

Apollo Domain Systems

MANAGEMENT SUMMARY

UPDATE: Apollo has made three announcements since this report was last revised. The company doubled the memory capacity of its top-of-the-line workstation, the DN660 and quadrupled memory on two other DOMAIN system nodes, the DN460 and DSP160 computational server. A memory expansion program was also introduced for customers who wish to field-upgrade memory on various DOMAIN workstations. Also new for Apollo is the DN660A, an enhanced model of the DN660 which features an ergonomic display screen. The company also brought out an 86MB Winchester disk for its DN550 color workstation. Finally, Apollo now offers DOMAIN/IX, which implements both Berkeley 4.2 and System V Unix software.

Since introducing the Domain family in 1981, Apollo Computer, Inc. has periodically added to the lineup, evolving the computer system into seven models. In 1985 Apollo introduced the seventh model, the DN660A, an enhanced version of the DN660.

Apollo refers to each system as a node. Each node is part of an integrated computer environment that shares peripherals and functions as a distributed processing system. The nodes can operate as standalone systems or workstations. The definite number of workstations that can be supported on the Domain systems is not given; however, according to Apollo, it is estimated to be over 2,000.

The current product line includes the DN300 and DN320 desktop superminicomputers; DN550, a mid-range color workstation; RM550, the rack-mount version of the DN550; the DN460 high-performance workstation; the DN660, a high-performance color graphics workstation; and the DN660A, an enhanced DN660 with a new ergonomic monitor. The main differences among the nodes are the processors and the storage devices that are used.

The Apollo Domain Systems consist of seven models that offer multiple window graphics capabilities and have the ability to support multiple concurrent processes, with each process having a virtual address space of up to 16MB. Each Domain System Node contains a 32-bit processor, a memory management unit, interface to the Domain Network, an integrated high-resolution bit-mapped graphics display, keyboard, and Apollo's Operating System. Apollo has recently introduced the DN660A, an enhanced version of the DN660, while doubling the memory capacity of the DN660. Memory was quadrupled on the DN460 and DSP160 server. And, a memory expansion program was announced for DOMAIN workstations along with the introduction of a new operating system, the DOMAIN/IX. Also, an 86MB Winchester disk for the DN550 was announced.

MODELS: DN300, DN320, DN550, RM550, DN460, DN660, DN660A.

MEMORY: 1MB to 16MB.

DISK CAPACITY: Up to 1.167GB.

WORKSTATIONS: The number of workstations is dependent upon the network. At present, Apollo is operating over 900 workstations (nodes) on the network at its offices.

PRICE: \$19,900 to \$74,000.

CHARACTERISTICS

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



The Apollo Domain Systems are compatible 32-bit computers that feature high-resolution, bit-mapped graphics, and operate in a distributed local area network. The DN550 is a mid-range color workstation that supports up to 3MB of memory and 1.05GB of disk storage.

Apollo Domain Systems

CHART A. SYSTEM COMPARISON

MODEL	DN300	DN320	DN460	DN550	DN660	DN660A
SYSTEM CHARACTERISTICS						
Date of introduction	January 1983	January 1984	October 1983	June 1984	October 1983	May 1985
Date of first delivery	February 1983	—	—	—	—	—
Operating system	Aegis, Domain/IX	Aegis, Domain/IX	Aegis, Domain/IX	Aegis, Domain/IX	Aegis, Domain/IX	Aegis, Domain/IX
Upgradable from	None	None	DN420	None	DN600	DN600
Upgradable to	None	None	None	None	None	None
MIPS	0.4	0.4	0.1	0.4	0.1	0.1
Relative performance	—	—	—	—	—	—
MEMORY						
Minimum capacity, bytes	0.5MB	1.5MB	1MB	1MB	1MB	1MB
Maximum capacity, bytes	3MB	3MB	16MB	3MB	8MB	8MB
Type	RAM	RAM	RAM	RAM	RAM	RAM
Cache memory	None	None	4KB bipolar in- struction cache, 16KB bipolar data cache	None	4KB bipolar in- struction cache, 16KB bipolar data cache	—
Cycle time, nanoseconds	200	200	200	200	200	200
Bytes fetched per cycle	2	—	—	—	—	—
INPUT/OUTPUT CONTROL						
Number of channels	1 block multi- plexer	1 block multi- plexer	—	—	—	—
High-speed buses	Internal back- ground; Domain Network	Internal back- ground; Domain Network	—	—	—	—
Low-speed buses	None	None	—	Multibus (optional)	—	—
MINIMUM DISK STORAGE	34MB	34MB	80MB	50MB	80MB	80MB
MAXIMUM DISK STORAGE	70MB	70MB	1.167GB	1.050GB	1.167GB	1.167GB
NUMBER OF WORKSTATIONS	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited
COMMUNICATIONS PROTOCOLS	X.25, HASP, 3270, Ethernet	X.25, HASP, 3270, Ethernet	X.25, HASP, 3270, Ethernet	X.25, HASP, 3270, Ethernet	X.25, HASP, 3270, Ethernet	X.25, HASP, 3270, Ethernet

* A dash (-) in a column indicates that the information is unavailable from the vendor.

➤ The DN300, DN460, DN550, and RM550 are based on the Motorola MC68010 chip. A floating-point unit is a standard feature with the DN320; users have the option of adding a floating-point processor to the DN550 and RM550. The DN300 supports from 0.5MB to 3MB of memory while the DN460 supports from 1 to 16MB. The DN550 supports from 1MB to 3MB of main memory.

Apollo provides 34MB and 70MB Winchester disks for the DN300 and DN320 nodes. The DN300 and DN320 models support one hard disk only. A double-sided 1.2M-byte diskette is another option. The 550 models offer other storage options: an 86MB Winchester disk, a 45MB cartridge tape, a 300MB storage module disk, and a 500MB Winchester. The 300MB and 500MB storage options cannot be attached to a node at the same time. Up to 1.05 gigabytes of hard disk storage are supported by the DN550/RM550.

As previously mentioned, both the DN460 and DN660 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. An 80MB Winchester, a 167MB hard disk, and the 1.26MB diskette are available for these two models. Additional storage is available via a 300MB storage module disk and a 500MB Winchester. As with the DN550/RM550 nodes, the DN460 and DN660 support either a 300MB or 500MB storage device. The maximum storage capacity is 1.167GB. A 1600-bpi streaming tape drive is available for backup storage.

➤ **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: Single- (32-bit) and double- (64-bit) precision floating-point arithmetic functions. Apollo offers a performance enhancement board (PEB) that combines both a hardware floating-point unit and a cache memory on a single 19-inch by 19-inch printed circuit board.

The floating-point unit is a standard feature with the DN320. An optional floating-point unit is available for the DN550/RM550. The floating-point unit uses a 2900 bit-slice technology and has been designed to conform to the proposed IEEE floating-point standard. In addition to the traditional single (32-bit) and double (64-bit) floating-point arithmetic functions, the processor has implemented several special purpose instructions, including a polynomial evaluation primitive, absolute value, negate, conversions between single and double precision, conversions from integer to floating-point, and save and restore. Typical execution times for floating-point operations range from 2.8 microseconds for single-precision addition, to 15.5 microseconds for double-precision division.

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

➤ **INTERNAL CODE:** ASCII.

Apollo Domain Systems

➤ 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, introduced in 1985, is a combination of both Berkeley 4.2 and System V Unix programs. DOMAIN/IX lets the two Unix standards operate as coresident 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 page 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 Apollo-based software suppliers. Many of these applications cover the artificial intelligence and engineering areas.

COMPETITIVE POSITION

Apollo compares their DN460 to the DEC VAX-11/730 and time-sharing computers in that machine class, when referring to the floating-point specifications. The company states that the floating-point computational performance of the DN460 is equivalent to the DEC system. Both products offer a single- and double-precision floating-point processor. Single-precision fractions are 24 bits long and double-precision are 56 bits long for the DEC processor. This compares to the DN460, which features 32-bit single- and 54-bit double-precision functions.

Regarding the memory and storage specifications, the Domain nodes are fairly close to the DEC VAX-11/730. The 11/730 features from 1MB to 5MB memory and from 20MB to 26GB storage capacity. The DN460 outperforms the VAX model in the memory category, with 16MB maximum memory capacity. The VAX-11/730 wins in the disk storage division, and is able to handle 2GB of storage as compared with the DN460's 1.167GB total. The Apollo system has an advantage over the VAX with regards to workstation connections; the VAX-11/730 can configure up to 24 workstations while the Apollo system can configure an unlimited number of workstations.

The Apollo line also competes with the Harris 60, 600, 700, 800, 1000, and recently introduced 1200 family. The Harris systems are also used in engineering, scientific, and general business environments. The high-end Harris H1200 model has a maximum memory capacity of 12MB and 19.4GB of disk storage, compared with the Apollo DN660 offering 8MB of memory and over 1GB of disk storage. The H1200 can configure up to 224 workstations. The Harris model competes with Apollo for such application markets as CAD/CAM, design and modeling, and decision-support applications.

Sun Microsystems, a company that manufactures workstation-based systems that are linked by a network, compares itself to Apollo. All the Sun Microsystems SunStations

➤ MAIN STORAGE

TYPE: High-speed dynamic MOS RAM.

CYCLE TIME: 200 nanoseconds.

CAPACITY: The Domain DN300, DN550, and RM550 support from 1 to 3 megabytes of main memory; the DN320 supports 1.5 to 3 megabytes; and the DN460, DN660, DN660A support from 8 to 16 megabytes. The RM550 module adds slots for an optional 1 megabyte of extra display memory and floating-point hardware. The DN300, DN320, DN550, and RM550 provide 16 megabytes of virtual address space per process, with up to 24 concurrent processes per user. The DN460, DN660, and DN660A support 256 megabytes of virtual address space and 24 concurrent processes.

CHECKING: Parity checking memory is standard with the DN300, DN320 and DN550/RM550 nodes. The DN460, DN660, and DN660A 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 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 instruction set includes 32-bit data types as well as a 24-bit linear virtual address space. 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, DN320, and DN550/RM550 are based on Motorola's 16-/32-bit MC68010 processor. A proprietary chip is used in the DN460 and DN660.

The internal Domain node organization is comprised of 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 memory system is expandable to 16 megabytes for the DN460 and 8 megabytes for the DN660 and DN660A.

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.

Apollo Domain Systems

CHART B. MASS STORAGE

MODEL	MSD-1.2M or MSDS-1.2M	MSDS-34M	MSD-86M	MSD-70M
Type	Diskette	Fixed Winchester	Fixed Winchester	Fixed Winchester
Controller model	Apollo-supplied	Apollo-supplied	Apollo-supplied	Apollo-supplied
Drives per subsystem/controller	1	1	1	1
Formatted capacity per drive, megabytes	1.2MB (unformatted)	34MB (unformatted)	86MB (unformatted)	70MB (unformatted)
Number of usable surfaces	2	5	—	5
Number of sectors or tracks per surface	—	—	—	—
Bytes per sector or track	—	—	—	—
Average seek time	—	42ms	—	42ms
Average rotational/relay time	108ms	8.3ms	—	8.3ms
Average access time	—	50.3ms	—	50.3ms
Data transfer rate	—	0.8MB/sec.	—	0.8MB/sec.
Supported by system models	DN300, DN320	DN300, DN320	DN550	DN300, DN320
Comments				

CHART B. MASS STORAGE (Continued)

MODEL	MSD-80M	MSD-167M	MSD-300	MSD-500
Type	Fixed Winchester	Fixed Winchester	Removable Winchester	Winchester
Controller model	Apollo-supplied	Apollo-supplied	Apollo-supplied	—
Drives per subsystem/controller	1	1	2	2
Formatted capacity per drive, megabytes	80MB (unformatted)	167MB (unformatted)	300MB (unformatted)	500MB (unformatted)
Number of usable surfaces	To be determined	To be determined	19	12
Number of sectors or tracks per surface	—	—	—	—
Bytes per sector or track	—	—	—	—
Average seek time	25 ms	25 ms	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	DN460, DN660	DN460, DN660	DN460, DN550, DN660	DN460, DN550, DN660
Comments				

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

➤ include a 32-bit MC68010 CPU, 16MB virtual address space, 1MB to 4MB memory, an 1152 by 900 bit-mapped graphics controller, display, and keyboard with a mouse. The systems support Unix and feature the Ethernet interface. The Sun workstations support 42MB, 56MB, and/or 130MB hard disks. The Domain systems offer more memory and disk space than the Sun Microsystems, while also allowing connection of unlimited workstations.

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 other systems with comparable features. The nodes are also easy to install. Since the models run on standard electrical current, they can be plugged into a regular outlet.

In the area of software, users said that the available programming languages are standard and compatible with others. The Aegis operating system received high ratings; the DOMAIN/IX system software is too new to gather sufficient user reaction data. With the introduction of DOMAIN/IX, Apollo is banking that the combination of both the Berkeley 4.2 and System V Unix software will

➤ **CONTROL STORAGE:** On the Domain performance enhancement board (PEB), the control unit is made up of a 1024-by-56 loadable control store, a 2910-bit slice microsequencer, which has 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 16 megabyte linear virtual address space on the DN300, DN320, DN550, and RM550. 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 F at 20 to 80 percent relative humidity. DN300 is configurable at any voltage supply of 100, 120, 220, or 240 VAC at 50 or 60 Hz. The DN320 and DN460 nodes require 120 VAC (± 10 percent), 15 amps at 60 Hz or 220/240 VAC (± 5 percent), 8 amps (DN320) or 7.5 amps (DN460) at 50 Hz. The DN660 and DN660A requires 120 VAC (± 10 percent), 20 amps at 60 Hz or 220/240 VAC (± 5 percent), and 10 amps at 50 Hz.

The dimensions for the Domain nodes are as follows: The DN300 CPU and display measures 19.7 by 22.4 by 16.5 inches; the DN320 CPU and display measures 18.4 by 22.5 by 16.5 inches; DN550 is 24.5 by 13.5 by 28.5 inches; both the DN460 and DN660 CPU cabinets measure 29 by 23.25

Apollo Domain Systems

CHART C. WORKSTATIONS

MODEL	DN300	DN320	DN460	DN550	DN660
DISPLAY PARAMETERS					
Max. chars./screen	Varies	Varies	Varies	Varies	Varies
Buffer capacity	1MB	1MB	1MB	up to 2MB	up to 2MB
Screen size (lines x chars.)	Varies	Varies	Varies	Varies	Varies
Tilt/swivel screen	Tilt	Tilt	Tilt/Swivel	Tilt/Swivel	Tilt/Swivel
Symbol formation	—	—	—	—	—
Character phosphor	Black/White	Black/White	Black/White	Full color	Full color
Total colors/no. simult. displayed	0	0	0	16.7 million/256	16.7 million/256
KEYBOARD PARAMETERS					
Style	Low profile				
Character/code set	—	—	—	—	—
Detachable	Yes	Yes	Yes	Yes	Yes
Program function keys	32	32	32	32	32
TERMINAL INTERFACE					
	Straight phone jack				

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

offer its users in distributed processing environments a choice of standards. The company based the system on research it had performed; portability of programs was considered key.

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.

USER REACTION

Because the Apollo systems were not represented in the recent Datapro Computer Users Survey, Apollo supplied the names of five companies that are current system users. Datapro was able to contact two of these users. Both users were government offices running engineering and scientific applications on their Domain systems.

The first user represented a medium-to-large government installation in the Northeast in charge of correlating flight information. Since June 1984, the agency had installed Apollo models DN300, DN460, DN600, DN660 and a DN550, running the Aegis operating system. Memory capacity ranged from 16M to less than 32M, spread over 16 network nodes. Disk storage capacity was between 600MB to 1200MB. Seventeen local area networks were on-site with over 80 remote workstations operational. The principal application employed at the site was flow control of air traffic, including data correlation and analysis sent to workstation servers for use by air traffic controllers.

The user highly praised the Apollo system noting that, "this system represents the type of architecture that we will see in five years in the future, except that Apollo has it here now." The user went on to say that the only way the system could be improved would be with the high-end node, which he would like to see made into a highly intensive operation, similar to a supercomputer. The user also conjectured that he would like to see a little less expensive low-end entry model introduced knowing that new users would discover Apollo capabilities and would then upgrade their system.

The user said the only problem with the Apollo system had been applications software designed by the company. He

by 31.5 inches. The RM550 rack-mount version of the DN550 can be housed in a 19-inch rack. The DN300 and DN320 both weigh 87 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 to other processes. Map primitives are object location-independent and allow streams to operate across the network. All data transferred in the entire system occurs at the page level. The page level is the physical I/O to local and remote disks across the network. This data is transferred on demand, resulting exclusively from a CPU page fault.

The *Domain DSP80 Server Processor* lets users connect a wide variety of shared peripheral devices to a Domain system. The DSP80 can control peripherals such as storage module disks, communication gateways, magnetic tape devices, line printers and plotters, as well as a range of low-speed serial devices. By effectively managing peripherals and communications lines in the network, DSP80 frees user nodes to handle specific application-related processing.

DSP80 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 DSP80 or to multiple DSP80s in a Domain network. The DSP80 includes a 32-bit VLSI CPU, 512KB RAM, five IEEE-796 slots, two asynchronous RS-232-C ports, power supply, Domain Network Interface, and license to use the Aegis Operating System subset.

DSP80 is compatible with all the Domain nodes. The DSP80 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 DSP160 Server Processor* provides a computational resource to be shared throughout an Apollo network.

Apollo Domain Systems

stated, "It does not work as well as the operational system software." Also, a minor problem support problem with obtaining spare parts had been taken care of, according to the user.

The second user represented a county mapping and engineering department in the Midwest. The agency had installed a DN320, DN460, DSP80, and a DN550, over a 15-month time frame. Memory capacity ranged from 1.5 to 2MB; disk storage was 1.4GB. Between 6 to 15 workstations are supported by the system. The agency operated under the Aegis operating system. A Data Base Management System, the Apollo D3M, was installed and the user rated overall satisfaction of the data base system as good. Overall, the user rated the Apollo system as excellent across the board. Ease of operation, reliability of system, maintenance, technical support, manufacturers software, and support all received high marks. The principal application run on the system was mapping and engineering geoprocesses for the government. At present, the Apollo system is tied into a DEC microVax system and a large IBM system. The user noted that, "The ease of use of the Apollo is excellent. There is more done with the Apollo than with the larger IBM system." The user also said, "What made us look to Apollo most significantly, what impressed us most, is how the company offers workstations without using disk space, done through the data base management system."

The user said he would like to see Apollo offer a laser printer for both printing and scanning. He also said that Apollo could always make the system more user-friendly. □

► **Computation intensive jobs can be offloaded to the DSP160 server. The DSP160, like the DSP80, 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 RS-232-C ports, power supply, Domain Network Interface, and license to use the Apollo 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 floor standing unit that is housed in a 29 by 23.25 by 31.5-inch cabinet.

The (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 Computer 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.

DN550 or RM550 users can add an optional four-slot Multibus Peripheral Adapter (MBUS). MBUS allows additional data storage subsystems to be used. An I/F adapter, power supply, and fans are included in the MBUS package.

CHART D. PRINTERS

MODEL	HCD-MMP
Type	Multimode printer/plotter
Speed	Up to 125 cps-near letter quality; up to 500 cps-EDP mode
Bidirectional printing	Yes
Paper size	2.95" - 15.35"
Character formation	dot matrix
Horizontal character spacing (char./inch)	10, 12, 13.1, 16.7
Vertical line spacing (lines/inch)	—
Character set	96 ASCII
Controller/Interface	RS-232-C
No. of printers per controller/interface	1
Printer dimensions, in. (h x w x d)	—
Graphics capability	72 x 72 dots per inch
Comments	Supports a variety of fonts; near letter, draft, and graphics quality

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

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 RS-232-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 local area Domain network, integrated high-resolution bit-mapped graphics display with detachable keyboard, and license to use Aegis network-wide virtual memory operating systems with display manager software, font editor, graphics primitives, high-level language debugger, DEC VT100 emulator, software support for IBM 3270 and HASP communications (requires external hardware devices), and network management utilities.

WORKSTATIONS: The DN300 and DN320 are desktop superminicomputers that, individually, can be used as workstations. The DN460, DN550/RM550, DN660 and DN660A function as workstations, but have supermini capabilities. The number of workstations is only dependent upon the network. The largest number of workstations in the shared network—that is known to Apollo—is the configuration used at its offices. Presently, the system includes over 900 workstations. All the Domain nodes support a variety of peripheral and performance options.

DISK STORAGE: The DN300 and DN320 each support one 34MB or one 70MB Winchester disk subsystem and one 8-inch, double-sided/double-density 1.2MB diskette drive. A 86MB 5¼-inch Winchester, one or two 500MB Winchester disks, and a 45MB ¼-inch cartridge tape drive are available for the DN550/RM550. An integrated 80MB or 167MB Winchester disk, one 300MB storage module disk, one or two 500MB Winchester disks, and one 1.2MB diskette are available storage options with the DN460 and DN660. Both the DN460 and DN660 support up to 1.167 gigabytes of storage.

Apollo Domain Systems

CHART E. MAGNETIC TAPE EQUIPMENT

MODEL	MSD-1600	TBA
TYPE	Tape drive	¼" cartridge tape
FORMAT		—
Number of tracks	9	—
Recording density, bits per inch	1600	—
Recording mode	Phasing coded	—
CHARACTERISTICS		
Controller model	Integral	—
Drives per controller	1/node	—
Storage capacity, bytes	80MB	45MB
Tape speed, inches per second	25	—
Data transfer rate, units per second	40K/sec.	—
Streaming technology	100 ips	Yes
Start/stop mode; speed	25 ips	—
Switch selectable	Via software	—

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

► The Domain File Server (DFS) is available with either one or two 500MB hard disks. A storage subsystem unit contains an MC68010 processor, 1MB of memory, and a four-slot Multibus peripheral adapter. The Multibus allows users to connect a variety of peripherals to the Domain network. Both the 500MB and the 1000MB file servers can be interfaced to the DN550 workstation, RM550 rack-mount version, the DN460, DN660, or DN660A computational nodes, or the DSP80 and DSP160 server processors. The minimum prerequisites required to use either DFS is a PNA or MBUS and a DSP80.

MAGNETIC TAPE: A nine-track 1600 bpi magnetic tape subsystem is available for the DN460 and DN660 workstations. The DN550 and RM550 support a ¼-inch 45MB cartridge tape for backup storage.

PRINTERS: A multimode printer/plotter is available from Apollo. The printer is compatible with the DN550, RM550, DN460, DN660, and DN660A nodes and the DSP80 and DSP160 File Servers. 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 X.25 Gateway supports the protocol for public long-haul packet switching networks. It provides Domain users with shared access to long-distance communications via international public packet switching networks or private X.25 networks. The X.25 Gateway includes an intelligent hardware controller that mounts in a DPS80, PNA, or MBUS. The package contains dual synchronous lines, full X.25 software protocol with extensions, and two modem cables.

The Ethernet Gateway provides Domain users with shared access to existing Ethernet facilities and includes an intelligent hardware controller that mounts in DSP80, PNA, or MBUS. The package includes a transceiver, a cable between the controller and transceiver, and full TCP/IP software access protocol.

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 productivities. 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, artificial intelligence research, electronic publishing, and financial modeling.

The Aegis operating system features:

- Virtual memory for direct execution of large programs
- Network-distributed file system with access control list security and protection facility
- Concurrent, multiwindow Display Manager Environment which provides "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 that include 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-labelled tapes.

Apollo's DOMAIN/IX is a combination of Berkeley 4.2 and System V Unix software. Domain/IX software lets the two

Apollo Domain Systems

- 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 page 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 hierarchical file structure extending across the network; demand paging; a wide range of graphics libraries; support of bit-mapped monochromatic and color displays; and a development environment for C, LISP, Fortran-77, and ISO Pascal.

DOMAIN/IX supports the same communications options featured with the Aegis system.

DATABASE MANAGEMENT: Apollo offers two database management systems to Domain users: Oracle and D3M.

Oracle is being offered to users through Apollo's Software Supplier Program. A true relational database, 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 databases into a single, logical database 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 database 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 database tools needed to create, maintain, and update both small and large databases. These components include:

- D3M/Dataview—a query/update language that provides easy-to-use, relational capabilities for both queries and forms-oriented updates.
- D3M/Describe—a fully interactive database description tool that can be driven using either forms or commands.
- D3M/Unite—an aggregate schema compiler to create logical combinations of multiple databases 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 database descriptions.

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

D3M is supported by any DN300, DN320, DN460, or DN660 computational node equipped with a minimum of one megabyte of main memory. One node in the Domain network supporting D3M must also be equipped with Winchester and floppy disks.

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.

Domain's Fortran-77 is a compatible superset of the ANSI X3.9-1978 Fortran language standard. Domain's Fortran-77 simplifies conversion of existing Fortran programs to the Domain processing system.

The latest ANSI Fortran standard includes new features that increase the languages functionality. The character data type and related operators improve Fortran's text-handling capabilities. Multiple entry points, alternate RETURNS, and the IF/THEN/ELSE construct contribute to structured programming. The OPEN/CLOSE and INQUIRE auxiliary statements increase the flexibility of file-oriented input/output, while providing standards that increase program portability.

Domain Fortran-77 exceeds the requirements of the ANSI standard. Extensions include: subprogram and variable names of length up to 32 characters, with lowercase allowed; insertion of global declarations from common source files using the %INCLUDE directive; predefined calls and declarations to simplify use of system services; 32-bit pointer data type that permits direct reference to any portion of a Domain file of any size up to four gigabytes; and 16-bit and 32-bit integer, plus 32-bit and 64-bit real data types.

Domain's C Programming Language is a compatible superset of the language defined in the C Programming Language by Kernighan and Ritchie. Domain C simplifies conversion of existing C programs to the Domain processing system. In addition, 32-bit Domain C includes extensions to facilitate significant engineering/scientific application and systems projects.

Domain C features command line interpreters; a language-independent variable formatting package; a mailbox facility for network-wide interprocesses; display manager services; use of device-independent files via the graphics metafile manager; an optional library of Domain Distributed Data Management (D3M) routines; dynamic memory allocation routines; and extended error code processing for enhanced software debugging.

The performance of Domain C programs is enhanced by two compiler options. One option makes maximum use of the floating-point hardware on the Domain Performance Enhancement Board. The other causes the compiler to perform several global performances and storage optimizations. ►

Apollo Domain Systems

► The Domain C user can enable compiler switches to control the generation of traceback information, program listings, cross-reference listings, expanded machine code listings, and debugging tables for added ease in software development.

Domain's Pascal is based in the ISO's proposed DIS 7185 standard. Pascal simplifies conversion of existing Pascal programs to the Domain processing system and includes extensions for engineering/scientific applications and systems programming projects.

Extensions to Domain's Pascal beyond that of the proposed ISO standard include: full support for separately compiled external routines; insertion of global declarations from common source files using the %INCLUDE directive; predefined calls and declarations to simplify use of system services; 32-bit pointer data type that permits direct reference to any portion of a Domain file of any size up to four gigabytes; 16-bit and 32-bit integer, plus 32-bit and 64-bit real data types; static data initialization to improve maintainability and reduce the size of programs; and conditional compilation using the %DEBUG directive.

Apollo also offers the LISP programming language to enable artificial intelligence applications to run on the Domain systems. Domain Lisp includes an interpreter for quick checkout or rapid prototyping and an optimizing compiler to create fast production applications.

LISP includes features and utilities to ease the software development process. A few features include: an interpreter with a debugging package; a compiler for production applications; access to all operating system calls; a history facility; a scoped binding environment; and cross-call language capability. LISP compiler uses the DOMAIN language system's common code generator, separating pure, position-independent code from impure data areas, allowing all user programs to be reentrant.

System services available to LISP users include a set of DOMAIN device-independent graphic primitives while streaming I/O that is independent of file, device, or process type. Also available is Display Manager services for window management; and command line interpreters (shells) that support the Software Tools approach to software development. Apollo sees Domain users working with Lisp for building expert systems, special-purpose graphics, and robot vision applications.

COMMUNICATIONS: Communications support capabilities provided by Apollo's Domain nodes include X.25 and IBM HASP, and 3270, BSC, DEC VT100 emulation, and Ethernet TC/P.

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 ISO Open Systems Interconnection 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 DPS80, PNA, or MBUS.

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 International Standards Organization/Open System Interconnection (ISO/OSI) Reference Model. With this capa-

bility, 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.

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

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

APPLICATIONS: In addition to providing the *Domain Core Graphics System*, *Domain Professional Support Services*, and *Domain Software Engineering Environment (DSEE)*, a variety of applications are available from third-party vendors. Apollo's Catalogue of Applications for the Domain includes over 350 third-party software, hardware, and value-added supplier applications. These 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 Proposed Standard Graphics Software System. The Domain Core System provides high-level graphics functionality which allows the user to concentrate on developing applications rather than developing graphics system software. The Domain Core System adheres to the GSPC Proposal and supports the full range of 2D and 3D viewing and image transformations. It supports all Domain computational nodes and allows applications to be device-independent and input devices such as the touchpad, mouse, data-tablet, and keyboard. Device independence insures application transportability and helps protect the users application software investments.

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 database 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 that is 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 integrated set of tools designed to improve the technical professional's administrative productivity. DPSS includes five tools that are represented by icons (graphics symbol); they are DPSS/Document, DPSS/Mail, DPSS/File, DPSS/Calc, and DPSS/Calendar. A mouse is used to position the cursor on the icon that represents the desired tool. Then, the window that represents the tool expands to the appropriate size for data entry. All the DPSS tools can be accessed concurrently on the screen through the 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 deals with the construction of a system from its component parts. It controls multiple versions of systems, allows reconstruction of any original software configuration, and com-

Apollo Domain Systems

► piles the latest modules in the software cycle. Any dependencies in or changes made to an element are detected in DSEE/Advise Management. The advice management functions 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 organizations as a whole.

PRICING

POLICY: Apollo sells its products via direct sales; discounts are available for quantity purchases. The DN300, DN320, DN460, DN660, and DN660A are available 60 days after receipt of order (ARO). The DN550 is available 60 days after the order is received, while the RM550 is available 90 days ARO.

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 thereby reducing the time for service resolution.

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 qualified 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 preventative maintenance program.

- All labor and materials required to complete remedial and preventative maintenance.
- Updates of all maintained products (hardware/software).

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

TYPICAL CONFIGURATIONS: The following are configurations and purchase prices for representative Domain systems.

DN550/DN300 network system: \$102,700

One DN550 with 1MB main memory, 2MB display memory, one 50MB hard disk, one 45MB cartridge tape unit, electronics enclosure; two DN300 systems with 1MB main memory each; one 500MB Winchester disk multimode printer

DN300 packaged system: \$240,000

Two DN300 desktop systems with 1MB of memory, network interface, 17-inch 800 by 1024 bit-mapped graphics display and integrated hardware floating point; one DN660 with 2MB of memory, network interface, integrated hardware floating point, 167MB hard disk, 1.2MB diskette, Fortran-77, DPSS; one DSP80 peripheral with 300MB SMD disk with Ethernet multimode printer Gateway; cost @ \$47,240 per user

DN550/DN300/DN320 network package: \$249,000

Two DN550 systems with 3MB of main memory, 1MB display memory, 19-inch CRT, keyboard, one 50MB Winchester disk, one 45MB cartridge tape unit, electronics enclosure; two DN320 systems with 1.5MB of main memory, mouse or touchpad, floating-point hardware; two DN300 systems with 1MB of main memory, mouse or touchpad, one DFS with 500MB Winchester disk multimode printer and, peripheral server/processor

EQUIPMENT PRICES

		List Price (\$)	Monthly Maint. Cost (\$)	Field Install. Charge (\$)
DN300-1MB	DN300 with 1MB main memory with parity, 2 RS-232-C ports, 17" monochrome display, keyboard (see keyboard options below)	9,900	157	140
DN300-1.5MB	DN300 with 1.5MB main memory	12,150	186	140
DN300-3MB	DN300 with 3MB main memory	18,900	255	160
DN320-1.5MB	DN320 with 1.5MB main memory with parity, floating point unit, two RS-232-C ports, 17" monochrome display, keyboard (see keyboard options below)	11,110	218	140
DN320-2MB	DN320 with 2MB main memory	21,150	242	160
DN320-3MB	DN320 with 3MB main memory (cannot attach local disk)	25,650	289	160
DN550-1MB	DN550 with 1MB main memory with parity, 1MB dedicated display memory, two RS-232-C ports, 19" color graphics display, keyboard (see keyboard options below)	31,500	289	140

NA—Not available.

Apollo Domain Systems

		List Price (\$)	Monthly Maint. Cost (\$)	Field Install. Charge (\$)
DN550-1.5MB	DN550 with 1.5MB of main memory	34,000	312	140
DN550-3MB	DN550 with 3MB of main memory	41,500	379	160
RM550-1MB	RM550 is DN550 without packaging, control panel, or A/C distribution; suitable for vertical or 19" rack mounting	30,000	275	NA
RM550-1.5MB	RM550 with 1.5MB main memory	32,500	298	NA
RM550-3MB	RM550 with 3MB of main memory	40,000	367	NA
DN460-1MB	DN460 with 1MB main memory with ECC, integrated hardware floating point, three RS-232-C ports, 10-slot chassis, 19" monochrome display, keyboard (see keyboard options below)	39,500	397	160
DN460-2MB	DN460 with 2MB main memory	44,500	444	160
DN460-4MB	DN460 with 4MB main memory	54,500	538	160
DN660-1MB	DN660 with 1MB main memory with ECC, 1MB dedicated display memory, integrated hardware floating point, 10-slot chassis, 19" color graphics display, keyboard (see keyboard options below)	54,500	546	300
DN660-2MB	DN660 with 2MB main memory	59,500	593	300
DN660-4MB	DN660 with 4MB main memory	69,500	687	300
DN660-E-1MB	DN660 with 1MB main memory, 2MB dedicated display memory, 4/8/24 planes	59,000	592	300
DN660-E-2MB	DN660 with 2MB main memory, 2MB dedicated display memory, 4/8/24 planes	64,000	639	300
DN660-E-4MB	DN660 with 4MB main memory, 2MB dedicated display memory, 4/8/24 planes	74,000	733	300
Keyboard Options				
KBD	Low profile detachable keyboard, no pointing option (must order with node)	—	—	NA
KBD-TPAD	Low profile detachable keyboard with touchpad pointing device (must order with node)	400	5	NA
KBD-MSE	Low profile detachable keyboard with mouse pointing device (must order with node)	400	5	NA
Hardware Expansion Options				
DSP80A-HMB	Domain Server Processor with dedicated 32-bit VLSI CPU, 512KB main memory, five IEEE-796 (Multibus) slots, two RS-232-C ports, power supply, license to use Aegis operating system subset, Domain Network Interface (table top package—19" x 23" x 9")	9,750	84	120
DSP80AR-HMB	19" rack mount version of DSP80A-HMB	9,750	84	120
DSP80A-1MB	DSP80A with 1MB main memory	12,000	104	120
DSP80AR-1MB	19" rack mount version of DSP80A-1MB	12,000	104	120
DSP80A-1.5MB	DSP-80A with 1.5MB main memory	14,250	117	120
DSP80AR-1.5MB	DSP-80A-1.5MB rack mountable	14,250	117	120
DSP80A-3MB	DSP-80A with 3MB main memory	21,000	174	120
DSP80AR-3MB	DSP-80A-3MB rack mountable	21,000	174	120
DSP160-1MB	Domain Computational Server Processor with dedicated 32-bit CPU, 1MB main memory with ECC, integrated hardware floating point, 10-slot chassis, three RS-232-C ports, power supply, license to use Apollo operating system subset, Domain Network Interface (cabinet package)	32,500	327	120
DSP160-2MB	DSP160 with 2MB main memory	37,500	374	120
DSP160-4MB	DSP160 with 4MB main memory	47,500	468	120
PNA	Peripheral-To-Node Adapter includes five slot IEEE-796 (Multibus) card cage, power supply (requires DSP160, DN420, DN460, DN600, DN660)	3,000	30	NA
MBUS	Four slot Multibus peripheral adaptor includes I/F adaptor, power supply, fans (requires DN550, RM550)	3,000	35	40
FPA	Hardware floating point accelerator (requires DN550, RM550)	4,500	32	20
Add-on Memory				
SADM-HMB	512KB main memory expansion from 512KB to 1MB (for use with DN300)	3,500	29	20
SAD-1MB	1MB main memory expansion from 512KB to 1.5MB (for use with DN300)	6,500	58	20
SDDM-1MB	Four planes dedicated display memory (for use with DN550, RM550)	5,000	35	20
ADM60-1MB	1MB main memory expansion with ECC (for use with DN420, DN460, DN600, DN660)	6,500	47	20
DDM-1MB	1MB dedicated display memory upgrade for DN600 or DN660 node (converts DN6XX to DN6XX-E)	8,500	85	20
ADM80-HMB	512KB memory for expanding DSP80-HMB to DPS80-1MB	3,500	29	20
ADM60-1MB	1MB main memory expansion with ECC for DSP160, DN420, 460, 600, 660	6,500	47	20
Mass Storage				
SMSD-34M	34MB Winchester disk subsystem (requires DN300, DN320)	10,000	90	80
SMSD-34M-1.2M	34MB Winchester and 1.2MB diskette subsystem (requires DN300, DN320)	11,500	101	80
SMSD-70M	70MB Winchester Disk subsystem (requires DN300, DN320)	11,000	108	100
SMSD-70M-1.2M	70MB Winchester and 1.2 diskette subsystem (requires DN300, DN320)	12,500	123	100
NA—Not available.				

Apollo Domain Systems

		List Price (\$)	Monthly Maint. Cost (\$)	Field Install. Charge (\$)
MSD-50M	50MB 5¼" Winchester disk subsystem with controller, power supply, fans (requires DN550, RM550)	8,500	78	120
MSD-50M-TC	MSD-50M with an integrated 45MB ¼" cartridge tape unit (requires DN550, RM550)	10,600	97	120
MSD-1.2M	1.2MB diskette drive (requires DN460, DN660, or DPS160, one per node)	2,500	27	40
MSD-80M	80MB Winchester disk (requires DN460, DN660, or DSP160, one per node)	12,500	123	140
MSD-167M	167MB Winchester disk (requires DN420, DN660, or DSP160, one per node)	16,800	166	160
MSD-300M	300MB storage module disk drive with removable pack, controller (requires PNA, MBUS, DSP80)	*21,000	230	200
MSD-300MA	Second 300MB drive for storage module	*19,000	205	200
<i>*MSD-300M and MSD-300MA prices are not discounted for quantity purchases.</i>				
MSD-500M	500MB fixed Winchester disk with cabinet, controller, cables; controller supports up to two drives (requires PNA, MBUS, DSP80)	25,000	198	120
MSD-1000M	Two 500MB fixed Winchester disks with cabinet, controller, cables (requires PNA, MBUS, DSP80)	45,500	361	160
DFS-500M	Domain Fileserver with 500MB fixed Winchester disk, controller, cable, DSP80A with 1MB main memory, five slot IEEE-796 card cage, two RS-232-C ports, Aegis operating system subset, Domain Network Interface; power distribution unit	36,000	312	160
DFS-1000M	DFS-500M with a second 500MB Winchester	56,500	472	180
DMSD-500MA	Expansion 500MB Winchester for MSD-500M or DFS-500M	21,500	165	140
MSD-1600	Nine track, 1600 bpi magnetic tape drive and controller mounted in cabinet (requires PNA, MBUS, DSP80)	*12,500	160	60

**MSD-1600 price is not discounted for quantity purchases.*

I/O Hardware Options

HCD-MMP	Multimode printer (used with any DN node, DSP80, DSP160)	*3,800	40	60
MSE	Domain mouse option for existing keyboard (requires keyboard equipped with mouse port)	400	5	NA
MSE-UPG	Keyboard and mouse upgrade (old keyboard must be returned to the factory)	*820	5	NA

**HCP-MMP and MSE prices are not discounted for quantity purchases.*

Communications Control Options

COM-X.25	Domain X-25 Gateway with hardware controller that mounts in DSP80, PNA, or MBUS; two synchronous lines; full X.25 software protocol with extensions; two modem cables (requires DSP80, PNA, MBUS)	*6,950	138	60
COM-ETH	Ethernet Gateway with hardware controller that mounts in DSP80, PNA, or MBUS; transceiver; cable between controller and transceiver; full TCP/IP Software Access Protocol (requires DSP80, PNA, MBUS)	*3,500	111	80

**COM-X.25 and COM-ETH prices are not discounted for quantity purchases.*

Miscellaneous Options

PWR-CNV-1	Power Converter Subsystem for 100 VAC to 120 VAC, 50 Hz or 60 Hz (for use with DN420, DN460, DN600, DN660, DSP160)	900	15	NA
NET-SWT-1	Manual switch used to partition Domain networks into multiple subnetworks	250	NA	NA

SOFTWARE PRICES

List
Price
(\$)

Software licenses are sold on a per node or per site basis. The distinction between the two is indicated in the model number. Per node versions have an -N suffix in the model number. The per node price includes the software licensed to run on a designated node only; documentation and distribution media (diskette, mag tape) are also covered. An -S suffix indicates that the software is licensed for up to 100 nodes at a designated site (one building or a group of buildings within a ½ mile radius). Site licenses are not discounted, and only one copy of the documentation and storage media is included.

Programming Languages

SFW-FTN-N	Fortran-77	1,250
SFW-FTN-S	Fortran-77	10,500
SFW-PAS-N	Pascal	1,250

NA—Not available.

Apollo Domain Systems

		List Price (\$)
SFW-PAS-S	Pascal	10,500
SFW-C-N	C	1,250
SFW-C-S	C	10,500
SFW-LISP-N	LISP	1,850
SFW-LISP-S	LISP	15,500
Operating Systems		
Domain IX	Domain IX 4.2 and Unix V (as many as 100 nodes allowed per site)	425/9,100
Domain IX	Either Berkeley 4.2 or Unix V (as many as 100 nodes allowed per site)	300/6,500
Database Mangement		
SFW-D3M-N	Domain Distributed Data Base Management (D3M)	2,500
SFW-D3M-S	Domain Distributed Data Base Management (D3M)	12,500
Applications		
SFW-CORE-N	Siggraph Core Graphics Software	1,000
SFW-CORE-S	Siggraph Core Graphics Software	7,000
SFW-DPSS-N	Domain Professional Support Services	500
SFW-DPSS-S	Domain Professional Support Services	4,000
SFW-DSEE-N	Domain Software Engineering Environment	1,500
SFW-DSEE-S	Domain Software Engineering Environment	12,500
SFW-VERS-N	Versatec V80 Software Driver Support	200
SFW-VERS-S	Versatec V80 Software Driver Support	1,250
Communications		
SFW-TCP/IP-S	TCP/IP Access Protocol includes a per site license where the site is a communication gateway that serves a community of Domain users	700
SFW-GPIO-S	General-Purpose I/O Software (requires PNA, DSP80, DSP160)	2,000
SFW-RJE-N	HASP, 2780, 3780 Gateway Access Software	1,800

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.

NA—Not available. ■