DEC VAX 8000 Systems

MANAGEMENT SUMMARY

UPDATE: *Since the last update of this report, Digital has introduced seven new systems: the low-end VAX 8250, 8350, and 8530, which replace the VAX 8200, 8300, and 8500, respectively; the mid-range VAX 8550 and 8700; and the quasi- mainframe VAX 8974 and 8978. The VAX 8000 product line now features a smooth continuum of systems from the low to the high end of the product line.*

Years ago, when Digital Equipment introduced the industry's first minicomputer, the company chose not to compete head-to-head with IBM in the mainframe market and instead produced mid-range systems targeted towards scientific and engineering applications—an area in which IBM had not been particularly strong. Digital stressed that its systems were designed to coexist with rather than threaten IBM's presence in the MIS department. Digital marketed its computers as systems suitable for the particular data processing needs of individual departments. Infiltrating large corporations at the departmental level, Digital has been able to depend on users to recognize and spread the word about the its systems' technical excellence to other departments. Consequently, Digital came to be recognized throughout the corporate world as a total systems provider.

Digital was in the right place at the right time when the mainframe industry slumped in 1985 and the supermini-computer, implemented as a departmental system, began to be recognized as the best price/performance alternative to more costly, centralized mainframes. With a proven architecture in demand, Digital extended its marketing efforts beyond engineering and scientific applications into ▷

Digital Equipment Corporation's VAX 8000 systems are intended for use in a range of environments, from office automation to compute-intensive engineering and scientific applications. United by a common architecture and the VAX/VMS operating system, the VAX 8000s can be used as standalone processors or can be configured in multinode VAXclusters for enhanced power, mass storage, and availability.

MODELS: VAX 8250, 8350, 8530, 8550, 8600, 8650, 8700, 8800, 8974, and 8978.
MAIN MEMORY: 4MB to 256MB.
DISK CAPACITY: 205MB to 120GB.
WORKSTATIONS: Up to 2,560 (practical limit).
PRICE: $79,000 to $5,240,000 (base configuration prices).
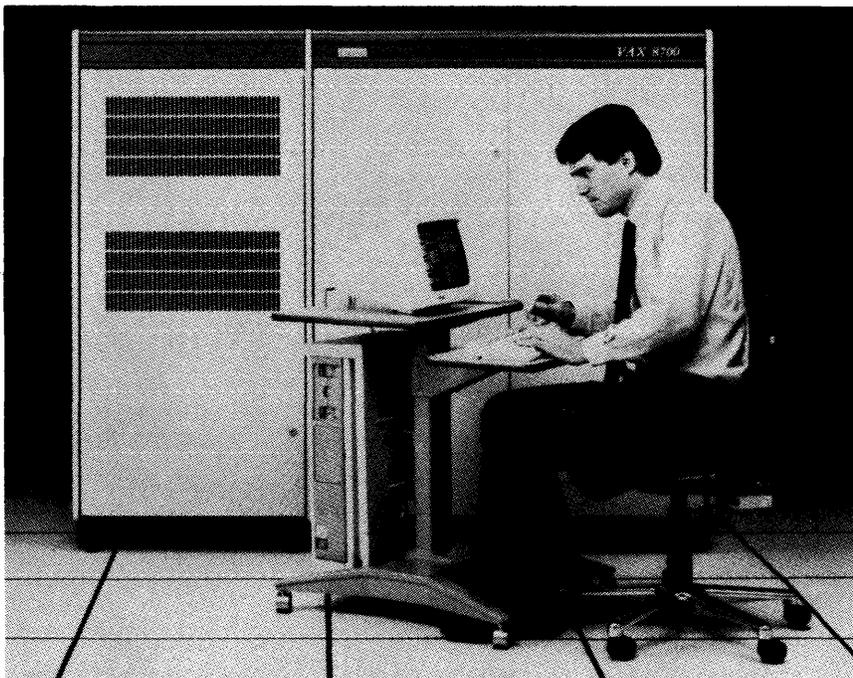
CHARACTERISTICS

MANUFACTURER: Digital Equipment Corporation, 146 Main Street, Maynard, Massachusetts 01754-2571. Telephone (617) 897-5111.

CANADIAN ADDRESS: Digital Equipment of Canada Ltd., P.O. Box 13000, 100 Herzberg Road, Kanata, Ontario K2K 2A6. Telephone (613) 592-5111.

DATA FORMATS

BASIC UNIT: 32-bit word.

Digital Equipment Corporation's VAX 8700 is high-performance system suitable for industrial and scientific applications requiring large memory and high data transfer rates.

DEC VAX 8000 Systems

CHART A. SYSTEM COMPARISON

MODEL	VAX 8250	VAX 8350	VAX 8530	VAX 8550	VAX 8600
SYSTEM CHARACTERISTICS					
Date of introduction	March 1987	March 1987	March 1987	August 1986	October 1984
Date of first delivery	March 1987	March 1987	March 1987	—	April 1985
Operating system	VAX/VMS, Ultrix-32	VAX/VMS, Ultrix-32	VAX/VMS, Ultrix-32	VAX/VMS, Ultrix-32	VAX/VMS, Ultrix-32
Upgradable from	Not applicable	VAX 8250*	Not applicable	8530*	Not applicable
Upgradable to	VAX 8350*	Not applicable	8550*	Not applicable	VAX 8650
MIPS	1.2 (approx.)	2.2-2.3 (approx.)	4.2 (approx.)	6.0 (approx.)	4.4 (approx.)
Relative performance (based on a rating of the VAX 8200 at 1.0)	1.2	2.0	4.0	6.0	4.2
MEMORY					
Minimum capacity, bytes	4M	4M	32M	32M	4M
Maximum capacity, bytes	32M	32M	80M	80M	68M
Type	MOS	MOS	MOS	MOS	MOS
Cache memory	8KB	8KB per CPU	64KB	64KB	16KB
Cycle time, nanoseconds	600	600 to 1600	135 to 1260	495	560
Bytes fetched per cycle	—	—	—	—	—
INPUT/OUTPUT CONTROL					
Number of channels	2	2	2	3	11
High-speed buses	1 VAXBI	1 VAXBI	2 VAXBI	2 VAXBI	4 MASSBUS
Low-speed buses	1 UNIBUS	1 UNIBUS	1 UNIBUS	1 UNIBUS	7 UNIBUS
MINIMUM DISK STORAGE	205MB	205MB	205MB	205MB	205MB
MAXIMUM DISK STORAGE	3.6GB local; 164GB in VAXcluster	1.8GB local; 164GB in VAXcluster	5.4GB local; 164GB in VAXcluster	5.4GB local; 164GB in VAXcluster	25.5GB local; 164GB in VAXcluster
NUMBER OF WORKSTATIONS	16-64 (typical)	24-96 (typical)	32-200 (typical)	72-370 (typical)	512 (56-256 typical)
COMMUNICATIONS PROTOCOLS	Bisync, DNA, Ethernet, SNA, 2780/3780, 3271, X.25, X.400, LU6.2, TCP/IP	Bisync, DNA, Ethernet, SNA, 2780/3780, 3271, X.25, X.400, LU6.2, TCP/IP	Bisync, DNA, Ethernet, SNA, 2780/3780, 3271, X.25, X.400, LU6.2, TCP/IP	Bisync, DNA, Ethernet, SNA, 2780/3780, 3271, X.25, X.400, LU6.2, TCP/IP	Bisync, DNA, Ethernet, SNA, 2780/3780, 3271, X.25, X.400, LU6.2, TCP/IP

Note: A dash (—) in a column indicates that the information is unavailable from the vendor.
An asterisk (*) next to a system number indicates that an upgrade kit will be available.

▷ the commercial marketplace. Digital capitalized on the fact that IBM had virtually neglected the departmental systems marketplace by failing to offer mid-range product lines that were fully compatible with each other, let alone with its PC and mainframe computers. Digital's systems have long been revered for their connectivity features and ability to exist in multivendor environments. It is an industry adage that Digital's computers communicate better with IBM systems than IBM systems do with each other.

With the introduction of the VAX 8000 systems, Digital continued its departmental marketing approach and maintained a technical focus on producing compatible systems with good connectivity features. The company is now reaping the rewards of such strategies and has reported higher earnings during 1985 and 1986 while many other companies, including IBM, have reported lower earnings. International Data Corporation (IDC), a Framingham, MA-based market research organization, estimates that one out of every four medium-scale systems installed in America today is a Digital VAX system.

A major advantage of having such a successful product already on the market is that Digital has been able to enhance systems and fill out the product line rather than scramble to come up with a brand new product line to carry the company through the persistent industry slump. On the other hand, witness IBM's current struggle to bring to the market a departmental system that is compatible with its mainframe architecture and that can attract enough sales to make up for the decline in mainframe business.

Once criticized for being slow in bringing new products to market, Digital has recently created for itself an image of ▷

▶ **FIXED-POINT OPERANDS:** Integers can be 8-bit bytes, 16-bit words, 32-bit longwords, 64-bit quadwords, and 128-bit octawords. Integer data is stored in a binary format that can be signed or unsigned. As unsigned quantities, integers increment from zero. As signed quantities, the integers are represented in two's complement form.

FLOATING-POINT OPERANDS: The VAX instruction set supports floating-point data in longwords, quadwords, and octawords. Four types of floating-point data are available. Two types—D and G—are eight bytes long; the third type—F—is four bytes long; the last type—H—is 16 bytes long. Data type F is single-precision; type D is double-precision.

A Floating-Point Accelerator (FPA) is optional on the VAX 8600 and 8650 but standard on all other VAX 8000 systems. The FPA executes in parallel with the base CPU, taking advantage of the CPU's instruction buffer to prefetch instructions and of the memory cache to access main memory. Once the CPU has the required data, the FPA overrides the normal execution flow of the standard floating-point microcode and forces use of its own code. Then, while the FPA is executing, the CPU performs other operations in parallel.

INSTRUCTIONS: The native VAX instruction set consists of 304 basic operations, most of which can be applied to any one of several types of data, which can in turn be addressed in any one of nine ways. The native instruction set provides 32-bit addressing, 32-bit I/O operations, and 32-bit arithmetic.

In conjunction with a software executive running in native mode, the VAX 8000 processors can concurrently execute a compatibility-mode instruction set, which is a subset of the Digital Equipment PDP-11 instruction set. This is not done by emulation or simulation; both instruction sets are built into the microcode and logic of the processor. The compatibility-mode instruction set contains all the PDP-11 instructions except those which perform execution of floating-point ▶

DEC VAX 8000 Systems

CHART A. SYSTEM COMPARISON (Continued)

MODEL	VAX 8650	VAX 8700	VAX 8800	VAX 8974	VAX 8978
SYSTEM CHARACTERISTICS					
Date of introduction	December 1985	August 1986	January 1986	January 1987	January 1987
Date of first delivery	1st quarter 1986	—	2nd quarter 1986	—	—
Operating system	VAX/VMS, Ultrix-32	VAX/VMS, Ultrix-32	VAX/VMS, Ultrix-32	VAX/VMS, Ultrix-32	VAX/VMS, Ultrix-32
Upgradable from	VAX 8600	Not applicable	8700	Not applicable	8974
Upgradable to	Not applicable	8800	Not applicable	8978	Not applicable
MIPS	6.3 (approx.)	6.0 (approx.)	9.5-12.7 (approx.)	26 (approx.)	53 (approx.)
Relative performance (based on a rating of the VAX 8200 at 1.0)	6.0	6.0	9.0-12.0	20-25	40-50
MEMORY					
Minimum capacity, bytes	16M	32M	32M	128M	256M
Maximum capacity, bytes	68M	128M	128M	512M	1G
Type	MOS	MOS	MOS	MOS	MOS
Cache memory	16KB	64KB	64KB per CPU	64KB	64KB
Cycle time, nanoseconds	384	495	135 to 1260	495	495
Bytes fetched per cycle	—	—	—	—	—
INPUT/OUTPUT CONTROL					
Number of channels	12	6	6	24	48
High-speed buses	4 MASSBUS	4 VAXBI	4 VAXBI	16 VAXBI	32 VAXBI
Low-speed buses	7 UNIBUS	2 UNIBUS	2 UNIBUS	8 UNIBUS	16 UNIBUS
MINIMUM DISK STORAGE	205MB	205MB	205MB	2.5GB	5GB
MAXIMUM DISK STORAGE	25.5GB local; 218.8GB in VAXcluster	7.2GB local; 218.8GB in VAXcluster	7.2GB local; 218.8GB in VAXcluster	—	—
NUMBER OF WORKSTATIONS	512 (56-256 typical)	72-320 (typical)	72-320 (typical)	288-1,280 (typical)	576-2,560 (typical)
COMMUNICATIONS PROTOCOLS	Bisync, DNA, Ethernet, SNA, 2780/3780, 3271, X.25, X.400, LU6.2, TCP/IP	Bisync, DNA, Ethernet, SNA, 2780/3780, 3271, X.25, X.400, LU6.2, TCP/IP	Bisync, DNA, Ethernet, SNA, 2780/3780, 3271, X.25, X.400, LU6.2, TCP/IP	Bisync, DNA, Ethernet, SNA, 2780/3780, 3271, X.25, X.400, LU6.2, TCP/IP	Bisync, DNA, Ethernet, SNA, 2780/3780, 3271, X.25, X.400, LU6.2, TCP/IP

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

▷ vitality and directedness, reflected by the number and the compatibility of the new systems announced in the past 16 months. The 11 VAX 8000 systems (three of which have already been replaced by new models) introduced since January of 1986 are all based on a common I/O architecture, run the same operating system, and connect the same peripheral devices, resulting in a range of systems that are hardware- and software-compatible from the entry level to the high end of the product line, as well as with older VAX-11 systems. The VAX 8000s fit right into corporate environments where Digital has already established a presence. The systems' compatibility facilitates the expansion of processing power horizontally through clustering, as well as vertically by ensuring a smooth upward migration to more powerful systems in the VAX 8000 line. The VAX 8000s also support communications based on IBM's SNA and on the International Standards Organization's (ISO's) Open Systems Interconnect (OSI) suite of protocols, enabling communication and coexistence with systems from many other vendors.

Introduced in March 1987, the VAX 8250, 8350, and 8530 are the newest VAX 8000s and the first to directly replace existing systems in the product line (the 8200, 8300, and 8500). The new systems offer slightly more processing power than the systems they replace, but do not fill any major processing power gaps between existing systems— large gaps simply do not exist in this line anymore. The new systems are more an indication that Digital can now focus on enhancing its systems and respond to the demands for more power for less price, thus keeping its systems competitive. Also, the VAX 8250 provides a lower priced entry point to the VAX 8000 line, narrowing the jump from the MicroVAX line to a VAX 8000, thus attracting customers ▷

▶ instructions, use of both instruction space and data space, and execution of privileged functions.

INTERNAL CODE: ASCII for text-oriented data; binary for calculations.

MAIN STORAGE

TYPE: Main memory for all VAX 8000 processors is 256K-bit ECC MOS RAM.

CYCLE TIME: Depending on the operation, main memory cycle times on VAX 8000 systems range from 135 to 1600 nanoseconds. Refer to Chart A for the cycle times of individual machines.

CAPACITY: Main memory capacities range from 4MB to 1GB. All VAX 8000 systems provide up to 4GB of virtual memory space. For the main memory capacities of specific VAX 8000 systems, refer to Chart A.

CHECKING: Information unavailable from the vendor.

STORAGE PROTECTION: The system's memory management logic divides memory into 512-byte pages. Each page is assigned a protection code specifying which, if any, access modes are to be permitted read or write access to the page. In addition, fault detection hardware causes a memory error-correcting code to detect all double-bit errors and correct all single-bit errors. Each VAX 8000 features a 7-bit error-correcting code per 32-bit longword.

Battery backup is standard on the VAX 8600, 8650, 8700, 8800, 8974, and 8978; it is optional on the 8250 and 8350.

RESERVED STORAGE: Minimum reserved storage for the VAX/VMS operating system is 2MB on the VAX 8600 and 8650 VAXclusters with the CI780 Computer Interconnect (CI). Information on other models is unavailable from the vendor. ▶

DEC VAX 8000 Systems

CHART B. MASS STORAGE

MODEL	RA60	RA80	RA81	SA482	RL02	RC25
Type	Removable	Winchester	Winchester	Storage Array	Cartridge	Fixed/Removable
Controller model	UDA50, KDA50, KDB50, HSC5X-BA (on HSC70 or HSC50)	UDA50, KDA50, KDB50, HSC5X-BA (on HSC70 or HSC50)	UDA50, KDA50, KDB50, HSC5X-BA (on HSC70 or HSC50)	UDA50, KDA50, KDB50, HSC50, HSC70	Integrated	Integrated
Drives per subsystem/controller	4	4	4	—	4	2
Formatted capacity per drive, megabytes	205	121	456	2.5GB	10.4	26/26
Number of usable surfaces	6	7	7	32	2	—
Number of sectors or tracks per surface	1600 tracks	1092 tracks	2496 tracks	—	512 tracks	—
Bytes per sector or track	512/sector	512/sector	512/sector	512/sector	256/sector	—
Average seek time	41.7 ms	25 ms	28 ms	24 ms/spindle	55 ms	35 ms
Average rotational/relay time	8.3 ms	8.3 ms	8.3 ms	8.3 ms/spindle	12.5 ms	10.5 ms
Average access time	50 ms	33.3 ms	36.3 ms	32.3 ms/spindle	67.5 ms	45.5 ms
Data transfer rate	1.98MB/sec.	1.2MB/sec.	2.2MB/sec.	2.4MB/sec./spindle	512KB/sec.	1.25MB/sec.
Supported by system models	All	8600, 8650	All	All	8600, 8650	All
Comments				SA482 subsystem comprises four RA82 drives	Not supported as system disk; data transfer device only	Not supported as system disk; data transfer device only

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

▷ who want a less expensive system which provides super-mini processing performance.

The replacement of the VAX 8000 low-end systems so soon after the introduction of the VAX 8974 and 8978 (just over one month later) is Digital's reaction to the rampant speculation that IBM plans to ship its 9370s earlier than originally announced. To prevent IBM from making too many inroads into the departmental market, Digital must maintain a focus on the low end of the product line. The lower-priced entry-level system, the VAX 8250, may also be an attempt to pave the way for the introduction of a more powerful MicroVAX and perhaps attract sales from customers who would go elsewhere until such a system is available.

With its superminicomputers firmly established in the marketplace, and with no processing power gaps between the systems, Digital is in a good position to pursue new markets, widening its product range at both the low and high ends. Digital leaped into the high end in announcing the VAX 8974 and 8978, preconfigured VAXcluster systems specifically targeted at traditional mainframe environments: commercial and technical data centers in *Fortune* 100 companies for applications such as electronic funds transfer, management of large data bases, and research and development. The introduction of these "mainframe-class" systems signifies Digital's optimism that it can finally compete with IBM in the mainframe market. However, since these systems are not really mainframes, they are not likely to pose an effective challenge to the IBM 3090, at which they are targeted. Composed of loosely coupled VAX 8700 CPUs, the VAX 8974 and 8978 will probably attract customers who already have VAX departmental systems and who would have opted for a VAXcluster configuration, anyway, to handle their large data processing needs. The 8900s just give them a discount. Users looking for traditional mainframe computing power will continue to purchase the traditional mainframe, and ▷ probably from IBM.

▶ CACHE MEMORY: All VAX 8000 systems include cache memory. Refer to Chart A for cache sizes on specific machines.

CENTRAL PROCESSOR

GENERAL: All VAX 8000 CPUs feature virtual memory management facilities; bootstrap loader; cache memory; programmable realtime clock; time-of-year clock with battery backup; control store; and console subsystem. The VAX 8530, 8550, 8600, 8650, 8800, 8974, and 8978 CPUs employ Emitter Coupled Logic (ECL) gate array circuitry; the 8250 and 8350 use ZMOS technology.

The VAX 8250 and 8350 feature 200-nanosecond cycle times. The 8250 is a single-board CPU with a built-in hot floating-point accelerator. The system uses a VAXBI memory interconnect and incorporates testing checks and diagnostic facilities. The 8350 is a dual-CPU system that delivers up to 1.9 times the performance of the 8250. It is basically the same as the 8250, except that it incorporates a second CPU module and VAX/VMS support facilities. Main memory is sharable by both processors over the VAXBI system bus.

The VAX 8530 employs four-stage pipelining; the VAX 8550, which offers one and a half the processing power of the 8530, employs five-stage pipelining. On both systems a three-way interleaved memory controller and private memory bus reportedly provide average read and write bandwidths in excess of 50MB per second.

The VAX 8600 and 8650 CPUs also employ four-stage pipeline processing. The VAX 8600 achieves a CPU cycle time of 80 nanoseconds; the cycle time of the VAX 8650 is 55 nanoseconds. The VAX 8600 and 8650 CPUs interface to their respective memory controllers through a dedicated memory bus called the MD-Bus. The memory controller, in turn, interfaces to the main memory arrays over the Array Bus. The CPU also features a system diagnostic bus and incorporates self-monitoring and error-testing programs.

The VAX 8700 CPU employs five-stage pipelining and achieves a 45-nanosecond cycle time.

The VAX 8800, comprising two tightly coupled CPUs sharing a memory controller, uses a five-stage pipelining scheme to deliver a CPU speed of 45 nanoseconds. The internal CPU-to-memory bus transfers data at 60MB per second. In ▶

DEC VAX 8000 Systems

CHART A. SYSTEM COMPARISON (Continued)

MODEL	VAX 8650	VAX 8700	VAX 8800	VAX 8974	VAX 8978
SYSTEM CHARACTERISTICS					
Date of introduction	December 1985	August 1986	January 1986	January 1987	January 1987
Date of first delivery	1st quarter 1986	—	2nd quarter 1986	—	—
Operating system	VAX/VMS, Ultrix-32	VAX/VMS, Ultrix-32	VAX/VMS, Ultrix-32	VAX/VMS, Ultrix-32	VAX/VMS, Ultrix-32
Upgradable from	VAX 8600	Not applicable	8700	Not applicable	Not applicable
Upgradable to	Not applicable	8800	Not applicable	8978	Not applicable
MIPS	6.3 (approx.)	6.0 (approx.)	9.5-12.7 (approx.)	26 (approx.)	53 (approx.)
Relative performance (based on a rating of the VAX 8200 at 1.0)	6.0	6.0	9.0-12.0	20-25	40-50
MEMORY					
Minimum capacity, bytes	16M	32M	32M	128M	256M
Maximum capacity, bytes	68M	128M	128M	512M	1G
Type	MOS	MOS	MOS	MOS	MOS
Cache memory	16KB	64KB	64KB per CPU	64KB	64KB
Cycle time, nanoseconds	384	495	135 to 1260	495	495
Bytes fetched per cycle	—	—	—	—	—
INPUT/OUTPUT CONTROL					
Number of channels	12	6	6	24	48
High-speed buses	4 MASSBUS	4 VAXBI	4 VAXBI	16 VAXBI	32 VAXBI
Low-speed buses	7 UNIBUS	2 UNIBUS	2 UNIBUS	8 UNIBUS	16 UNIBUS
MINIMUM DISK STORAGE	205MB	205MB	205MB	2.5GB	5GB
MAXIMUM DISK STORAGE	25.5GB local; 218.8GB in VAXcluster	7.2GB local; 218.8GB in VAXcluster	7.2GB local; 218.8GB in VAXcluster	—	—
NUMBER OF WORKSTATIONS	512 (56-256 typical)	72-320 (typical)	72-320 (typical)	288-1,280 (typical)	576-2,560 (typical)
COMMUNICATIONS PROTOCOLS	Bisync, DNA, Ethernet, SNA, 2780/3780, 3271, X.25, X.400, LU6.2, TCP/IP	Bisync, DNA, Ethernet, SNA, 2780/3780, 3271, X.25, X.400, LU6.2, TCP/IP	Bisync, DNA, Ethernet, SNA, 2780/3780, 3271, X.25, X.400, LU6.2, TCP/IP	Bisync, DNA, Ethernet, SNA, 2780/3780, 3271, X.25, X.400, LU6.2, TCP/IP	Bisync, DNA, Ethernet, SNA, 2780/3780, 3271, X.25, X.400, LU6.2, TCP/IP

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▷ instructions, use of both instruction space and data space, and execution of privileged functions.

INTERNAL CODE: ASCII for text-oriented data; binary for calculations.

MAIN STORAGE

TYPE: Main memory for all VAX 8000 processors is 256K-bit ECC MOS RAM.

CYCLE TIME: Depending on the operation, main memory cycle times on VAX 8000 systems range from 135 to 1600 nanoseconds. Refer to Chart A for the cycle times of individual machines.

CAPACITY: Main memory capacities range from 4MB to 1GB. All VAX 8000 systems provide up to 4GB of virtual memory space. For the main memory capacities of specific VAX 8000 systems, refer to Chart A.

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STORAGE PROTECTION: The system's memory management logic divides memory into 512-byte pages. Each page is assigned a protection code specifying which, if any, access modes are to be permitted read or write access to the page. In addition, fault detection hardware causes a memory error-correcting code to detect all double-bit errors and correct all single-bit errors. Each VAX 8000 features a 7-bit error-correcting code per 32-bit longword.

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Drives per subsystem/controller	4	4	4	—	4	2
Formatted capacity per drive, megabytes	205	121	456	2.5GB	10.4	26/26
Number of usable surfaces	6	7	7	32	2	—
Number of sectors or tracks per surface	1600 tracks	1092 tracks	2496 tracks	—	512 tracks	—
Bytes per sector or track	512/sector	512/sector	512/sector	512/sector	256/sector	—
Average seek time	41.7 ms	25 ms	28 ms	24 ms/spindle	55 ms	35 ms
Average rotational/relay time	8.3 ms	8.3 ms	8.3 ms	8.3 ms/spindle	12.5 ms	10.5 ms
Average access time	50 ms	33.3 ms	36.3 ms	32.3 ms/spindle	67.5 ms	45.5 ms
Data transfer rate	1.98MB/sec.	1.2MB/sec.	2.2MB/sec.	2.4MB/sec./spindle	512KB/sec.	1.25MB/sec.
Supported by system models	All	8600, 8650	All	All	8600, 8650	All
Comments				SA482 subsystem comprises four RA82 drives	Not supported as system disk; data transfer device only	Not supported as system disk; data transfer device only

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who want a less expensive system which provides super-mini processing performance.

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CACHE MEMORY: All VAX 8000 systems include cache memory. Refer to Chart A for cache sizes on specific machines.

CENTRAL PROCESSOR

GENERAL: All VAX 8000 CPUs feature virtual memory management facilities; bootstrap loader; cache memory; programmable realtime clock; time-of-year clock with battery backup; control store; and console subsystem. The VAX 8530, 8550, 8600, 8650, 8800, 8974, and 8978 CPUs employ Emitter Coupled Logic (ECL) gate array circuitry; the 8250 and 8350 use ZMOS technology.

The VAX 8250 and 8350 feature 200-nanosecond cycle times. The 8250 is a single-board CPU with a built-in hot floating-point accelerator. The system uses a VAXBI memory interconnect and incorporates testing checks and diagnostic facilities. The 8350 is a dual-CPU system that delivers up to 1.9 times the performance of the 8250. It is basically the same as the 8250, except that it incorporates a second CPU module and VAX/VMS support facilities. Main memory is sharable by both processors over the VAXBI system bus.

The VAX 8530 employs four-stage pipelining; the VAX 8550, which offers one and a half the processing power of the 8530, employs five-stage pipelining. On both systems a three-way interleaved memory controller and private memory bus reportedly provide average read and write bandwidths in excess of 50MB per second.

The VAX 8600 and 8650 CPUs also employ four-stage pipeline processing. The VAX 8600 achieves a CPU cycle time of 80 nanoseconds; the cycle time of the VAX 8650 is 55 nanoseconds. The VAX 8600 and 8650 CPUs interface to their respective memory controllers through a dedicated memory bus called the MD-Bus. The memory controller, in turn, interfaces to the main memory arrays over the Array Bus. The CPU also features a system diagnostic bus and incorporates self-monitoring and error-testing programs.

The VAX 8700 CPU employs five-stage pipelining and achieves a 45-nanosecond cycle time.

The VAX 8800, comprising two tightly coupled CPUs sharing a memory controller, uses a five-stage pipelining scheme to deliver a CPU speed of 45 nanoseconds. The internal CPU-to-memory bus transfers data at 60MB per second. In

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▷ The introduction of the VAX 8900s, however, is not insignificant. Digital has finally made a formal statement that it is no longer content to be the lamb that lies down with the lion; it is ready to take on IBM on the mainframe vendor's own turf. The VAX 8900s serve as a positioning statement that Digital is looking beyond the departmental solution to the needs of the centralized computing environment. Customers will begin to look to Digital even more as a total systems supplier and eventually as a mainframe vendor, when a true mainframe system, compatible with the entire VAX range of products, is offered—as it surely will be.

Along with the VAX 8974 and 8978, Digital also announced the VAX Performance Advisor (VPA), a software package used to examine system statistics and help system managers identify system bottlenecks and tune their systems for optimum performance. This is the kind of performance management software normally offered only for mainframes in a data center environment. Such an offer demonstrates Digital's intention not only to pursue the mainframe market, but to provide the software necessary to support mainframe operations.

The VAX 8550 and 8700, announced in August 1986, filled the processing gap that existed in the middle of the VAX 8000 line and resulted in a complete range of compatible systems. By basing the 8550 and 8700 on the same VAX Bus Interconnect (VAXBI) I/O architecture implemented in the other VAX 8000 systems available at that time (8200, 8300, 8500, and 8800), Digital further demonstrated its commitment to the enhanced I/O architecture and to standardization within the VAX 8000 product line.

The charter members of the VAX 8000 family, the VAX 8600 and the VAX 8650, employ the older and slower UNIBUS/MASSBUS I/O technology used by the high-end VAX-11 systems. These systems are not fully compatible with the rest of the VAX 8000s and, it appears, will eventually be dropped from the product line in favor of the VAXBI-based 8550 and 8700, which are comparable in performance. The 8600 and 8650, however, do support many of the same peripherals as the VAXBI-based systems and still provide features demanded by Digital's customers. Also, Digital now offers the VAXBI Bridge, which allows these systems to access VAXBI options through VAXclusters. Another indication that the 8600 and 8650 may be on their way out, however, is that Digital now offers ULTRIX-32 on all the VAX 8000 systems, where previously it was only supported by the VAX 8200 (no longer marketed), 8600, and 8650; the older systems are no longer critical to the company as entries in the Unix environment. The 8600 and 8650 do account for the majority of the VAX 8000 installed base, however, so it is likely that Digital will continue to offer products that support the integration of these systems into the VAXBI environment for the near term.

COMPETITIVE POSITION

In markets where Digital and IBM formerly avoided direct competition, both companies are now opponents in the ▷

▶ case one of the VAX 8800 processors fails or suffers intermittent faults, the system can be reconfigured as a uniprocessor until remedial maintenance is performed.

The VAX 8974 and VAX 8978 are VAXcluster configurations consisting of four or eight VAX 8700 CPUs, respectively. The CPUs are loosely coupled, each having its own memory and running its own copy of the operating system.

Internal diagnostic facilities, invoked either locally through the system console or remotely from a Digital Service Center, are intrinsic to the VAX 8530, 8550, 8700, 8800, 8974, and 8978.

CONTROL STORAGE: The control store sizes on the VAX 8000 systems are as follows:

• VAX 8250—15K 40-bit words of ROM, plus 1K 40-bit words of RAM.

• VAX 8350—Same as 8250 for each processor.

• VAX 8530/8550—16K 144-bit words writable and 1K 144-bit words user accessible.

• VAX 8600/8650—8K 86-bit words writable.

• VAX 8700—16K 144-bit words writable.

• VAX 8800—16K 144-bit words writable on each processor.

• VAX 8974/8978—16K 144-bit words writable on each processor.

REGISTERS: The VAX systems provide sixteen 32-bit general registers that can be used for temporary storage, as accumulators, as index registers, and as base registers. A base register contains the address of the base of a software data structure such as a table or queue, and an index register contains a logical offset into a data structure. Whenever a register is used to contain data, the data is stored in the register in the same format as it would appear in memory. If a quadword or double floating operand is stored in a register, it is actually stored in two adjacent registers.

Four registers have special significance: the Program Counter contains the address of the next instruction to be executed; the Stack Pointer contains the address of the base (or top) of a stack maintained for subroutine and procedure calls; the Frame Pointer contains the address of the base of a software data structure stored on the stack and called the stack frame, which is maintained for procedure calls; and the Argument Pointer contains the address of the base of a software data structure called the argument list, which is maintained for procedure calls.

In addition, the first six registers have special significance for instructions whose execution must be interruptible, including character and packed decimal string instructions, cyclic redundancy check, and polynomial instructions. These instructions use the first six registers to store temporary results and, upon completion, leave results in the registers that a program can use as the operands of subsequent instructions.

A register's special significance does not preclude its use for other purposes, except for the Program Counter. The Program Counter cannot be used as an accumulator, as a temporary register, or as an index register.

ADDRESSING: The processor's addressing modes allow almost any operand to be in a register or in memory, or used as an immediate constant. There are nine basic addressing ▶

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CHART C. WORKSTATIONS

MODEL	VT220	VT240	VT241
DISPLAY PARAMETERS			
Max. chars./screen	3168	3168	3168
Buffer capacity	—	—	—
Screen size (lines x chars.)	24 x 80 or 132	24 x 80 or 132	24 x 80 or 132
Tilt/swivel screen	Tilt standard	Standard	Standard
Symbol formation	7 x 10 dot-matrix	8 x 10 dot-matrix	8 x 10 dot-matrix
Character phosphor	White, green, or amber	White, green, or amber	P4
Total colors/no. simult. displayed	Not applicable	Not applicable	—
KEYBOARD PARAMETERS			
Style	Typewriter	Typewriter	Typewriter
Character/code set	ASCII, Digital Special Graph-ics, and Supplemental	ASCII, Digital Special Graph-ics, and Supplemental	ASCII, Digital Special Graph-ics, and Supplemental
Detachable	Yes	Yes	Yes
Program function keys	15	15	15
TERMINAL INTERFACE	RS-232-C, RS-423, and 20 ma std.	RS-232-C, RS-423, and 20 ma std.	RS-232-C, RS-423, and 20 ma std.
COMMENTS		800 x 240 pixel graphics array	800 x 240 pixel graphics ar-ray; includes color monitor

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

same arena. Solidly established as a corporate systems provider through its departmental approach, Digital has now challenged IBM in the mainframe market. Responding to users' demands for a better departmental system, IBM has announced the 9370 has and promised to provide users with the same kind of departmental solutions—compatibility and connectivity—that Digital provides. Like wrestlers circling each other at the beginning of a match, the two vendors are preparing for a gripping confrontation.

The major advantage that the 9370 has over a VAX 8000 is that IBM sells it, and it is compatible with IBM System/370 architecture, enabling it to run the same software that runs on the IBM mainframes. The 9370 also supports some of the same peripheral and storage devices as the System/36 and System/38, easing the migration into the 370 environment. Customers with IBM mainframes who might have purchased VAX 8000s as departmental systems—because of their ability to communicate with IBM mainframes—now have another option that promises to provide the connectivity and compatibility that have been lacking on the IBM System/3X departmental systems. As a departmental processor, the 9370 may present even more of a threat to the VAX 8000s if IBM comes up with an Intel 80386-based personal computer that is also compatible with S/370 architecture. Such a strategy would result in three levels of systems based on the same architecture and capable of addressing the same needs, in the same way, that Digital does with its MicroVAX and VAX 8000 systems, although without the true mainframe dimension.

A major advantage that the VAX 8250 and 8350 have over the 9370 is that these systems are currently available, whereas the 9370 is scheduled for delivery in the third quarter of 1987 (but will probably be delivered earlier). Digital customers who have ordered and have been waiting for an 8200 or 8300 will receive an 8250 or 8350. On the day that the new systems were announced, Digital stated that 40 VAX 8250s and 8350s had already been shipped. ▷

modes that use the general registers to identify the operand location: Register; Register Deferred; Autodecrement; Autoincrement; Immediate; Autoincrement Deferred; Absolute; Displacement; and Displacement Deferred. The processor also provides Literal Mode addressing.

INTERRUPTS: Each VAX 8000 processor recognizes 31 interrupt priority levels—16 for hardware and 15 for software. Normal user software runs at the process level, which is interrupt priority level zero.

The interrupt service routine executes at the interrupt priority level of the interrupt request. When the processor receives an interrupt request at a level higher than that of the currently executing software, the processor honors the request and services the new interrupt at its priority level. When the interrupt service routine issues the Return from Exception or Interrupt (REI) instruction, the processor returns control to the previous level.

OPERATING ENVIRONMENT: Configuration one (with a 12-slot backplane) of both the VAX 8250 and 8350 is 42 inches (106 cm) high, 22 inches (54 cm) wide, and 32 inches (81 cm) deep, and weighs 400 pounds (180 kg). Configuration two (with a 24-slot backplane) of both the 8250 and 8350 is 42 inches high, 29 inches (73 cm) wide, 32 inches deep, and weighs 500 pounds (230 kg). Each system has a power requirement of 92 to 132 VAC or 184 to 264 VAC, 47 to 63 Hz, single-phase. Maximum AC power consumption is 1.69 kilowatts. Maximum heat dissipation is 5,760 Btu per hour.

Both the VAX 8530 and 8550 are 60 inches (152 cm) high, 27 inches (68.5 cm) wide, and 30 inches (76 cm) deep, and weigh 650 pounds (295 kg). Power requirements are 180 to 220 VRMS, 59 to 61 Hz; 331 to 407 VRMS, 49 to 51 Hz; or 360 to 443 VRMS, 49 to 51 Hz, all triple-phase. Maximum AC power consumption is 3.2 kilowatts; maximum heat dissipation is 12,000 Btu per hour. The system occupies 5.6 square feet of space; noise level is 6.2 dBA.

The VAX 8600 and VAX 8650 each stand 60.5 inches (153.7 cm) high, 73.5 inches (186.7 cm) wide, and 30 inches (76.2 cm) deep. Both weigh 1,700 pounds (773 kg). Power requirements are 120/208 VAC, 47 to 63 Hz, triple-phase. Power of 240/415 VAC, 50 Hz is also available. Maximum AC power consumption is 6.5 kilowatts. Heat dissipation is 22,200 Btu per hour on the 8600, and 23,000 Btu on the ▶

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CHART D. PRINTERS

MODEL	LXY12/22	LP25	LP26	LP27	LG01/LG02
Type	Dot-matrix	Band	Band	Band	Matrix
Speed	300/600 lpm	300 or 300/215 lpm	600 or 600/445 lpm	1200/800 lpm	600 lpm
Bidirectional printing	No	Not applicable	Not applicable	Not applicable	—
Paper size	—	Up to 15 inches	Up to 15 inches	Up to 18.75 inches	4-16 in. wide, 3-20 in. long
Character formation	Variable	Full	Full	Full	Dot-matrix
Horizontal character spacing (char./inch)	Variable	Variable	10	10	Variable
Vertical line spacing (char./inch)	—	6 or 8	6 or 8	6 or 8	—
Character set	96 or 192	64 or 64/96	64 or 64/96	64/96	64 (data proc. mode)
Controller/Interface	LP11, RS-232-C, DMF32, DMB32	LP11, DMF32, DMB32	LP11, DMF32, DMB32	Integrated, DMF32, DMB32	RS-232-C, Datapro-ducts parallel
No. of printers per controller/interface	—	—	—	—	—
Printer dimensions, in. (h x w x d)	46.5 x 30 x 24.3	43.8 x 30.3 x 33.6	43.8 x 30.3 x 33.6	49 x 35 x 38	38 x 33.5 x 22.3
Graphics capability	Yes	No	No	No	LG02 only
Comments					LG01 text printer up-gradable to LG02 text/graphics printer

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

CHART D. PRINTERS (Continued)

MODEL	LN01S	LN01B	LN03
Type	Laser	Laser	Laser
Speed	12 ppm	12 ppm	8 ppm
Bidirectional printing	Not applicable	Not applicable	Not applicable
Paper size	8.5 x 11 or 8.5 x 14 inches	8.5 x 11 or 8.5 x 14 inches	8.5 x 11 inches
Character formation	300 x 300 dots/sq. in.	300 x 300 dots/sq. in.	300 x 300 dots/sq. in.
Horizontal character spacing (char./inch)	Variable	Variable	Variable
Vertical line spacing (char./inch)	Variable	Variable	Variable
Character set	12 Courier-like fonts standard	16 Courier-like graphics labeling fonts std.	ASCII; 16 resident Courier/ Elite fonts
Controller/Interface	LP11, DMF32, DMB32	LP11, DMF32, DMB32	RS-232-C
No. of printers per controller/interface	—	—	1
Printer dimensions, in. (h x w x d)	36 x 25.8 x 26	36 x 25.8 x 26	15 x 21 x 23.5
Graphics capability	Yes	Yes	150 dpi (average)
Comments		Includes PLOTLN software and 2 EPROMs.	Prints in landscape and portrait modes

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

▷ Another advantage that the VAX 8000s have over the 9370 is that Digital communications products, specifically DECnet, implement both OSI and SNA protocols, enabling participation in multivendor networking environments. IBM, on the other hand, continues to invest primarily in SNA, providing only gateways to OSI protocols, thus making its networking products more expensive and less flexible than those that integrate OSI standards.

The VAX 8250 and 8350 (rated at approximately 2 and 3 MIPS, respectively) compete most directly with the 9375-40 and -60 (rated at 0.5 and 1.3 MIPS, respectively). A basic configuration of the 8250 offers a price/performance ratio of $32,500 per MIPS. A basic configuration of the 8350 offers a price/performance ratio of $29,300 per MIPS. Compare this to $130,000 per MIPS for the 9375-40 and $70,000 per MIPS for the 9375-60. Also, keep in mind that Digital's basic systems include a floating-point processor, Ethernet communications adapter, disk controller, and one-year operating system license. The 9370s come with the CPU and memory; other components and communications devices must be added.

Digital is pitting the VAX 8974 and 8978 directly against the IBM 3090, but considering the technology implemented in the Digital systems, this is not an even match. The ▷

▶ 8650. Maximum noise generated by the 8600 is 60 dBA. The VAX 8600 and 8650 can be positioned on either a solid or raised floor, because both can draw air under the skirt of the machine as well as through a floor.

The VAX 8700 and VAX 8800 are both 60 inches (152 cm) high, 74 inches (188 cm) wide, and 30 inches (76.2 cm) deep; each occupies 15.5 square feet of space. Weight with a 60-Hz power supply is 1,474 pounds (668 kg); a 50-Hz system weighs 1,769 pounds (802 kg). Power requirements for the VAX 8800 are 156 to 220 VRMS, 59 to 61 Hz, or 360 to 443 VRMS, 49 to 51 Hz, triple-phase. Surge current is 500 amp for 60 Hz and 250 amp for 50 Hz. Maximum power consumption is 3.7 kilowatts. Maximum heat dissipation is 12,600 Btu per hour.

The VAX 8974, a complete VAXcluster configuration, occupies 312 square feet and weighs 8,780 pounds (3,951 kg). The VAX 8978, also a VAXcluster configuration, occupies 603.25 square feet and weighs 17,410 pounds (7,834.5 kg). Power consumption on the VAX 8974 is 60 kVA, 20 kW; that on the VAX 8978 is 115 kVA, 40 kW. Maximum heat dissipation is 58.86K Btu per hour for the VAX 8974, and 117.72K Btu per hour for the VAX 8978.

Operating temperature for all VAX 8000 systems is 59 to 90 degrees Fahrenheit (15 to 32 degrees Celsius). Relative operational humidity for the 8250, 8350, 8600, and 8650 is 20 to 80 percent, noncondensing; that for the 8530, 8550, 8700, 8800, 8974, and 8978 is 10 to 90 percent, noncondensing. (A VAX 8250 not using an RX50 diskette operates at 50 ▶

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CHART E. MAGNETIC TAPE EQUIPMENT

MODEL	TA78	TU78	TA81	TU77
TYPE	Reel-to-Reel	Reel-to-Reel	Streaming	Reel-to-Reel
FORMAT				
Number of tracks	9	9	9	9
Recording density, bits per inch	1600/6250	1600/6250	1600/6250	800/1600
Recording mode	PE/GCR	PE/GCR	PE/GCR	NRZI/PE
CHARACTERISTICS				
Controller model	HSC5X-CA (on HSC70 or HSC50)	TA78 master (on HSC5X-CA) or Massbus adapter	HSC5X-CA (on HSC70 or HSC50)	Massbus adapter
Drives per controller	4 per HSC5X-CA	3 per TA78 or 32 on Massbus adapter	4 per HSC5X-CA	4
Storage capacity, bytes	40M PE, 145M GCR	145M GCR	40M PE, 145M GCR	20M NRZI, 40M PE
Tape speed, inches per second	125	125	75 and 25 (streaming)	125
Data transfer rate, units per second	200KB PE; 781KB GCR	781KB	468KB	200KB
Streaming technology	No	No	Yes	No
Start/stop mode; speed	Not applicable	Not applicable	Yes; 25 ips	Not applicable
Switch selectable	Yes	Yes	—	Yes

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

CHART E. MAGNETIC TAPE EQUIPMENT (Continued)

MODEL	TU80	TU81	TU81-Plus
TYPE	Streaming	Streaming	Streaming
FORMAT			
Number of tracks	9	9	9
Recording density, bits per inch	1600	1600/6250	1600/6250
Recording mode	PE	PE/GCR	PE/GCR
CHARACTERISTICS			
Controller model	Unibus adapter	Unibus or Massbus adapter; HSC5X-CA (on HSC70 or HSC50)	VAXBI adapter
Drives per controller	1	4 per Unibus or HSC5X-CA; 8 per Massbus	—
Storage capacity, bytes	40M	40M PE, 145M GCR	—
Tape speed, inches per second	25 and 100 (streaming)	75 and 25 (streaming)	75 ips
Data transfer rate, units per second	160KB	468KB	—
Streaming technology	Yes	Yes	Yes
Start/stop mode; speed	Yes; 25 ips	Yes; 25 ips	—
Switch selectable	No	—	—

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

▷ new systems are not really mainframes, but loosely coupled processors that do not share memory and therefore do not present a single system image; nor can the separate multiple processors work on the same job simultaneously. The system as a whole cannot execute a job more quickly than any single processor can do it. The 3090 multiprocessor configurations, on the other hand, are tightly coupled and share main storage, providing a degree of parallelism the 8900s do not give.

This is not to say that the VAX 8900 systems are not capable of powerful performance, especially in multistream computing where the loosely coupled approach permits smooth load balancing and provides a degree of fault resistance: if one processor in the configuration goes down, it does not take the others in the configuration with it. The fault resistance of the hardware is enhanced by new Volume Shadowing software, which enables systems to automatically duplicate critical data so that the data is still available even if one storage device becomes unavailable. ▷

▶ to 104 degrees Fahrenheit—10 to 40 degrees Celsius—at 10 to 90 percent humidity, noncondensing.) Maximum altitude for all systems is 8,000 feet (2,400 meters).

INPUT/OUTPUT CONTROL

The input/output information provided here is for systems running under VAX/VMS; ULTRIX-32 systems use the same I/O control devices, but are more restricted as to the number that can be configured.

The *VAX Bus Interconnect (VAXBI)*, a 32-bit synchronous bus, serves as a combination system and I/O bus on the VAX 8250 and 8350 and as the I/O bus only on the 8530, 8550, 8700, 8800, 8974, and 8978, all of which employ a high-speed memory interconnect as the system bus.

In the VAXBI bus, all arbitration, address, and data transmissions are time-multiplexed over 32 data lines. Physical address space is 1GB. The maximum data transfer rate, as implemented by the Bus Interconnect Interface Chip (BIIC), is 13.3MB per second for 16-byte transfers.

The VAXBI provides connection for up to 16 VAXBI nodes. A VAXBI node consists of one or more VAXBI modules. A ▶

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> In addition to offering true mainframe processing power, IBM peripherals are generally of better quality than those offered by Digital. For instance, the Digital SA482 disk subsystem provides a storage improvement over the previous high-end storage facilities based on the 456MB RA81 disk, but the SA482 is really only a collection of four 622MB RA82 disk drives. Each of IBM's extended-capacity 3380 disk drives holds 5.04GB. Up to 16 can be configured on a single 3880 storage controller, providing a 3090 with much more storage than is available for a VAX 8900. Digital users have remarked that the technology used in both Digital disk and tape drives is years behind that implemented in the IBM storage devices.

As previously mentioned, the introduction of the VAX 8900 systems is obviously a positioning statement to let Digital customers know that the company has plans to address users' large-system needs with tightly coupled multiprocessor VAX/VMS systems a few years down the road. Such mainframe posturing at this time prepares customers to think of Digital as a provider of centralized data processing products, not just as a departmental systems manufacturer. This is a valuable image to project into the future, when customers will realize that, though cost effective, departmental computing can result in organizational problems and equipment incompatibility not encountered in a data center environment. With a customer base already firmly established within the corporate environment, Digital is sowing seeds in fertile ground, for it already provides a wide range of sophisticated products capable of lashing together components from a variety of vendors; however, these seeds will bear fruit only if Digital can bring to market a mainframe that is truly competitive with those mainframes offered by IBM.

ADVANTAGES AND RESTRICTIONS

The VAX 8000s' most notable assets are their common I/O architecture and networking capabilities. All systems but the VAX 8600 and 8650 are based on the VAXBI, which features a throughput rate of at least 13.3MB per second (and higher aggregate rates if multiple VAXBIs are configured), a great improvement over the 1MB to 2MB per second throughput rate of the UNIBUS implemented on earlier VAX models. By basing newer VAX 8000 systems on the VAXBI, Digital is committed to keeping the VAX 8000 systems as the company's pacesetter for 32-bit computing, protecting users' investments in VAX products years down the line. The VAXBI also allows easy movement of peripherals from one system to another—including UNIBUS-based systems—simplifying the allocation and management of computer resources and also protecting users' investments in peripherals purchased to operate in a VAX 8000 environment.

Digital's emphasis on networking and communications is a distinct advantage for the VAX 8000 systems. The company's IBM/SNA connectivity products and other networking software provide VAX users with gateways to IBM mainframes and strengthen the position of department-level VAX 8000 systems as intermediaries between mainframes and personal computers. Digital also provides a ▷

> node is a VAXBI interface that occupies one of 16 logical locations on a VAXBI bus; it can be a mix of processors, memories, and adapters. Processor nodes execute machine instructions, access memory, and control the action of adapters. Memory nodes store instructions and data for, and respond to the read and write transactions issued by, processors and adapters. Adapter nodes transfer data to and from memory and accept control from processors.

Types of VAXBI adapters include mass storage adapters, which provide high-speed data transfers to and from VAXBI memory nodes; bus adapters, which permit connections to Digital's UNIBUS options, to VAXclusters, and to the private memory interconnects on other VAX processors; and communications adapters, which link the VAXBI to Ethernet local area networks and provide communications between modems and terminals in VAXBI systems.

The BIIC, a single ZMOS interface chip, is the primary interface between the VAXBI bus and the user interface logic on each node. The BIIC implements the VAXBI bus protocol. The VAXBI chip interface, or BCI, is a synchronous interface bus that provides for all communications between the BIIC and the user interface.

The VAXBI bus provides a built-in multiprocessing capability, as well as self-test and error control functions.

The VAXBI supports the following adapters:

- *CIBCI*—a high-speed interface to the Computer Interconnect, which is used to create VAXclusters; data can be transferred between the VAXBI and the CIBCI at 2MB to 3MB per second.

- *DB88*—interface between the Memory Interconnect (MI) bus and the VAXBI bus on the 8530, 8550, 8700, 8800, 8974, and 8978. The DB88 is the principal I/O path to VAXBI-based disk storage, terminals, and other peripheral devices. DB88s can be added to increase the number of VAXBI channels on a system.

- *DMB32 Communications Adapter*—transfers data between host processors on the VAXBI bus and various communications interfaces. For further details on the DMB32, see the "Communications Control" section of this report.

- *DWBUA*—VAXBI-to-UNIBUS adapter; transfers data between the high-speed, synchronous VAXBI and the asynchronous UNIBUS. Maximum data transfer rate is approximately 1MB per second.

- *KDB50*—an intelligent disk controller that connects up to four Standard Disk Interconnect (SDI) drives to VAXBI systems. The KDB50 provides throughput rates as high as 1MB per second.

- *KLESI*-B—connects a host to a tape or disk device (such as Digital's TU81 streamer or RC25 Winchester disk) using the Low End Storage Interconnect (LESI).

The VAXBI provides a bandwidth of 13.3MB per second on the VAX 8250 and 8350. The VAX 8530 and 8550 support two VAXBI channels, which provide an I/O rate in excess of 16MB per second. The VAX 8700 and 8800 permit configuration of four VAXBI channels and deliver a usable I/O bandwidth of more than 30MB per second. The 8974 supports up to 16 VAXBIs for an aggregate I/O rate of 212.8MB per second. The 8978 supports up to 32 VAXBIs for an aggregate I/O rate of 425.6MB per second.

All VAX systems support the *UNIBUS*, an asynchronous bidirectional bus, which controls all Digital- and user-developed realtime peripherals other than high-speed disk drives ▶

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▷ product that implements the LU6.2 protocol, the linchpin in peer-to-peer communications with IBM systems and among all types of hardware.

In the realm of non-IBM communications, the VAX OSI Transport Service and Message Router X.400 Gateway simplify information exchange both among multivendor systems in a network and among different networks, linking disparate systems that support OSI protocols. These products will prove particularly useful in the future, as more vendors introduce products that conform to the ISO/OSI model.

Digital's principal networking product is DECnet, which allows creation of Ethernet local area networks and wide area networks centered around VAX/VMS-based Digital systems. The company's Internet products permit interconnection of Digital computers and Digital networks to systems built by IBM and other manufacturers.

The VAX 8000s feature a high degree of software compatibility. Because all systems run the VMS operating system, applications are transportable among systems from the bottom of the line to the top. This congruent operating environment actually provides a dual advantage: it allows users to migrate upward to more powerful single systems without altering their applications and also permits those with networked systems to load applications up, down, and across the systems on the network, as the computing requirements of the organization dictate. It also provides software compatibility with the MicroVAX systems and with VAXstations, which run under the MicroVMS superset.

VMS also includes support for VAXclusters. A single application can be used across every processor in a VAXcluster, with shared files, allowing more users to access the same data. A VAXcluster can be expanded incrementally by adding VAXcluster building blocks and storage to the existing configuration. The company claims that the addition of such nodes to a VAXcluster causes little performance degradation. Clustering also provides load balancing among the processors and a measure of fault tolerance through processor failover and automatic dual-ported disk failover for HSC storage controllers.

The availability of the Unix-based ULTRIX-32 operating system for all of the VAX 8000s is also advantageous, for it allows users to choose between the realtime VMS and timesharing Unix environments, depending upon their application requirements. ULTRIX-32 has features that provide compatibility with AT&T's Unix System V—the version of Unix around which most supermicro, mini-, and supermini vendors are converging. Thus, it increases the possibility of application portability between ULTRIX-based VAX systems and System V-based computers.

Digital's leasing scheme for VMS software on the VAX 8000s (excepting the 8600 and 8650) is a very good feature, for it gives VAX users an alternative to outright purchase. Leasing permits the distribution of costs at regular intervals ▷

▶ and magnetic tape transports. The UNIBUS is connected to the memory interconnect through the UNIBUS adapter. The UNIBUS adapter handles priority arbitration among devices on the UNIBUS. UNIBUS adapters may be placed on the memory interconnect as follows: one on the VAX 8250, 8350, 8530, and 8550; up to seven on the VAX 8600 and 8650; up to two on the VAX 8700 and 8800; up to eight on the 8974; and up to 16 on the 8978.

The UNIBUS adapter provides access from the VAX processors to the UNIBUS peripheral device registers by translating UNIBUS addresses, data transfer requests, and interrupt requests to their memory interconnect equivalents, and vice versa. The UNIBUS adapter includes an address translation map.

The VAX 8600 and 8650 support the *MASSBUS* adapter, which is used to attach high-speed disk or magnetic tape devices and perform control, arbitration, and buffering functions. Up to four MASSBUS adapters can be attached to each of those systems. Each VAX MASSBUS adapter includes its own address translation map and 32-bit data buffer.

The *Hierarchical Storage Controller (HSC)* family is a series of intelligent servers for high-speed disks and tapes, primarily in VAXclusters. (For details on VAXclusters, see the "Configuration Rules" section of this report.) These controllers conform both to the Digital Storage Architecture (DSA) standard and to the Systems Communication Architecture (SCA); the latter architecture specifies the methods and protocol for communication among clustered systems.

The HSC connects to the host system through Digital's Computer Interconnect (CI), a serial bus with a bandwidth of 70MB per second; the CI features a dual-path interface to hosts in a cluster. The port onto the CI bus can support a sustained 4.2MB-per-second transfer rate.

The HSC servers use the Standard Disk Interconnect and the Standard Tape Interconnect (STI) to attach disk drives and tape formatters. The SDI and STI buses both support burst transfer rates up to 3.1MB per second.

The two members of the family are the HSC70 and the HSC50. According to Digital, the former is designed for mid-range to high-end cluster configurations and for stand-alone VAX 8650 and 8800 processors. The latter is intended more for low-range to mid-range VAX processors and clusters.

The HSC70 allows up to eight data channels, providing direct support for up to 32 devices, all of which can be Digital's RA-series disk drives; up to 16 can be Digital's TA-series tape formatters. The HSC50 can directly support up to 24 devices through six data channels.

In the VAX 8600 and 8650, the interface between the memory controller and the SBIs (Synchronous Backplane Interconnects)—the TTL logic subsystems that control I/O—is handled through the *DB86 SBI Adapters*, which are connected to the Adapter Bus, or A-Bus. Those adapters control the asynchronism between the CPU cycle and the slower SBI cycle. One SBI is standard on the system; an optional second SBI supports up to eight more adapters. The VAX 8600 can support up to 11 SBI adapters; the 8650 can support up to 12.

CONFIGURATION RULES

System Building Blocks (SBBs) are available for the VAX 8250, 8350, 8530, 8550, 8600, 8650, 8700, and 8800. SBBs can be added to the already configured VAX 8974 and 8978. SBBs begin with a core of components: CPU; main ▶

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▷ over a period of time; in addition, the 90-day cancellation provision allows users to try software before committing to it.

On the hardware service side, the one-year warranty has been extended to all Digital hardware, deferring the time users must begin paying maintenance fees; the previous warranty period for the VAX 8600 and 8650 and peripherals was 90 days. A one-year warranty, even on the 8600 and 8650, is needed to compete against IBM. At the time of purchase, customers can elect to extend their hardware warranties up to three years. In addition, Digital's guaranteed two-hour service response for all VAX 8000s but the 8250 and 8350 is commendable, signaling the company's commitment to providing maximum uptime for its midrange to large-system users. Users looking for a system to run critical applications should keep in mind that the VAX 8250 and 8350 are only guaranteed a four-hour service response time.

Limited upgradability within the product line could be a problem for users looking to expand system performance. Digital has not yet stated whether users will be able to upgrade a VAX 8200, 8300, or 8500 to the replacement models. Upgrade kits will be available to upgrade the 8250 to the 8350; the 8530 will be field upgradable to the 8550, since differences in these systems' CPUs are only in the microcode. Upgrade kits are currently available for upgrading the 8600 to the 8650 and the 8700 to the 8800. Also, each 8700 processor in an 8900 configuration can be upgraded to an 8800. However, there is no upgradability between low-end, mid-range, and high-end systems (e.g., the 8250 cannot become an 8550), necessitating replacement of the processor box if a user wants to upgrade to a more powerful processor or increase the number of VAXBIs beyond the number supported by the existing system.

The cross-system peripheral compatibility, combined with the VAXclustering concept, compensates somewhat for the lack of direct system upgradability, allowing the incremental development of more powerful multisystem configurations and homogenous networks. Also, the availability of UNIBUS adapters enables attachment of peripherals used with older UNIBUS-based systems.

Another restriction, however, is the limited VAXBI licensing extended to third-party vendors, resulting in only a few vendors now offering products for the VAXBI-based systems. Licensed vendors are provided VAXBI interface chip design information only as long as they do not manufacture products too similar to those offered by Digital. Nonlicensed vendors must design their own interface chip to be able to connect their products to the VAXBI. The end result is that customers may be forced to buy add-on and peripheral devices from Digital and pay more than if they purchased from a third-party vendor. This also limits possible technological improvements that could come out of third-party shops—a disadvantage considering the inferior reputation of Digital's mass storage devices. Limited VAXBI licensing could also encourage users to continue buying the 8600, 8650, and high-end configurations of ▷

▶ memory; cabinet, disk/tape controllers, and, in some cases, other controllers; and VAX/VMS or ULTRIX-32 operating system license. To the core of the SBB the user must add selections from the mass storage (system device and load device), communications interface, and console terminal menus; selections from the software and software services menus are optional. (See EQUIPMENT PRICES, at the end of this report, for further details on SBBs.)

A *VAXcluster* is a multiprocessing system composed of one or more VAX 8000 (and/or VAX-11/750, 11/780, and 11/785) processors and/or HSC Hierarchical Storage Controllers running under VAX/VMS and connected by a high-speed Computer Interconnect bus. Each processor or HSC in the configuration is considered a node. The smallest VAXcluster configuration can be two VAX processors connected by an interconnect and a Star Coupler. An HSC is not required for a cluster; VAX/VMS allows locally connected disks to be shared by VAXcluster users through a Mass Storage Control Protocol (MSCP) server.

Available for VAXclusters is a VAXcluster Console System, linked to nodes in the cluster through fiber optic facilities. The Console System, based on Digital's MicroVAX II, allows system management operations to be performed from any terminal, local or remote, attached to it. The VAXcluster Console System typically comprises a MicroVAX II computer with 5MB of memory, fiber optic converters and power supply, fiber optic cable, and associated software.

In general, VAXclusters are based on *VAXcluster SBBs*, of which there are two types. The first type is a basic system element, which consists of a CPU with memory, a Computer Interconnect, an HSC storage controller, a Star Coupler, a disk/tape interface, and VAX/VMS and DECnet licenses. The second type of VAXcluster SBB is an upgrade to an existing VAXcluster. The upgrade consists of a CPU with main memory, a Computer Interconnect, and VAX/VMS and DECnet licenses; mass storage devices and a console terminal must also be ordered. VAXcluster SBBs are available for the 8250 up through the 8800.

The VAX 8250, 8350, 8530, and 8550 are also available in several preconfigured systems.

GENERAL: The configuration rules provided here are for SBBs under VAX/VMS. Systems operating under ULTRIX-32 use the same components, but configurability is more limited.

Two types of configurations are available for the VAX 8250 and 8350. Configuration one provides a 12-slot backplane; configuration two provides a 24-slot backplane.

VAX 8250 or 8350 SBBs consist of the following:
- CPU; dual CPUs on 8350
- 8MB of memory on the 8250; 12MB or memory on the 8350
- Integral floating point
- VAXBI Ethernet communications interface
- KDB50 disk controller
- One year hardware on-site warranty
- Available VAXBI expansion slots: six on 8250 configuration one; 18 on 8250 configuration two; four on 8350 configuration one; 16 on 8350 configuration two.

An 8250 or 8350 VAXcluster SBB is the same as the respective SBBs but includes a VAXcluster port and one set of CI cables. It does not include the KDB50 disk controller.

The preconfigured 8250 and 8350 are similar to the respective SBBs but also include an LA100 console terminal with stand; RA81 disk drive; TU81-Plus tape drive; and a DMB32 communications controller and cabinet kit (on configuration two only). ▶

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▷ MicroVAX systems, which are based on the open UNIBUS technology, thus holding back sales of VAXBI systems. Digital's purpose behind such a strategy is not simply to maintain the sales of its own products, but also to ensure the standardization of controllers and peripherals, thus alleviating some of the problems Digital service people would encounter when maintaining and servicing networked systems.

USER REACTION

Datapro's 1986 Computer Users Survey received responses for five VAX 8600s; the 8600 was the only VAX 8000 system generally available at the time the survey was conducted. (According to Computer Intelligence, a La Jolla, CA-based market research group, only two percent of all VAXs installed at this time are members of the VAXBI-based generation.) Four of the systems had been purchased from Digital Equipment, while one was leased from the manufacturer.

Oddly enough, all five systems were deployed as organizational (rather than departmental) computers. Two were employed in educational institutions, two in the automotive industry, and one in communications. Two users cited engineering and scientific applications as principal functions. Three mentioned education/scheduling/administration applications as primary; one of those users said that the system was also used for accounting/billing, mathematics/statistics, payroll/personnel, and purchasing applications. Fortran was the primary programming language on two systems; Cobol was used on two more; and Basic was mentioned for one system.

All users reported relatively large configurations (two of the 8600s were in a VAXcluster with other systems). All had at least 8MB of main memory. Three users reported disk capacities between 1.2GB and 4.8GB, while two more said that they had between 4.8GB and 10GB. Two users had between 31 and 60 local workstations, while three had over 60. Four users reported more than 60 remote workstations; one user had between 31 and 60 remote stations.

The following table shows how the users rated their VAX 8600 systems.

	Excellent	Good	Fair	Poor	WA*
Ease of operation	3	2	0	0	3.6
Reliability of system	2	3	0	0	3.4
Reliability of peripherals	0	5	0	0	3.0
Maintenance service:					
Responsiveness	3	1	0	1	3.2
Effectiveness	3	1	0	1	3.2
Technical support:					
Troubleshooting	1	3	0	1	2.8
Education	1	3	0	1	2.8
Documentation	1	3	1	0	3.0
Manufacturer's software:					
Operating system	3	2	0	0	3.6
Compilers & assemblers	3	2	0	0	3.6
Application programs	0	5	0	0	3.0
Ease of programming	1	4	0	0	3.2
Ease of conversion	2	3	0	0	3.4
Overall satisfaction	3	2	0	0	3.6

*Weighted Average on a scale of 4.0 for Excellent. ▷

▶ Options for the 8250 and 8350 include memory up to 32MB, available in 4MB increments; battery backup; VAXBI disk controllers; HSC storage controllers and disk and tape interfaces; additional 205MB RA60 and 456MB RA81 disk drives; tape drives; and one UNIBUS adapter.

The 8250 and 8350 also support up to two DMF32 8-line communications controllers, two DMZ32 24-line communications controllers, four DHU11 16-line communications controllers, two DMR11 synchronous interfaces, and an 8-line DMB32-M communications printer controller. They also support DECserver 100 or 200 8-line Ethernet terminal servers.

The VAX 8530 and 8550 SBBs consist of the following:
• CPU
• 16MB of memory on the 8530; 32MB on the 8550
• Integral floating point-processor
• One VAXBI channel
• A KDB50 disk controller
• A VAXBI Ethernet communications controller
• Console subsystem
• One-year hardware on-site warranty
• Two available VAXBI expansion slots.

A preconfigured 8530 or 8550 includes the above, as well as a DMB32 communications controller and cabinet kit; RA81 disk drive; and TU81-Plus tape drive.

An 8530 or 8550 VAXcluster SBB is similar to the appropriate SBB, but also includes a VAXcluster port, one set of CI cables, and an expansion cabinet for the VAXcluster port. The 8530 and 8550 VAXcluster SBBs do not include the KDB50 disk controller.

Options for the 8530 and 8550 include additional memory up to 80MB in 16MB increments; a second VAXBI channel; VAXBI expansion box with 11 VAXBI slots; one UNIBUS adapter, UNIBUS expansion box, and UNIBUS backplane; two KDB50 disk controllers; and all other options available for the 8250 and 8350.

The VAX 8600 and 8650 SBBs comprise a CPU cabinet and a CPU front-end cabinet. The CPU cabinet contains the following:
• CPU
• The memory controller
• 4MB of memory on the 8600; 16MB on the 8650
• One DW780 UNIBUS adapter
• One DB86 SBI adapter
• RB86 integrated disk and tape controller
• One-year hardware on-site warranty.

The CPU cabinet contains dedicated space for a CI780 Computer Interconnect, an FP86 floating-point accelerator, a second UNIBUS adapter, and a second SBI adapter. Up to eight adapters can be connected to the second SBI. The front-end cabinet includes the console, disk, and a UNIBUS expansion box.

Main memory in the VAX 8600 and 8650 CPU cabinets can be expanded to 68MB in 4MB and 16MB increments.

The two 8600-series systems can support the DHU11, DMF32, and DMZ32 asynchronous interfaces and the DEUNA, DMP11, DMR11, DR11-W, and DUP11 communications interfaces; the maximum number of those devices is dependent on total communications requirements and other considerations.

The VAX 8700 SBB consists of the following:
• CPU
• 32MB of memory
• Battery backup
• Integral floating-point processor ▶

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Four of the users said that the VAX 8600 did what they had expected it to do; four also said that they would recommend the 8600 to a prospective user. One user was undecided in each category.

We contacted two users by telephone for amplifying comments. The first user we contacted was affiliated with a manufacturer of communications equipment in the Southeast. He said that the 8600 was chosen primarily because the organization was already a Digital shop and was looking to upgrade its equipment; those making the buying decision felt that the ALL-IN-1 and electronic mail applications they wanted to run would perform best on Digital's newest and most powerful machine.

This user said that he is particularly pleased by the performance of the VAX/VMS operating system and by the compatibility of the 8600 with the two VAX-11/780s and the 11/785 that the company already had installed ("compatibility with better horsepower," he called it). He said that his organization planned to cluster the whole group of VAXs within two months of the time we spoke.

The only drawback to the system, in his view, is slow I/O throughput caused by the system's UNIBUS controllers. In fact, when asked what advice he would give prospective 8600 users, he remarked that he would ask what their principal applications are. If the applications are I/O bound, he said, he would recommend that the user consider one of the newer, VAXBI-based 8000 systems.

He did say that he felt Digital offered a good upgrade path, allowing him to upgrade directly to an 8650 or to install an 8800 and, thus, take advantage of the new VAXBI bus, which he felt could solve the I/O bottlenecks that have plagued his 8600.

This user said that he receives very good hardware service from Digital. Software support, on the other hand, is slow at times. He said that 75 percent of the time, Digital's support representatives are able to solve his software problems; the remainder of the time, he must rely on self-help and support from third parties.

The second user was with a major automobile manufacturer in the Detroit area; he employs a VAXcluster of 11/780s and 8600s. Both of his 8600s are used for development of microprocessors for automobile control. One is employed for software development, cross-assembly, and elementary simulation; the other is used for more intensive simulation tasks, such as design verification and validation. As in the case cited above, the second user's organization selected the VAX 8600 because Digital systems (four VAX-11/780s and a couple of DECSYSTEM-20s) were already installed; another 11/780 had been considered, but the group decided to go with the newer 8600.

The second user said he was "very satisfied" with the 8600, characterizing it as "a great system." He said that he is impressed with the power of the system, especially compared to that of the 11/780. He also praised the 8600s for their reliability. He said that during a recent power outage, ▷

- One VAXBI bus
- KDB50 disk controller
- VAXBI Ethernet communications interface
- Console subsystem
- One-year hardware on-site warranty.

A preconfigured 8700 includes the SBB and a DMB32 communications controller, RA81 disk drive, and TU81-Plus tape drive. An 8700 VAXcluster SBB includes the same features as the SBB, as well as a VAXcluster port and set of CI cables.

Options available for the 8700 include additional memory up to 128MB in 16MB increments; three additional VAXBI buses; two UNIBUS adapters; and all communications devices, mass storage controllers, and disk and tape devices available for use on the other VAX systems.

A VAX 8800 SBB consists of the following:
- Tightly coupled dual CPUs
- 48MB of memory
- Battery backup
- Integral floating-point processor
- Two VAXBI channels
- VAXcluster port and set of CI cables
- VAXBI Ethernet communications interface
- Console subsystem
- One-year hardware on-site warranty.

Options for the 8800 include additional memory up to 128MB, available in 16MB increments, two additional VAXBI channels, and two UNIBUS channels. Two slots in the first VAXBI channel are used for the Computer Interconnect port; one slot in the second VAXBI channel is used for the DWBUA UNIBUS interface. One DWBUA is allowed on any given VAXBI channel. The 8800 can also support two DMF32 communications controllers, one DR11 UNIBUS interface, and one DMR11 synchronous interface. The 8800 supports all communications devices, storage controllers, disk and tape drives available for the other VAX systems.

The VAX 8974 and 8978 are, respectively, 6- and 12-node VAXclusters. The VAX 8974 consists of the following:
- Four 8700 CPUs
- 128MB of memory, expandable to 512MB in 16MB increments
- VAXcluster Computer Interconnect in each processor
- Four VAXBIs, expandable to 16
- An Ethernet adapter in each processor
- Two HSC70 I/O processors
- One 2.4GB SA482 storage array
- 12 disk and two tape channels
- TA78 tape drive
- System console
- One-year hardware on-site warranty.

The VAX 8978 consists of the following:
- Eight 8700 CPUs
- 256MB of memory, expandable to 1GB in 16MB increments
- VAXcluster Computer Interconnect in each processor
- Eight VAXBIs, expandable to 32
- An Ethernet adapter in each processor
- Four HSC70 I/O processors
- Two 2.4GB SA482 storage arrays
- 24 disk and four tape channels
- Two TA78 tape drives
- System console
- One-year hardware on-site warranty.

The VAX 8974 and 8978 support all communications, disk, and tape devices available for the other VAX systems. These two systems can be expanded by adding preconfigured VAX systems or SBBs.

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▷ the 11/780s in the cluster went down. While the 8600s lost their system disks for six minutes, the computers stayed up; processes were suspended for the duration of the outage, but resumed when the power came back on.

When asked about the growth path that Digital provides him, the user expressed mixed feelings. He said that the introduction of the newer, VAXBI-based 8000 systems "decreases flexibility," because it renders his older systems somewhat incompatible. Despite the UNIBUS compatibility provided on the newer systems, he feels that the older systems do not fit totally into Digital's current architectural scheme; thus, he may have to get rid of them.

Still, he said that he feels Digital offers two ways in which his computing power can grow: he can add other systems to his existing cluster or he can migrate to larger VAXBI systems, such as the 8800.

When asked whether he would recommend the 8600 to a prospective VAX purchaser, the second user said that he would do so without hesitation: "I'm obviously a fan . . . . Digital has [its] act together." □

▶ **WORKSTATIONS:** Digital contends that the number of users supported by any system depends on the type of application and the associated demands on the processor and bus. Consequently, the company shies away from stating maximums, except for the 8600 and 8650, for which it has cited 512 terminals as the most that can be locally connected, with more available through terminal servers; the local connection/terminal server combination is applicable to all systems. However, Digital does provide typical workstation ranges for each VAX 8000 system, cutting across a range of different applications. Refer to Chart A for the range for each system.

Digital also states that for large numbers of users or in distributed environments, Ethernet is the most efficient means of handling user interconnection.

DISK STORAGE: The KDB50 disk controller supports up to four RA60 (205MB fixed/removable) and RA81 (456MB Winchester) drives in any combination. The KDB50 can be configured on the VAX system as follows:

- VAX 8250: two on configuration 1; four on configuration 2
- VAX 8350: one on configuration 1; three on configuration 2
- VAX 8530/8550: four
- VAX 8700/8800: eight
- VAX 8974: 32
- VAX 8978: 64.

On the VAX 8600 and 8650, one RB86 disk controller is integral to the system. Each system can support up to 13 UDA50 UNIBUS disk controllers; each UDA50 controls up to four RA60, RA81, or RA80 (121MB Winchester) drives, in any combination. The first UNIBUS supports only one UDA50; each UNIBUS thereafter supports two. The 8600 and 8650 also allow configuration of one RL02 (10.4MB cartridge) disk subsystem per computer. (The RL02 cannot be used as a system disk, but, rather, as a data file-resident device for transport of data to or from other Digital computer systems.)

The intelligent HSC70 and HSC50 storage controllers can be attached to the VAX 8000 systems through the Computer

Interconnect. The HSC70 supports eight HSC5X-BA disk and HSC5X-CA tape interfaces (32 devices) in any combination; the HSC50 supports six (24 devices). Each HSC5X-BA disk interface supports up to four RA60 and RA81 drives in any combination.

MAGNETIC TAPE: The VAX 8250 and 8350 each support one or three TU80/TU81 UNIBUS tape drives depending on the type of configuration (configuration 1 or configuration 2). The 8530, 8550, 8700, and 8800 each allow configuration of four TU81-Plus VAXBI tape units.

The 8600 and 8650 permit attachment of four TU81 tape subsystems per UNIBUS; each computer supports up to seven UNIBUS adapters. Eight tape devices per MASSBUS adapter can be configured on both the 8600 and the 8650; each system supports up to four MASSBUS adapters.

Tape devices can also be connected through the HSC70 and HSC50.

As stated in the "Disk Storage" subsection, the HSC70 and HSC50 controllers, attachable to all VAX 8000 systems through the Computer Interconnect, support eight and six HSC5X-CA tape interfaces, respectively. Each HSC5X-CA supports four TA78 and TA81 tape drives in any combination. The HSC70 and HSC50 can each support up to eight TA81, TA78, and TU78 add-on units in any combination. (A TA78 can control three TU78s.)

PRINTERS: Up to 16 line printers can be supported on each VAX 8000 system. On the VAX 8250, 8350, 8530, 8550, 8700, and 8800, each printer must connect to an asynchronous line or to a DMF32 (on the 8250, 8350, or 8800) or DMB32 (on the 8530) controller. A maximum of two DMF32 or DMB32 printer ports can be used per system.

MASS STORAGE

For information on available mass storage devices for VAX systems, please refer to Chart B, Mass Storage.

The SA482—included with the VAX 8974 and 8978 but available for use on the other VAX systems—consists of four RA82 disk drives and provides 2.488GB of disk storage. The SA482 connects to a VAX system through the KDB50, KDA50, or UDA50 controllers or the HSC50 or HSC70 I/O processor.

INPUT/OUTPUT UNITS

Refer to Chart C for terminals, Chart D for printers, and Chart E for magnetic tape equipment.

OTHER PERIPHERALS: VAX systems also support printing terminals, a pen plotter, and a voice synthesis module.

The LA100 is a microprocessor-controlled hardcopy terminal and printer; it can print up to 240 cps in draft mode, 30 cps in letter-quality mode, and 80 cps in memo mode. The LA120 is a 180 cps printing terminal. Those two printing terminals constitute the console options for the VAX 8000 systems.

The LCP01 color printer is an inkjet color graphics device that provides output on paper and transparencies. It provides print resolution of 154 dots per inch, a print rate of approximately two minutes per copy, and up to 216 shades.

The LVP16, a six-color graphics pen plotter with print speeds up to 15 ips, is supported by all VAX systems that use HP-GL graphics software. The LVP16 holds up to six pens and prints up to six colors without manual intervention; it includes an RS-232-C interface. ▶

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► DECtalk, a speech synthesis unit, converts standard ASCII text into speech output. The unit features 10 voices (nine predefined and one user-defined). Available in single- and eight-line versions, DECtalk uses an RS-232-C interconnection for each line. DECtalk accepts input from a Touch-Tone telephone keypad, and provides voice output through a built-in speaker, headphones, audio jack, or telephone. The eight-line version is upward-compatible with the single-line version.

COMMUNICATIONS CONTROL

The variety of communications interfaces supported by the VAX/VMS operating system allows VAX systems to be connected to other VAX systems, other Digital systems, and to other manufacturers' computer systems. Synchronous, point-to-point, and multipoint connections are supported for interprocessor communication. For terminal-to-host communications, asynchronous connections are supported. While systems running under ULTRIX-32 use the communications control devices discussed below, the models and the number of lines that can be configured vary from those available for VAX/VMS-based systems.

The *DMB32 Communications Controller* is an intelligent device for VAXBI systems. It includes eight full-duplex asynchronous ports, one synchronous port, and one line printer interface. The asynchronous and synchronous ports are fully programmable and provide full modem control. The synchronous ports support DDCMP, HDLC, SDLC, and IBM Bisync protocols.

The *DMF32 Communications Controller* is an intelligent device that enables a combination of modems and terminals to communicate with UNIBUS VAX systems. The unit contains three basic elements: an eight-line asynchronous interface for operation with modems and terminals; a single-line synchronous interface for connection to a network communications facility; and a parallel interface for either a line printer (in DMA mode) or a user-developed device. The DMF32 uses DMA mode and first-in/first-out buffers. Only the asynchronous lines of the DMF32 are supported under ULTRIX-32.

The *DHU11 Asynchronous Multiplexer* interfaces up to 16 asynchronous lines to any VAX computer with an integral UNIBUS operating under VAX/VMS. It connects to external equipment through RS-232-C and RS-432-A interfaces, and features Direct Memory Access (DMA) and first-in/first-out (Fifo) operations. The DHU11 can provide half- or full-duplex communications. It is programmable for split speeds on each of its lines and provides full modem control on all channels.

The *DMZ32 Asynchronous Multiplexer* supports up to 24 asynchronous lines to UNIBUS VAX computers. The DMZ32 has 24 RS-232-C connectors and allows DMA and Fifo operations; it permits half- or full-duplex communications.

The *DMR11* network link is a single-line synchronous interface for local and remote support. It implements DDCMP in hardware and supports direct memory access data transfers, DECnet point-to-point configurations, and full modem control. The DMR11 can communicate with another DMR11 or synchronous interface implementing DDCMP.

The *DR11* is a general-purpose digital interface that permits bidirectional 16-bit parallel transfers between a user's device and the UNIBUS; the interface is also available in a long-line version.

The *DEUNA Ethernet-to-UNIBUS Communications Controller* connects a UNIBUS system to an Ethernet local area network (LAN). It provides Ethernet data link layer functions and a portion of physical channel functions. The DEUNA complies with the Ethernet specifications, transmits and receives 10M bits per second, and provides full-address filtrating to off-load the host computer.

The *DELUA Ethernet-/IEEE 802.3-to-UNIBUS Communications Controller* is a replacement product for the DEUNA controller. The DELUA connects UNIBUS VAX 8000 systems to both Ethernet and IEEE 802.3 LANs. The microprocessor-based DELUA operates at 10M bps and allows 4M bps throughput.

The *H4000 Ethernet Transceiver* is a device that provides the functional interface between the Ethernet coaxial cable and Ethernet nodes. The H4000 station transmits signals onto and receives signals from the cable, and detects any message collisions that may occur.

The *H4005 Ethernet/IEEE 802.3 Transceiver*, a replacement for the H4000, physically attaches to an Ethernet coaxial cable; it meets Ethernet and IEEE 802.3 LAN specifications. It accommodates devices that require heartbeat, that is, verification that collision detection circuitry is working through a test of the circuitry at the end of each transmission. The 4005 can also be field-configured to accommodate devices that do not permit heartbeat.

The *DELNI Local Network Interconnect (LNI)* allows up to eight Ethernet-compatible devices (not terminals) to be grouped together. The LNI can be configured three ways: standalone, hierarchical standalone, and connected.

The *DECSA Ethernet Terminal Server* is a network terminal switch that supports the simultaneous operation of up to 32 terminals at speeds up to 19.2K bps full-duplex. The Terminal Server employs the Local Area Transport (LAT) software protocol for intersystem operations; the protocol is supported under the VAX/VMS operating system. It also provides logical terminal connections to hosts that do not employ LAT protocols. The DECSA server is available in 16- and 32-terminal versions.

DECserver 100 is a network terminal switch that connects up to eight asynchronous terminals to one or more service nodes (hosts) on an Ethernet. Transmission is at speeds between 75 and 19.2K bps. DECserver 100 supports split-speed (transmit and receive) terminal operation, block-mode transfers, and X-on/X-off handling, among other features.

DECserver 200 provides all the features of DECserver 100 and is available in two versions—DECserver 200/MC (Modem Control) and DECserver 200/DL (Data Leads). DECserver 200/MC provides modem control and monitoring, an RS-232-C line interface, LED-enhanced visual communication monitors, and connection to non-LAT (Digital's Local Area Transport) hosts. DECserver 200/DL does not support modems or applications with devices that require modem control signals; it is intended for applications utilizing the DECconnect cabling system.

SOFTWARE

OPERATING SYSTEMS: Operating systems for the VAX systems are the general-purpose VAX/VMS and ULTRIX-32, Digital's version of Berkeley Unix.

VAX/VMS is a general-purpose operating system that provides the environment for the concurrent execution of multiuser timesharing, batch, and time-critical applications. It also contains special features for VAXcluster support, and provides programming tools, scheduling services, and protection mechanisms for multiuser program development.

Under VAX/VMS, applications can be divided into several independent subsystems whose data and code are protected ►

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▶ from one another but which have general communication and data sharing facilities. Jobs can communicate using general, group, or local communications facilities.

Jobs can be scheduled as time-critical jobs that have strict priorities of execution. When a time-critical job is ready to execute, it executes until it becomes blocked or until another time-critical job of higher priority needs the resources of the processor. Normal jobs can be scheduled using a modified preemptive algorithm that ensures that they receive processor and peripheral resources at regular intervals commensurate with their processing needs.

If insufficient memory is available for keeping concurrently executing jobs resident, the operating system will swap jobs in and out of memory to allocate each its share of processor time. Time-critical jobs can be locked in memory to ensure that they can be started up rapidly when they need to execute.

The I/O request processing system is optimized for throughput and interrupt response. The operating system provides the user with several data accessing methods, from logical record accessing for device-independent programming to direct I/O accessing for rapid data processing. Files can be stored in any of several ways to optimize subsequent processing.

The VAX/VMS operating system's own jobs run as independent activities. They include the Job Controller, which initiates and terminates user processes and manages spooling; the Operator Communications Manager, which handles messages queued to the system operators; and the Error Logger, which collects all hardware and software errors detected by the processor and the operating system.

A command interpreter executes as a service for interactive and batch jobs. It enables the general user to request the basic functions that the operating system provides, such as program development, file management, and system information services.

Both hardware-detected and software-detected exception conditions are tracked through the exception dispatcher, which passes control to user-programmed condition handlers or, in the case of system-wide exception conditions or the absence of user routines, to operating system condition handlers.

The operating system's memory management routines include the virtual activator, which controls the mapping of virtual memory to system and user jobs, and the pager, which moves portions of a process in and out of memory as required. They respond to a program's dynamic memory requirements and enable programs to control their allocated memory, share data and code, and protect themselves from one another. The scheduler controls the allocation of processor time to system and user jobs.

The operating system's I/O processing software includes interrupt service routines, device-dependent I/O drivers, device-independent control routines, and user-programmed record processing services.

For system and data security, VAX/VMS provides password and login limits to control access to the system; methods of defining data access; operator interface facilities that allow different classes of operators to be defined; and security auditing capabilities for monitoring unusual or suspicious system activities.

VAX/VMS also features user and operator interfaces. The former allows special prompts and command recall and editing, while the latter permits management of batch and print queues.

VAX/VMS incorporates VAXcluster support features that allow the creation of homogenous environments providing transparent cross-cluster data access and resource sharing to loosely coupled systems. Those features include:

- Distributed File System, which manages all files in the VAXcluster as a single entity.

- Distributed Lock Manager, which synchronizes resource use across the VAXcluster.

- Terminal Server support, allowing terminals to be connected flexibly to VAXcluster systems and providing load balancing and availability features.

- Cluster Operator support, enabling a single person to manage an entire VAXcluster.

- Mass Storage Control Protocol server, which allows disks connected locally to a system to be accessed from anywhere in the cluster.

- Cluster-wide balancing, through the Job Controller, of the number of jobs per system.

ULTRIX-32 is Digital's native-mode implementation of the Unix operating system. It is based on the University of California at Berkeley's Fourth Berkeley Software Distribution (4BSD) and is compatible with AT&T's Unix System V, Release 2.0. ULTRIX-32 can be used on all VAX systems. Depending upon the application, ULTRIX-32 can support over 64 users.

ULTRIX-32 is an interactive, timesharing system. It employs a demand-paging scheme to take advantage of the virtual memory architecture of VAX systems. It features a hierarchical file system with demountable volumes, sharing of input/output resources among processes, and asynchronous process execution.

ULTRIX-32 incorporates the Source Code Control System (SCCS) from AT&T's Unix System III, a diagnostic testing facility for loading and testing corrections from an UL-TRIX-32 file system, and System V interprocess communications mechanisms.

ULTRIX-32 supports Unix Version 7 Bourne and C shells. Among other features, ULTRIX-32 provides a file transfer utility, backup/restore, file system integrity checking, remote login and job execution, line editors (ex and ed), a screen editor (vi), and text processing utilities.

ULTRIX-32 also has facilities that permit communication among Unix and non-Unix systems, including uucp (Unix-to-Unix Copy facility), allowing point-to-point file transfer between an ULTRIX-32 system and other Unix systems using the "g" protocol; Ethernet connection between homogenous systems using DEC's Ethernet adapter; ability to communicate with Ethernet networks based on TCP/IP protocols; and a mail utility that allows communication among users in single-user or multinode environments.

ULTRIX-32 has limited compatibility with ULTRIX-11, the Unix Version 7-based operating system available for PDP-11 systems. Source programs written in the C language can be passed between the two systems; the systems' Bourne shells are also compatible. VAX processors are capable of directly executing portions of ULTRIX-11-developed Unix images in compatibility mode.

DATA BASE MANAGEMENT SYSTEM: The data base management facilities available for the VAX 8000 systems are part of a larger scheme called VAX Information Architecture—a collection of data base and data management tools arranged in layers above the operating system. ▶

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► On the top layer, the VAX languages and VAX Forms Management System (FMS) provide a user interface for interactive and language-callable video forms.

On the next level, the VAX Common Data Dictionary (CDD) integrates the other components of the architecture. The CDD provides a facility for storing logical data definitions. Also on this level are the VAX Datatrieve high-level and distributed data management facilities, which allow access to data without the user's having to specify the means to access it, such as the file type and keys. Datatrieve uses definitions in the CDD that contain information about data characteristics and user needs. The high-level data access facility also supports a "relational join" capability that can be used to dynamically link related records. The distributed data access facility retrieves data from remote VAX nodes running VAX Datatrieve. The process is transparent to the user.

The lowest level consists of four online, multiuser data management facilities: VAX DBMS (Data Base Management System), VAX Rdb/VMS, VAX Record Management Services (RMS), and VAX Application Control and Management System (ACMS). The first two products, discussed below, are the actual data base management systems for the VAX 8000 series.

The VAX programming languages are integrated into the information architecture. Language support for high-level access and direct access to VAX RMS files and VAX DBMS data bases is provided through the VAX standard calling interface to VAX Datatrieve.

Some VAX Information Architecture products are offered in bundles, called VAXinfo packages; three are available.

VAX DBMS is a multiuser, general-purpose, Codasyl-compliant data base management system based on the March 1981 Working Document of the ANSI Data Definition Committee. VAX DBMS is used to administer data bases ranging from simple hierarchies to complex, multisystem networks with multilevel relationships. The VAX Information Architecture allows DBMS data to be accessed directly from programming languages through VAX Datatrieve or DBMS utilities. VAX DBMS can operate in a VAXcluster environment and can access remote data bases through DECnet networking software.

VAX Rdb/VMS is a relational data base management system. Unlike VAX DBMS, designed for large, highly structured data bases, the Rdb/VMS system is designed for medium-volume applications in which data items and relationships among records change frequently.

In Rdb/VMS, data is independent of application programs; users can change data definitions without modifying or recompiling their programs. The product can retrieve and update information from both local data bases and from remote data bases through DECnet. The VAX Rdb/VMS system also features a data definition language; an interactive query language; transaction management facilities; data validation functions; transaction recovery facilities; security constraints; and contention arbitration facilities that handle simultaneous attempts to access the same information. VAX Rdb/VMS can work with VAX Datatrieve to access the VAX Rdb/VMS data base interactively; it can also work in conjunction with other VAX information management tools.

VAX Rdb/VMS can operate in a VAXcluster, providing shared data base access, transparent failover, and automatic recovery.

Available for use with Rdb/VMS is *VAX Structured Query Language (SQL)*, a complete data base language that may be used to define and access relational data bases and to manipulate the data stored there. VAX SQL offers an interactive data manipulation language (DML); a data definition language (DDL) utility; preprocessors for VAX Cobol, VAX Fortran, and VAXPL/1; and dynamic SQL.

VAX Data Distributor manages the automated distribution of relational data among multiple processors running VMS. VAX Data Distributor provides two methods of data distribution—extraction and replication. Both methods allow a complete copy or subset of a source data base to be created at a user-specified location. Data can be transferred to the target data base on demand or on a scheduled basis.

LANGUAGES: VAX/VMS provides a native programming environment which consists of language processors that produce native object code and program development tools that support native program development. VAX Fortran, RPG II, Cobol, Dibol, Basic, PL/1, Pascal, Coral 66, Bliss-16, Bliss-32, APL, Digital Standard Mumps (DSM), C, Ada, Lisp, and OPS5 (for artificial intelligence programming) are native-mode language processors that produce native object code and take advantage of the native instruction set and 32-bit architecture of the VAX hardware. A VAX Macro assembler is available.

C, Fortran, and Lisp are available for the ULTRIX-32 operating system.

COMMUNICATIONS: *Digital Network Architecture (DNA)* is a set of protocols governing the format, control, and sequencing of message exchange for all DECnet implementations. DNA controls all data that travels through a DECnet network and provides a modular design for DECnet.

Conforming to the International Standards Organization model for Open Systems Interconnection (ISO/OSI), DNA consists of the following seven functional layers; corresponding OSI layers are provided in parentheses: User and Network Management (Application); Network Application (Presentation); Session Control (Session); End Communications (Transport); Routing (Network); Data Link (same in OSI); and Physical Link (Physical).

DNA specifies the interface by which DECnet software modules in the same system interact with one another. Within each node, a layer contains only those modules required to support modules in higher layers.

In addition to defining vertical interfaces, DNA also defines the protocols governing interaction between modules in different nodes. A module in one node communicates only with a module in the same layer that is servicing the same function in another node.

The protocols define the form and content of messages to be exchanged by modules.

Some of the DNA protocols and their functions are:

• Network Information and Control Exchange protocol (NICE), which defines mechanisms for exchanging network, node, and configuration data and for servicing requests from modules residing in the Network Management Layer.

• The Data Access Protocol (DAP), which defines mechanisms for performing remote file access and remote file transfer on behalf of software modules residing in the Network Management Layer.

• The Network Services Protocol (NSP), which defines a mechanism for creating and maintaining logical links between modules of higher level that reside in the same or different nodes. ►

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➤ • The transport protocol (Transport), which defines a mechanism for dispatching data to any node in the network via the best possible route.

• The Maintenance Operation Protocol (MOP), which defines mechanisms for transmitting data over a communications channel for downline loading of a remote node, upline dumping from a remote node, testing a node and network connections, and starting up an unattended remote node.

• The Digital Data Communications Message Protocol (DDCMP), which defines a mechanism for ensuring the integrity and sequentiality of data transmitted over a communications channel.

DECnet-VAX permits suitably configured VAX/VMS-based systems to participate as routing or end nodes in DECnet computer networks. DECnet-VAX is a Phase IV network product warranted only for use with other Digital Equipment Phase III and Phase IV products. It offers task-to-task communications, file management, downline system and task loading, network command terminals, and network resource-sharing capabilities through Digital Network Architecture (DNA) protocols. DECnet-VAX communicates with adjacent and nonadjacent Phase III and Phase IV nodes. Among its features, DECnet-VAX permits area routing for development of networks containing several thousand processors. DECnet-VAX interfaces are standard with VAX/VMS.

DECnet-VAX provides task-to-task communication, access control, remote file access, and terminal-to-terminal communications.

Task-to-task communication is a method of creating a logical link between two tasks, exchanging data between the tasks, and disconnecting the link when the communication is complete.

Access control is the method by which network users are screened before gaining access to network facilities. With the appropriate access control information, a user program can log into a remote system and access any of the remote system's resources.

Remote file access permits exchange of sequential ASCII or binary files. The DECnet software translates the file syntax of the sending node into a common network syntax and then retranslates at the receiving end appropriately for that node.

For terminal-to-terminal communication, a DECnet/VAX utility enables a user to send messages to any VAX system. Messages can be directed to any specific terminal or to the operator's console at the destination node.

Nodes communicate based on some combination of physical and logical capabilities. The physical capabilities for DECnet-VAX are point-to-point, multipoint, and adaptive routing. A point-to-point node communicates only with adjacent nodes to which it is directly connected. A multipoint network party line shares time on one line with several nodes. Routing is a method for sending messages from source to destination through intermediate nodes.

DECnet-ULTRIX is a Phase IV Ethernet-based end-node implementation of the Digital Network Architecture for the ULTRIX-32 operating system. It provides for communications among Digital systems using DNA Phase III or IV protocols and for communications, including electronic mail, with non-Digital systems using TCP/IP protocols.

DECnet-ULTRIX allows users to transfer data and files between ULTRIX- and VMS-based systems, and also per-

mits DECnet and TCP/IP protocols to share system resources, such as Ethernet communications controllers.

Other capabilities of DECnet-ULTRIX are remote resource access from other Digital systems; a network command terminal facility; task-to-task communication between programs on different systems; and interface to network management facilities for administration and troubleshooting of ULTRIX-based nodes.

Digital's *Internet* family of products supports the interconnection of Digital computers and Digital networks to systems built by IBM and other manufacturers. Members of the Internet family are DECnet/SNA Gateway, DECnet/SNA VMS DISOSS Document Exchange Facility (DDXF), DECnet/SNA VMS Distributed Host Command Facility (DHCF), DECnet/SNA VMS Printer Emulator (PrE), VAX 2780/3780 Protocol Emulator, VAX 3271 Protocol Emulator, and MUX200/VAX.

DECnet/SNA Gateway allows a DECnet network and an IBM Systems Network Architecture (SNA) network to be connected. One version of this product links Digital local area networks to SNA networks, and another connects Digital wide area networks to SNA nets.

The *DECnet/SNA VMS DISOSS Document Exchange Facility (DDXF)* allows VMS-based VAX systems to exchange documents with an IBM host and office systems running in a DISOSS (Distributed Office Support System) environment. It allows both Digital and IBM users to participate in a common office network in which documents can be transferred, edited, and deleted.

The *DECnet/SNA VMS Distributed Host Command Facility (DHCF)* allows IBM 3270-class displays connected to an IBM host running the Host Command Facility (HCF) program product in an SNA network to access VMS-based VAX systems; Digital refers to this connection as the IBM-to-DEC equivalent of 3270 terminal emulation. Through this connection, an IBM network manager can control both the IBM and DEC networks from an IBM display; IBM users can also access mail and perform program development tasks on a VAX system.

The *DECnet/SNA VMS Printer Emulator (PrE)* allows bulk data transfers from an IBM system to a Digital system for printing. Either an IBM or a Digital terminal user operating in 3270 emulation mode can have a document printed on a Digital printer attached to a local VMS-based VAX system.

The *VAX 2780/3780 Protocol Emulator* allows data files to be transferred between VAX systems and other host computer systems capable of using 2780 or 3780 communications protocol. VAX 2780/3780 emulates binary synchronous communications (BSC) protocol, appearing to be an actual IBM 2780 or 3780 remote batch terminal on a point-to-point line. The product can run concurrently on up to four lines, each with a different set of attributes at speeds up to 9600 bps per line.

The *VAX 3271 Protocol Emulator* permits user programs running on VAX systems to communicate interactively with user tasks running on systems with IBM's System/370 architecture. The IBM application program may run under either the IMS/VS or CICS/VS DB/DC system. The Protocol Emulator uses the BSC protocol.

Mux200/VAX is a VAX-based software package that allows communication with a CDC Cyber series or other host computer system capable of using the 200UT communications protocol. It can be configured to support either the ASCII or the extended BCD versions of the protocol. ➤

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► *DECnet/SNA VMS Advanced Program-to-Program Communications/LU6.2 Programming Interface (APPC)* allows VMS-based applications for VAX systems to communicate with IBM host applications on a peer-to-peer basis through the DECnet/SNA Gateway; all DECnet/SNA interconnect functions are transparent to the user.

In *DECnet/SNA VMS Application Programming Interface (API)*, SNA functionality is apparent to the user. The API product is a collection of routines that allows user-written applications running on VAX systems in a DECnet network to exchange information, files, and data with IBM host applications; it is designed for users doing more advanced applications programming with SNA resources and requiring a flexible interface to an IBM application system.

DECnet/SNA VMS 3270 Data Stream Program Interface, specifically designed for 3270 emulation interfaces, enables programmers to develop programs that implement Logical Unit 2 sessions for communication with IBM application programs, build a color graphics interface, and intercept preprocess/postprocess terminal data. In the 3270 Data Stream Program Interface, as in APPC, SNA functionality is transparent to the user.

VAX Bisync Terminal Support (BTS) is a VAX-based software package that enables VAX/VMS systems to support block-mode synchronous terminals using the Binary Synchronous Communications (BSC) protocol. Bisync terminal users can then either run applications on the VAX system, or use the VAX as a pass-through device to access applications on an IBM mainframe.

VAX PSI (Packetnet System Interface) allows suitably configured VAX systems to connect to both private and public Packet Switching Data Networks (PSDNs) conforming to the CCITT X.25 Recommendations for 1978, 1980, or 1984; access to the PSDN is through a PSDN physical connection. Other VAX systems in the same DECnet network can use another package, *VAX PSI Access*, to communicate with the same PSDN.

VAX OSI Transport Service (VOTS) is an implementation of the OSI Transport and Network layers (layers four and three of the OSI model) as defined by ISO 8072, 8073, and 8473. VOTS provides VMS users with a program-to-program interface for exchanging data between a local VAX/VMS system and one or more remote VAX or non-VAX systems that also support corresponding OSI protocols.

Message Router X.400 Gateway is a layered VMS application that provides a communications path between a message router-based network and any other message transport system that conforms to the CCITT 1984 X.400 Recommendations for Message Handling Systems. The X.400 Gateway allows users of mail agents running on a message router, such as Digital's ALL-IN-1 office software, to send messages to other X.400 mail systems in other networks or within the same network. The X.400 Gateway requires VAX PSI and VOTS.

VAX-to-IBM Data Access (VIDA) enables VAX end users to interactively access data on IBM mainframes running the MVS operating system. VIDA employs Digital's VAX Information Architecture and SNA Gateway, as well as Cullinet Software's Information Center Management System (C/ICMS) for IBM-hosted processing.

Network Management Control Center (NMCC)/DECnet Monitor is a layered VMS software product that allows all Phase III and IV DECnet systems in a network to be monitored from a single VAX node. The system uses English-like commands and screen displays presenting traffic data, error statistics, and status information both graphically and textually.

NMCC/VAX Ethernim, a VMS layered product, reports the current online status of an entire Ethernet LAN, including non-Digital nodes. The system depicts the network graphically and maintains a historical reference file of events.

UTILITIES: Available for the VAX 8000 systems are a number of utility programs (or, as Digital categorizes them, program development tools), including text editors, a linker, a librarian, a common runtime procedure library, and a symbolic debugger. More specialized products include a code management system, a Unix-like command line interpreter, a spreadsheet package, a ReGIS graphics library (RGL) package, and a graphical kernel system. These tools are available to the programmer through the VAX/VMS command language.

The text editors can be used to create memos, documentation, and data files, as well as source program modules for any language processor. The linker, librarian, debugger, and runtime procedure library are used only in conjunction with language processors that produce native code.

More specialized tools available for VAX systems are *VAX RSX*, an environmental aid for development and execution of applications for Digital's PDP-11 minicomputer; *Fortran IV/VAX-to-RSX Cross Compiler*, for development and execution of RSX Fortran programs VAX systems with VAX RSX facilities; *RPG II Migration Assistance Service*, allowing IBM System/34 and /36 users to transfer application programs to VAX systems; *VAX RALLY*, *VAX TEAMDATA*, and *VAX Cobol Generator*, three fourth-generation information management products; and *Spatial II*, a specialized data base management product for petroleum exploration and production, utilities, telecommunications, and government applications.

OFFICE AUTOMATION: *VAX ALL-IN-1 Office Menu* provides office applications such as electronic mail, document processing, desk management, and forms development on VAX/VMS-based systems. The system also features voice messaging support, DECtalk mail access through Touch-Tone telephones, and integrated computer-based instruction for all major functions. A flow-control facility allows a user at a VT100 or VT200 family terminal to select from an option menu, moving from one application to another. The ALL-IN-1 software requires a VAX/VMS system with at least 2M bytes of dedicated main memory.

WPS-Plus/VMS, an ALL-IN-1 application, provides users with DECmate-style "gold key" full-function word processing. It includes scientific/technical character sets accessible from a word processing keyboard and a standard two-dimensional text editor that allows building and editing of equations, diagrams, matrices, and charts. It also incorporates the DECspell spelling checker with advanced linguistics.

VAX DECmail is a standalone, single-node mail and filing system that runs under the VAX/VMS operating system. *DECdx/VMS* is an exchange facility that allows two-way transfer of documents between Digital word processing systems and VAX systems while fully preserving document content and format.

External Document Exchange (EDE) is a VAX-based software package that permits full, two-way document transfer and conversion between a Digital VAX system and a Wang OIS.

EDE with DISOSS is a software product that allows DECdx/VMS and WPS-Plus users to search for, retrieve, ►

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▶ file, edit, or delete text contained in an IBM DISOSS (Distributed Office Support System) document library. Documents can also be created on VAX systems, transformed into IBM final or revisable DCA (Document Content Architecture) DISOSS documents, and filed in an IBM host document library. Conversely, Digital states that EDE with DISOSS transparently converts IBM documents to WPS-Plus or DECdx formats. Both final form and revisable IBM documents can be accessed through EDE menus. Those menus can also be integrated into the ALL-IN-1 main menu system. EDE with DISOSS also includes online help facilities.

According to Digital, EDE with DISOSS provides an interface conforming to Document Interchange Architecture (DIA)/DCA using Logical Unit 6.2, IBM's peer-to-peer communications capability. Prerequisite software includes DECnet-VAX, Gateway Access Routines (incuding those for Gateway Management and DDXF), and DECnet/SNA VMS DDXF.

APPLICATIONS: Digital offers both proprietary and third-party applications packages for VAX systems. The company's External Applications Software (EAS) Library service acquires software from third parties and makes it available through the company's software distribution channels. Software is tested by Digital for operation, documentation, and ease of installation prior to being included in the EAS Library. Software products from the EAS Library are sold on an "as is" unsupported basis, although the author of the software may offer a separate maintenance agreement.

PRICING

POLICY: Digital provides VAX systems on a purchase basis, with separately priced maintenance agreements. Leasing arrangements are available through Digital's U.S. Customer Finance Group.

Digital software is licensed rather than sold. Users purchase licenses and distribution rights separately. A license can be purchased outright for all systems. A licensing option available for the 8250, 8350, 8530, 8550, 8700, 8800, 8974, and 8978 is the Periodic Payment License. Through this option the user pays an initial license fee, then makes monthly payments thereafter. The software is licensed with a 90-day cancellation option. The monthly licensing option applies to all Digital-engineered, VMS-compatible software.

Customers ordering the ULTRIX-32 product receive a Unix binary license directly from Digital. For new VAX system purchasers, an ULTRIX-32 license can be ordered as part of a VAX System Building Block. Current users of Digital's VAX/VMS operating system and VAX users with third-party Unix licenses can order the ULTRIX-32 license as an add-on product.

SUPPORT: All VAX systems come with a one-year on-site warranty on CPU components and peripherals. The warranty includes system installation; repair parts and labor; Field Change Orders installation; and optional coverage up to seven days a week, 24 hours a day. The hardware warranty can be extended up to three years.

Digital's Field Service organization offers both on-site and off-site support services for VAX systems.

Standard on-site services include the Basic Service Agreement, the DECservice Agreement, and Per Call service. The basic service agreement includes the following components:

- On-call remedial maintenance from 8 a.m. to 5 p.m., Monday though Friday, excluding locally observed Digital holidays.

- A planned preventive maintenance program.

- All material and labor required to complete repairs.

- Installation of engineering changes.

- Priority response during hours of coverage (typically next day).

- An assigned account representative responsible for system maintenance.

- A Site Management Guide.

- A problem escalation system.

- A fixed monthly charge.

- A minimum term of one year.

- A remote diagnostics capability.

The DECservice Agreement, for higher level support, incorporates the features of the Basic Service Agreement and adds the following provisions:

- An option for extended coverage to 12-, 16-, and 24-hour workdays, as well as for Saturdays, Sundays, and holidays.

- Defined response for calls placed within the contracted hours of coverage.

- Continuous remedial service until the system is fully operational, as long as the call is received within a specific period immediately following system failure.

Support for the VAX 8974 and 8978 also includes preinstallation site evaluation; complete hardware and software installation; one-year on-site software consulting through a resident systems engineer; one year VAXcluster DECsupport Software Product Services; and Educational Services training credits.

DECservice is available in the United States without distance restrictions.

In addition, Digital has committed itself to delivering two-hour service response for the VAX 8530, 8550, 8600, 8650, 8700, 8800, 8974, and 8978 and a four-hour response time for the 8250 and 8350. The response time guarantee is available at no charge to customers located up to 50 road miles from any of Digital's 166 United States service locations.

Per Call Service is available to customers without service agreements, or as a supplementary program for service agreement customers requiring remedial maintenance outside their normal hours of coverage. Per Call Service is available on a best-efforts basis 24 hours a day, 7 days a week. Customers are billed for time and materials; charges are portal-to-portal, with labor, parts, and travel expenses rated separately.

An optional adjunct to Digital's on-site field service, Recover-all, provides full product repair or replacement for equipment damage caused by accidents or incidents normally not covered under service agreements, such as fire or water damage, power failures, and natural disasters. The cost of Recover-all is a percentage of the total monthly service charge of each covered contract line item. Actual charges depend on system configuration and type of service coverage.

Off-site maintenance is available through Digital's Customer Returns Center, Product Repair Center, and Digital ▶

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► Servicenters, which are all equipped with parts inventories, special diagnostic systems, and repair kits.

The Customer Returns Center, in Woburn, MA, provides service for all products under return-to-factory warranties, as well as for products requiring post-warranty work. The Customer Returns Center services products returned under the DECmailer agreement, which guarantees users a replacement within five working days for any defective board shipped to the center; it also provides as-needed service for modules and subassemblies under Digital's Loose Piece Module Repair Service plan.

The worldwide Product Repair Centers fix and refurbish modules, subassemblies, options, and systems for customers who have some technical expertise but who require additional field service assistance.

Digital Servicenters provide carry-in service for terminal products on a contractual or per-call basis; they also permit over-the-counter module swaps for users who prefer to perform maintenance themselves.

Software support is provided through Digital's Software Services organization; installation, training, telephone support, newsletter, and on-site support services are available.

Digital also offers the DECompatible Service program, through which the company's Field Service organization provides maintenance for over 120 specific non-Digital hardware products linked to Digital systems. The company claims that the designated products receive the same response time and service coverage as Digital hardware under standard service agreements.

All warranted VAX software products are covered under a policy guaranteeing that the product conforms to the Software Product Description (SPD) shipped with it. The warranty is included with most VAX software products at no extra charge. Delivery of the warranty is provided through automated and manual problem reporting. Services included in warranty prior to January 2, 1984 have been unbundled; customers can purchase added-value services such as installation, training, telephone support, newsletters, and on-site support separately, or they can select a System Startup Service Package.

System Startup Service Packages provide customers with the system-level support and training required to start up and manage their systems. Currently available only in the United States, the packages provide training, documentation, and software service. The user selects from among three levels of support, based on a number of factors, including computer experience and system use. All three levels include dial-in telephone support, and both the operating system and associated software products purchased with the system are supported. Prices are based on the size and complexity of the system and the level of support required.

Another software support service is the Digital Software Information Network, which enables customers to access informational data bases for help with software problems. The network provides messages that alert users to critical software problems and their solutions, a symptom/solution data base to answer questions on software problems, and a means of submitting questions to Digital support personnel. The network is available at no extra charge to customers in the United States with systems currently under warranty or covered by a DECsupport or Basic Support service contract.

For general support, Digital also sponsors the Digital Equipment Computer Users Society (DECUS), a voluntary, nonprofit users' group. DECUS provides an extensive program library, users' groups, special interest groups, and workshops/symposia. The society is responsible for maintaining the DECUS program library and publishing a library catalog, the proceedings of symposia, and a periodic newsletter.

TRAINING: Digital maintains over 25 training centers worldwide. Courses covering both Digital equipment-related and nonproduct-related topics are offered. A variety of instructional methods are used, including Digital's Interactive Video Information System (IVIS), which provides system-based instruction. Digital's Educational Services division publishes a digest listing available courses four times a year.

TYPICAL CONFIGURATIONS: Sample configurations for the VAX 8250, 8530, and 8800 are provided in the following tables. Complete hardware and software prices follow these configurations.

VAX 8250:

VAX 8250 VAX/VMS System Building Block; includes CPU; 8MB main memory; hot floating-point; Ethernet interface; KDB50 disk controller; 1-year hardware warranty; paid-up VAX/VMS and DECnet licenses	$ 89,000
LA100-BA hardcopy console terminal	2,195
RA81-AA(AD) 456MB fixed disk drive	19,000
TU81-AA 75-ips streaming tape drive	25,500
DHU11-M 16-line communications controller	3,420
16 VT220-F2(F3) terminals/keyboards with country kits	12,720
LG01-AA 600-lpm matrix text printer	11,950
TOTAL PURCHASE PRICE:	**$ 163,785**

VAX 8530:

VAX 8530 VAX/VMS System Building Block; includes CPU; 16MB main memory; hot floating-point; KDB50 disk controller; one VAXBI channel; Ethernet communications interface; console; one-year hardware warranty; paid-up VAX/VMS and DECnet licenses	$ 331,000
RA81-EA(ED); three 456MB fixed disk drives in cabinet	50,000
TU81E-BA; TU81-Plus 75-ips streaming tape drive	25,500
Five DMB32 8-line communications controllers	16,750
40 VT220-F2(F3) terminals/keyboards with country kits	31,800
Two LG02-AA 600-lpm matrix text/graphics printers	28,000
TOTAL PURCHASE PRICE:	**$ 483,050**

VAX 8800:

882CB-AP VAXcluster System Building Block; includes dual CPU; 48MB main memory; battery backup; hot floating-point; two VAXBI channels; VAXcluster port and Computer Interconnect cables;	$ 721,000

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Ethernet communications interface; console; 1-year hardware warranty; paid-up VAX/VMS and DECnet licenses		Two DECSA-DA 32-line Ethernet terminal servers with software licenses	42,050
SC008-AC Star Coupler	8,250	60 VT220-F2(F3) terminals/keyboards with country kits	47,700
HSC70-AA(AB) intelligent storage controller	51,600	20 VT241-AA color terminals with country kits	63,900
HSC5X-BA(BB) disk interface	9,500	Two LG02-AA 600-lpm matrix text/graphics printers	28,000
RA81-JA(JD); four 456MB fixed disk drives in cabinet	68,000	LN03 8-ppm laser printer	3,495
HSC5X-CA tape interface	9,500		
TA81-AA(AB); two 75-ips streaming tape drives	59,000	TOTAL PURCHASE PRICE:	$1,117,625
Two DMF32-M 8-line communications controllers	5,630		

EQUIPMENT PRICES

	Purchase Price ($)	Basic Service (Monthly) ($)	DECserv. (Monthly) ($)

VAX SYSTEM BUILDING BLOCKS (SBBs)

VAX System Building Blocks (SBBs) are available for all 8000 systems except the VAX 8800. SBBs begin with a core of components: CPU, main memory, cabinetry, and the VAX/VMS or Ultrix-32 operating system license. To that core the user must add selections from the mass storage (system and load devices), communications interface, and console terminal menus. Choices from the software and software services menus are optional.

VAX 8700 SBBs

		Purchase Price ($)	Basic Service (Monthly) ($)	DECserv. (Monthly) ($)
871BC-AE(AJ)	VAX 8700 CPU; 32MB of 256K-bit main memory; hot floating-point; battery backup unit; VAXBI channel; KDB50 disk controller; Ethernet interface; console terminal; one-year hardware warranty; and paid-up VAX/VMS and DECnet licenses	479,000	*	*
871BC-DE(DJ)	Same as 871BC-AE(AJ), but with one-year VAX/VMS and DECnet licenses	433,000	*	*

VAX 8650 SBBs

865XB-AE(AJ)	VAX 8650 CPU; 16MB ECC MOS memory; RB86-AA integrated disk and tape controller; VAX/VMS license and warranty	400,000	*	*
865XB-BE(BJ)	Same as 865XB-AE(AJ), but with Ultrix-32 license and warranty for 1 to 32 users	400,000	*	*

VAX 8600 SBBs

861XA-AE(AJ)	VAX 8600 CPU; 4MB ECC MOS memory; RB86-AA integrated disk and tape controller; VAX/VMS operating system license and warranty	350,000	1,301	1,549
861XA-BE(BJ)	Same as 861XA-AE (AJ), but with Ultrix-32 license and warranty for 1 to 32 users	350,000	1,301	1,549

VAX 8550 SBBs

855BB-AE(AJ)	System Building Block (SBB); includes CPU, 20MB of 256K-bit main memory, hot floating-point, VAXBI channel, KDB50 disk controller, Ethernet interface, console terminal, one-year hardware warranty, and paid-up VAX/VMS and DECnet licenses	411,000	*	*
855BB-DE(DJ)	Same as 855BB-AE(AJ), but with one-year VAX/VMS and DECnet licenses	364,000	*	*
855BB-HE(HJ)	ALL-IN-1 system; includes CPU, 48MB of 256K-bit main memory, hot floating point, VAXBI channel, KDB50 disk controller, Ethernet interface, console terminal, one-year hardware warranty, and paid-up ALL-IN-1, VAX/VMS, and DECnet licenses	521,000	*	*
855BB-JE(JJ)	Same as 855BB-HE(HJ), but with one-year ALL-IN-1, VAX/VMS, and DECnet licenses	441,000	*	*

VAX 8530 SBBs

—	VAX 8530 CPU; 16MB of 256K-bit ECC MOS memory; integral hot floating-point; KDB50 disk controller; VAXBI channel; Ethernet communications interface; console; one-year hardware warranty; and one-year VAX/VMS and DECnet licenses	292,000	*	*
—	Same as VAX 8530 SBB above, but with paid-up VMS and DECnet licenses	331,000	*	*

*Contact vendor.
NA—Not applicable.
NC—No charge.

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		Purchase Price ($)	Basic Service (Monthly) ($)	DECserv. (Monthly) ($)

> **VAX 8350 SBBs**

—	VAX 8350 CPU; 12MB of 256K-bit ECC MOS memory; integral hot floating-point; Ethernet communications interface; KDB50 disk controller; one-year hardware warranty; one-year VAX/VMS and DECnet licenses; 12-slot backplane	88,000	*	*
—	Same as 8350 SBB above (12-slot backplane), with paid-up VAX/VMS and DECnet licenses	112,000	*	*
—	Same as 8350 SBB above, but with 24-slot backplane and one-year VAX/VMS and DECnet licenses	93,000	*	*
—	Same as 8350 SBB above, but with 24-slot backplane and paid-up VAX/VMS and DECnet licenses	117,000	*	*

VAX 8250 SBBs

—	VAX 8250 CPU; 8MB of 256K-bit ECC MOS memory; integral hot floating-point; Ethernet communications interface; KDB50 disk controller; one-year hardware warranty; one-year VAX/VMS and DECnet licenses; 12-slot backplane	65,000	*	*
—	Same as 8250 SBB above (12-slot backplane), but with paid-up VAX/VMS and DECnet licenses	84,000	*	*
—	Same as 8250 SBB above, but with 24-slot backplane and one-year VAX/VMS and DECnet licenses	70,000	*	*
—	Same as 8250 SBB above, but with 24-slot backplane and paid-up VAX/VMS and DECnet licenses	89,000	*	*

VAXCLUSTER SBBs

A VAXcluster is composed of one or more VAX 8000, 11/750, 11/780, or 11/785 processors running on VAX/VMS connected by a high-speed bus, one or more mass storage servers, and communication links to the user community. Each cluster element connected to the high-speed bus is referred to as a cluster node. Cluster nodes interconnect via a Star Coupler. There are two types of VAXcluster SBBs. The first type is a basic system element comprising a CPU complex, Star Coupler, high-speed storage controller, disk and tape interfaces, and Computer Interconnect cables. Mass storage (system and load devices) must be selected. The second type of VAXcluster SBB is an upgrade to an existing VAXcluster. It consists of a CPU, main memory, a Computer Interconnect, cables, VAX/VMS license, and DECnet full-function VAXcluster license.

VAX 8800 VAXcluster SBBs

882CB-DP(DT)	VAX 8800 CPU; 48MB of 256K-bit ECC MOS memory; battery backup; integral hot floating-point; two VAXBI channels; VAXcluster port and set of Computer Interconnect cables; Ethernet communications interface; console; one-year hardware warranty; and one-year VAX/VMS and DECnet licenses	672,000	*	*
882CB-AP(AT)	Same as 882CB-DP(DT), but with paid-up VAX/VMS and DECnet licenses	721,000	*	*

VAX 8700 VAXcluster SBBs

871CB-AP(AT)	VAX 8700 CPU; 32MB of 256K-bit main memory; hot floating-point; battery backup unit; VAXBI channel; Computer Interconnect port; Ethernet interface; console; one-year hardware warranty; and paid-up VAX/VMS and DECnet licenses	492,000	*	*
871CB-DP(DT)	Same as 871CB-AP(AT), but with one-year VAX/VMS and DECnet licenses	442,000	*	*

VAX 8650 VAXcluster SBB

865CD-AP(AT)	VAX 8650 CPU; 32MB of memory; Ethernet port; VAX/VMS license and warranty; a DECnet full-function license	445,000	1,839	2,189

VAX 8600 VAXcluster SBBs

861CC-AP(AT)	VAX 8600 CPU; 16MB of ECC MOS memory; Computer Interconnect port; cables; DEUNA Ethernet-to-Unibus controller; VAX/VMS license and warranty; and DECnet full-function license	395,000	1,360	1,619

VAX 8550 VAXcluster SBBs

855CB-AP(AT)	VAX 8550 CPU; 32MB of 256K-bit main memory; hot floating-point; VAXBI channel; Computer Interconnect port; Ethernet interface; console; one-year hardware warranty; and paid-up VAX/VMS and DECnet licenses	429,000	*	*
855CB-DP(DT)	Same as 855CB-AP(AT), but with one-year VAX/VMS and DECnet licenses	378,000	*	*

Contact vendor.
NA—Not applicable.
NC—No charge.

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		Purchase Price ($)	Basic Service (Monthly) ($)	DECserv. (Monthly) ($)
VAX 8530 VAXcluster SBBs				
—	VAX 8530 CPU; 16MB of 256K-bit ECC MOS memory; integral hot floating-point; VAXcluster port and Computer Interconnect cables; expansion cabinet for VAXcluster port; one VAXBI channel; Ethernet communications interface; console; one-year hardware warranty; and one-year VAX/VMS and DECnet licenses	313,000	*	*
—	Same as 8530 SBB above, but with paid-up VAX/VMS and DECnet licenses	351,000	*	*
VAX 8350 VAXcluster SBBs				
—	VAX 8350 CPU; 12MB of 256K-bit ECC MOS memory; integral hot floating-point; VAXcluster port and set of Computer Interconnect cables; Ethernet communications interface; one-year hardware warranty; one-year VAX/VMS and DECnet licenses; and 12-slot backplane	100,000	*	*
—	Same as 8350 VAXcluster SBB above (12-slot backplane), but with paid-up VAX/VMS and DECnet licenses	124,000	*	*
—	Same as 8350 VAXcluster SBB above, but with 24-slot backplane and one-year VAX/VMS and DECnet licenses	105,000	*	*
—	Same as 8350 VAXcluster SBB above, but with 24-slot backplane and paid-up VAX/VMS and DECnet licenses	129,000	*	*
VAX 8250 VAXcluster SBBs				
—	VAX 8250 CPU; 8MB of 256K-bit ECC MOS memory; integral hot floating-point; VAXcluster port and Computer Interconnect cables; Ethernet communications interface; one-year hardware warranty; one-year VAX/VMS and DECnet licenses; and 12-slot backplane	77,000	*	*
—	Same as 8250 VAXcluster SBB above (12-slot backplane), but with paid-up VAX/VMS and DECnet licenses	96,000	*	*
—	Same as 8250 VAXcluster SBB above, but with 24-slot backplane and one-year VAX/VMS and DECnet licenses	82,000	*	*
—	Same as 8250 VAXcluster SBB above, but with 24-slot backplane and paid-up VAX/VMS and DECnet licenses	101,000	*	*
VAX 8900 PRECONFIGURED SYSTEMS				
894CB-DP(DT)	VAX 8974 with four VAX 8700 processors; 128MB of 256K-bit main memory; VAXcluster Interconnect and Ethernet adapter in each processor; four VAXBIs; two HSC70s; SA482 storage array; console; TA78 tape drive; one-year warranty; and one-year VAX/VMS and DECnet licenses	2,570,000	*	*
8974CB-AP(AT)	Same as 8974CB-DP(DT) but with paid-up VAX/VMS and DECnet licenses	2,810,000	*	*
898CB-DP(DT)	VAX 8978 with eight VAX 8700 processors; 256MB of 256K-bit main memory; VAXcluster Interconnect and Ethernet adapter in each processor; eight VAXBIs; four HSC70s; two SA482 storage arrays; console; two TA78 tape drives; one-year warranty; and one-year VAX/VMS and DECnet licenses	4,792,000	*	*
898CB-AP(AT)	Same as 898CB-DP(DT) but with paid-up VAX/VMS and DECnet licenses	5,240,000	*	*
VAX 8700 PRECONFIGURED SYSTEMS				
SV-87EEB-EK(EN)	VAX 8700 CPU; 32MB of main memory; hot floating-point; VAXBI channel; KDB50 disk controller; RA81 456MB disk drive and TU81-Plus streaming tape drive; Ethernet interface; console terminal; DMB32 communications controller; one-year hardware warranty; and paid-up VAX/VMS and DECnet licenses; also includes battery backup unit	529,000	*	*
SV-87EEB-EL(EM)	Same as SV-87EEA-EK(EN), but with one-year VAX/VMS and DECnet licenses	483,000	*	*
VAX 8550 PRECONFIGURED SYSTEMS				
SV-8EEEB-EK(EN)	VAX 8550 CPU; 32MB of main memory; hot floating-point; VAXBI channel; KDB50 disk controller; RA81 456MB disk drive; TU81-Plus streaming tape drive; Ethernet interface; console terminal; DMB32 communications controller; one-year hardware warranty; and paid-up VAX/VMS and DECnet licenses	444,000	*	*
SV-8EEEB-EL(EM)	Same as SV-8EEEB-EK(EN), but with one-year VAX/VMS and DECnet licenses	398,000	*	*

*Contact vendor.
NA—Not applicable.
NC—No charge.

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		Purchase Price ($)	Basic Service (Monthly) ($)	DECserv. (Monthly) ($)
VAX 8530 PRECONFIGURED SYSTEMS				
—	VAX 8530 CPU; 16MB of main memory; disk controller; RA81 456MB disk drive; TU81-Plus 1600/6250 bpi tape drive; Ethernet port; DMB32 communications controller; console; VAXBI I/O channel; one-year hardware warranty; and one-year VAX/VMS and DECnet licenses	338,000	•	•
—	Same as 8530 preconfigured system above, but with paid-up VAX/VMS and DECnet licenses	377,000	•	•
VAX 8350 PRECONFIGURED SYSTEMS				
—	VAX 8350 CPU; 12MB of 256K-bit ECC MOS memory; integral hot floating-point; disk controller; Ethernet communications interface; Unibus adapter, cabinet, box, and backplanes; LA100 console terminal with stand; RA81 disk drive and TU81 tape drive; one year-warranty; one-year VAX/VMS and DECnet licenses; 12-slot backplane	135,000	•	•
—	Same as 8350 preconfigured system above (12-slot backplane), but with paid-up VAX/VMS and DECnet licenses	159,000	•	•
—	Same as 8350 preconfigured system above, but with 24-slot backplane and one-year VAX/VMS and DECnet licenses	145,000	•	•
—	Same as 8350 preconfigured system above, but 24-slot backplane and paid-up VAX/VMS and DECnet licenses	169,000	•	•
VAX 8250 PRECONFIGURED SYSTEMS				
—	VAX 8250 CPU; 8MB of 256K-bit ECC MOS memory; integral hot floating-point; disk controller; Ethernet communications interface; LA100 console terminal with stand; RA81 disk drive and TU81 tape drive; one-year hardware warranty; one-year VAX/VMS and DECnet licenses; 12-slot backplane	112,000	•	•
—	Same as 8250 preconfigured systems above (12-slot backplane), but with paid-up VAX/VMS and DECnet licenses	131,000	•	•
—	Same as 8250 preconfigured system above, but with 24-slot backplane and one-year VAX/VMS and DECnet licenses	122,000	•	•
—	Same as 8250 preconfigured system above, but with 24-slot backplane and paid-up VAX/VMS and DECnet licenses	141,000	•	•
UPGRADE KITS				
861UP-AA	VAX 8600-to-8650 upgrade kit	95,000	NA	NA
CPU OPTIONS				
VAX 8600/8650 Options				
FP86-AA	Floating-Point Accelerator	28,000	65	77
DR780-FA(FB)	General-purpose intelligent interface	18,700	92	110
DW780-AA(AB)	Unibus adapter	12,900	39	46
DW780-MB	Second Unibus adapter	12,900	39	46
DB86-AA	Second SBI adapter	10,000	30	36
DB86-BA	VAXBI Bridge	110,000	•	•
VAX 8250/8350 Options				
H7231-L	Battery backup	1,800	16	19
MEMORY EXPANSION OPTIONS				
VAX 8800, 8700, 8550, 8530 Options				
MS88-CA	16MB ECC MOS (256K-bit) memory module	16,000	NC	NC
VAX 8600/8650 Options				
MS86-AA	4MB ECC MOS (256K-chip) memory module	5,500	NC	NC
MS86-CA	16MB ECC MOS (256K-chip) memory module	22,000	NC	NC
VAX 8250/8350 Options				
MS820-BA	4MB ECC MOS (256K-chip) memory with controller	6,000	NA	NA

*Contact vendor.
NA—Not applicable.
NC—No charge.

DEC VAX 8000 Systems

		Purchase Price ($)	Basic Service (Monthly) ($)	DECserv. (Monthly) ($)

► VAXcluster OPTIONS

CI780-MA	Computer Interconnect adapter for VAX 8600 and 8650	21,450	150	179
SC008-AC	Star Coupler; 8-node with cabinet; for all VAX 8000 systems	8,250	23	27
SC008-AD	Upgrade to Star Coupler; for 9 to 16 nodes	6,050	23	27
BNCIA-10	CI cable set; 32 ft. (10 m.)	600	NC	NC
BNCIA-20	CI cable set; 65 ft. (20 m.)	830	NC	NC
BNCIA-45	CI cable set; 145 ft. (45 m.)	1,460	NC	NC

MASS STORAGE

HSC50-AA(AB)	HSC50 intelligent I/O server with space for six HSC5X; cables not included	34,500	100	119
HSC5X-BA(BB)	Data channel interface for interfacing up to four disk drives	9,500	45	54
HSC5X-EA(EB)	Second power supply for over three HSC5X on the HSC50	3,000	26	31
HSC70-AA(AB)	HSC70 Computer-Interconnect-based intelligent controller; includes space for eight HSC5X-BA; cables not included	51,600	220	262
RB86-AA	RB86 integrated disk and tape controller; for VAX 8600/8650	18,400	110	131
KDB50-A	KDB50 VAXBI controller with 8-ft. cable	8,000	60	71
KDB50-B	KDB50 VAXBI controller with 15-ft. cable	8,000	60	71
UDA50-A	Unibus controller; allows attachment of up to four disk drives	5,500	53	63
RA60-AA(AD)	205MB rack-mounted RA60 drive (no cabinet); requires controller and mounting cabinet	17,500	105	125
RA60-CA(CD)	205MB cabinet-mounted RA60-AA add-on drive	20,000	105	125
RA60-EA(ED)	Three 205MB RA60 drives in cabinet	49,000	315	375
RA60-JA(JD)	Four 205MB RA60 drives in cabinet	66,000	420	500
RA60-UA	RA60 reconfiguration kit; for remounting RA60s originally configured in an H9642 cabinet in an H9646 cabinet	400	NA	NA
RA80-AA(AD)	121MB rack-mounted RA80 drive; requires controller and mounting cabinet	14,000	85	101
RA80-CA(CD)	121MB cabinet-mounted RA80 drive; requires controller	16,500	85	101
RUA80-UA(UD)	UDA50 controller for dual-porting RA80, RA81, and RA60 disks; includes cable	5,500	32	38
RA81-AA(AD)	456MB RA81 rack-mounted drive; requires controller and mounting cabinet	19,000	95	113
RA81-CA(CD)	456MB cabinet-mounted RA81 drive; requires controller	21,500	95	113
RA81-EA(ED)	Three 456MB RA81 drives mounted in a cabinet; requires controller	50,000	284	338
RA81-FA(AD)	456MB RA81 cabinet-mounted drive; requires controller	23,000	95	113
RA81-HA(HD)	456MB RA81 rack-mounted drive; requires controller, cabinet, and cable	18,640	95	113
RA81-JA(JD)	Four cabinet-mounted 456MB RA81 disk drives; requires controller	68,000	380	452
RA81-UA	RA81 reconfiguration kit; required for remounting RA81s originally configured in an H9642 cabinet; not required for RA81-AA	400	NA	NA
RL211-AK	10.4MB RL02 top-loading, rack-mounting, removable cartridge drive and controller with interconnect cabling	7,900	75	89
RL02-AK	10.4MB RL02 add-on cartridge drive; requires RL211-AK	4,200	72	86
RL02K-DC	10.4MB cartridge for the RL02	230	NA	NA
RUC25-AA(AB)	Tabletop 26MB/26MB RC25 fixed/removable disk drive with Unibus adapter	12,500	39	46
RUC25-BA(BB)	Rack-mounted 26MB/26MB RC25 fixed/removable disk drive with Unibus adapter	12,500	39	46
RC25-DA(DB)	Tabletop add-on RC25 disk drive	5,500	85	101
RC25-EA(EB)	Rack-mounted add-on RC25 disk drive	5,500	85	101
RC25K-DC	Removable 26MB RC25 cartridge	299	NA	NA
SA482	2.4GB storage array	84,000	•	•

MAGNETIC TAPE EQUIPMENT

HSC70-AA(AB)	HSC70 Computer-Interconnect-based intelligent controller; includes space for eight HSC5X-CA; cables not included	51,600	220	262
HSC5X-CA	Tape interface for HSC50 I/O controller	9,500	45	54
TA78-BF(BJ)	TA78 PE/GCR tape subsystem; requires HSC50 with HSC5X-CA	52,000	357	425
TA81-AA(AB)	TA81 magnetic tape subsystem	29,500	150	179
TU81-AA(AB)	TU81 9-track streaming tape subsystem	25,500	140	167
TU81E-BA(BB)	TU81-Plus 1600-/6250-bpi, 75-ips streaming tape drive	27,500	•	•
TU80-AA(AB)	TU80 9-track magnetic tape subsystem in cabinet	12,500	89	106
TU78-AB(AD)	TU78 magnetic tape transport and formatter; requires TM78-C for dual-porting capability	48,000	322	383
TU78-AF(AJ)	TU78 magnetic tape transport without formatter; requires TU78 master	25,500	196	233
TM78-C	TU78 dual-port kit containing drive logic and cables to provide dual-porting capability	5,150	21	25
TU77-AF(AJ)	TU77 magnetic tape transport	23,800	222	264
TSU05-AA(AB)	Unibus TS05 magnetic tape subsystem with hardware for rack-mounting, control module, and cables; also available in 100 VAC (-AC) and 220 VAC (-AD) models	13,500	89	106

*Contact vendor.
NA—Not applicable.
NC—No charge.

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		Purchase Price ($)	Basic Service (Monthly) ($)	DECserv. (Monthly) ($)
➤ VAX 8530 PRECONFIGURED SYSTEMS				
—	VAX 8530 CPU; 16MB of main memory; disk controller; RA81 456MB disk drive; TU81-Plus 1600/6250 bpi tape drive; Ethernet port; DMB32 communications controller; console; VAXBI I/O channel; one-year hardware warranty; and one-year VAX/VMS and DECnet licenses	338,000	*	*
—	Same as 8530 preconfigured system above, but with paid-up VAX/VMS and DECnet licenses	377,000	*	*
VAX 8350 PRECONFIGURED SYSTEMS				
—	VAX 8350 CPU; 12MB of 256K-bit ECC MOS memory; integral hot floating-point; disk controller; Ethernet communications interface; Unibus adapter, cabinet, box, and backplanes; LA100 console terminal with stand; RA81 disk drive and TU81 tape drive; one year-warranty; one-year VAX/VMS and DECnet licenses; 12-slot backplane	135,000	*	*
—	Same as 8350 preconfigured system above (12-slot backplane), but with paid-up VAX/VMS and DECnet licenses	159,000	*	*
—	Same as 8350 preconfigured system above, but with 24-slot backplane and one-year VAX/VMS and DECnet licenses	145,000	*	*
—	Same as 8350 preconfigured system above, but 24-slot backplane and paid-up VAX/VMS and DECnet licenses	169,000	*	*
VAX 8250 PRECONFIGURED SYSTEMS				
—	VAX 8250 CPU; 8MB of 256K-bit ECC MOS memory; integral hot floating-point; disk controller; Ethernet communications interface; LA100 console terminal with stand; RA81 disk drive and TU81 tape drive; one-year hardware warranty; one-year VAX/VMS and DECnet licenses; 12-slot backplane	112,000	*	*
—	Same as 8250 preconfigured systems above (12-slot backplane), but with paid-up VAX/VMS and DECnet licenses	131,000	*	*
—	Same as 8250 preconfigured system above, but with 24-slot backplane and one-year VAX/VMS and DECnet licenses	122,000	*	*
—	Same as 8250 preconfigured system above, but with 24-slot backplane and paid-up VAX/VMS and DECnet licenses	141,000	*	*
UPGRADE KITS				
861UP-AA	VAX 8600-to-8650 upgrade kit	95,000	NA	NA
CPU OPTIONS				
VAX 8600/8650 Options				
FP86-AA	Floating-Point Accelerator	28,000	65	77
DR780-FA(FB)	General-purpose intelligent interface	18,700	92	110
DW780-AA(AB)	Unibus adapter	12,900	39	46
DW780-MB	Second Unibus adapter	12,900	39	46
DB86-AA	Second SBI adapter	10,000	30	36
DB86-BA	VAXBI Bridge	110,000	*	*
VAX 8250/8350 Options				
H7231-L	Battery backup	1,800	16	19
MEMORY EXPANSION OPTIONS				
VAX 8800, 8700, 8550, 8530 Options				
MS88-CA	16MB ECC MOS (256K-bit) memory module	1,600	NC	NC
VAX 8600/8650 Options				
MS86-AA	4MB ECC MOS (256K-chip) memory module	5,500	NC	NC
MS86-CA	16MB ECC MOS (256K-chip) memory module	22,000	NC	NC
VAX 8250/8350 Options				
MS820-BA	4MB ECC MOS (256K-chip) memory with controller	1,350	NA	NA

*Contact vendor.
NA—Not applicable.
NC—No charge.

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		Purchase Price ($)	Basic Service (Monthly) ($)	DECserv. (Monthly) ($)
► VAXcluster OPTIONS				
CI780-MA	Computer Interconnect adapter for VAX 8600 and 8650	21,450	150	179
SC008-AC	Star Coupler; 8-node with cabinet; for all VAX 8000 systems	8,250	23	27
SC008-AD	Upgrade to Star Coupler; for 9 to 16 nodes	6,050	23	27
BNCIA-10	CI cable set; 32 ft. (10 m.)	600	NC	NC
BNCIA-20	CI cable set; 65 ft. (20 m.)	830	NC	NC
BNCIA-45	CI cable set; 145 ft. (45 m.)	1,460	NC	NC
MASS STORAGE				
HSC50-AA(AB)	HSC50 intelligent I/O server with space for six HSC5X; cables not included	34,500	100	119
HSC5X-BA(BB)	Data channel interface for interfacing up to four disk drives	9,500	45	54
HSC5X-EA(EB)	Second power supply for over three HSC5X on the HSC50	3,000	26	31
HSC70-AA(AB)	HSC70 Computer-Interconnect-based intelligent controller; includes space for eight HSC5X-BA; cables not included	51,600	220	262
RB86-AA	RB86 integrated disk and tape controller; for VAX 8600/8650	18,400	110	131
KDB50-A	KDB50 VAXBI controller with 8-ft. cable	8,000	60	71
KDB50-B	KDB50 VAXBI controller with 15-ft. cable	8,000	60	71
UDA50-A	Unibus controller; allows attachment of up to four disk drives	5,500	53	63
RA60-AA(AD)	205MB rack-mounted RA60 drive (no cabinet); requires controller and mounting cabinet	17,500	105	125
RA60-CA(CD)	205MB cabinet-mounted RA60-AA add-on drive	20,000	105	125
RA60-EA(ED)	Three 205MB RA60 drives in cabinet	49,000	315	375
RA60-JA(JD)	Four 205MB RA60 drives in cabinet	66,000	420	500
RA60-UA	RA60 reconfiguration kit; for remounting RA60s originally configured in an H9642 cabinet in an H9646 cabinet	400	NA	NA
RA80-AA(AD)	121MB rack-mounted RA80 drive; requires controller and mounting cabinet	14,000	85	101
RA80-CA(CD)	121MB cabinet-mounted RA80 drive; requires controller	16,500	85	101
RUA80-UA(UD)	UDA50 controller for dual-porting RA80, RA81, and RA60 disks; includes cable	5,500	32	38
RA81-AA(AD)	456MB RA81 rack-mounted drive; requires controller and mounting cabinet	19,000	95	113
RA81-CA(CD)	456MB cabinet-mounted RA81 drive; requires controller	21,500	95	113
RA81-EA(ED)	Three 456MB RA81 drives mounted in a cabinet; requires controller	50,000	284	338
RA81-FA(AD)	456MB RA81 cabinet-mounted drive; requires controller	23,000	95	113
RA81-HA(HD)	456MB RA81 rack-mounted drive; requires controller, cabinet, and cable	18,640	95	113
RA81-JA(JD)	Four cabinet-mounted 456MB RA81 disk drives; requires controller	68,000	380	452
RA81-UA	RA81 reconfiguration kit; required for remounting RA81s originally configured in an H9642 cabinet; not required for RA81-AA	400	NA	NA
RL211-AK	10.4MB RL02 top-loading, rack-mounting, removable cartridge drive and controller with interconnect cabling	7,900	75	89
RL02-AK	10.4MB RL02 add-on cartridge drive; requires RL211-AK	4,200	72	86
RL02K-DC	10.4MB cartridge for the RL02	230	NA	NA
RUC25-AA(AB)	Tabletop 26MB/26MB RC25 fixed/removable disk drive with Unibus adapter	12,500	39	46
RUC25-BA(BB)	Rack-mounted 26MB/26MB RC25 fixed/removable disk drive with Unibus adapter	12,500	39	46
RC25-DA(DB)	Tabletop add-on RC25 disk drive	5,500	85	101
RC25-EA(EB)	Rack-mounted add-on RC25 disk drive	5,500	85	101
RC25K-DC	Removable 26MB RC25 cartridge	299	NA	NA
SA482	2.4GB storage array	84,000	*	*
MAGNETIC TAPE EQUIPMENT				
HSC70-AA(AB)	HSC70 Computer-Interconnect-based intelligent controller; includes space for eight HSC5X-CA; cables not included	51,600	220	262
HSC5X-CA	Tape interface for HSC50 I/O controller	9,500	45	54
TA78-BF(BJ)	TA78 PE/GCR tape subsystem; requires HSC50 with HSC5X-CA	52,000	357	425
TA81-AA(AB)	TA81 magnetic tape subsystem	29,500	150	179
TU81-AA(AB)	TU81 9-track streaming tape subsystem	25,500	140	167
TU81E-BA(BB)	TU81-Plus 1600-/6250-bpi, 75-ips streaming tape drive	27,500	*	*
TU80-AA(AB)	TU80 9-track magnetic tape subsystem in cabinet	12,500	89	106
TU78-AB(AD)	TU78 magnetic tape transport and formatter; requires TM78-C for dual-porting capability	48,000	322	383
TU78-AF(AJ)	TU78 magnetic tape transport without formatter; requires TU78 master	25,500	196	233
TM78-C	TU78 dual-port kit containing drive logic and cables to provide dual-porting capability	5,150	21	25
TU77-AF(AJ)	TU77 magnetic tape transport	23,800	222	264
TSU05-AA(AB)	Unibus TS05 magnetic tape subsystem with hardware for rack-mounting, control module, and cables; also available in 100 VAC (-AC) and 220 VAC (-AD) models	13,500	89	106

*Contact vendor.
NA—Not applicable.
NC—No charge.

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DEC VAX 8000 Systems

		Purchase Price ($)	Basic Service (Monthly) ($)	DECserv. (Monthly) ($)

▶ **MAGNETIC TAPE EQUIPMENT (Continued)**

TK50-DA/-DB	TK50 desktop cartridge tape drive (120/240 VAC); includes 9-ft. cable	3,095	22	26
TK50-RA/-RB	TK50 rack-mounted cartridge tape drive (120/240 VAC); includes 9-ft. cable	3,095	22	26
TK50-K	CompacTape cartridge for TK50	29	NA	NA
TUK50-AB	Unibus controller for TK50-DX/RX drives; includes cabinet and bulkhead plate	1,895	8	9

EXPANSION OPTIONS

DB88-AB	First VAXBI channel expansion for VAX 8800	300	*	*
DB88-AE	Third VAXBI channel for VAX 8800; requires BA32-BA/BB VAXBI expansion box and space in H9652-EC/ED expansion cabinet	14,500	*	*
DB88-AC	Internal second VAXBI channel for VAX 8700	14,500	*	*
DB88-AD	External second or fourth VAXBI channel for VAX 8700/8800 or second external VAXBI channel for 8250/8550. Requires DB88-AB(AE) and BA32-BA/BB on 8700/8800; requires BA32-BA/BB on 8530/8550	14,500	*	*
DWBUA-CA	VAX 8800 Unibus adapter; requires BA11-AW/AX expansion box and space in H9652-EC/ED expansion cabinet	6,000	40	48
DWBUA-FA(FB)	VAXBI-to-Unibus adapter for 8250/8350	13,000	65	77
H9652-EC(ED)	VAX 8800/8530 expansion cabinet; provides space for any combination of up to two BA32-BA(BB) VAXBI expansion boxes or BA11-AW(AX) Unibus expansion boxes on 8800; space for one BA32 VAXBI box on 8530; includes 37 panel units	5,000	NC	NC
BA32-BA(BB)	VAX 8800/8530 rack-mountable VAXBI expansion box with slides for H9652-EC(ED) expansion cabinet; provides five VAXBI mounting slots (with a sixth slot used for VAXBI system interface)	6,000	*	*
H9652-FA(FB)	VAX 8600/8650 expansion cabinet; includes one BA11-A box and 40 panel units; can be expanded with a second BA11-A; requires DD11-DK/CK backplanes	7,200	NC	NC
H9652-FC(FD)	VAX 8600/8650 Unibus expansion cabinet; includes two BA11-A boxes and 40 panel units; requires DD11-DK/CK backplanes	10,700	NC	NC
H9652-FE (FF)	VAX 8600/8650 Unibus expansion cabinet; customer-configurable	3,700	NC	NC
H9652-CA(CB)	VAX 8600/8650 SBI expansion cabinet; provides four option panel spaces	5,000	NC	NC
H9642-FC(FD)	VAX 8250 and 8350 Unibus expansion cabinet; fully shielded; contains controller, I/O connector panel, and space for BA11-A expander box	2,050	NC	NC
BA11-AL(AM)	Rack-mountable expansion box with slides for VAX 8600/8650 Unibus expansion cabinets; provides mounting space for six system units and is compatible with DD11-DK/CK expansion backplanes	3,500	25	30
BA11-AW(AX)	Rack-mountable exansion box with slides for VAX 8800, 8350, and 8250 Unibus expansion cabinets; provides mounting space for six system units and is compatible with DD11-DK(CK) expansion backplanes	3,500	25	30
DB11-MP	Unibus repeater; adds 19 unit bus loads and up to 50 ft. (15.2 m.) of additional Unibus length to the system	2,240	8	10
H9646-CA	60-inch standalone communications cabinet	1,630	NA	NA
H9646-DA	Same as H9646-CA, but without end panels	1,256	NA	NA
H9544-MK	Shelf assembly for H9646 cabinet	54	NA	NA
H9544-JD	60-inch to 40-inch joiner panel to mount H9642	235	NA	NA
DD11-CK	Expansion backplane mounting for BA11 box; provides for two hex- and two quad-slot modules; mounts in one system unit	470	NC	NC
DD11-DK	Same as DD11-CK except for providing seven hex- and two quad-slot modules; mounts in two system units	940	NC	NC

UNIBUS ASYNCHRONOUS OPTIONS

DMB32-M	Eight-line asynchronous multiplexer with single-line synchronous interface and dual-purpose parallel interface; for VAXBI	3,350	*	*
DMF32-M	Eight-line asynchronous multiplexer with single-line synchronous interface and dual-purpose parallel interface; for Unibus	2,815	58	69
DHU11-M	16-line multiplexer with direct memory access and full modem control for EIA/CCITT terminals; includes base module only; requires appropriate external cables and cabinet kit	3,420	45	54
DMZ32-M	24-line multiplexer with direct memory access for EIA/CCITT terminals; base module only, without modem control; requires appropriate cables and cabinet kit	3,215	90	107
DMZ32-N	Base module, modem control upgrade kit	700	NA	NA

UNIBUS SYNCHRONOUS OPTIONS

DMR11-M	Single-line interface for EIA/CCITT devices; base module only; requires appropriate external cable and cabinet kit	4,975	41	49
DUP11-M	Single-line interface for EIA/CCITT devices; base module only; requires appropriate external cable and cabinet kit	1,485	13	15

*Contact vendor.
NA—Not applicable.
NC—No charge.

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DEC VAX 8000 Systems

		Purchase Price ($)	Basic Service (Monthly) ($)	DECserv. (Monthly) ($)
ETHERNET COMMUNICATIONS				
DEUNA-M	Ethernet-to-Unibus synchronous communications controller	3,775	44	52
H4000	Ethernet transceiver	300	4	5
DELUA-M	Ethernet/IEEE 802.3 Unibus single-line interface communications controller	3,275	33	39
H4005	Ethernet/IEEE 802.3; version A has heartbeat, version B has not	300	*	*
DELNI-AA	Local Network Interconnect; supports up to eight Ethernet-compatible, nonterminal devices	1,275	10	12
DECSA-DA	32-line terminal server with 16 DCSAX-LC line cards	20,000	354	421
DECSK-AA	U.S. country kit for DECSA-DA; includes power cord, hardware manuals, and labels with front panel display; required	25	NC	NC
DCSAX-LC	Two-line asynchronous EIA RS-232-C/CCITT V.28 line card	375	7	8
DSRVA-AA	Eight-line DECserver 100, 120 V; includes U.S. country kit	2,950	30	36
DSRVB-AA	DECserver 200, supports eight RS-232 ports; includes country kit	2,950	30	36
DSRVB-BA	DECserver 200, supports eight DECconnect ports; includes country kit	3,050	28	33
REALTIME OPTIONS				
DR11-W	General-purpose Unibus DMA digital interface; requires appropriate cables and cabinet kit	1,350	14	17
DR11-WC	Longline, general-purpose interface; includes differential adapter module, interconnect cables, test connectors, and FCC-compliant user I/O panel	3,295	42	50
DR11-WD	Long-line upgrade kit for DR11-W; includes all items in DR11-WC except DR11-W interface module	1,795	24	29
BAND PRINTERS				
LP11-AA	132-column, 64-character LP25 Unibus band printer; 300 lpm	8,350	175	208
LP11-BA	132-column, 64- and 96-character LP25 Unibus band printer; 300/215 lpm	8,950	175	208
LP32-AA	132-column, 64-character LP25 printer and universal power supply, 300 lpm; prerequisite, DMF32 Unibus controller	8,350	98	117
LP32-BA	Same as LP32-AA, but can also operate at 215 lpm with a 96-character set	8,950	98	117
LSP25-CA	Longline LP25 Unibus printer, 300/215 lpm; includes U.S./U.K. bands, universal power supply, and 50-ft. cable	9,990	119	142
LP11-EA	LP26 Unibus band printer, 600 lpm	13,600	150	179
LP11-EB	LP26 Unibus band printer, 600/445 lpm; includes both 64- and 96-character sets	14,400	150	179
LP32-EA	LP26 Unibus band printer, 600 lpm; includes 30-ft. cable; requires DMF32 controller	13,600	143	170
LP32-EB	LP26 Unibus band printer, 600/445 lpm; includes both 64- and 96-character sets and 30-ft. cable; requires DMF32 controller	14,400	143	170
LSP26-CA	Longline LP26 Unibus band printer, 300/215 lpm; includes U.S./U.K. bands, universal power supply, and 50-ft. cable	15,600	172	205
LP27-UA(UB)	LP27 Unibus band printer, 1200/800 lpm	29,990	259	308
LP27-DA(DB)	Longline LP27 Unibus band printer, 1200/800 lpm	32,990	310	369
LP27-VA(VB)	LP27 Unibus band printer with 30-ft. data cable and controller; requires DMF32	28,990	252	300
MATRIX LINE PRINTERS				
LG01-AA	600-lpm matrix text printer with 64-character data processing mode; Unibus device	11,950	128	152
LG01-CA	Same type as LG01-AA, but requires DMF32 controller	11,950	118	140
LG02-AA	600-lpm matrix text and graphics printer with 64-character data processing mode; Unibus device	14,000	128	152
LG02-CA	Same type as LG02-AA, but requires DMF32 controller; includes 30-ft. cable	14,000	118	140
LG02-DA	Same type as LG02-AA, but requires DMF32 controller and RS-232-C serial interface; includes 25-ft. cable	14,000	118	140
LG01-UG	Upgrade kit to convert LG01 to LG02	3,500	NA	NA
LASER PRINTERS				
LN01S-CA	12-ppm laser printer with LP11 interface and 30-ft. cable	19,995	353	420
LN01S-DA	Same as LN01S-CA, but with DMF32-compatible interface	19,995	353	420
LN01B-CA(CB)	12-ppm laser printer; includes PLOTLN VMS software, EPROMs, LP11 interface, and 30-ft. cable	13,995	310	369
LN01B-DA(DB)	Same as LN01B-CA(CD), but with DMF32 interface	13,995	310	369
LN01K-AA	Parallel longline kit for operation up to 1,000 ft. from CPU; cables not included	1,995	20	24
LN01K-LS	Serial RS-232-C kit	495	5	6

*Contact vendor.
NA—Not applicable.
NC—No charge.

DEC VAX 8000 Systems

		Purchase Price ($)	Basic Service (Monthly) ($)	DECserv. (Monthly) ($)
▶ **LASER PRINTERS (Continued)**				
LN03-AA	8-ppm desktop laser printer; includes two toner cartridges, organic photo receptor (OCP) cartridge, AC power cord, toner collection bottle, 250 sheets of letter-size paper, and documentation; 150 dpi graphics capability	3,495	49	58
LN03S-AA	Same as LN03-AA but with 300 dpi graphics capability	4,995	*	*
PRINTERS/PLOTTERS				
LXY12-CA(CB)	Freestanding line printer/plotter, 170/240/300 lpm; with LP11 controller for Unibus interface, 30-ft. cable, pedestal with basket, and paper guide	11,250	104	124
LXY12-DA(DB)	Same type as LXY12-CA(CB), but with RS-232-C interface cable, pedestal with basket, and paper guide	11,250	104	124
LXY12-EA(EB)	Same type as LXY12-CA(CB), but with DMF32 interface cable, pedestal with basket, and paper guide	11,250	104	124
LXY22-CA(CB)	Freestanding line printer/plotter, 320/465/600 lpm; with LP11 controller for Unibus interface, 30-ft. cable, pedestal with basket, and paper guide	15,800	135	161
LXY22-DA(DB)	Same type as LXY22-CA(CB), but with RS-232-C interface cable, pedestal with basket, and paper guide	15,800	135	161
LXY22-EA(EB)	Same type as LXY22-CA(CB), but with DMF32 interface cable, pedestal with basket, and paper guide	15,800	135	161
COLOR GRAPHICS PEN PLOTTER				
LVP16-AA	Six-color graphics pen plotter, 15 ips; includes RS-232-C interface, documentation, and initial supplies; requires interface cable	1,995	10	12
COLOR PRINTER				
LCP01-AA	Inkjet color printer with graphics processor	14,595	125	149
RECEIVE-ONLY PRINTING TERMINAL				
LA120-RA	DECprinter III, 180 cps; for use with 1- to 6-part forms	2,420	39	46
CONSOLE TERMINALS				
LA100-BA	KSR 30/80/240 cps hardcopy terminal with keyboard, numeric keypad, tractors, cable, ribbon cartridge, package of paper, and Courier-10/Orator-10 fonts in U.S./U.K. character sets only	2,195	27	32
LA120-DA	Freestanding DECwriter III KSR hardcopy terminal; 180 cps bidirectional	2,800	34	40
TERMINALS				
VT220-A2(A3)	VT220 terminal with white phosphor, nonglare screen	580	12	14
VT220-B2(B3)	VT220 terminal with green phosphor, nonglare screen	580	12	14
VT220-C2(C3)	VT220 terminal with amber phosphor, nonglare screen	580	12	14
VT22K-AA	Data entry keyboard for VT220	215	NC	NC
VT22K-BA	Word processing keyboard for VT220	215	NC	NC
VT22X-AA	Integral 300-/1200-baud auto-answer modem for VT220 series	395	6	7
VT240-A2(A3)	VT240 text/graphics terminal; includes monochrome monitor, system box with logic and power supply, and keyboard; white phosphor, nonglare screen	1,980	19	23
VT240-B2(B3)	VT240 terminal with green phosphor, nonglare screen	1,980	19	23
VT240-C2(C3)	VT240 terminal with amber phosphor, nonglare screen	1,980	19	23
VT241-AA	VT241 color text/graphics terminal; includes monitor, system box with logic and power supply, and keyboard	2,980	26	31
VT24K-AA	Data entry keyboard for VT240/VT241 terminals	215	NC	NC
VT24K-BA	Word processing keyboard for VT240/VT241 terminals	215	NC	NC
VT24X-AA	300-/1200-baud autodial integral modem for VT240 series	495	6	7
VOICE SYNTHESIS MODULE				
DTC01-AA	Single-line DECtalk text-to-speech unit; includes cable	4,000	22	26
DTC03-AA	8-channel DECtalk text-to-speech unit; cables not included	24,000	250	298

*Contact vendor.
NA—Not applicable.
NC—No charge.

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DEC VAX 8000 Systems

SOFTWARE PRICES

License
Fee*
($)

VAX/VMS SOFTWARE

VMS system and layered software licenses for the VAX 8600 and 8650 are available for purchase only. Licenses for all other VAX systems software are available either for purchase or for monthly rental. Contact Digital Equipment for monthly rental prices.

Communications

Q5D05-UZ	DECnet-VAX for VAX 8250	6,591
Q7D05-UZ	DECnet-VAX for VAX 8350	6,591
Q9D05-UZ	DECnet-VAX for VAX 8530	8,850
Q2D05-UZ	DECnet-VAX for VAX 8550/8700	10,620
QKD05-UZ	DECnet-VAX for VAX 8600/8650	11,400
QMD05-UZ	DECnet-VAX for VAX 8800	13,275
Q5545-UZ	DECnet/SNA Gateway for VAX 8250	3,120
Q7545-UZ	DECnet/SNA Gateway for VAX 8350	3,120
Q9545-UZ	DECnet/SNA Gateway for VAX 8530	4,000
Q2545-UZ	DECnet/SNA Gateway for VAX 8550/8700	4,800
QK545-UZ	DECnet/SNA Gateway for VAX 8600/8650	4,000
QM545-UZ	DECnet/SNA Gateway for VAX 8800	6,000
Q5727-UZ	DECnet Router/X.25 Gateway for VAX 8250	4,150
Q7727-UZ	DECnet Router/X.25 Gateway for VAX 8350	4,150
QK725-UZ	DECnet Router Server for VAX 8600/8650	2,660
Q5044-UZ	DECnet/SNA VMS Printer Emulator for VAX 8250	1,560
Q7044-UZ	DECnet/SNA VMS Printer Emulator for VAX 8350	1,560
Q9044-UZ	DECnet/SNA VMS Printer Emulator for VAX 8530	2,000
Q2044-UZ	DECnet/SNA VMS Printer Emulator for VAX 8550/8700	2,400
QK044-UZ	DECnet/SNA VMS Printer Emulator for VAX 8600/8650	2,000
QM044-UZ	DECnet/SNA VMS Printer Emulator for VAX 8800	3,000
Q5070-UZ	Mux200/VAX for VAX 8250	9,048
Q7070-UZ	Mux200/VAX for VAX 8350	9,048
Q5708-UZ	DECdx/VMS for VAX 8250	3,666
Q7708-UZ	DECdx/VMS for VAX 8350	3,666
Q9708-UZ	DECdx/VMS for VAX 8530	4,700
Q2708-UZ	DECdx/VMS for VAX 8550/8700	5,640
QK708-UZ	DECdx/VMS for VAX 8600/8650	4,700
QM708-UZ	DECdx/VMS for VAX 8800	7,050
QK071-UZ	VAX Packetnet System Interface (PSI) and PSI Access for VAX 8600/8650	3,000
Q5111-UZ	VAX 2780/3780 Protocol Emulator for VAX 8250	8,268
Q7111-UZ	VAX 2780/3780 Protocol Emulator for VAX 8350	8,268
Q2111-UZ	VAX 2780/3780 Protocol Emulator for VAX 8550/8700	12,720
QK111-UZ	VAX 2780/3780 Protocol Emulator for VAX 8600/8650	9,800
QM111-UZ	VAX 2780/3780 Protocol Emulator for VAX 8800	14,700
Q5112-UZ	VAX 3271 Protocol Emulator for VAX 8250	9,984
Q7112-UZ	VAX 3271 Protocol Emulator for VAX 8350	9,984
Q2112-UZ	VAX 3271 Protocol Emulator for VAX 8550/8700	15,360
QK112-UZ	VAX 3271 Protocol Emulator for VAX 8600/8650	11,600
QM112-UZ	VAX 3271 Protocol Emulator for VAX 8800	17,400
Q5730-UZ	VMS Message Router for VAX 8250	3,432
Q7730-UZ	VMS Message Router for VAX 8350	3,432
Q9730-UZ	VMS Message Router for VAX 8530	4,400
Q2730-UZ	VMS Message Router for VAX 8550/8770	5,280
QK730-UZ	VMS Message Router for VAX 8600/8650	4,400
QM730-UZ	VMS Message Router for VAX 8800	6,600
Q5726-UZ	Ethernet Terminal Server for VAX 8250	1,000
Q7726-UZ	Ethernet Terminal Server for VAX 8350	1,000
Q9726-UZ	Ethernet Terminal Server for VAX 8530	1,000
Q2726-UZ	Ethernet Terminal Server for VAX 8550/8700	1,000
QK726-UZ	Ethernet Terminal Server for VAX 8600/8650	2,000
QM726-UZ	Ethernet Terminal Server for VAX 8800	1,000
Q5925-UZ	DECserver 100 Terminal Server for VAX 8250	150
Q7925-UZ	DECserver 100 Terminal Server for VAX 8350	150
Q9925-UZ	DECserver 100 Terminal Server for VAX 8530	150
Q2925-UZ	DECserver 100 Terminal Server for VAX 8550/8700	150
QK925-UZ	DECserver 100 Terminal Server for VAX 8600/8650	150
QM925-UZ	DECserver 100 Terminal Server for VAX 8800	150

Data Base Management/Data Management

Q5897-UZ	VAX Common Data Dictionary (CDD) for VAX 8250	3,549
Q7897-UZ	VAX CDD for VAX 8350	3,549
Q9897-UZ	VAX CDD for VAX 8530	4,550
Q2897-UZ	VAX CDD for VAX 8550/8700	5,460
QK897-UZ	VAX CDD for VAX 8600/8650	4,550
QM897-UZ	VAX CDD for VAX 8800	

Non-hardware-dependent, single-use license and warranty.

DEC VAX 8000 Systems

Data Base Management/Data Management (Continued)

		License Fee* ($)
		6,825
Q5898-UZ	VAX Datatrieve for VAX 8250	12,792
Q7898-UZ	VAX Datatrieve for VAX 8350	12,792
Q9898-UZ	VAX Datatrieve for VAX 8530	16,400
Q2989-UZ	VAX Datatrieve for VAX 8550/8700	19,680
QK898-UZ	VAX Datatrieve for VAX 8600/8650	16,400
QM898-UZ	VAX Datatrieve for VAX 8800	26,600
Q5899-UZ	VAX DBMS for VAX 8250; requires VAX CDD	29,392
Q7899-UZ	VAX DBMS for VAX 8350; requires VAX CDD	28,392
Q9899-UZ	VAX DBMS for VAX 8530; requires VAX CDD	36,400
Q2899-UZ	VAX DBMS for VAX 8550/8700; requires VAX CDD	43,680
QK899-UZ	VAX DBMS for VAX 8600/8650; requires VAX CDD	36,400
QM899-UZ	VAX DBMS for VAX 8800; requires VAX CDD	54,600
Q5706-UZ	VAX Terminal Data Management System (TDMS) for VAX 8250	6,443
Q7706-UZ	VAX TDMS for VAX 8350	6,443
Q9706-UZ	VAX TDMS for VAX 8530	8,260
Q2706-UZ	VAX TDMS for VAX 8550/8700	9,910
QK706-UZ	VAX TDMS for VAX 8600/8650	4,700
QM706-UZ	VAX TDMS for VAX 8800	12,390
Q5079-UZ	VAX Application Control and Management System (ACMS) for VAX 8250	25,537
Q7079-UZ	VAX ACMS for VAX 8350	25,537
Q9079-UZ	VAX ACMS for VAX 8530	32,740
Q2079-UZ	VAX ACMS for VAX 8550/8700	39,290
QK079-UZ	VAX ACMS for VAX 8600/8650	32,740
QM079-UZ	VAX ACMS for VAX 8800	49,110
Q5354-UZ	VAX Rdb/VMS for VAX 8250	18,408
Q7354-UZ	VAX Rdb/VMS for VAX 8350	18,408
Q9354-UZ	VAX Rdb/VMS for VAX 8530	23,600
Q2354-UZ	VAX Rdb/VMS for VAX 8550/8700	28,320
QK354-UZ	VAX Rdb/VMS for VAX 8600/8650	23,600
QM354-UZ	VAX Rdb/VMS for VAX 8800	35,400
Q5DZE-UZ	VAX SQL for 8250; full development package	18,408
Q7DZE-UZ	VAX SQL for 8350; full development package	18,408
Q9DZE-UZ	VAX SQL for 8530; full development package	23,600
Q2DZE-UZ	VAX SQL for 8550/8700; full development package	28,320
QKDZE-UZ	VAX SQL for 8600/8650; full development package	23,660
QMDZE-UZ	VAX SQL for 8800; full development package	35,400
Q5DZF-UZ	VAX SQL for 8250; programming option	11,310
Q7DZF-UZ	VAX SQL for 8350; programming option	11,310
Q9DZF-UZ	VAX SQL for 8530; programming option	14,500
Q2DZF-UZ	VAX SQL for 8550/8700; programming option	17,400
QKDZF-UZ	VAX SQL for 8600/8650; programming option	14,500
QMDZF-UZ	VAX SQL for 8800; programming option	21,750
Q5DZG-UZ	VAX SQL for 8250; runtime development option	2,129
Q7DZG-UZ	VAX SQL for 8350; runtime development option	2,129
Q9DZG-UZ	VAX SQL for 8530; runtime development option	2,730
Q2DZG-UZ	VAX SQL for 8550/8700; runtime development option	3,276
QKDZG-UZ	VAX SQL for 8600/8650; runtime development option	2,730
QMDZG-UZ	VAX SQL for 8800; runtime development option	4,000
Q5Z96-UZ	VAX Data Distributor for 8250	14,040
Q7Z96-UZ	VAX Data Distributor for 8350	14,040
Q9Z96-UZ	VAX Data Distributor for 8530	18,000
Q2Z96-UZ	VAX Data Distributor for 8550/8700	21,600
QKZ96-UZ	VAX Data Distributor for 8600/8650	18,000
QMZ96-UZ	VAX Data Distributor for 8800	27,000

Languages

		License Fee* ($)
Q5056-UZ	VAX Ada for VAX 8250	38,844
Q7056-UZ	VAX Ada for VAX 8350	38,844
Q9056-UZ	VAX Ada for VAX 8530	49,800
Q2056-UZ	VAX Ada for VAX 8550/8700	53,000
QK056-UZ	VAX Ada for VAX 8600/8650	49,800
QM056-UZ	VAX Ada for VAX 8800	56,025
Q5020-UZ	VAX APL for VAX 8250	12,433
Q7020-UZ	VAX APL for VAX 8350	12,433
Q9020-UZ	VAX APL for VAX 8530	15,940
Q2020-UZ	VAX APL for VAX 8550/8700	19,130
QK020-UZ	VAX APL for VAX 8600/8650	15,940
QM020-UZ	VAX APL for VAX 8800	23,910
Q5095-UZ	VAX Basic for VAX 8250	8,268
Q7095-UZ	VAX Basic for VAX 8350	8,268
Q9095-UZ	VAX Basic for VAX 8530	10,600
Q2095-UZ	VAX Basic for VAX 8550/8700	12,720
QK095-UZ	VAX Basic for VAX 8600/8650	10,600
QM095-UZ	VAX Basic for VAX 8800	

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DEC VAX 8000 Systems

► **Languages (Continued)**

		15,900
Q5106-UZ	VAX Bliss-32 for VAX 8250	9,009
Q7106-UZ	VAX Bliss-32 for VAX 8350	9,009
Q9106-UZ	VAX Bliss-32 for VAX 8530	11,550
Q2106-UZ	VAX Bliss-32 for VAX 8550/8700	13,860
QK106-UZ	VAX Bliss-32 for VAX 8600/8650	11,550
QM106-UZ	VAX Bliss-32 for VAX 8800	17,325
Q5015-UZ	VAX C for VAX 8250	7,371
Q7015-UZ	VAX C for VAX 8350	7,371
Q9015-UZ	VAX C for VAX 8530	9,450
Q2015-UZ	VAX C for VAX 8550/8700	11,340
QK015-UZ	VAX C for VAX 8600/8650	9,450
QM015-UZ	VAX C for VAX 8800	14,175
Q5099-UZ	VAX Cobol for VAX 8250	12,433
Q7099-UZ	VAX Cobol for VAX 8350	12,433
Q9099-UZ	VAX Cobol for VAX 8530	15,940
Q2099-UZ	VAX Cobol for VAX 8550/8700	19,130
QK099-UZ	VAX Cobol for VAX 8600/8650	15,940
QM099-UZ	VAX Cobol for VAX 8800	23,910
Q5018-UZ	VAX Dibol for VAX 8250	6,474
Q7018-UZ	VAX Dibol for VAX 8350	6,474
Q9018-UZ	VAX Dibol for VAX 8530	8,300
Q2018-UZ	VAX Dibol for VAX 8550/8700	9,960
QK018-UZ	VAX Dibol for VAX 8600/8650	8,300
QM018-UZ	VAX Dibol for VAX 8800	12,450
Q5130-UZ	VAX Digital Standard Mumps (DSM) for VAX 8250	14,040
Q7130-UZ	VAX DSM for VAX 8350	14,040
Q9130-UZ	VAX DSM for VAX 8530	18,000
Q2130-UZ	VAX DSM for VAX 8550/8700	21,600
QK130-UZ	VAX DSM for VAX 8600/8650	18,000
QM130-UZ	VAX DSM for VAX 8800	27,000
Q5100-UZ	VAX Fortran for VAX 8250	8,065
Q7100-UZ	VAX Fortran for VAX 8350	8,065
Q9100-UZ	VAX Fortran for VAX 8530	10,340
Q2100-UZ	VAX Fortran for VAX 8550/8700	12,410
QK100-UZ	VAX Fortran for VAX 8600/8650	10,340
QM100-UZ	VAX Fortran for VAX 8800	15,510
Q9107-UZ	Fortran IV/VAX-to-RSX Cross Compiler for VAX 8530	1,400
Q2107-UZ	Fortran IV/VAX-to-RSX Cross Compiler for VAX 8550/8700	1,680
QK107-UZ	Fortran IV/VAX-to-RSX Cross Compiler for VAX 8600/8650	4,500
QM107-UZ	Fortran IV/VAX-to-RSX Cross Compiler for VAX 8800	6,750
Q5917-UZ	VAX Lisp for VAX 8250	12,480
Q7917-UZ	VAX Lisp for VAX 8350	12,480
Q9917-UZ	VAX Lisp for VAX 8530	16,000
Q2917-UZ	VAX Lisp for VAX 8550/8700	19,200
QK917-UZ	VAX Lisp for VAX 8600/8650	16,000
QM917-UZ	VAX Lisp for VAX 8800	24,000
Q5913-UZ	VAX OPS5 for VAX 8250	7,800
Q7913-UZ	VAX OPS5 for VAX 8350	7,800
Q9913-UZ	VAX OPS5 for VAX 8530	10,000
Q2913-UZ	VAX OPS5 for VAX 8550/8700	12,000
QK913-UZ	VAX OPS5 for VAX 8600/8650	10,000
QM913-UZ	VAX OPS5 for VAX 8800	15,000
Q5126-UZ	VAX Pascal for VAX 8250	7,371
Q7126-UZ	VAX Pascal for VAX 8350	7,371
Q9126-UZ	VAX Pascal for VAX 8530	9,450
Q2126-UZ	VAX Pascal for VAX 8550/8700	11,340
QK126-UZ	VAX Pascal for VAX 8600/8650	9,450
QM126-UZ	VAX Pascal for VAX 8800	14,175
Q5114-UZ	VAX PL/1 for VAX 8250	12,433
Q7114-UZ	VAX PL/1 for VAX 8350	12,433
Q9114-UZ	VAX PL/1 for VAX 8530	15,940
Q2114-UZ	VAX PL/1 for VAX 8550/8700	19,130
QK114-UZ	VAX PL/1 for VAX 8600/8650	15,940
QM114-UZ	VAX PL/1 for VAX 8800	23,910
Q5631-UZ	VAX RPG II for VAX 8250	4,914
Q7631-UZ	VAX RPG II for VAX 8350	4,914
Q9631-UZ	VAX RPG II for VAX 8530	6,300
Q2631-UZ	VAX RPG II for VAX 8550/8700	7,560
QK631-UZ	VAX RPG II for VAX 8600/8650	6,300
QM631-UZ	VAX RPG II for VAX 8800	9,450

ULTRIX-32 SOFTWARE

Q5716-UZ	DECnet-Ultrix for VAX 8250	2,621
Q7716-UZ	DECnet-Ultrix for VAX 8350	2,621

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DEC VAX 8000 Systems

		License Fee* ($)

ULTRIX-32 SOFTWARE (Continued)

		License Fee* ($)
Q9716-UZ	DECnet-Ultrix for VAX 8530	5,310
Q2716-UZ	DECnet-Ultrix for VAX 8550/8700	6,370
QK716-UZ	DECnet-Ultrix for VAX 8600/8650	7,170
QM716-UZ	DECnet-Ultrix for VAX 8800	7,965
Q5917-UZ	VAX Lisp-Ultrix for VAX 8250	12,480
Q7917-UZ	VAX Lisp-Ultrix for VAX 8350	12,480
Q9917-UZ	VAX Lisp-Ultrix for VAX 8530	16,000
Q2917-UZ	VAX Lisp-Ultrix for VAX 8550/8700	19,200
QK917-UZ	VAX Lisp-Ultrix for VAX 8600/8650	16,000
QM917-UZ	VAX Lisp-Ultrix for VAX 8800	24,000

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