

NAS Advanced Systems

MANAGEMENT SUMMARY

UPDATE: During the past year, National Advanced Systems has announced a plethora of hardware and software enhancements across its entire line of plug-compatible mainframe processors. The most recent enhancements include three engineering/scientific enhancements for the AS/60X0 Series; increased main memory capacity and expanded VM support for the AS/80X0 Series; and lastly, increased main memory and channel capacity as well as microcode-assist functions on the AS/90X0.

When National Advanced Systems introduced its Hitachi-based line of mega-mainframes last year, the Alliance AS/XL Series became NAS' flagship system. Since NAS closed its mainframe production and development facilities three years ago, the two-model AS/XL Series is the third mainframe system in NAS' marketing fleet that was built and launched by Hitachi. The series consists of the uniprocessor AS/XL Model 60 and the dyadic AS/XL Model 80. With expected delivery early in the second quarter of 1986, NAS expects its prime market to be very large corporate users who typically experience data processing growth of 60 percent or better annually.

The entry-level uniprocessor, AS/XL Model 60, can operate in the 28 million instructions per second (MIPS) range, has a base main memory of 64 megabytes (expandable to 256 megabytes), and has a cache memory of 256K bytes. The execution speed, combined with the main memory capacity and up to 64 I/O channels, makes it comparable to IBM's 3090 Model 200.

At the high end of the Alliance Series, the dual processor Model 80 comes with 64 megabytes of main memory (expandable to 256 megabytes), 32 I/O channels (expand-

The NAS Advanced Systems (AS) family currently consists of 21 models that are plug-compatible with the entire IBM mainframe line. Additionally, the AS Series of processors is functionally compatible with IBM software, firmware, and peripheral equipment.

MODELS: AS/6620, AS/6630, AS/6650, AS/6660, AS/8023, AS/8043, AS/8053, AS/8063, AS/8083, AS/9040, AS/9050, AS/9060, AS/9070, AS/9080, AS/9140, AS/9150, AS/9160, AS/9170, AS/9180, AS/XL 60, and AS/XL 80.

CONFIGURATION: One or 2 CPUs with from 8 to 256 megabytes of main memory, 16K to 256K bytes of buffer storage per processor, and 5 to 64 I/O channels.

COMPETITION: IBM 4361, 4381, 308X, 3090 Series; Amdahl 580 Series; and IPL 4400 Series.

PRICING: Purchase prices range from \$255,000 to \$8,900,000.

CHARACTERISTICS

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MODELS: AS/6620, AS/6630, AS/6650, AS/6660, AS/8023, AS/8043, AS/8053, AS/8063, AS/8083, ▶



The top-of-the-line AS/XL Series is available in a single- or a dual-processor model that is comparable in performance to IBM's 3090 Series. The AS/XL processors have from 64 to 256 megabytes of main memory and from 16 to 64 I/O channels. The system features VLSI circuits throughout, and a one-megabyte dynamic working storage caching system between the main memory and the cache buffer.

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TABLE 1. SYSTEM COMPARISON

MODEL	AS/6620, AS/6630	AS/6650, AS/6660	AS/8023	AS/8043, AS/8053	AS/8063
SYSTEM CHARACTERISTICS					
Date announced	Jan. 1983 (6620), Oct. 1982 (6630)	Oct. 1982 (6650), Sept. 1984 (6660)	April 1984	April 1984	April 1984
Date first delivered	July 1983 (6620), Oct. 1982 (6630)	Nov. 1982 (6650), Dec. 1984 (6660)	July 1984	May 1983 (8043), June 1983 (8053)	Dec. 1983
Field upgradable to	AS/6630, AS/6650	AS/6650 to AS/6660	AS/8043	AS/8063, AS/8083	Not applicable
Relative performance	—	—	—	—	—
Number of processors	1	1	1	1	1
Cycle time, nanoseconds	60	50 (6650), 43 (6660)	35	35 (8043), 35 (8053)	33
Word size, bits	32	32	32	32	32
Operating systems	VM/SP, DOS/VSE, MVS	VM/SP, DOS/VSE, MVS	VM/SP, DOS/VSE, MVS	VM/SP, DOS/VSE, MVS	VM/SP, DOS/VSE, MVS
MAIN MEMORY					
Type	256K-bit NMOS	256K-bit NMOS	256K-bit NMOS	256K-bit NMOS	256K-bit NMOS
Minimum capacity, bytes	8M	8M	16M	16M	16M
Maximum capacity, bytes	16M	16M	64M	64M	64M
Increment size*	4M or 8M	4M or 8M	16M	16M	16M
Cycle time, nanoseconds	420	420	360	360	315
BUFFER STORAGE					
Minimum capacity	—	—	—	—	—
Maximum capacity	64K	64K	32K (8043) 64K (8053)	64K	64K
Increment size	—	—	—	—	—
INPUT/OUTPUT CONTROL					
Number of channels:					
Byte multiplexer	1 or 2	1 or 2	0 to 6	0 to 6	0 to 6
Block multiplexer	4 or 6	4, 6, 8, or 10	6 to 24	6 to 24	6 to 24
Word	—	—	—	—	—
Other	—	—	—	—	—

* For the AS/8000 Series main memory is expandable in 16MB increments for single processor models, and 32MB increments for multiprocessor models.

able to 64), and 512K bytes of cache memory (256K bytes per CPU). According to NAS, performance and benchmark statistics show a better than even comparison with the IBM 3090-400 quadradic processor complex.

An innovative feature available for the AS/XL is a 1-megabyte dynamic working storage (DWS) subsystem that serves as a caching system between the main memory and the cache buffer. The DWS significantly reduces access time for the machine's I/O and instruction processors. On still another level, a high-speed cache storage subsystem uses 4K-byte ECL RAM devices to assist in implementing a 256K-byte cache buffer in each instruction processor. This cache also provides fast storage and retrieval for microcode control programs.

Both members use complementary metal oxide semiconductors (CMOS) for logic circuits, while the majority of the high-speed functions are built with bipolar ECL gate array logic. The ECL devices feature 2,000 and 5,000 logic gates per chip, operating at switching speeds as fast as 200 trillionths of a second. The AS/XL is the only mega-mainframe in the market to rely solely on the use of very large-scale integrated (VLSI) circuitry. Other logic circuitry includes 40,000-gate CMOS components in the associated I/O processors. In the data streaming mode each channel is capable of data transfer rates of 3 megabytes per second.

In addition to the logic and circuitry innovations incorporated in the AS/XL, NAS uses CMOS and bipolar chip technology to reduce the heat output per gate. This feature allows greater operational switching speed (less than one-quarter nanosecond) and greater density of gates without

AS/9040, AS/9050, AS/9060, AS/9070, AS/9080, AS/9140, AS/9150, AS/9160, AS/9170, AS/9180, AS/XL 60, and AS/XL 80.

DATA FORMATS

All data formats, instruction formats, and other architectural features of the NAS Advanced Systems (AS) processors follow the IBM System/370 architecture. Like the System/370, the NAS AS 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. In the EC mode, the Program Status Word (PSW) and the layout of the permanently assigned lower 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: 8-bit byte. Each byte can represent 1 alphanumeric character, 2 BCD digits, or 8 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: 1 word consisting of 24-bit fraction and 7-bit hexadecimal exponent, in "short" format; 2 words, consisting of 56-bit fraction and 7-bit hexadecimal exponent, in "long" format; or 4 words in "extended precision" format.

INSTRUCTIONS: 2, 4, or 6 bytes in length, which usually specify 0, 1, or 2 memory addresses, respectively. The Advanced Systems (AS) instruction set consists of the complete System/370 Universal Instruction Set, including the five S/370 instructions for Dynamic Address Translation.

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

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TABLE 1. SYSTEM COMPARISON (Continued)

MODEL	AS/8083	AS/9040, AS/9050	AS/9060	AS/9070	AS/9080	AS/XL 60, AS/XL 80
SYSTEM CHARACTERISTICS						
Date announced	April 1984	Sept. 1982	May 1982	Jan. 1982	May 1982	Mar. 1985
Date first delivered	Mar. 1985	Nov. 1982, Sept. 1982	Aug. 1982	Sept. 1982	Dec. 1982	—
Field upgradable to	Not applicable	AS/9050, AS/9060	AS/9080	AS/9080	Not applicable	AS/XL 60 to AS/XL 80
Relative performance	—	—	—	—	—	—
Number of processors	2	1	1	2	2	1 or 2
Cycle time, nanoseconds	35	38	30	38	30	—
Word size, bits	32	32	32	32	32	32
Operating systems	MVS, MVS/XA, VM/SP	MVS, MVS/XA, VM/SP	MVS, MVS/XA, VM/SP	MVS, MVS/XA, VM/SP	MVS, MVS/XA, VM/SP	MVS/XA
MAIN MEMORY						
Type	256K-bit NMOS	256K-bit NMOS	256K-bit NMOS	256K-bit NMOS	256K-bit NMOS	256K-bit CMOS
Minimum capacity, bytes	32M	8M	16M	16M	16M	64M
Maximum capacity, bytes	128M	64M	64M	64M	64M	256M
Increment size*	16M & 32M	8M & 16M	8M	16M	16M	32M or 64M
Cycle time, nanoseconds	315	342	270	342	270	—
BUFFER STORAGE						
Minimum capacity	—	—	—	—	—	—
Maximum capacity	64K/CPU	64K	256K	64K/CPU	256K/CPU	256K/CPU
Increment size	—	—	—	—	—	—
INPUT/OUTPUT CONTROL						
Number of channels:						
Byte multiplexer	0 to 8	1 to 6	1 to 6	2 to 8	0 to 8	0 to 8
Block multiplexer	12 to 32	6 to 23	12 to 23	12 to 46	12 to 46	32 to 64
Word	—	—	—	—	—	—
Other	—	—	—	—	—	—

*Main memory is expandable in 8MB increments for single processor models with less than 32MB of main memory. For single processor models with 32MB or more of main memory and for all multiprocessor models, main memory can be expanded in 16MB increments to a maximum of 64MB. The 64MB limitation does not apply to the AS/XL Series.

▷ the problem of excess heat production. The practical result is that the AS/XL can be air-cooled, thereby eliminating the need for costly liquid cooling apparatus and reducing the footprint to half that of the AS/90X0 Series, and 30 percent less than IBM's 3090.

The AS/XL Series supports all current versions of MVS and VM operating systems in both Extended Architecture (XA) and System/370 modes. All peripherals currently supported by these operating systems on large-scale processors will attach to the AS/XL Series models.

The use of advanced chip and circuit technology as well as the introduction of new processor models up and down the product line has been characteristic of NAS' program to provide its users with an attractive alternative to IBM.

The company's entry-level mainframe, the AS/66X0 Series, has main memory of 8 megabytes, expandable to 16 megabytes, 64K bytes of buffer storage, and up to 8 I/O channels on the AS/6620 and 6630 and 12 I/O channels on the AS/6650 and 6660. Recent enhancements to the AS/66X0 Series include the Engineering/Scientific Assist, High-Accuracy Arithmetic Facility, and the Remote Operator Control Facility. The engineering/scientific enhancements are the Engineering/Scientific Assist for work loads that must manipulate vector data structures; the High-Accuracy Arithmetic Facility, which provides a higher degree of accuracy for work involving scientific and engineering applications; and the High-Speed Arithmetic feature for increasing execution times. Another enhancement is the Remote Operator Control Facility which allows an operator at the central site the ability to control the operation of a processor at a remote site.

▷ MAIN MEMORY

Main memory modules for all AS Series models use 256K-bit NMOS chips (the AS/XL Series uses 256K-bit CMOS chips), and memory is interleaved 2, 4, 8, or 16 ways (depending on model and configuration) to reduce intersystem contention in highly interactive environments.

The entry-level AS/66X0 processor has a base configuration of 8 megabytes of main storage expandable to 16 megabytes. The two-way interleaving technique implemented in main storage significantly reduces main storage contention and increases the aggregate data rate.

For the mid-range AS/80X0 processor, main storage can be expanded from 16 megabytes to 128 megabytes in 16-megabyte increments for the uniprocessor models and 32-megabyte increments for the multiprocessor model. For uniprocessor models, each 8-megabyte main storage extension comprises four banks, each bank having a 2-megabyte capacity using an 8-byte data path. On the multiprocessor model, each processors' 16-megabyte main storage extension comprised four banks, each bank with a 4-megabyte capacity using an 8-byte data path. Main storage is interleaved (4-way on uniprocessor models and 8-way on multiprocessor model), four-bank, real storage using monolithic integrated circuit memory elements. The four banks may be accessed independently. Interleaving reduces apparent memory access time and memory contention and, additionally, increases the effective memory bandwidth.

The large-scale processors are the 5-member AS/90X0 Series. It has a main memory capacity that is expandable from 16 megabytes to 64 megabytes. Uniprocessor models implement 8-way, double-word interleaving, while the dual processor models use 16-way, double-word interleaving. Each logical storage element of main-storage is able to support a memory access independent of other logical storage element activity. The AS/90X0's main storage is able to concurrently support any 8 memory accesses, (16 for the dual processor models), without memory contention.

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➤ The AS/80X0 family comprises NAS' mid-range processor series. The five-model series is available with single or dual processors, with 16 to 128 megabytes of main memory, buffer storage of 32K or 64K bytes, and up to 24 I/O channels on the single processors and 32 I/O channels on the dual processor. Recent enhancements to the AS/80X0 Series include increased main memory capacities, and four new microcode assist functions known collectively as the Extended Control Program Support for VM (ECPS:VM). On the AS/8023, AS/8043, AS/8053, and AS/8063 single processors, main memory capacities were increased from 8 to 32 megabytes to 16 to 64 megabytes. Memory on the dual-processor AS/8083, the largest processor in the series, was quadrupled from 16 to 32 megabytes to 32 to 128 megabytes. Main memory is expandable in 16-megabyte increments on all models, and in 32-megabyte increments on multiprocessor configurations with more than 64 megabytes of memory.

The four microcode assist functions include Expanded Virtual Machine Assist, (EVMA), Control Program Assist, (CPA), Virtual Interval Timer Assist, (VITA), and Shadow Table Bypass Assist, (STBA). EVMA lets the Virtual Machine Assist handle other privileged instructions that can include Test Channel, Load PSW, Set System Mask, Store Then and System Mask, and Store Then or System Mask. CPA optimizes frequently used subroutines and handles linkage to resident subroutines. VITA helps maintain the accuracy of the interval timer to obtain correct accounting and monitoring data. The STBA modifies VMA and EVMA functions and eliminates shadow-table validation functions. The assist provides a fastpath execution of dynamic address translation functions when shadow tables are not used.

The AS/90X0 Series, first introduced in 1982, offers the user large-scale IBM plug-compatibility, and the ability to upgrade within the series as well as the family. These upgrades can, according to NAS, yield an overall performance increase of 300 percent when migrating from the AS/9040 to the AS/9080. With a main memory capacity of 64 megabytes, buffer storage of 64K or 256K bytes, an I/O channel capacity of 24 or 46 channels, and, according to NAS benchmarks, equal or superior performance to IBM's 308X Series, the AS/90X0 Series can be an attractive alternative to IBM.

More recently, NAS expanded maximum main memories on the AS/9040 and AS/9050 from 8 to 48 megabytes to 8 to 64 megabytes. In addition to memory expansions, NAS increased maximum channel capacity to 48 channels. Up to 24 channels can be installed on single-processor models and up to 48 channels can be installed on multiprocessors. When more than 16 channels are installed on a uniprocessor or more than 32 channels are installed on a multiprocessor, they can only be supported in IBM extended architecture (XA) mode. On single-processor configurations, memory can be expanded in 8-megabyte increments. For single-processor configurations with 32 megabytes or more and on all multiprocessors, main memory can be expanded in 16-megabyte increments to the maximum capacity of 64 megabytes.

➤ A subset of the AS/90X0 Series is the AS/91X0 Vector Processor Series. The 5-member series has the same architecture and functional characteristics as the AS/90X0 Series plus vector processing capability. Any member of the AS/90X0 Series can be upgraded to any member of the AS/91X0 Vector Processing series, and dual processors models are possible, each with a separate vector processor. See the *Special Features* section later in this report for details.

The top-of-the-line is the 2-member AS/XL Series. The entry-level, single processor, Model 60, has main memory which can be expanded from 64 to 256 megabytes; and the dual processor, Model 80, has main memory that can be expanded to 256 megabytes from 64 megabytes. Both models feature 16-way interleaving to reduce memory contention, and main memory can be expanded in 32- or 64-megabyte increments. In addition, the AS/XL Series uses 4KB ECL RAM devices for a 256KB high-speed cache buffer that is implemented in each instruction processor. This 256KB cache buffer provides fast storage for microcode control programs. At another level, a 1-megabyte Dynamic Working Storage (DWS), located between the cache buffer and main storage, decreases the access times for the instruction processors as well as the I/O processors. The DWS is built with 16KB ECL RAM devices which are capable of switching at 12 billionths of a second.

STORAGE TYPE: See Table 1.

CAPACITY: See Table 1.

CYCLE TIME: See Table 1.

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 models. In the event of an unrecoverable error, or any other problem with a memory module, the operator can "dial out" the problem module (one-half million, one million, or two million bytes) and reconfigure the remaining memory for continuous operation.

The Store and Fetch Protection features, guard against inadvertent overwriting and/or unauthorized reading of data. In addition, the 370-EF feature provides protection for the first 512 bytes of storage for MVS/SE and MVS/SP users. The PLPA segment protection feature protects portions of the MVS/SP Version 1 pageable length packed area, and CMS for VM/HPO users. In Extended Architecture mode, any 4K page can be protected to enhance availability.

RESERVED STORAGE: Not supplied by vendor.

CENTRAL PROCESSORS

The configuration for all NAS Advanced Systems Central Processing Units (CPU) is the same, and its functional units are as follows: 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 are a High-Speed Buffer which reduces apparent fetch time of main storage; a Dynamic Address Translation Facility which carries out all virtual-to-real translations; and a Storage Protection Facility which uses 7-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 ➤

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➤ An added feature of the AS/90X0 Series is the ability to migrate to the AS/91X0 Vector Processor Series. This offers the user entry-level supercomputing capability on the same machine that is used to run general computing applications such as payroll and accounts receivable. In fact, the scientific/engineering capability not only enhances the user's hardware capability, and protects the user's software investment, but it also extends the useful life of the machine.

The AS/91X0 Series marked NAS' entrance into the realm of vector processing. Although the AS/91X0 is not a standalone computer system, it fits in the same enclosure as AS/90X0 Series, and accesses and integrates with the same system resources. According to NAS, the AS/91X0 Series is an entry-level supercomputer that can process vector data up to eight times faster than NAS' AS/90X0 Series. Intended to provide high-speed computing for applications such as medical, scientific, aerospace, and defense research, automotive manufacturing, and semiconductor design, the incorporation of the new vector processors into the existing NAS product line will generate new market opportunities for NAS.

The AS/91X0 Vector Processor Series provides an upgrade path for existing AS/90X0 users and is designed to perform at 50 MFLOPS (million floating-point operations per second). When compared to the supercomputer standard of 100 MFLOPS, the AS/91X0 does fall a bit short, but when compared to the conventional standard of less than 4 MFLOPS for most mainframes, the AS/91X0 offers the users with scientific/engineering requirements a cost effective and plug-compatible alternative. The AS/91X0 Series features a Vector and Array Syntax Translator (VAST) developed by Pacific-Sierra Research that 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 enables users upgrading to these processors to retain their present base of IBM 370 software. All of the AS/91X0 processors support both the MVS and VM operating systems. In addition to VAST, NAS has acquired rights to *Math Advantage* from Quantitative Technology Corporation. *Math Advantage* is a library of mathematical subroutines used for numerically intensive engineering studies.

All NAS Advanced Systems processors are software and firmware compatible with IBM's System/360, System/370, 4300, 303X, 308X, and 3090 Series. Operating systems supported will vary depending on series and model, but the principal operating systems for the AS processors include IBM's DOS/VS, DOS/VSE, VM/370, OS/VS1, SVS, MVS, and MVS/XA. The AS processors also include firmware enhancements comparable to IBM's. The firmware enhancements implement several frequently used operating system functions in microcode for increased operational efficiency. Firmware assist features supported by the AS processors include System/370 Extended Facility, Virtual Machine Assist, VM Extended Control Program Support, OS/VS1 Extended Control Program Support, MVS/SP AS

➤ 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 incremter 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.

SPECIAL FEATURES: The *AS/91X0 Series Vector Processor* enhances the AS/90X0 processor by adding the ability to perform array processing. Field upgradable from existing AS/90X0 Series models, the AS/91X0 Series is designed to accelerate vector processing at a rate that is eight times faster than other large-scale mainframes. With the architectural expansion of the AS/91X0 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/9140, AS/9150, AS/9160, AS/9170, and AS/9180 processors utilize a Fortran preprocessor called VAST (Vector and Array Syntax Translator) which enable the systems to 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 support both MVS and VM operating systems. Also available is a software library of mathematical subroutines called *Math Advantage*, from Quantitative Technology Corporation. Users who upgrade to the AS/91X0 Vector Processing Series will find it useful for numerically intensive engineering studies.

In addition to the vector processing feature for the AS/90X0 Series, the AS/66X0 and the AS/80X0 have the following special features in common with the AS/90X0. The *Timing Features* of the System/370 architecture are included in the AS 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 on the AS/66X0, the AS/80X0, the AS/90X0 Series, and the AS/XL Series.

The selection of the *Extended Architecture Feature* at IPL time allows the AS/80X0, AS/90X0, AS/91X0, and AS/XL Series processors to support 370-XA (Extended Architecture) mode. This feature is standard on the AS/80X0, AS/90X0, and AS/XL Series processors, and allows the addressing of real storage beyond 16 megabytes as supported by MVS/SP Release 3 and subsequent releases, as well as VM/HPO from Release 3. In 370-XA mode, the AS/80X0, AS/90X0, and AS/XL Series processors support MVS/SP Version 2 and related products, as well as the VM/XA Migration Aid. The Extended Channel Adapter is a prerequisite.

The optional *Preferred Machine Assist* feature is a hardware/microcode assist which is used in conjunction with VM/HPO to provide a high performance "preferred" capability for one MVS/SP guest machine achieving near native performance. ➤

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TABLE 2. MASS STORAGE

MODEL	7360-A4, B4	7380-A4, B4	7380-AE, BE
Cabinets per subsystem	4 or 8	1 to 8	1 to 4
Disk packs/HDA's per cabinet	2	2	4
Capacity*	1.269G	1.269G	5.042G
Tracks/segments per drive unit	16,650	13,275	26,550
Average seek time, msec.	20	16	9.3
Average access time, msec.	28.3	24.3	17.6
Average rotational delay, msec.	8.3	8.3	8.3
Data transfer rate	1.198MB/sec.	1.5MB/sec.	3.0MB/sec.
Controller model	7860 Model 2	7880-3	7880-3, 7880-3C
Comments	7360-A4 is the head of string drive/controller; one 7360-B4 drive unit may be attached to each 7360-A4	7380-A4 is the head of string drive/controller; up to three 7380-B4 drive units may be attached to each 7380-A4	7380-AE is the head of string drive/controller; up to three 7380-BE drive units may be attached to each 7380-AE

* The number of bytes of storage for each of the models above is given for the entire disk storage unit.

► sists, and Preferred Machine Assists. The System/370 Extended Facility enables NAS users to execute the MVS/SE or MVS/SP enhancement program product that permits the MVS operating system to utilize the firmware enhancements.

COMPETITIVE POSITION

Along with the system enhancements and new processor introductions, NAS has further strengthened its marketing stance by initiating the use of 256K-bit chip technology on the AS/66X0, AS/80X3, AS/90X0, and the AS/XL Series processors. This was a strategic marketing move because NAS was the first manufacturer to use this technology. According to NAS, using a 256K-bit chip reinforces the inherent reliability of its processors, and results in reducing the total number of components, memory prices, and maintenance costs, as well as enhancing system flexibility.

With the introduction of the AS/XL Series, NAS has again protected its current and prospective users' software investment by offering upward migration, and maintaining IBM compatibility up and down its product line. In addition, NAS is hoping that its current commercial customers who need to expand their present performance capability over the AS/9080, and also potential IBM customers who are looking for upward migration from the 308X Series will find the new AS/XL mega-mainframe an attractive alternative.

In comparing the NAS processor family with their IBM counterparts, NAS claims to have the edge on performance ratings. Specifically, according to NAS benchmarks, the performance ratings of the AS/6620 and AS/6630 are 20 to 55 percent better than IBM's 4361 Model Group 3, and the AS/6660 and AS/6650 have performance ratings better than or equal to the IBM 4381 Model Group 1. Again according to the benchmark study, the AS/8043 provided 10 percent better performance than the IBM 3083 Model Group EX, and had equivalent processing power to the IBM 4381 Model Group 3. The AS/8053 showed the same performance rating as the IBM 3083 Model Group BX, the

► **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 feature provides instructions to perform floating-point arithmetic operations on both short (1-word) and long (2-word) operands.

The Extended Precision Floating-Point feature provides seven instructions for performing floating-point arithmetic on 4-word (16-byte) operands that provide a precision of up to 28 hexadecimal or 34 decimal digits.

The High-Speed Arithmetic feature provides faster execution of fixed and floating-point arithmetic instructions as well as certain packed decimal instructions on AS/66X0, and AS/XL Series systems. Designed to improve system performance by up to 50 percent, this option is suited for engineering and scientific applications.

The Channel-to-Channel Adapter permits direct communication between an AS 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 is standard on all AS processor models. Instruction retry, command retry, and channel retry are also standard on all models. The AS/80X0 Series, AS/90X0 Series, and AS/XL Series also feature enhanced I/O logout and a stage tracer for fault logging. On the AS/90X0 and AS/XL Series, a Log-Out Analyzer speeds fault diagnosis and verification. In addition to the error-logging facility supported by the operating system, up to 9K bytes of status information is 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/66X0, AS/80X0, AS/90X0, and AS/XL Series also have 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 enables the remote support site to 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.

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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.
7420-44	9	1600	PE	80	128K
		6250	GCR	80	500K
7420-66	9	1600	PE	125	200K
		6250	GCR	125	780K
7420-77	9	800	NRZI	200	160K
		1600	PE	200	320K
7420-88	9	1600	PE	200	320K
		6250	GCR	200	1250K

AS/8063 paralleled the performance of the IBM 3083 Model Group JX, the AS/8023 compared to IBM's 4381 Model Group 2, and the AS/8083 is rated equal to the IBM 3081 Model Group KX.

In the AS/90X0 Series, NAS targets the AS/9040 at IBM's 3083 Model Group BX, and the AS/9050 at IBM's 3083 Model Group JX. The study showed that the performance of the AS/9060 is equal to the IBM 3081 Model Group GX, while the AS/9070 and AS/9080 (dual-processor versions of the AS/9050 and AS/9060) were comparable with IBM's 3081 Model Group KX and the IBM 3084. Finally, at the high end, the new AS/XL Series Models 60 and 80 were shown to effectively match the performance of IBM's 3090 Model 200 and 400.

NAS not only matches its processors against IBM products, it also maintains a highly competitive position among other plug-compatible mainframe vendors. The IPL 4400 Series processors compete directly with the NAS low-end AS/66X0 Series as replacements for IBM's 4361 Model Group 5 and 4381 Model Group 2, while Amdahl's 580 Series competes with NAS' mid-, large-, and very large-scale AS/80X0, AS/90X0, and AS/XL Series. Amdahl's continued expansion of its 580 Series, and the company's enhancement of the existing models, has enabled Amdahl to maintain its lead in the plug-compatible mainframe market. The 580 Series enhancements include an increase in main memory capacity to 128 megabytes for the 5840, 5850, 5860, 5867, and 5870 processors; an increase of main memory to 256 megabytes for the 5868 and 5880 processors; and the availability of 32, 48, 64, or 128 input/output channels, depending on model. In addition, Amdahl's introduction of its three-model 5890 Series mega-mainframe and the expansion of its vector processor series, has sharpened its competitive edge against NAS' AS/XL and AS/91X0 Series. Both Amdahl and NAS feature full software and peripheral compatibility across the entire product line, and can be field-upgraded to the next higher model within a series.

The NAS design policy of field upgrades was reinforced by the addition of the AS/91X0 Series of vector processors. Targeted at users requiring vector processing capabilities, NAS is marketing the AS/91X0 processors as alternatives to the full-fledged supercomputers like those manufactured by Cray Research or Control Data Corporation. The performance level of the AS/91X0 Series (50 MFLOPS), while

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

	Width (in.)	Ht. (in.)	Depth (in.)	Wt. (lb.)
AS/66X0 Series:				
Models 6620, 6630	32	66	48	818
Models 6650, 6660	32	66	80	974
AS/80X0 Series:				
Models 8023, 8043, 8053, 8063	32	66	56	860
Model 8083	32	66	276	2,900
AS/90X0 Series:				
Models 9040, 9050, 9060	94	66	179	9,607
Models 9070, 9080	156	66	181	16,683
AS/XL Series:				
Model 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.

CONFIGURATION RULES

The basic configuration for any of the single processor AS Series complex is 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 Multi-function Service Processor (MSP). (For descriptions of the CPU and the MSU see the sections titled Main Storage and Central Processor.) 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 communication between the computer operator and the central processor for system maintenance and operator command functions.

For multiprocessor configurations, (Models AS/8083, AS/9070, AS/9080, and AS/XL 80) each complex consists of two independent processors that share a common main memory, and the appropriate number of IOPs, MSUs, PDUs, system consoles, and MSPs. All AS multiprocessor models are capable of running in a single-system or a partitioned two-system mode. If one processor fails, the

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▷ significantly less than that of supercomputers (100 MFOPS or more), is an option for users that have occasional scientific/engineering requirements. NAS has indicated that an AS/91X0-type vector processor will soon be available for the AS/XL Series. This fact, coupled with integration of the NAS vector processors into the already firmly established AS/90X0 product family, provides NAS with additional ammunition in the price/performance battle with IBM and the other IBM plug-compatible vendors.

ADVANTAGES AND RESTRICTIONS

NAS' consistent policy of protecting the customer's investment by providing growth paths across an entire product line remains a distinct advantage. The recent strengthening of the low- and mid-range processor series, and its decision to incorporate the AS/91X0 Vector Processor into the AS/90X0 and AS/XL product line further strengthens its marketing stance against IBM. Those users who need vector processing capabilities, but cannot afford high-priced supercomputers, will find the NAS AS/91X0 a cost-effective alternative. NAS' commitment to its user base was further demonstrated by the announcement of upgrade plans and lease options which allow customers leasing a low-end AS/66X0 system to apply a portion of their accrued lease payments towards the purchase of a high-end AS/80X3 mainframe. Another advantage is the capability to reconfigure Advanced Systems dual-processors to a uniprocessor system from the console. Control of input/output operations can be switched at any time to the available processor. Lastly, all Advanced Systems processors are air-cooled and are manufactured with fewer components than their IBM counterparts. This enables the processors to operate using less power, floor space, and maintenance, while producing less heat.

USER REACTION

In the 1985 User Ratings of Computer Systems Survey, we received five responses from the users of installed NAS computer systems. The respondents' systems represented a range of NAS models; included were two AS/6650s, an AS/7000, AS/8023, and AS/8043. Two leased their equipment from the manufacturer and three leased from a third party. The five respondents were involved in a variety of industries including banking/finance/securities, education, public utilities, and software development. The most common applications included accounting/billing, payroll/personnel, order processing/inventory, purchasing, and statistics.

The majority of the respondents reported that more than 60 local and remote terminals or workstations were installed, and three used data base management systems. All five of the respondents stated that they had converted to NAS from another vendor's system. Three converted from an IBM 4341, one from an IBM 370/158, and one from a Magnuson M80/43. When asked about future acquisitions, four of the five NAS users indicated that they intend to expand present hardware and data communications capabilities along with adding additional proprietary software from other suppliers, and two stated a need to incorporate power conditioning equipment. ▷

▶ system can be reconfigured to 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.

INPUT/OUTPUT CONTROL

The operator communicates with the system via the main console, which also serves as a diagnostic tool for maintenance purposes. The AS/80X0, AS/90X0, AS/91X0, and AS/XL systems include two 7-color display units, as well as 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/66X0 Series processors have a single IOP and 5 integrated I/O channels: 1 or 2 byte multiplexer channels and 3 or 4 block multiplexer channels.

The AS/80X0 Series processor has 1 or 2 IOPs and 24 or 32 integrated I/O channels: 0 to 6 byte multiplexer and 6 to 24 block multiplexer channels on single processor models, and 0 to 8 byte multiplexer and 16 to 32 block multiplexer channels on the dual processor models.

AS/90X0 Series uniprocessor models have one microprogram-controlled IOP, while the dual processor models have two IOPs. The single processor models have up to 24 I/O channels: 1 to 6 byte multiplexer channels and 6 or 12 to 23 block multiplexer channels. The dual processor model has a maximum of 48 I/O channels: 2 to 8 byte multiplexer and 12 to 46 block multiplexer channels.

The AS/XL Series has a dynamic channel subsystem (DCS) on the IOP(s). The DCS controls input/output queuing and channel path selection. Up to 32 standard channel paths (expandable to 64) are possible. The DCS is implemented through the IOP(s) which can manage 32 channels at 3 megabytes per second in the data streaming mode, or 64 simultaneous channels at 192 megabytes per second for data transfer. The AS/XL Series can be configured with up to 64 I/O channels: 0 to 8 byte multiplexer and 32 to 64 block multiplexer channels. (See Table 1 for the channel capacity of each processor model.)

Expansion of channels on the AS/80X0 and 90X0 Series processors is done through the extended channel group, which provides an additional I/O Processor with channels. The AS/66X0 System has a separate channel group which has an additional 12 channels.

Datastreaming support is standard on all Advanced System models. Each I/O channel implements the standard IBM interface and is provided with 256 Unit Control Words. All block multiplexer channels can operate at up to 3.0 megabytes per second. The data transfer rate for byte multiplexer channels is 100K bytes per second for all processor models.

MASS STORAGE

See Table 2, and Datapro's report "NAS Disk Subsystems" (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 Series processors.

INPUT/OUTPUT UNITS

See Table 3, and the report on the NAS 7803/7420 tape subsystem (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 Series processors. ▶

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As part of the survey, the users were asked to rate their NAS equipment from excellent to poor. A weighted average was then calculated based on the total number of responses. A summary of these ratings is included in the following table.

	Excellent	Good	Fair	Poor	WA*
Ease of operation	3	2	0	0	3.60
Reliability of mainframe	4	1	0	0	3.80
Reliability of peripherals	3	2	0	0	3.60
Maintenance service:					
Responsiveness	3	2	0	0	3.60
Effectiveness	3	1	1	0	3.40
Technical support:					
Troubleshooting	3	1	0	1	3.20
Education	2	2	0	0	3.50
Documentation	0	2	1	1	2.25
Overall satisfaction	1	1	0	0	3.50

*Weighted Average on a scale of 4.0 for Excellent.

Datapro talked with three NAS users to find out how well their systems performed. We spoke with a securities house in Washington state, a college in eastern Virginia, and a public utility company in southern Florida. Across the board the respondents stated that "once the machine was cabled in, all we had to do was hit the button and go." All of the respondents indicated that the service was excellent, and that NAS system engineers went out of their way to accommodate the user.

The vice president of the securities house stated that his firm had converted to NAS AS/6630 from an IBM 4331 Model Group 2 because at the time his company was looking, IBM had no offerings in mid-range mainframes. They also wanted to protect their software investment. They investigated other PCM vendors, but on a price/performance basis NAS was the best investment. The system has been installed for 22 months and has yet to be down except for scheduled maintenance.

The director of computing for the college converted to a NAS AS/6650 from an IBM 370/158. Stating "there was nothing to it," the spokesman indicated that the conversion was exceptionally smooth. As soon as the college had installed the new NAS equipment, and pushed the start button, the system was up and running. He told us that although the AS/6650 has not yet had any performance problems, his opinion of the NAS service representatives was very favorable. He said that he anticipated no drawbacks if a problem should occur.

The director of information systems for the public utility converted to an NAS AS/8043 from an IBM 4341. The system has been installed for about 16 months, and they have experienced no problems. His responses to our questions mirrored those of the other two respondents. His strongest statement was, "NAS service engineers go out of their way to satisfy the user." In the 16 months that the system has been up and running, he has experienced no problems. □

TERMINALS

Not available from vendor, but any IBM or IBM plug-compatible terminal may be used in support of AS Series processors.

COMMUNICATIONS

Since NAS neither manufactures nor markets communications hardware or software, an IBM 3705 or an IBM plug-compatible, 3705-type communications controller can be used in support of AS Series processors. Additionally, any IBM communications product (i.e., CICS or TSO) may also be used.

SOFTWARE

All AS Series processors are IBM plug-compatible and can run any IBM-compatible software. For detailed information on IBM software see the Characteristics section of Datapro's IBM 308X product report (70C-504MK-601) in this volume.

OPERATING SYSTEM: The Advanced Systems Series offers complete functional compatibility with IBM's OS/VS1, SVS, VM/SP, VM/370, DOS/VSE, DOS/VS, MVS, and MVS/XA operating system software. NAS supports users of current IBM system software by supplying software support services for its customers. In addition, AS systems include firmware that supports the following IBM operating system enhancements: System/370 Extended Facility (370 EF), which allows the use of the MVS/System Extensions (MVS/SE) and MVS/System Product (MVS/SP); OS/VS1 Extended Control Program Support (VS1:ECPS); Virtual Machine Assist (VMA); Virtual Machine Extended Control Program Support (VM:ECPS); 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 processors in 370-XA mode fully support MVS/SP Version 2 and its associated products collectively known as MVS/XA, and provide every feature of the compatible IBM processors in 370-XA mode.

PROGRAMMING LANGUAGES: Programming languages available for the AS Series include Pascal/VS, Cobol VS II, Fortran, PL/1, Basic, APL/VS, and Assembler.

DATA BASE MANAGEMENT: Not offered by the vendor, but any IBM or IBM-compatible data base manager may be used.

DATA MANAGEMENT: Not offered by the vendor, but any IBM or IBM-compatible data manager may be used.

PROGRAM DEVELOPMENT: The Advanced Conversational Editing and Programming System, ACEP is an online 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 over 100 programmers, has full and split screen capability, and can dynamically allocate data sets.

An optional System Productivity Facility (SPF) enables users to 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. ▶

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► In addition to the above, any IBM or IBM-compatible program development tool may be used.

UTILITIES: Along with all the IBM utilities available for AS 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/SP3 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 which 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, online, 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: The NAS Advanced Systems are available for purchase, or for lease under 24-month, 36-month, 48-month, or 60-month noncancelable lease terms. An upgrade plan allows low-end AS/66X0 Series users on a 48-month lease to upgrade at any time after the 24th month to a high-end AS/80X0 or AS/90X0 Series computer. An additional upgrade option enables users signing up to lease an AS/66X0 computer to apply a percentage of the accrued AS/66X0 lease payments toward the purchase of an AS/80X0 mainframe at the end of the leasing term.

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 IPAR (Incident Program Analysis Report) 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, DOS/VSE Advanced Functions Release 3, 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, 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, MD 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. ►

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EQUIPMENT PRICES

		<u>Purchase</u> <u>(\$)</u>	<u>Monthly</u> <u>Maint.*</u> <u>(\$)</u>	<u>2-Year</u> <u>Lease</u> <u>(\$)</u>	<u>3-Year</u> <u>Lease</u> <u>(\$)</u>
PROCESSOR COMPLEXES					
AS/6000 Series:					
AS/6620	Processor with 8 megabytes of main memory, 64K bytes of buffer storage, 5 I/O channels, and a standalone operator console with color CRT	255,000	805	9,545	6,500
AS/6630	Processor with 8 megabytes of main memory, 64K bytes of buffer storage, 5 I/O channels, and a standalone operator console with color CRT	341,500	891	11,785	8,125
AS/6650	Processor with 8 megabytes of main memory, 64K bytes of buffer storage, 5 I/O channels, and a standalone operator console with color CRT	417,500	1,052	15,265	10,155
AS/6660	Processor with 8 megabytes of main memory, 64K bytes of buffer storage, 5 I/O channels, and a standalone operator console with color CRT	475,000	1,215	17,435	11,605
AS/8000 Series:					
AS/8023	Processor with 16 megabytes of main memory, 64K bytes of buffer storage, 8 I/O channels, a single power distribution unit, and color CRT	730,500	3,382	20,260	13,310
AS/8043	Processor with 16 megabytes of main memory, 64K bytes of buffer storage, 8 I/O channels, a single power distribution unit, and color CRT	1,092,000	4,594	25,845	19,450
AS/8053	Processor with 16 megabytes of main memory, 64K bytes of buffer storage, 8 I/O channels, a single power distribution unit, and color CRT	1,492,000	4,740	42,770	30,895
AS/8063	Processor with 16 megabytes of main memory, 64K bytes of buffer storage, 8 I/O channels, a single power distribution unit, and color CRT	1,880,000	5,540	54,305	40,730
AS/8083	Dual processor with 32 megabytes of main memory, 64K bytes of buffer storage per processor, 16 I/O channels, a single power distribution unit, a color CRT	2,871,000	7,378	86,440	67,130
AS/9000 Series:					
AS/9040	Processor with 8 megabytes of main memory, 64K bytes of buffer storage, I/O processor, 8 I/O channels, and service processor console with dual 4-color CRTs, keyboards, and 2 diskette drives	1,402,000	4,288	48,330	34,390
AS/9050	Processor with 8 megabytes of main memory, 64K bytes of buffer storage, I/O processor, 8 I/O channels, and service processor console with dual 4-color CRTs, keyboards, and 2 diskette drives	1,794,000	5,052	58,110	43,585
AS/9060	Processor with 16 megabytes of main memory, 256K bytes of buffer storage, I/O processor, 16 I/O channels, and service processor console with dual 4-color CRTs, keyboards, and 2 diskette drives	2,156,000	5,865	73,475	52,075
AS/9070	Dual processors with 16 megabytes of main memory, 64K bytes of buffer storage per processor, 2 I/O processors, 16 I/O channels and 2 service processor consoles with dual 4-color CRTs, keyboards, and 2 diskette drives	3,041,000	7,714	98,540	71,485
AS/9080	Dual processors with 16 megabytes of main memory, 256K bytes of buffer storage per processor, 2 I/O processors, 16 I/O channels, and 2 service processor consoles with dual 4-color CRTs, keyboards, and 2 diskette drives	3,878,000	9,644	105,910	83,980
AS/9100 Series:					
	9140 Vector Processor with 16 megabytes of main memory, 64K bytes of buffer storage, I/O processor, 8 I/O channels, and service processor with dual 4-color CRTs, keyboards, and 2 diskette drives	1,797,000	6,082	65,225	45,415
	9150 Vector Processor with 16 megabytes of main memory, 64K bytes of buffer storage, I/O processor, 8 I/O channels, and service processor with dual 4-color CRTs, keyboards, and 2 diskette drives	2,189,000	6,835	75,005	54,610
	9160 Vector Processor with 16 megabytes of main memory, 256K bytes of buffer storage, I/O processor, 16 I/O channels, and service processor with dual 4-color CRTs, keyboards, and 2 diskette drives	2,456,000	7,193	86,770	60,780
	9170 Vector Processors with 16 megabytes of main memory, 256K bytes of buffer storage, 2 I/O processors, 16 I/O channels, and 2 service processors with dual 4-color CRTs, keyboards, and 2 diskette drives	3,641,000	10,346	125,105	88,895
	9180 Vector Processors with 16 megabytes of main memory, 256K bytes of buffer storage, 2 I/O processors, 16 I/O channels, and 2 service processors with dual 4-color CRTs, keyboards, and 2 diskette drives	4,487,000	12,431	132,475	101,390
AS/XL Series:					
AS/XL Model 60	Single processor with 64 megabytes of main memory, 256K bytes of buffer storage, one I/O processor, 32 I/O channels	4,840,000	10,846	—	—
AS/XL Model 80	Dual processor with 64 megabytes of main memory, 256K bytes of buffer storage per processor, two I/O processors, 32 I/O channels	8,470,000	18,674	—	—

NC—No charge.

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

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	Purchase (\$)	Monthly Maint.* (\$)	2-Year Lease (\$)	3-Year Lease (\$)
PROCESSOR UPGRADES				
AS/6600 Series				
AS/6620 to AS/6630 Upgrade	95,000	86	—	—
AS/6630 to AS/6650 Upgrade	115,000	161	—	—
AS/6630 to AS/6660 Upgrade	172,000	324	—	—
AS/6650 to AS/6660 Upgrade	57,500	163	—	—
AS/8000 Series				
AS/8023 to AS/8043 Upgrade	361,500	1,212	—	—
AS/8043 to AS/8053 Upgrade	400,000	146	—	—
AS/8053 to AS/8063 Upgrade	388,000	764	—	—
AS/8063 to AS/8083 Upgrade	991,000	1,874	—	—
AS/9000 Series				
AS/9040 to AS/9050 Upgrade	392,000	764	—	—
AS/9050 to AS/9060 Upgrade	144,000	813	—	—
AS/9050 to AS/9070 Upgrade	1,152,000	2,662	—	—
AS/9060 to AS/9080 Upgrade	1,845,000	3,779	—	—
AS/9070 to AS/9080 Upgrade	837,000	1,930	—	—
AS/9100 Series				
AS/9040 to AS/9140 Upgrade	300,000	1,794	—	—
AS/9050 to AS/9150 Upgrade	300,000	1,783	—	—
AS/9060 to AS/9160 Upgrade	300,000	1,328	—	—
AS/9070 to AS/9170 Upgrade	600,000	2,632	—	—
AS/9080 to AS/9180 Upgrade	600,000	2,787	—	—
AS/XL Series				
AS/XL Model 60 to AS/XL Model 80 Upgrade	3,630,000	—	—	—
MEMORY UPGRADES & ADDITIONAL FEATURES				
AS/6000 Series				
Additional Memory Increment, 4 megabytes	38,000	79	1,260	870
Additional Memory Increment, 8 megabytes	64,000	158	2,025	1,395
Additional Block Channels Increment, 2 channels	20,000	40	845	580
Additional Byte Channels, each	8,000	20	340	235
High-speed Arithmetic	80,000	250	3,390	2,320
Console Printer	3,700	139	175	110
Channel to Channel Adapter: standalone model	20,000	43	840	580
Direct Control	5,000	300	210	145
AS/8000 Series				
Additional Memory Increment, 8 megabytes (uniprocessor only)	95,000	452	3,695	2,320
Additional Memory Increment, 16 megabytes (multiprocessor)	190,000	904	5,935	3,485
Additional Channel Group, 8 channels	123,000	202	4,440	3,020
Additional Console	29,000	300	1,380	845
Channel to Channel Adapter	14,000	56	575	510
High-speed Arithmetic	200,000	300	5,975	5,220
Console Printer	6,000	139	315	290
AS/9000 Series				
Additional Memory Increment for AS/9040, AS/9050, and AS/9060; 8 megabytes	95,000	452	3,600	2,320
Additional Memory Increment for AS/9070 and AS/9080; 16 megabytes	190,000	904	7,630	4,640
Additional Channel Group, 8 channels	123,000	202	4,490	3,020
Channel to Channel Adapter	14,000	56	575	510
Direct Control	1,500	21	75	65
Console Printer	6,000	139	315	290
Additional Console	29,000	300	1,380	845
AS/9100 Series				
Additional Memory Increment; 16 megabytes	190,000	904	7,630	4,640
Additional Channel Group, 8 channels	123,000	202	4,490	3,020
Channel to Channel Adapter	14,000	56	575	510
Direct Control	1,500	21	75	65
Console Printer	6,000	139	315	290
Additional Console	29,000	300	1,380	845
AS/XL Series				
Additional memory increments for the AS/XL Models 60 and 80; 64 megabytes	394,000	626	—	—
Additional channel group for the AS/XL Models 60 and 80; 16 channels	247,000	403	—	—

NC—No charge.

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

NAS Advanced Systems

		Purchase (\$)	Monthly Maint.* (\$)	2-Year Lease (\$)	3-Year Lease (\$)
MASS STORAGE					
7260-A4	Disk drive with dual port	54,000	205	1,935	1,715
7360-B4	Disk drive with dual port	39,000	160	1,395	1,240
7860-2	Disk controller with 2-channel switch	55,000	185	1,950	1,730
	Additional 2-channel switch	6,000	15	210	185
7380-A4	Disk drive with dual port	85,500	410	3,230	2,495
7380-B4	Disk drive with dual port	58,500	300	2,355	1,820
7380-AE	Dual capacity disk drive with dual port	128,000	410	—	—
7380-BE	Dual capacity disk drive with dual port	104,880	300	—	—
7880-3	Disk controller	58,500	245	2,170	1,670
7880-3S	Disk controller	73,800	356	2,825	2,180
7880-3C	Disk controller with 8MB cache and 2-channel switch	142,500	800	5,510	4,275
	2-channel switch	5,850	15	245	185
	8-channel switch	21,600	75	820	625
	Additional 8MB cache memory	38,000	35	1,365	1,030
	Single to double capacity upgrade	45,960	—	—	—
MAGNETIC TAPE EQUIPMENT					
7420-44	Tape drive	15,000	373	665	615
7420-66	Tape drive	17,000	398	740	705
7803-23	Tape drive controller	20,000	245	895	825
	2 x 8 switch	5,000	17	190	170
	2 x 16 switch	4,500	17	170	155
	2-channel switch	3,500	8	120	110
7420-77	Tape drive	24,000	482	845	800
7420-88	Tape drive	25,000	534	915	875
7803-21	Tape drive controller	30,000	385	920	830
	800 bpi feature	2,980	30	130	120

NC—No charge.

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

SOFTWARE PRICES

	Onetime License Fee (\$)
ACEP (Advanced Conversational Editing and Programming System)	
VS1 Version	24,000
MVS Version	24,000
VS1 to MVS conversion feature	4,000
SPF (System Productivity Facility) 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	3,450
DISCERN/VM (online)	4,450
DISCERN/VM (offline and online if purchased together)	7,450
DP Technician	12,000
NAS Performance Monitor (QCM):	
Performance Monitor (required module)	14,000
SPI (System Performance Interrogator)	6,000
SPM (System Performance Module)	6,000
Performance Data Base for SAS Users:	6,000
IMS Data Option	1,000
CICS Data Option	1,000
VM Data Option	1,000
JAB (Job Analysis and Billing):	6,000
IMS Option	2,000
CICS Option	2,000
VM Option	2,000
VPARS	11,500
VAST	10,000

NAS Advanced Systems

Local Program Support

	Category A (\$)	Category B (\$)
AS/6620	730	1,040
AS/6630	688	982
AS/6650	724	1,030
AS/6660	724	1,030
AS/8023	713	1,015
AS/8043	791	1,125
AS/8053	1,005	1,430
AS/8063	1,145	1,630
AS/8083	1,660	2,375
AS/9040	1,005	1,430
AS/9050	1,145	1,630
AS/9060	1,360	1,940
AS/9070	1,660	2,375
AS/9080	1,875	2,675
AS/9140	1,005	1,430
AS/9150	1,145	1,630
AS/9160	1,360	1,940
AS/9170	1,660	2,375
AS/9180	2,060	2,938 ■