, NetView, and Inter-System Control Facility, although these IBM products are not required. AS/CF includes password protections and an interlock switch to protect systems from unauthorized access. User-furnished lease lines and encryption features may also be used for increased security.

SOFTWARE

All AS/XL 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.

OPERATING SYSTEM: The AS/XL Series offers complete functional compatibility with IBM's MVS/XA operating system software. Additionally, NAS announced it would support IBM's Enterprise System Architecture/370 (ESA/370) by the fourth quarter of 1989. As on the 3090, older OS/VS1, MVS versions, VM versions, DOS/VS, and DOS/VSE operating systems cannot run standalone but can run under a 3090-compatible version of VM. NAS supports users of current IBM system software by supplying software support services for its customers. In addition, AS/XL 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); Virtual Machine Assist (VMA); Segment Protection; Preferred Machine Assist; and MVS/SP Assists, which consist of the Cross Memory Services Assist, Auxiliary Storage Management Assist, Real Storage Management Assist, and I/O Assist features. All of these enhancements improve system throughput by implementing a number of frequently used system routines in microcode. AS/XL processors in 370 XA mode fully support MVS/SP Version 2 and 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/XL 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. ▶

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▶ DATA BASE MANAGEMENT: Not offered by the vendor, but any IBM or IBM-compatible data base manager that can run on the 3090 series may be used.

DATA MANAGEMENT: Not offered by the vendor, but any IBM or IBM-compatible data manager that can run on the 3090 series may be used.

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 that is easy to use. 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 the IBM 3090 may be used.

UTILITIES: Along with all the IBM utilities available for AS/XL 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 to boost 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 enable System/370 users to take advantage of MVS/SP V.1, R.3 without making hardware modifications. According to NAS, Extend, when used in conjunction with IBM's MVS/SE or MVS/SP operating systems, offers a 12 to 20 percent improvement in performance.

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 which 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 which follows. Maintenance charges 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 the 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/XL Series lease-rate factors released in July 1988 were 0.02650 for a three-year lease; 0.02243 for a four-year lease; and 0.01956 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 Center function in Mountain View and San Diego, California provides a Central Program Support Service, which 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 ▶

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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, among others, is 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 ($)	Monthly Maint.* ($)
PROCESSOR COMPLEXES			
AS/XL50	Single processor with 32 megabytes of main memory, 128 kilobytes of buffer storage, one I/O processor, 16 I/O channels	3,050,000	4,689
AS/XL 50M	Multiprocessor version of AS/XL 50; includes two Model 50 processors with 256 megabytes of main memory and 32 I/O channels	6,785,000	10,728
AS/XL60	Single processor with 64 megabytes of main memory, 256 kilobytes of buffer storage, one I/O processor, 32 I/O channels	4,356,605	5,951
AS/XL 60M	Multiprocessor version of AS/XL 60; includes two Model 60s, 256 megabytes of main memory, 64 I/O channels	8,856,000	12,802
AS/XL70	Dual processor with 64 megabytes of main memory, 128 kilobytes of buffer storage per processor, 32 I/O channels	5,281,000	7,809
AS/XL 70M	Multiprocessor version of AS/XL 70; includes 384 megabytes of main memory and 64 I/O channels	9,581,000	17,418
AS/XL80	Dual processor with 64 megabytes of main memory, 256 kilobytes of buffer storage per processor, two I/O processors, 32 I/O channels	7,227,410	10,509
AS/XL90	Triple processor with 128 megabytes of main memory, 256 kilobytes of buffer storage per processor, three I/O processors, 48 I/O channels	9,916,410	14,162
AS/XL100	Quad processor with 128 megabytes of main memory, 256K bytes of buffer storage per processor, four I/O processors, 128 I/O channels	12,690,000	19,252
AS/XL V50	Same as AS/XL 50, with the addition of an integrated vector processor	3,406,000	5,014
AS/XL V60	Same as AS/XL 60, with the addition of an integrated vector processor	4,712,605	6,276
AS/XL V70	Same as AS/XL 70, with the addition of an integrated vector processor	5,637,000	8,134
AS/XL V80	Same as AS/XL 80, with the addition of an integrated vector processor	7,583,410	10,834
AS/XL V90	Same as AS/XL 90, with the addition of an integrated vector processor	10,272,410	14,487
AS/XL V100	Same as AS/XL 100, with the addition of an integrated vector processor	13,046,000	19,577
PROCESSOR UPGRADES			
	AS/XL 50 to AS/XL 60; 32 megabytes and 16 channels added	1,306,605	1,262
	AS/XL50 to AS/XL 70; 32 megabytes and 16 channels added	2,231,000	3,120
	AS/XL 60 to AS/XL 80	2,870,805	4,558
	AS/XL 70 to AS/XL 80	1,946,410	2,700
	AS/XL 80 to AS/XL 90; 64 megabytes and 16 channels added	2,689,000	3,653
	AS/XL 90 to AS/XL 100	2,773,590	5,090
	AS/XL V50 to AS/XL V60; 32 megabytes and 16 channels	1,306,605	1,262
	AS/XL V50 to AS/XL V70; 32 megabytes and 16 channels	2,231,000	3,120
	AS/XL V60 to AS/XL V80	2,870,805	4,558
	AS/XL V70 to AS/XL V80	1,946,410	2,700
	AS/XL V80 to AS/XL V90; 64 megabytes and 16 channels	2,689,000	3,653
	AS/XL V90 to AS/XL V100	2,773,590	5,090
MEMORY UPGRADES AND ADDITIONAL FEATURES			
	Additional Memory Increment; 32 megabytes (AS/XL 50 only)	197,000	225
	Additional Memory Increment; 64 megabytes	394,000	450
	Expanded Memory Feature; 64 megabytes	394,000	450
	Additional Channels; 16 channel group	247,000	290

*Complete service for 24 hours/day, 7 days/week.
NA—Not applicable.
NC—No charge.

NAS AS/XL Series

		Purchase Price ($)	Monthly Maint.* ($)
	Six-megabyte-per-second channel feature; for 7900-2X or 7480	NC	NA
	Additional Console	25,270	215
	Remote Master Console	36,800	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 AJX double-capacity master disk drive	107,350	—
	Model BJX double-capacity add-on disk drive	85,500	—
	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/XL Series

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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 ∎