Apollo Domain Systems

MANAGEMENT SUMMARY

UPDATE: *Since we updated this report, Apollo has inundated its product line by announcing the DN330 workstation, the DN560 workstation, the DN570 workstation, the DN580 workstation, the DSP90 server processor, the Series 3000 Personal Workstation, the DSP3000 server, and the DSP9000 server. In addition to these new products, the vendor announced expanded disk capacity, a tape drive, a laser printer, and communications packages.*

Apollo Computer, Inc. has revamped its product line to compete in the hotly contested scientific workstation market. In the past 11 months, Apollo has added six workstations and three compute servers to the Domain Systems, while beefing up disk and tape capacities. Firmly entrenched in the heat of the scientific workstation battlefield, Apollo is shoring up its products to compete in this bulging segment of the computer industry.

The DN330 is based on Motorola's 32-bit 68020 microprocessor; it also incorporates an MC68881 floating-point processor. The DN330 supports 2MB to 3MB main memory and a 70MB Winchester disk with an optional 1.2MB floppy diskette. The DN330 features a 17-inch, 1024-by-800 bit-mapped monochromatic display and two RS232-C ▷

Apollo's 32-bit Domain Systems supply a range of Unix-based computing resources for the technical workgroup environment. Left (bottom to top) DN570 with a 15-inch color monitor, high-end DN580; and top of the line DSP9000 compute server. Right (bottom to top) Series 3000 with a 15-inch color monitor; Series 3000 with a 19-inch monochrome monitor; and DN570 with a 19-inch color monitor.

The Apollo Domain Systems consist of ten 32-bit workstations that offer multiple-window graphics capabilities and support multiple concurrent processes, with each process having virtual address space of up to 16MB. The operating system is either Apollo's proprietary Aegis or the Unix-based Domain/IX. The Domain Systems are targeted for a range of engineering, solids modeling, presentation graphics, technical publication, and design analysis applications.

MODELS: DN300, DN330, DN460, DN560, DN570, DN570A, DN580, DN660, DN660A, Series 3000.
MEMORY: 1MB to 16MB.
DISK CAPACITY: Up to 1.167GB.
WORKSTATIONS: The number of workstations is dependent upon the network.
PRICE: $9,900 to $71,500 (base price).

CHARACTERISTICS

MANUFACTURER: Apollo Computer Inc., 330 Billerica Road, Chelmsford, MA 01824. Telephone (617) 256-6600.

CANADIAN ADDRESS: 1530 Markham Road, Suite 130, Scarborough, Ontario M1B 3G4. Telephone (416) 297-0700.

DATA FORMATS

BASIC UNIT: 32-bit word.

FIXED-POINT OPERANDS: Byte, word, 32-bit longword, and ASCII.

FLOATING-POINT OPERANDS: The DN330, DN460, DN560, DN570, DN580, and DN660 support an integrated hardware floating-point VLSI processor. Single (32-bit), double (64-bit), and extended (80-bit) precision data formats are supported.

The floating-point unit employs monadic and dyadic floating-point operations, with a 56-bit-wide Arithmetic Logic Unit. Nineteen common, high-level language trigonometric and transcendental functions are implemented in microcode.

INSTRUCTIONS: The instruction set of the processor includes 32-bit data types as well as a 24-bit linear virtual address space.

INTERNAL CODE: ASCII.

MAIN STORAGE

TYPE: High-speed dynamic MOS RAM.

CYCLE TIME: 200 nanoseconds for DN300, DN460, DN660, and DN660A.

CAPACITY: The Domain Systems main memory ranges from 1MB to 16MB. See Chart A for capacities of specific models. ▶

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CHART A. SYSTEM COMPARISON

MODEL	DN300	DN330	DN460	DN560	DN570
SYSTEM CHARACTERISTICS					
Date of introduction	January 1983	—	October 1983	September 1985	February 1986
Date of first delivery	February 1983	September 1985	—	—	—
Operating system	Aegis, Domain/IX	Aegis, Domain/IX	Aegis, Domain/IX	Aegis, Domain/IX	Aegis, Domain/IX
Upgradable from	—	—	—	—	—
Upgradable to	—	Domain Family	—	Domain Family	Domain Family
MIPS	0.4	—	0.1	—	—
Relative performance	—	—	—	—	—
MEMORY					
Minimum capacity, bytes	1MB	2MB	1MB	2MB	2MB
Maximum capacity, bytes	3MB	3MB	4MB	3MB	16MB
Type	RAM	RAM	RAM	RAM	RAM
Cache memory	None	—	4KB instruction/ 16KB data	—	256KB
Cycle time, nanoseconds	200	—	200	—	—
Bytes fetched per cycle	2	—	—	—	—
INPUT/OUTPUT CONTROL					
Number of channels	1 block multiplexer	—	—	—	—
High-speed buses	Internal background; Domain Network	—	—	Multibus	—
Low-speed buses	None	—	—	—	—
MINIMUM DISK STORAGE	34MB; 1.2MB floppy	70MB; 1.2MB floppy	80MB; 1.2MB floppy	86MB	86MB
MAXIMUM DISK STORAGE	70MB	140MB	1GB	172MB	—
NUMBER OF WORKSTATIONS	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited
COMMUNICATIONS PROTOCOLS	X.25, HASP, 3270 Ethernet, TCP/IP	X.25, HASP, 3270, Ethernet, TCP/IP	X.25, HASP, 3270, Ethernet, TCP/IP	X.25, HASP, 3270, Ethernet, TCP/IP	X.25, HASP, 3270, Ethernet, TCP/IP

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

CHART A. SYSTEM COMPARISON (Continued)

MODEL	DN570A	DN580	DN660	DN660A	Series 3000
SYSTEM CHARACTERISTICS					
Date of introduction	February 1986	February 1986	October 1983	May 1985	February 1986
Date of first delivery	—	—	—	—	—
Operating system	Aegis, Domain/IX	Aegis, Domain/IX	Aegis, Domain/IX	Aegis, Domain/IX	Aegis, Domain/IX
Upgradable from	—	—	—	—	—
Upgradable to	Domain Family	Domain Family	—	—	—
MIPS	—	—	1.0	1.0	—
Relative performance	—	—	—	—	—
MEMORY					
Minimum capacity, bytes	2MB	2MB	1MB	1MB	2MB
Maximum capacity, bytes	16MB	16MB	8MB	8MB	4MB
Type	RAM	RAM	RAM	RAM	—
Cache memory	256KB	—	4KB instruction/ 16KB data	—	—
Cycle time, nanoseconds	—	—	200	200	—
Bytes fetched per cycle	—	—	—	—	—
INPUT/OUTPUT CONTROL					
Number of channels	—	—	—	—	—
High-speed buses	—	—	—	—	—
Low-speed buses	—	—	—	—	—
MINIMUM DISK STORAGE	86MB	86MB	80MB	80MB	72MB
MAXIMUM DISK STORAGE	—	466MB	1.167GB	1.167GB	144MB
NUMBER OF WORKSTATIONS	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited
COMMUNICATIONS PROTOCOLS	X.25, HASP, 3270, Ethernet, TCP/IP	X.25, HASP, 3270, Ethernet, TCP/IP	X.25, HASP, 3270, Ethernet, TCP/IP	X.25, HASP, 3270, Ethernet, TCP/IP	X.25, HASP, 3270, Ethernet, TCP/IP

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

▷ ports. The DN330 supports both the Domain/IX and Aegis operating system environments, either concurrently or independently.

The DN560 color workstation is also based on Motorola's 32-bit 68020 microprocessor. The DN560 supports 2MB to 3MB of main memory, dual 86MB Winchester disk drives, and a quarter-inch 60MB streaming tape drive as an option, and two RS232-C ports. A hardware floating-point is standard on the DN560. The DN560 display is 19-inch, with an 1024-by-800 bit-mapped color display. The DN560's Multibus module contains a four-slot Multibus peripheral adaptor, power supply, and fans. ▷

▶ **CHECKING:** Parity checking memory is standard with the DN300 and the DN330 nodes. The DN460, DN560, DN570, DN580, and DN660 workstations feature error-correcting memory.

STORAGE PROTECTION: ACL system protection for any level.

RESERVED STORAGE: Information not available from vendor.

CACHE MEMORY: Both the DN460 and DN660 include 4KB of bipolar instruction cache memory and 16KB of bipolar data cache memory. The 4KB, write-through cache uses a two-way set associative structure and retains least ▶

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The DN570 has the same 32-bit CPU as the DN580 and includes an integrated display processor capable of performing up to 40,000 2-D integer transformed and clipped vectors per second. The screen is 15 inches, with tilt-and-swivel capabilities, and includes a 60Hz noninterlaced, 1024-by-800 pixel bit-mapped display. The DN570 comes with 2MB or 3MB of ECC main memory, expandable to 8MB, 12MB, or 16MB. The DN570 workstation offers 256 colors out of a palette of 16 million.

The DN570 is targeted for compute-intensive applications, such as IC design, PCB routing, circuit simulation, and cell compiling. Standard equipment on the DN560 and DN570 include dedicated video memory with eight color planes, a detachable programmable keyboard and optional mouse, two RS232-C ports, an integrated 12M-bit-per-second local area network interface, and licenses for Aegis and Domain/IX software.

The DN580 is a 3-D-color graphics workstation designed specifically for graphics-intensive applications. The DN580 supports a 16MHz, 32-bit CPU with a MC68881 co-processor. The DN580 can be configured with 2MB or 3MB of ECC main memory, expandable to 8MB, 12MB, or 16MB. The screen is 19-inch, 60Hz noninterlaced, 1280 by 1024 pixels, with a bit-mapped display. The system supports 24 concurrent processes with up to 64MB of address space per process.

The DN580 boasts up to 100,000 2-D integer transformed and clipped vectors per second with the basic display processor; the high-performance display processor is capable of over 18 million operations per second. The DN580 uses Apollo's recently introduced realtime graphics processor, 3DGA, which speeds up the display of graphic objects generated with 3D GMR, Apollo's proprietary graphics system. The 3DGA executes graphics instructions directly from graphics metafiles resident in the system's virtual memory. The company's Domain Series 3000 Personal Workstation is available in color and monochrome; it combines a 32-bit Motorola MC68020 processor and an MC68881 floating-point co-processor.

The Series 3000 workstations are compatible with the Domain system of workstations, compute servers, and software applications. Series 3000 color personal workstation features include a 15-inch, 60Hz color monitor with 1024-by-800 pixel resolution and four-bit planes for display of 16 colors from a palette of 4,096 colors. The Series 3000 supports 2MB or 4MB of memory, an optional 72MB Winchester disk, a 1.2MB, 5¼-inch floppy disk drive, and a 60MB, ¼-inch cartridge tape drive. The operating system supports either Domain/IX or Aegis.

The DSP90 server processor is configured with 2MB of memory, dedicated floating-point co-processor, a five-slot IEEE-P796 multibus adaptor, two asynchronous I/O ports, and a network interface: it provides 64MB of virtual address space per process. The DSP90 offloads compute-intensive operations such as large compiles, and simulations and other processes that involve remote pro-

recently used (LRU) information to achieve a cache hit rate of approximately 90 percent.

CENTRAL PROCESSOR

GENERAL: The central processing unit (CPU) is built around a Very Large Scale Integration (VLSI) microprocessor with a 32-bit architecture. The physical parameters of the system, most notably the width of the data path, can be viewed in an hierarchical arrangement. At the system level, computer nodes are interconnected with a 1-bit serial packet network. Internal CPU registers and an arithmetic logic unit are all implemented with full 32-bit data paths. The DN300, DN330, DN560, DN570, and DN580 are based on Motorola's MC68020 processor. A proprietary chip is used in the DN460 and DN660.

The internal Domain node organization comprises several key parts. First, the CPU includes multiple VLSI packages. This CPU is connected to a memory management unit (MMU) which translates the 24-bit virtual address out of the CPU into a 22-bit physical address on the physical memory bus.

The MMU is composed of two parts: one for the CPU and another part for the I/O system. The memory system includes multiple units—each unit containing either 0.5 or 1 megabyte.

The MMU works on 1024-byte physical page sizes and has separate protection and statistics information for each page. The MMU is a two-level hierarchy, the frame page table being at the highest level. A lower level cache, called the page translation table, contains the most recently used pages and acts as a speed-up mechanism to search the page frame table.

CONTROL STORAGE: On the Domain performance enhancement board (PEB), the control unit is made up of a 1024-by-56-bit loadable control store, a 2910-bit slice microsequencer with a five-level-deep subroutine stack, and fourteen 2903 ALU/register file devices.

REGISTERS: In addition to the 56-bit-wide arithmetic logic unit (ALU), there are sixteen 56-bit registers used for command, control, and storage facilities.

ADDRESSING: Each Domain node supports up to 24 concurrent processes. Each of the processes is a 64-megabyte linear virtual address space on the DN300, DN330, DN560, DN570, and DN580. The DN460, DN660, and DN660A each support 256 megabytes per process. Various instructions access data within byte, word, and longword ranges.

INTERRUPTS: Information not available from vendor.

OPERATING ENVIRONMENT: The recommended operating temperature for the Domain nodes is between 60 and 90 degrees Fahrenheit at 20 to 80 percent relative humidity. The Series 3000 operates at 500 Volt-Amps. The DN570 operates at 120 VAC ±10 percent. The DN580 operates at 120 VAC ±10 percent. The DN300 and DN330 operate at 120 VAC ±10 percent, 15A at 60Hz. The DN560 operates at a maximum of 117 VAC ±16 percent. The DN460 operates at 120 VAC ±10 percent, 20 amp at 60Hz. The DN660 operates at 120 VAC ±10 percent, 20 amp at 60Hz, 625 watts.

The dimensions for the Domain Systems are as follows. The Series 3000 is 7 inches high, 21 inches wide, and 17 inches deep. The 3000 weighs about 52 pounds. The DN570 is 24.5 inches high, 13.5 inches wide, and 28.5 inches deep. The DN570 weighs 100 pounds. The DN580 is 24.5 inches high,

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CHART B. MASS STORAGE

MODEL	MSD-1.2M	SMSD-70M	SMSD-70M-1.2M	MSD-80M	MSD-86M (Dual)	MSD-167M
Type	Diskette	Winchester	Winchester/diskette	Winchester	Winchester	Winchester
Controller model	Apollo-supplied	Apollo-supplied	Apollo-supplied	Apollo-supplied	Apollo-supplied	Apollo-supplied
Drives per subsystem/controller	1	1	1	1	1	1
Formatted capacity per drive, megabytes	1.2MB	70MB (unformatted)	63MB/1.2MB	74MB	138MB	147MB
Number of usable surfaces	—	5	—	—	—	—
Number of sectors or tracks per surface	—	—	—	—	—	—
Bytes per sector or track	—	—	—	—	—	—
Average seek time	—	42 ms	—	25 ms	—	25 ms
Average rotational/relay time	108 ms	8.3 ms	—	—	—	—
Average access time	—	50.3 ms	—	—	—	—
Data transfer rate	—	0.8MB/sec.	—	—	—	—
Supported by system models	DN460, 660 (A), DSP160	DN3XX	DN3XX	DN460, 660 (A), DSP160	DN5XX	DN460, 660(A), DSP160
Comments						

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

CHART B. MASS STORAGE (Continued)

MODEL	MSD-190M	MSD-190M-190M	MSD-300M	MSD-500M	MSD-1000M	MSD-2000M
Type	Winchester	Winchester	Removable	Fixed	Fixed	Fixed
Controller model	Apollo-supplied	Apollo-supplied	Apollo-supplied	Included	Included	Included
Drives per subsystem/controller	2	2	2	2	2	2
Formatted capacity per drive, megabytes	154MB	308MB	281MB	442MB	1000MB (unformatted)	2000MB (unformatted)
Number of usable surfaces	—	—	19	12	—	—
Number of sectors or tracks per surface	—	—	—	—	—	—
Bytes per sector or track	—	—	—	—	—	—
Average seek time	—	—	30 ms	20 ms	—	—
Average rotational/relay time	—	—	8.3 ms	8.3 ms	—	—
Average access time	—	—	38.3 ms	28.3 ms	—	—
Data transfer rate	—	—	1.2MB/sec	1.8MB/sec.	—	—
Supported by system models	DN5XX	DN5XX	DSP 80 (A), DSP90, DFS, DN660	DSP80 (A), DSP90, DN660	DSP80 (A), DSP90, DN660	DSP80 (A), DSP90, DN660
Comments						

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

cessing. The DSP90 can be used as a communications and peripheral server, offloading workstations from performing administrative functions.

The DSP3000 is a peripheral server based upon the Series 3000 system. Users across Domain networks can share PC-compatible peripheral devices integrated with the server's IBM PC/AT-compatible bus.

The DSP9000 is a parallel processor and compute server. Apollo states that the machine is rated up to 94MFLOPS and 35 MIPS of power. Domain network users can assign compute-intensive applications to the DSP9000, freeing the workstation's processor. A prepackaged DSP9011, the entry-level DSP9000, is configured with one computational element, 8MB of memory expandable to 16MB, 2GB of virtual memory per process, a 268MB disk, and a cartridge tape drive. All configurations include hardware and software for interfacing with the Domain network. The DSP9000 server cabinet is 30 inches wide, making it suitable for office environments.

Apollo has enhanced the integrated disk storage capacity of its workstations with the addition of a 5¼-inch, 154MB (190MB unformatted) Winchester disk. The storage is also available in a dual Winchester disk (308MB formatted)

13.5 inches wide, and 28.5 inches deep. The DN580 weighs 100 pounds. The DN300 and DN330 are 18.4 inches high, 22.5 inches wide, and 16.5 inches deep. The DN300 and DN330 weigh about 88 pounds. The DN560 is 24.5 inches high, 13.5 inches wide, and 28.5 inches deep. The DN560 weighs 80 pounds. The DN460 is 29 inches high, 23.25 inches wide, and 31.5 inches deep. The DN460 weighs 210 pounds. The DN660 is 29 inches high, 23.25 inches wide, and 31.5 inches deep. The DN660 weighs 210 pounds.

INPUT/OUTPUT CONTROL

Peripherals on the optional Multibus are mapped into the 22-bit Domain physical address bus by means of an I/O map. The I/O map consists of 256 page entries, each entry pointing to a particular physical page. A peripheral on the Multibus can generate a 16-bit word or byte address and have the high order bits indexed into the page map and low order bits indexed relative to the page. In this way, Multibus peripherals can directly address themselves into the virtual memory of a process.

There are four levels in the I/O system of the Domain nodes: the language level, the stream level, mapped primitives, and the page level. The language level is supported by language constructs such as Fortran's Read and Write. The stream level is object-type-independent and can talk to files, peripheral devices, or other processes. Map primitives are object-location-independent and allow streams to operate across the network. All data transfers in the entire system occur at the page level. The page level is the physical I/O to local and

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configuration. The disk subsystem is additionally offered in a configuration with a ¼-inch, 60MB streaming tape cartridge for backup.

The dual-density tape drive, Model MSD6250, can be used with the Domain local-area-network-based workstations and server processors. The MSD6250 can read or record half-inch tapes in both the 6250-bytes-per-inch (bpi) format and the 1600-bpi Phase Encoded format. It also offers a 128KB data buffer.

The Domain/Laser-26 printer prints up to 26 pages of text and graphics per minute, at 300-dots-per-inch resolution. The printer can be configured as a shared resource on a transparent Domain network.

Apollo announced three communications packages: Domain/Vaccess, Domain/SNA, and Domain/PCI. The Vaccess package distributes Digital Equipment Corporation VAX/VMS resources across a Domain network. SNA allows Domain users to share resources with IBM computers through IBM-compatible System Network Architecture. The PCI communications package allows IBM PC users to communicate and share resources in a Domain system.

Three older systems—DN300, DN460, and DN660—round out Apollo's Domain product line. The DN300 workstation features a 32-bit VLSI processor and from 1MB to 3MB of memory. The DN300 supports a 34MB or 70MB Winchester disk and an 1.2MB floppy diskette as an option. Two RS232-C ports are included in the basic configuration, as well as a 1024-by-800 bit-map raster display.

Both the DN460 (monochrome) and DN660 (color) workstations feature proprietary processors. Each CPU includes 4KB of bipolar instruction cache memory, 16KB of bipolar data cache memory, and an integral single- and double-precision hardware floating-point.

The DN460 supports from 1MB to 4MB of main memory, an 80MB or 167MB Winchester disk, and three RS232-C ports. Optionally, the DN460 can support 80MB or 167MB integral disk drives, and an 1.2MB floppy diskette. External disk drives of 300MB, 500MB, or 1GB can also be configured, as well as a 1600-bpi magnetic tape drive.

The DN660 workstation can support up to 8MB of main memory and an 80MB or 167MB Winchester disk. The DN660 features a 1024-by-1024, 19-inch color display. Optionally, an 80MB or 167MB integral disk drive can be added, along with a 1.2MB floppy diskette. External disk drives of 300MB, 500MB, 1GB, and 2GB (unformatted) can also be configured. Nine-track, 1600-bpi and 3250-bpi tape drives are also options.

Two operating systems are available with Domain systems: Aegis and the Domain/IX. Aegis, a network-wide virtual memory operating system, is geared to support highly interactive operations. Domain/IX is a combination of ▷

remote disks across the network. This data is transferred on demand, resulting exclusively from a CPU page fault.

The *Domain DSP80A Server Processor* lets users connect a wide variety of shared peripheral devices to a Domain system. The DSP80A can control peripherals such as storage module disks, communication gateways, magnetic tape devices, and line printers and plotters, as well as a range of low-speed serial devices. By effectively managing peripherals and communications lines in the network, DSP80A frees user nodes to handle specific application-related processing.

DSP80A can serve as a communications gateway that supports X.25, Hasp, and Ethernet. It can also be used as a backend file server that supports large disk subsystems with a magnetic tape backup facility. The user controls whether devices are connected to a single DSP80A or to multiple DSP80As in a Domain network. The DSP80A includes a 32-bit VLSI CPU, 512KB RAM, five IEEE-796 slots, two asynchronous RS232-C ports, power supply, Domain Network Interface, and license to use the Aegis operating system subset.

DSP80A is compatible with all the Domain nodes. The DSP80A fits in a standard 19-inch rack or, with cabinet covers, can be placed on a tabletop or as a freestanding floor unit.

The *Domain DSP90 Server Processor* is an intelligent server processor, expanding network resource sharing capabilities. The DSP90 is a communications and peripheral server, off-loading workstations from performing administrative functions. The DSP90 includes a 32-bit VLSI central processor, up to 3MB of main memory, a subset of the Aegis operating system, and a five-slot Multibus card cage. The DSP90 lets a Domain network incorporate larger peripherals, external communications gateways, and specialized subsystems, such as array processors. The DSP90 comes standard with an MC68881 hardware floating-point VLSI processor. The DSP90 is compatible with all Domain nodes

The *Domain DSP160 Server Processor* provides a computational resource to be shared throughout an Apollo network. Computation-intensive jobs can be off-loaded to the DSP160 server. The DSP160, like the other servers, has the capability of managing peripheral resources.

The DSP160 includes a 32-bit CPU with integral floating-point processor, 1MB to 16MB of ECC main memory, a 10-slot chassis, three asynchronous RS232-C ports, power supply, Domain Network Interface, and license to use the Aegis operating system subset. An optional Peripheral-to-Node Adapter (PNA) is available for peripheral expansion.

The DSP160 is software-compatible with all the members of the Apollo family of user nodes and servers. DSP160 is a floorstanding unit housed in a 29 by 23.25 by 31.5-inch cabinet.

The *DSP3000* is a peripheral server based upon the Series 3000 system. Users across Domain networks can share PC-compatible peripheral devices integrated with the server's IBM PC AT-compatible bus.

The *DSP9000 Compute Server* is based on an MC68020 processor and applies up to eight compute elements (CEs) in parallel to the solution of every problem. Each CE is a 4.45-MIPS, 32-bit microprogrammed computer, delivering 11.8MFLOPS performance. The DSP900 is integrated into any Domain network. All network users can transparently off-load computationally demanding problems to the server and free workstations for interactive tasks. The entry-level DSP9000 is 30 inches wide. ▶

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CHART C. WORKSTATIONS

MODEL	DN300	DN330	DN460	DN560	DN570
DISPLAY PARAMETERS					
Max. chars./screen	Varies	1024 x 800	1024 x 800	1024 x 800	1024 x 800
Buffer capacity	1MB	1MB	1MB	—	—
Screen size (lines x chars.)	Varies	Varies	19-inch	19-inch	19-inch
Tilt/swivel screen	Tilt	Tilt	Tilt/Swivel	Tilt/Swivel	Yes
Symbol formation	—	—	—	—	—
Character phosphor	Black/White	—	Black/White	Color	Color
Total colors/no. simult. displayed	0	—	0	256 from 16 million	256 from 16 million
KEYBOARD PARAMETERS					
Style	Low profile	Low profile	Low profile	Low profile	Low profile
Character/code set	—	—	—	—	ASCII, PHIGS
Detachable	Yes	Yes	Yes	Yes	Yes
Program function keys	32	—	96	96	—
TERMINAL INTERFACE	RS-232-C	RS-232-C	RS-232-C	RS-232-C	RS-232-C
COMMENTS					

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

CHART C. WORKSTATIONS (Continued)

MODEL	DN570A	DN580	DN660	DN660A	Series 3000
DISPLAY PARAMETERS					
Max. chars./screen	1024 x 800	1280 x 1024	1024 x 1024	1024 x 1024	1280 x 1024
Buffer capacity	—	—	Up to 2MB	Up to 2MB	—
Screen size (lines x chars.)	19-inch	19-inch	19-inch	19-inch	19-inch
Tilt/swivel screen	Yes	Yes	Yes	Yes	Yes
Symbol formation	—	—	—	—	—
Character phosphor	Color	Color	Full color	Full color	—
Total colors/no. simult. displayed	256 from 16 million	256 from 16 million	256 from 16 million	256 from 16 million	16 colors from 4,096
KEYBOARD PARAMETERS					
Style	Low profile	Low profile	Low profile	Low profile	Low profile
Character/code set	ASCII, PHIGS	ASCII, PHIGS	—	—	—
Detachable	Yes	Yes	Yes	Yes	Yes
Program function keys	—	—	96	96	10
TERMINAL INTERFACE	RS-232-C	RS-232-C	RS-232-C	RS-232-C	RS-232-C
COMMENTS					

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

▷ both Berkeley 4.2 and AT&T System V Unix programs. Domain/IX lets the two Unix standards operate as co-resident operating systems on Domain workstations. Apollo users can run either standard, or both simultaneously, on the same node. The Domain/IX software allows any workstation to demand pages from anywhere in the network, eliminating the need for a local disk for each workstation.

The Domain programming environment includes ANSI-standard Fortran-77, Pascal, Lisp, and C, as well as a wide range of standardized software tools. In addition, over 350 third-party applications packages are available from over 100 software suppliers. Many of these applications cover scientific graphics, artificial intelligence, and engineering areas.

COMPETITIVE POSITION

With the 32-bit workstation market booming-- predictions from International Data Corporation (IDC) indicate that 42,000 scientific workstations will be shipped in 1986, versus 19,000 in 1985—Apollo is in the thick of a workstation shoot out. Apollo officials have stated that they see the major competition for the Domain systems coming from the likes of International Business Machines and Digital Equipment Corporation. Even though Apollo claims its primary competitors are IBM and Digital, IDC's installed-base figures indicate that Sun is Apollo's primary competi- ▷

▶ The *Peripheral-to-Node Adaptor (PNA)* and *General-Purpose Input/Output (GPIO)* software are two Apollo products used for connecting peripheral devices to the Domain DN460, DN660, and DN660A. The PNA is required to support peripherals supplied by Apollo, such as storage module disk subsystems, magnetic tape subsystems, and high-speed line printers. A PNA includes a five-slot IEEE-796 (Multibus) card cage and a power supply. In addition, Domain users may write their own device control software and use the GPIO package to support other available IEEE-796-compatible peripherals. Bus specifications, a guide to the use of GPIO software, and a sample device driver are included with the GPIO package. A PNA, DSP80, or DSP160 is required to use GPIO.

Domain users also have the option of connecting their own specialized devices or peripherals through either the IEEE-796 Multibus or one of the two RS232-C serial I/O ports. This feature—along with the GPIO software—lets users write their own transparent device drivers in a high-level language without concern for the underlying bus structure, assembly language, or other hardware specifics.

CONFIGURATION RULES

GENERAL: All Domain computational nodes include a high-performance 32-bit processor, memory management unit, interface to the Domain local area network, integrated high-resolution bit-mapped graphics display with detachable keyboard, and license to use both the Aegis and Unix operating systems. (Both systems feature virtual memory with a display manager.) Also included are a font editor, Graphics Metafile Resource, the Domain/Dialogue User ▶

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CHART D. PRINTERS

MODEL	HCD-MMP	HCD-LP26S+
Type	Multimode printer/plotter	Laser
Speed	125/500 cps	26 pages per minute
Bidirectional printing	Yes	No
Paper size	2.95-15.35 in.	Up to 11 x 17 in.
Character formation	Dot matrix—144 dpi	300 dpi
Horizontal character spacing (char./inch)	10, 12, 13.1, 16.7	—
Vertical line spacing (char./inch)	—	—
Character set	96 ASCII	96 ASCII
Controller/Interface	RS232-C	Centronics parallel/RS232-C
No. of printers per controller/interface	1	1
Printer dimensions, in. (h x w x d)	—	16.1 x 26.7 x 23.4
Graphics capability	72 x 72 dots per inch	Yes
Comments		Full bit-map images, logos, and special characters

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

CHART E. MAGNETIC TAPE EQUIPMENT

MODEL	MSD-1600	MSD-6250
TYPE	—	—
FORMAT		
Number of tracks	9	9
Recording density, bits per inch	1600	6250/1600
Recording mode	PE	—
CHARACTERISTICS		
Controller model	Integral	Integral
Drives per controller	1/node	1/node
Storage capacity, bytes	80MB	60MB
Tape speed, inches per second	25	25
Data transfer rate, units per second	40K/sec.	—
Streaming technology	100 ips	—
Start/stop mode; speed	25 ips	—
Switch selectable	Via software	Via software

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

tor in the workstation market, and that together the two dominate the area. Other contenders include Hewlett-Packard, Digital, and Masscomp.

The Sun Microsystems SunStations include a 32-bit MC68020 CPU, a MC68881 floating-point co-processor, and an 1152-by-900 bit-mapped graphics controller. The systems support Unix and feature the Ethernet interface and Sun's Network File System.

Comparing the Sun-3/160C to Apollo's DN570 workstation, we find that the workstations have equal amounts of main memory—up to 16MB. The Sun-3/160C outdistances the DN570 in disk capacity, allowing up to 900MB of disk. Both operating systems are Unix-based; the Sun workstation supporting Unix System 5. Sun and Apollo systems allow for the supporting of an unlimited number of users.

Digital Equipment Corporation's sparing partner for the Apollo DN580 color workstation is the MicroVAX II. The DN570 allows for more main memory than the Micro-VAX II; the DN570 supports 16MB of memory versus 9MB for the Digital system. However, the MicroVAX II wins in the disk contest, supporting up to 1.8GB of disk. The DN580 allows for 466MB of disk storage. The Micro-

Interface Management System, 2-D and 3-D graphics primitives, language debugger, a software driver for the Apple LaserWriter printer, VT100 emulators, open system toolkit, and network management utilities.

WORKSTATIONS: The DN300 and DN330 are desktop superminicomputers that, individually, can be used as workstations. The DN460, DN560, DN570, DN580, and DN660 function as workstations, but have supermini capabilities. The number of workstations that can be clustered together is dependent upon the network. All the Domain nodes support a variety of peripheral and performance options.

The Series 3000 personal workstation is available in both monochrome and color display models. The Series 3000 supports a 32-bit MC68020 central processor and MC68881 floating-point coprocessor. An IBM PC AT-compatible bus is standard on the Series 3000. The Series 3000 personal workstation is compatible with the rest of the Domain System Product Family. The Series 3000 workstation includes a color display workstation with a 15-inch screen, 60Hz refresh rate, and 1024-by-800 resolution. The Domain 4014 emulator lets Series 3000 workstations function as Tektronix 4014 graphics terminals, and lets users access a range of 4014 applications running on remote mainframes and superminis.

DISK STORAGE: The DN300 supports a 34MB or 70MB Winchester disk and a 1.2MB floppy diskette. The DN330 supports a 70MB Winchester disk and a 1.2MB diskette option. The DN460 supports 80MB and 167MB integral

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▷ VAX II can accommodate up to 33 workstations, while the Apollo model can link up with an unlimited number of Domain members. Both systems support floating-point operations; both systems are designed for realtime, scientific and engineering operations. Digital boasts over 2,000 software packages written for the VAX line, while Apollo offers about 400 packages for the Domain Systems. However, the Apollo packages are targeted specifically for engineering and scientific applications.

The IBM PC RT is the newcomer in the 32-bit workstation marketplace. At this time though, IBM is unable to network the RT, except through PC Net. And, IBM is not limiting the RT to the engineering and scientific niche.

ADVANTAGES AND RESTRICTIONS

One of the main advantages of the Domain nodes is the compatibility of the product line. All the nodes are software-compatible and can share peripherals. Although the hard disk options are not supported by each node, users on one node have access to the storage devices on another. The price of the systems are comparable to the power they supply. Apollo prices are in the same range as those for other systems with comparable features. (Generally speaking, the price of engineering workstations has tumbled, allowing more workstations to be sold to more users.) The nodes are also easy to install. Because the models run on standard electrical current, they can be plugged into a regular outlet.

Another advantage Apollo provides is its varied product line. Apollo now offers an assortment of low-, middle-, and high-end monochrome and color workstations, compute servers, and peripheral servers. This selection allows for the construction of flexible and powerful networks; Apollo has dipped below the $10,000 mark for making a compute-intensive workstation.

A positive aspect of Apollo's maintenance program is that each service representative is qualified to support both hardware and software. Many vendors have two different organizations or departments that support either hardware or software, unlike Apollo's organization which provides a single source for service.

USER REACTION

The Apollo systems were not represented in the recent Datapro Computer Users Survey and Apollo was unable to supply us with a list of users. Thus, we were unable to contact any Apollo users to obtain evaluations of system performance. □

▶ disk drives, a 1.2MB 8-inch diskette, and 300MB, 500MB, or 1000MB external disk drives. The DN560 supports a dual 5¼-inch 86MB Winchester disk drive. The DN570 and DN580 each can support an 86MB 5¼-inch Winchester disk, or a 190MB disk, and dual 190MB Winchester disks. The DN660 supports an 80 and 167MB integral Winchester disk, a 1.2MB, 8-inch floppy diskette, and 300MB, 500MB, 1000MB, or 2000MB external disk drives. The Series 3000 supports a 86MB Winchester disk and a 5¼-inch, 1.2MB, double-sided, high-density floppy disk drive.

MAGNETIC TAPE: Two magnetic tape drives and controllers are available for the Domain systems. The MDS-1600 is a 1600-bps, 25-ips, 9-track tape drive mounted in a cabinet. The MSD-6250 is a 6250-1600-bpi, 25-ips, 9-track tape drive mounted in a cabinet. Prerequisites for both drives are: PNA, MBUS, DSP80(A), DSP90, or DFS.

PRINTERS: A multimode near-letter-quality, draft/graphics printer/plotter is available from Apollo. The printer is compatible with any DN node and with DSP80(A), DSP90, and DSP160 File Servers. A laser printer is also available, also supporting any DN node, DSP80(A), DSP90, or DSP160. The laser printer, either serial or Centronics parallel version, prints up to 26 pages per minute. Each Domain node supports one printer.

MASS STORAGE

See Chart B.

INPUT/OUTPUT UNITS

See Chart C for Workstations, Chart D for Printers, and Chart E for Magnetic Tape Equipment.

COMMUNICATIONS CONTROL

The *Domain X.25 Gateway* provides Domain users with shared access to long-distance communications via international public packet switching networks or private X.25 networks. Either a DSP90, DSP80A Server Processor, or PNA-equipped DN660, DN460, DN5XX, or DSP 160 can support the Domain X.25 intelligent communications controller. They can then perform as a gateway server to a community of Domain system users. The package contains dual synchronous lines, full X.25 software protocol with extensions, and two modem cables.

The *Domain Networking Ethernet Gateway* consists of an intelligent transceiver and a floppy diskette containing TCP/IP software. This product provides Domain system users with shared access to existing Ethernet transport facilities. With this capability, TCP/IP-Ethernet-attached Domain networks, mainframes, and superminicomputers can exchange information. Each Domain workstation has equal access to Ethernet Gateway services. The Ethernet Gateway Communications Controller can be installed in a DSP80A or a DSP160 Server, a DN660 or a DN460 user node equipped with a PNA, or a DN550 user node equipped with a Multibus Peripheral Adaptor.

The *Domain/ComController* is an intelligent Multibus card that lets Domain users share information and resources with IBM and IBM-compatible System Network Architecture (SNA) computers. The Domain/ComController card supports two interface ports. A single port can be used at 19,200 bits per second (bps); both ports can be used simultaneously at 9600 bps on each port. The 3274-1C cluster controller is supported, as is the SDLC data link interface.

SOFTWARE

OPERATING SYSTEMS: There are two operating systems available for the Domain systems: Aegis and Domain/IX.

The *Aegis operating system* provides an integrated computing environment designed to enhance technical professionals' individual and teamwork productivity. Aegis combines virtual memory management with access to the Domain system's graphics displays and local area network. It offers a multiuser system environment for applications that include computer-aided design, engineering and scientific computation, computer-aided software engineering, artifi- ▶

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► cial intelligence research, electronic publishing, and financial modeling.

The Aegis operating system includes the following features:

• Virtual memory support for direct execution of large programs

• Network-distributed file system with access control list security and protection facility

• Concurrent, multiwindow Display Manager Environment providing "virtual terminals" to programs, text, and graphics; includes screen-oriented editing

• Interprocess communication, process creation, and event synchronization to coordinate execution of separate programs

• On-line HELP facility, including documentation of access to system services

• Shell command line interpreter for application control

• Support for a variety of programming languages and data management techniques

Aegis also supports a wide selection of options for communications beyond the Domain network, including file transfer, remote virtual terminal, and virtual circuit services based on X.25 and related protocols; mainframe file transfer and remote job entry using the HASP protocol; 3270 interactive terminal emulation using either bisync or SDLC data links; Ethernet interface at the data link level; asynchronous ASCII file and interactive terminal emulation; and the ability to read and write both EBCDIC and ANSI-labeled tapes.

Apollo's *Domain/IX* is a combination of Berkeley 4.2 and AT&T System V Unix software. Domain/IX software lets the two Unix standards operate as coresident operating systems on Domain workstations. Users can run either standard, or both standards, simultaneously on the same node.

The Unix file system on Apollo's token passing ring network appears to all users as a single file structure, although the data may be located on various system nodes. With Domain/IX software, any workstation or server processor can demand pages from anywhere in the network—eliminating the need for a local disk for every workstation. Domain/IX software supports C, Fortran-77, ISO Pascal, and Lisp programming languages, in addition to a multiwindow debugger. The four compilers share a common code generator which allows programmers to write different portions of large programs in the appropriate language and later combine them into one application.

Other features of Domain/IX include: a wide range of graphics libraries and support of bit-mapped monochromatic and color displays.

Domain/IX supports the communications options discussed under the Aegis system.

DATA BASE MANAGEMENT: Apollo offers two data base management systems to Domain users: Oracle and D3M.

Oracle is offered to users through Apollo's Software Supplier Program. A true relational data base, Oracle provides high-level data manipulation and query languages that operate on sets of records simultaneously.

Domain Distributed Data Management (D3M) allows users to organize and access information located anywhere in a Domain processing network. Users may combine whole or partial views of many individual data bases into a single, logical data base for both query and update purposes. According to Apollo, D3M integrates the runtime efficiency of a Codasyl-compliant design with the personal productivity advantages of a relational interface to span a spectrum of data management applications from simple, file-drawer chores to CAD/CAM, engineering, scientific, and software development applications.

Features of Domain's Distributed Database Management System include Codasyl-compliance with relational access functions; distributed data base support with aggregate schemas; ease of use features that include query with update functions, automatic subschema generation, implicit disk allocation, and electronic file drawer (no programmer needed); program callable relational query functions; and distributed recovery and concurrency control.

D3M, as a family of software components, provides users with all the necessary data base tools needed to create, maintain, and update both small and large data bases. These components include:

• D3M/Dataview—a query/update language that provides relational capabilities for both queries and forms-oriented updates.

• D3M/Describe—a fully interactive data base description tool that can be driven using either forms or commands.

• D3M/Unite—an aggregate schema compiler to create logical combinations of multiple data bases located anywhere in a Domain local area network.

• D3M/Formatter—a complete report writing package specifically tailored for the nonprogrammer.

• D3M/Runtime Library—resides in the shared virtual memory with the rest of the Domain distributed operating system. It is bound to user programs at execution time to provide D3M services.

• Schema and Subschema Compilers—process the Codasyl-standard data description language to generate data base descriptions.

• Data base maintenance utilities—such as Index, Collect Freespace, and Initialize Diskspace, which work on an ongoing basis with the shared routine library.

LANGUAGES: Pascal, Fortran-77, C, and Lisp are members of the Domain Language System. The Language System is a software development environment that includes Pascal, Fortran-77, and C language compilers; a common code generator, binder, and runtime package; and a high-level language debugging system. The Language System runs under the Aegis operating system on any Domain computational node.

COMMUNICATIONS: Communications support capabilities provided by Apollo's Domain nodes include X.25, RJE Access Gateway and 3270, BSC, Ethernet TCP/IP, Domain/VACCESS-1, Domain/PCI, and Domain/Bridge.

Domain X.25 Gateway provides Domain users with shared access to long-distance communications via international public packet switching networks or private X.25 networks. Domain X.25 conforms to CCITT recommendations for communications protocols and is compatible with the International Standards Organization Open Systems Interconnection (ISO/OSI) Reference Model. In addition, it includes a file transfer service for use between remote Domain computing systems. Domain X.25 operates under the Aegis virtual memory operating system. The X.25 Gateway includes an intelligent hardware controller that mounts in a DSP80(A), PNA, or MBUS. ►

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▶ *RJE Access Gateway* provides shared access to HASP/ 2780/3780 environments from Domain workstations. The RJE Access Gateway comprises three programs.

The *Domain Networking-Ethernet Gateway* provides Domain users with shared access to existing Ethernet transport facilities. The transport, network, and data link level protocols used are Transmission Control Protocol (TCP), Internetworking Protocol (IP), and Ethernet. This gateway conforms to the IEEE 802.3 standard and is compatible with the ISO/OSI Reference Model. With this capability, TCP/IP-Ethernet attached networks, mainframes, and superminicomputers can exchange information. The package also includes a bidirectional file transfer protocol and a Telenet protocol for unidirectional Domain node virtual terminal services.

Domain/VACCESS-1 gateway is a transparent communications product that supports file transfer, file management, and remote login to Digital Equipment Corporation VAX/ VMS systems over Department of Defense standard TCP/IP and industry-standard Ethernet protocols. The Domain/VACCESS-1 gateway requires a Domain server node to house Domain/VACCESS-1 hardware components, and an Ethernet cable to the VAX/VMS systems.

Domain/PCI (Personal Computer Interconnect) links users of IBM and IBM-compatible PCs to the Domain system. Through the Domain/PCI product, PC users can access the distributed file system of a Domain network, along with system resources, such as printers and other peripheral devices.

Domain/Bridge Internet Router is a high-speed communications bridge that provides a link between Domain network rings. This connection can be via T-1 and equivalent common carrier services, as well as via local area networks, microwave links, fiber optic links, and PABX.

UTILITIES: Apollo provides terminal emulators, font editors, and a high-level debugger.

OFFICE AUTOMATION: The Apollo Domain Systems are targetted to the engineering and scientific market and not the the general office environment.

APPLICATIONS: In addition to the specific applications discussed below, a variety of applications are available from third-party vendors. Catalogue of Applications for the Domain Systems includes over 350 third-party software, hardware, and value-added supplier applications. Application areas include electronic engineering, mechanical engineering, finite element analysis, artificial intelligence, and software engineering.

The Domain Core Graphics System is a set of user-callable subroutines that implement the 1979 GSPC Core Proposed Standard Graphics Software System. The Domain Core System provides high-level graphics functionality designed to allow the user to concentrate on developing applications rather than graphics system software. The Domain Core System adheres to the GSPC Proposal and supports the full range of 2-D and 3-D viewing and image transformations. It supports all Domain computational nodes, allows applications to be device-independent, and supports input devices, such as the touchpad, mouse, data tablet, and keyboard.

Domain's Graphic Metafile Resources (GMR) combines a set of graphics capabilities with high graphics throughput. The package is designed to accommodate emerging industry standards. GMR integrates graphics data base and advanced graphics display routines. With GME, graphics entries are stored in a Graphic Metafile, which can be shared among other applications. The Metafile is a virtual file capable of storing up to 256MB of data. Metafile data

can be displayed in multiple viewpoints within a given window. GMR handles all scaling, translation, windowing, and clipping.

Apollo's Graphics Primitives Resource (GPR) offers program developers a set of graphics routines.

The *Domain Professional Support Services (DPSS)* is made up of an integrated set of tools designed to improve the technical professional's administrative productivity. DPSS includes five tools: DPSS/Document, DPSS/Mail, DPSS/ File, DPSS/Calc, and DPSS/Calendar. Each tool is accessible through a mouse-and-icon facility. All the DPSS tools can be accessed concurrently on the screen through Domain's windowing capabilities.

Apollo's *Domain Software Engineering Environment (DSEE)* includes a set of four integrated, interactive functions for the software engineer. The DSEE/History Management tool handles all the source code that makes up a project; it offers shared access to the past versions of multiple software modules. DSEE/Configuration Management monitors the construction of a system from its component parts. It controls multiple versions of systems, allows reconstruction of any original software configuration, and compiles the latest modules in the software cycle. Any dependencies in or changes made to an element are detected in DSEE/ Advise Management. The advise management function automatically notifies the affected people or projects by adding predefined tasks to their task lists. The fourth tool is DSEE/Task Management, which relates an individual engineer's work to the goal of the organization as a whole.

PRICING

POLICY: Apollo sells its products via direct sales; discounts are available for quantity purchases.

SUPPORT: Apollo Computer takes a system-level view toward the maintenance of its computer hardware and software products. Each system Support Representative is qualified to support both Apollo hardware and software products.

Service and information requests for customers with system maintenance agreements are conducted through the Apollo Response Center's toll-free line. The first point of contact is a System Support Specialist who performs diagnostic and resolution activities. If it is necessary for on-site remedial support, a System Support Representative is dispatched with the appropriate replacement modules and software expertise to effect resolution.

The System Maintenance Agreement features the following:

• Complete support of the Apollo operating system, software, and hardware products.

• Telephone assistance via the Apollo Response Center's toll-free line from 8:30 a.m. to 8:00 p.m. (EST), excluding Apollo-observed holidays.

• On-site remedial support from 8:30 a.m. to 5:30 p.m. Monday through Friday, excluding Apollo-observed holidays.

• Planned preventive maintenance program.

• All labor and materials required to complete remedial and preventive maintenance.

• Updates of all maintained products (hardware/software).

TRAINING: Apollo offers a variety of "custom" support and training programs to meet individual customer requirements. ▶

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TYPICAL CONFIGURATIONS: Sample configurations
for the Apollo Domain Systems are shown below. Complete
equipment and software prices follow these configurations.

DN3000-C2 COLOR WORKSTATION:

With 2MB of memory, 72MB Winchester disk and 1.2MB floppy diskette and controller, and RS232-C port	$19,400
One HCD-MMP multimode printer	3,800
TOTAL PURCHASE PRICE:	**$23,200**

DN570A-3MB COLOR NODE With 3MB of memory	$34,900
One MSD-190M-TC 190MB; 60MB tape unit	12,900
One HCP-LP26C+ laser printer	34,900
TOTAL PURCHASE PRICE:	**$82,700**

EQUIPMENT PRICES

		List Price ($)	Monthly Maint. Cost ($)	Field Install. Charge ($)

All Domain computational nodes include a 32-bit processor; memory management unit; interface to the Domain network; integrated bit-mapped graphics display; and detachable keyboard. Bundled with each node is the license to use the Aegis and Unix operation system; font editor, Graphics Metafile Resource, the Domain/Dialogue user interface management system, 2-D and 3-D graphics primitives, language debugger, software driver, VT100 emulators, Toolkit, and utilities.

Series 3000 Monochrome Workstations

		List Price ($)	Monthly Maint. Cost ($)	Field Install. Charge ($)
DN3000-M1	Series 3000 monochrome workstation includes license to use Aegis and Domain/IX operating system, 68020 processor, 68881 floating-point coprocessor, 2MB memory, 19-inch resolution, 1280-by-1024 bit-mapped monochromatic display, RS-232-C port, IBM PC/AT compatible bus, Domain ring interface, keyboard, and mouse	9,900	80	140
DN3000-M2	Series 3000 monochrome workstation includes same as DN3000-M1; disk controller, 72MB Winchester disk (formatted capacity), 1.2MB floppy disk (5¼-inch)	14,400	128	140
DN3000-M3	Series 3000 monochrome workstation includes same as DN3000-M1; disk controller, 72MB Winchester disk (formatted capacity), 60MB, ¼-inch cartridge tape drive and controller	16,400	131	140

Series 3000 Color Workstations

		List Price ($)	Monthly Maint. Cost ($)	Field Install. Charge ($)
DN3000-C1	Series 3000 color workstation includes license to use Aegis and Domain/IX operating system, 68020 processor, 68881 floating-point co-processor, 2MB memory, 15-inch resolution, 1024-by-800 bit-mapped color display, RS232-C port, IBM PC/AT compatible bus, Domain ring interface, keyboard, and mouse	14,900	98	140
DN3000-C2	Series 3000 color workstation includes same as DN3000-C1; disk controller, 72MB Winchester disk (formatted capacity), and 1.2MB floppy disk (5¼-inch)	19,400	146	140
DN3000-C3	Series 3000 color workstation includes same as DN3000-C1; disk controller, 72MB Winchester disk (formatted capacity), 60MB ¼-inch cartridge tape drive and controller	21,400	149	140

DN300/DN330 Desktop Computational Nodes

		List Price ($)	Monthly Maint. Cost ($)	Field Install. Charge ($)
DN300-2MB	DN300 computational node includes license to use Aegis and Domain/IX operating systems, 68010 processor, 1024-by-800 monochromatic display, 2MB memory, 2 RS232-C ports, keyboard	11,900	171	140
DN300-3MB	DN300 with 3MB main memory	14,900	209	160
DN330-2MB	DN330 computational node with hardware floating-point unit includes license to use Aegis and Domain/IX operating system, 68020 processor and 68881 floating-point co-processor, 2MB memory, 17-inch 1024-by-800 monochromatic graphics display, 2 RS-232-C ports, and keyboard	15,900	171	140
DN330-3MB	DN330 with 3MB main memory	18,900	209	160

DN560 Color Computational Nodes

		List Price ($)	Monthly Maint. Cost ($)	Field Install. Charge ($)
DN560-2MB	DN560 color computational node includes license to use Aegis and Doman/IX operating system, 68020 processor and 68881 floating-point co-processor, 19-inch 1024-by-800 color display, 2MB, 1MB display memory, 2 RS-232-C ports, Domain ring interface, and keyboard	35,500	302	140
DN560-3MB	DN560 with 3MB main memory	37,500	327	160

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		List Price ($)	Monthly Maint. Cost ($)	Field Install. Charge ($)

▶ **DN570/DN570A Color Computational Nodes**

DN570-2MB	DN570 color computational node includes license to use Aegis and Domain/IX operating system; 68020 processor and 68881 floating-point co-processor, 15-inch 1024-by-800 color display, 2MB memory, drawing processor, 8 planes display memory, 2 RS-232-C ports, Domain ring interface, and keyboard	29,000	206	220
DN570-3MB	DN570 with 3MB main memory	31,900	231	240
DN570A-2MB	Color compuational node includes license to use Aegis and Domain/IX operating system, 68020 processor and 68881 floating-point co-processor, 19-inch resolution 1024-by-800 color display, 2MB memory, drawing processor, 8 planes display memory, 2 RS232-C ports, Domain ring interface, keyboard, and mouse	32,900	222	220
DN570A-3MB	DN570A with 3MB memory	34,900	247	240
DN580-2MB	Color computational node includes license to use Aegis and Domain/IX operating system, 68020 processor and 68881 floating-point co-processor, 19-inch 1280-by-1024 color display, 2MB memory, drawing processor, Domain ring interface, 8 planes display memory, 2 RS232-C ports, and keyboard	43,900	312	220
DN580-3MB	DN580 with 3MB memory	45,900	337	240

DN460/DN660 Workstations

DN460-4MB	DN460 monochrome computational node includes license to use Aegis and Domain IX operating system; 19-inch 1024-by-800 monochromatic graphics display, 4MB, 10-slot chassis, 3 RS232-C ports, hardware floating-point, and keyboard	39,500	449	160
DN460-8MB	DN460 with 8MB main memory	51,500	489	160
DN460-16MB	DN460 with 16MB main memory	71,500	569	160
DN660-4MB	DN660 color computational node includes license to use Aegis and Domain/IX operating system; 19-inch 1024-by-1024 color graphics display, 4MB, 10-slot chassis, 1MB dedicated display, hardware floating-point, and keyboard	52,500	583	300
DN660-8MB	DN660 with 8MB main memory	64,500	623	300
DN660-E-4MB	DN660 with 4MB, 2MB display memory, and 4/8/24 planes	57,000	625	300
DN660-E-8MB	DN660 with 8MB, 2MB display memory, and 4/8/24 planes	69,000	665	300
DN660A-4MB	DN660A color computational node includes license to use Aegis and Domain/IX operating system; 19-inch 1024-by-800 color graphics display, 4MB, 10-slot chassis, 2 RS232-C ports, 1MB display memory, hardware floating-point, and keyboard	49,500	538	300
DN660A-8MB	DN660A with 8MB main memory	61,500	578	300
DN660A-E-4MB	DN660A with 4MB, 2MB display memory, and 4/8/24 planes	54,000	579	300
DN660A-E-8MB	DN660A with 8MB, 2MB display memory, and 4/8/24 planes	66,000	619	300

DSP80A/DSP90/DSP160 Server Processor

DSP80A-HMB	Server processor includes license to use Aegis and Domain/IX operating system; 68010 CPU, 0.5MB, 5 IEEE 796 slots, 2 RS232-C ports, interface printer, port, power supply, and Domain ring interface	9,750	84	120
DSP80A-2MB	Server processor includes DSP80A with 2MB main memory	12,000	136	120
DSP80A-3MB	Server processor includes DSP80A with 3MB main memory	14,000	174	120
DSP80AR-HMB	DSP80A-2MB, rack mountable	9,750	84	120
DSP80AR-2MB	DSP80A-2MB, rack mountable	12,000	136	120
DSP80AR-3MB	DSP80A-3MB, rack mountable	14,000	174	120
DSP90-2MB	Computational server processor includes license to use Aegis and Domain/IX operating system; 68020 VLSI processor, 68881 floating-point co-processor, 2MB, 5 IEEE 796 slots, 2 RS232-C ports, interface printer port, power supply, and Domain ring interface	16,000	136	120
DSP90-3MB	DSP90 with 3MB main memory	18,000	174	120
DSP90R-2MB	DSP90-2MB, rack mountable	16,000	136	120
DSP90R-3MB	DSP90-3MB, rack mountable	18,000	174	120
DSP160-4MB	Computational server processor includes license to use Aegis and Domain/IX operating system; 32-bit CPU, 4MB, hardware floating-point, 10-slot chassis, 3 RS232-C ports, power supply, cabinet, and Domain ring interface	35,000	386	120
DSP160-8MB	DSP160 with 8MB main memory	47,000	426	120
DSP160-16MB	DSP160 with 16MB main memory	67,000	506	120

Domain Fileserver Processors

DFS-80A-2MB	Fileserver with 500MB fixed storage capacity includes license to use Aegis and Domain/IX operating system; 500MB disk storage and controller, DSP80A server processor with 2MB, 68010 CPU, 5-Slot IEEE card cage, 2 RS232-C ports, Domain ring interface, and power distribution unit	36,900	271	300

▶

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		List Price ($)	Monthly Maint. Cost ($)	Field Install. Charge ($)
▶ DFS-80A-3MB	Fileserver with 500MB fixed storage capacity includes DFS80A with 3MB main memory	38,900	309	300
DFS-90-2MB	Fileserver with 500MB fixed storage capacity includes license to use Aegis and Domain/IX operating system; 500MB disk storage and controller, DSP90 server processor with 2MB, 68020 CPU, 68881 FPA, 5-slot IEEE card cage, 2 RS232-C ports, Domain ring interface, and power distribution unit	40,900	271	300
DFS-90-3MB	Fileserver with 500MB fixed storage capacity cabinet includes DFS90 with 3MB main memory	42,900	309	300

Fileserver Options

ADD-DFS-500M	Expansion 500MB disk for DFS fileserver includes additional storage of 442MB (formatted), and Apollo factory installation in DFS cabinet	21,500	119	360
ADD-DFS-1500M	Expansion 1500MB disk for DFS fileserver includes additional storage of 1362MB (formatted), and Apollo factory installation in DFS cabinet	63,900	357	690

Multibus Compatible Options

MSD-500M	Fixed storage disk with 500MB capacity (442MB formatted) includes cabinet, controller, and cables; controller supports up to 2 drives	25,000	135	120
MSD-1000M	Fixed storage disk with 1000MB capacity (884MB formatted), MSD-500M with second 500MB fixed disk	45,500	254	160
MSD-2000M	Fixed storage disk with 2000MB capacity (1768MB formatted), includes 2 cabinets, MSD-500M with four 500MB fixed disks	88,000	492	240
DMSD-500M-A	Expansion 500MB disk drive for MSD-500M	21,500	119	140
MSD-500M-A	Expansion 500MB disk drive for MSD-1000M	22,000	119	120
MSD-1000M-A	Two expansion 500MB disk drives for MSD-500, MSD-1000	42,500	238	160
MSD-300M	300MB storage module disk drive with removable pack, first drive with controller	21,000	212	200
MSD-300M-A	Additional 300MB storage module disk drive with removable pack, second drive	19,000	189	200
MSD-1600	Magnetic tape drive and controller, 1600-bpi, 25-ips, 9-track, in cabinet	12,500	147	60
MSD-6250	Magnetic tape drive and controller, 6250/1600-bpi, 25-ips, 9-track, in cabinet	26,000	175	280

Series 3000 Server Processor

DSP3000-S1	3000 server processor includes MC68020 processor and MC68881 floating-point co-processor, 2MB, 72MB, 5¼-inch Winchester disk, 60MB, ¼-inch cartridge tape drive and controller, 2 RS232-C ports, IBM PC/AT-compatible bus, Domain ring interface, and Domain/IX and Aegis software licenses.	15,500	103	140
DSP9011	Entry-level configuration includes one computational element, I/O subsystem, 2GB virtual memory per process; operating systems including C compiler and Emacs editor, hardware and software for interfacing with Domain network, Fortran 77 compiler for single CPU, 8MB memory, 268MB disk and controller, cartridge tape drive, 2 Multibus chassis, and expansion cabinet.	195,750	2,066	1,925
DSP9015	Compute server processor includes nonexpandable cabinet, CPU, 8MB memory, 379MB disk and controller, 2 interface processors, IP cache, system cabinet, 2 Ethernet controllers, 6250 tape drive, SFW9000-OS16, Fortran compiler for CPU, DSP-3MB, interface software, C compiler, and CCA Emacs Editor	243,750	2,291	2,365
DSP9081	Includes all of the features of the DSP9011 plus 8MB, 379MB disk, 800/1600/6250 tri-density tape drive, controller, and cabinet.	325,250	2,649	3,410

Keyboard Options

KBD	Low profile detachable keyboard, no pointing option	NC	NC	NA
KBD-TPAD	Low profile detachable keyboard with touchpad pointing device	400	5	NA
KBD-MSE	Low profile detachable keyboard with mouse pointing device	150	2	NA

Add-on Memory

A-ADD-2MB	2MB add-on memory	2,000	8	80
DDM-1MB	1MB display memory upgrade for DN6XX computational node	6,500	NA	20

Mass Storage

SMSD-70M	70MB Winchester disk subsystem	8,900	95	100
SMSD-70M-1.2M	70MB disk and 1.2 diskette subsystem	10,500	108	100
MSD-1.2M	1.2MB diskette drive (maximum of one per node)	2,000	24	40
MSD-80M	80MB Winchester disk	9,500	111	140
MSD-167M	167MB Winchester disk	12,500	149	160 ▶

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		List Price ($)	Monthly Maint. Cost ($)	Field Install. Charge ($)
► MSD-86M	86MB 5¼-inch Winchester disk subsystem; includes controller, power supply, and fans	5,900	70	120
MSD-86M-TC	86MB 5¼-inch Winchester disk and integrated 60MB ¼-inch cartridge unit	8,900	85	120
ADD-86M	Additional 86MB 5¼-inch Winchester disk drive	3,700	63	240
MSD-190M	190MB 5¼-inch Wincheser disk subsystem	9,200	80	160
MSD-190M-TC	190MB 5¼-inch Winchester disk and an integrated 60MB ¼-inch tape cartridge	12,900	95	160
MSD-190M-190M	Dual 190MB 5¼-inch Winchester disk drives	16,900	148	235
ADD-190M	Additional 190MB 5¼-inch Winchester disk drive	7,500	68	295

Hardcopy Devices

		List Price ($)	Monthly Maint. Cost ($)	Field Install. Charge ($)
HCD-MMP	Multimode printer, near letter quality, draft, graphics (plot); (1 RS-232-C)	3,800	40	60
HCD-LP26S+	Domain/Laser-26 serial version high-quality laser printer, 26 pages per minute maximum, Postscript interpreter integrated into printer's controller, uses one asynchronous RS232-C port processor	31,900	295	200
HCD-LP26C+	Domain/Laser-26 centronics parallel version high-quality laser printer, 26 pages per minute, PostScript interpreter integrated into printer's controller, Centronics parallel interface for use with multibus, controller board, and parallel cable for mounting into multibus cage	34,900	295	200

Communications

		List Price ($)	Monthly Maint. Cost ($)	Field Install. Charge ($)
COM-X.25	Domain X-25 Gateway with hardware controller that mounts in DSP80(A), PNA, DSP90 or MBUS; two synchronous lines; full X.25 software protocol with extensions; two modem cables (requires DSP80(A), PNA, MBUS, DSP90)	6,950	138	60
COM-ETH	Ethernet Gateway with hardware controller that mounts in DSP80(A), PNA, DSP90, or MBUS; transceiver; cable between controller and transceiver; full TCP/IP Software Access Protocol (requires DSP80(A), DSP90, PNA, MBUS)	3,500	111	60
COM-BRG-A	Domain/Bridge-A internetwork router intelligent communications controller that mounts in a dedicated DSP80A, single RS-449 (RS-422) interface operates full duplex to 1.5 Mbps, single RS-449 modem cable	8,400	150	300
COM-BRG-B	Domain/Bridge-B internetwork router intelligent communications controller that mounts in a dedicated DSP80A, dual coaxial cable interface for local internet connections to 2.0 Mbps	8,900	180	300
COM-VAC-1	Domain/Vaccess-1 Gateway software to provide transparent file access to a VAX/VMS system; hardware that mounts in a DSP80A, DSP90, DSP160 or a node equipped with Mbus controller board, cable, and transceiver	5,000	200	300
COM-CTLR	Domain/ComController controller that mounts in a shared DN550/560/570(A)/580, DSP80(A), or DSP90, 19-inch distribution panel, supporting 2 RS232 connections; RS232-C cabling provided by customer, for use with Domain/SNA	5,950	200	300
COM-PC18	Domain/PCI-8 personal computer interconnect. Allows the linking of 8 PCs to a Domain system network through a single host; provides transparent file access; bundled hardware/softare/documentation package	6,400	200	150
COM-ECMB	Ethercontroller-MB Ethernet communications hardware includes hardware controller, transceiver, cable between controller and transceiver. (For use with EtherBridge, Model SFW-EBR, FIC applies to both hardware and software)	3,300	65	345
COM-DFL	Domain/DFL-100 fiber optics link; links Domain token rings together using fiber optics	1,200	13	140
COM-DFL-R	Domain/DFL-100-R redundant fiber optics link; links Domain token rings together using fiber optics; used as part of redundant Domain/DFL-100 link; with connector cable to connect to a primary Domain/DFL-100 link (COM-DFL)	1,250	13	140

Miscellaneous Options

		List Price ($)	Monthly Maint. Cost ($)	Field Install. Charge ($)
DSP9000-CE	Computational element	54,000	250	440
DSP9000-MEM8	8MB memory board	44,000	200	440
DSP9000-CE64K	CE cache memory	38,500	170	440
DSP9000-IP32K	IP cache memory	27,500	140	440
DSP9000-IP	Interface processor	8,000	60	440
DSP9000-MBUS	Multibus chassis	6,500	25	330
DSP9080-CAB	Expansion cabinet for DSP9080	8,500	40	330
DSP9000-DSK268	268MB disk, includes cables	10,500	120	300
DSP9000-ETH	Ethernet controller	5,000	40	275
DSP9000-SMD	Disk controller	5,000	40	275
DSP9000-DSK379	379MB disk, includes cables	19,000	140	385
DSP-9000-T6250	Tri-density tape drive, includes cab and formatter	35,000	280	605
DSP9000-TCNTL	Tape controller	5,000	40	275 ►

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Apollo Domain Systems

SOFTWARE PRICES

► Licenses to use both the Aegis and Domain/IX operating systems and selected other software programs are included with every node. Media and documentation for the Aegis operating system included at no charge for end users on the following nodes and servers: DN300, DN330, DN460, DN560, DN660, DSP80A, DSP80AR, DSP90, DSP90R, and DSP160. Software program licenses are on a per node (-N suffix) or per site basis (-S suffix.) Software programs are licensed to run on designated nodes or server processors. Software programs are licensed for up to 100 nodes at the designated site. A site consists of a building(s) within a half mile radius.

		List Price ($)	Basic Software Maint.* ($)	Right to Execute Maint.* ($)	Site Soft. Program Maint. 1* ($)	Site Soft. Program Maint. 2* ($)
Programming Languages						
SFW-FTN-N/S	Fortran-77	1,000	50	5	85	105
SFW-PAS-N/S	Pascal	1,000	50	5	85	105
SFW-C-N/S	Domain/C	1,000	50	5	85	105
SFW-LISP-N/S	Domain LISP	1,000	75	8	131	163
SFW-DSEE-N/S	Domain Software Engineering Environment (DSEE)	1,500	60	8	116	148
SFW-COMLSP-N	Domain/Common LISP (no site license available; no telephone support)	3,500	56	17	165	243
SFW-COMLSP-R	Runtime license for node (no site license available; no telephone support)	650	26	8	82	114
Operating Systems						
SFW-IX-UPG-N	Provides nodes purchased prior to Feb. 19, 1986 with AT&T Unix icense.Includes one set media and documentation for Domain/IX.	485	—	—	—	—
SFW-IX-UPG-S	Provides sites with nodes purchased prior to Feb. 14, 1986 with AT&T Unix license. Includes one set media and documentation for Domain/IX.	9,100	—	—	—	—
Data Management						
SFW-D3M-N/S	Domain Distributed Data Management (D3M)	2,500	100	13	191	243
Graphics						
SFW-CORE-N/S	Domain/Core Graphics Software	1,000	40	5	75	95
SFW-DIAL-N/S	Domain/Dialogue-Programmer's Toolkit	1,200	60	8	116	148
SFW-4014-N/S	Domain/4014 emulator	750	30	4	58	74
Technical Office Software Applications						
SFW-MAIL-N/S	DPSS/Mail	200	10	2	24	32
Hardware Support Applications						
SFW-VERS-N/S	Versatec V80 Software Driver Support	200	10	2	24	32
SFW-POST-VERS-N	Postscript Driver for Versatec V80 (node only)	1,040	42	5	77	97
SFW-POST-MMP-N	Postscript Driver for HCD-MMP (node only)	500	20	3	41	53
Communications						
SFW-TCP/IP-S	TCP/IP Access Protocol (site only)	700	80	5	115	135
SFW-GPIO-S	General-Purpose I/O Software (requires PNA or DSP80(A), DSP90, or DSP160) (site only)	2,000	80	10	150	190
SFW-RJE-N	RJE-Access Gateway (node only)	1,800	72	9	135	171
SFW-EBR-N/S	Etherbridge Internet packing routing software	1,000	50	6	92	116
SFW-3270-N/S	Domain/SNA 3270 emulation	1,700	120	5	155	175
SFW-3770-N/S	Domain/SNA 3770 emulation	1,700	120	5	155	175
SFW-PC/1-N	Domain/PC-1 (node only)	500	50	3	71	83

The Field Installation Charge for software is based on the location of the site in relation to the Apollo Service Office. The rate is charged for each trip taken to complete the installation. The price for a site located within a 0-51 mile radius from the Apollo office is $90; 51-100, $180; 101-150, $270; and 151-200, $360. Consult Apollo for locations over a 200-mile radius. *Basic Software Maintenance and Right to Execute Maintenance are available on a previously licensed software program, per Node/DSP basis. Each software program covered by BSM receives software program updates with media and documentation, the right to executive software program updates on one designated Node/DSP, and one designated contact for telephone support. Each software program covered by RTE receives the right to execute software program updates on one designated Node/DSP. RTE software program updates must be acquired through an associated BSM Node/DSP. Site Software Program Maintenance (SM1, SM2, SM3, SM4, SM5) is available for software programs previously licensed node or site. Each software program covered by site software program maintenance receives software program updates on all covered nodes/DSPSs and one designated contact for telephone support. For sites over 100 nodes, order one SM4 option, plus one SM5 option for each additional 25 nodes. Option SM4 is a prerequisite to one or more SM5 options for a given product at a given site. ■