DEC VAX Systems

MANAGEMENT SUMMARY

UPDATE: *Since we last updated this report, Digital Equipment Corporation has delivered two new families of VAX Systems: the mid-range 6200 Series and the high-end 8800 Series, both of which employ a symmetrical multiprocessor architecture. The company has also embroiled itself in the burgeoning UNIX controversy as a sponsor of the Open Software Foundation, founded to challenge the AT&T/Sun Microsystems alliance for control of UNIX development. In addition, Digital has allied itself with Apple Computer to increase its shaky presence in the PC market.*

Despite Digital Equipment's recent successes in delivering new computer systems (20 models in the last two and one half years) and connectivity solutions, industry watchers continually take Digital to task for what it has failed to provide. In the wake of each product announcement, it seems, critics ask, "Where's a single system image?" or "Where's Digital's commitment to UNIX?" or "Where's a viable PC?" Digital's most recent spate of announcements seems geared toward answering those questions, although they generate additional questions.

Ever since the announcement of the VAX 8974 and 8978 in January 1987, users have been asking when Digital will provide a single-image multiprocessor system—that is, one in which all processors use a single copy of the operating system running in shared memory. The vendor has done so with the delivery of the mid-range VAX 6200 Series (replacing the 8530, 8600, and 8650) and the high-end VAX 8800 Series. (The 8800 Series renders the older 8700 and 8800 models obsolete as distinct entities. However, the 8800 *Series* machines are based on the same processor used in the 8700 model.)

Enabled by facilities in Version 5.0 of Digital's linchpin VMS operating system, the Symmetrical Multiprocessor

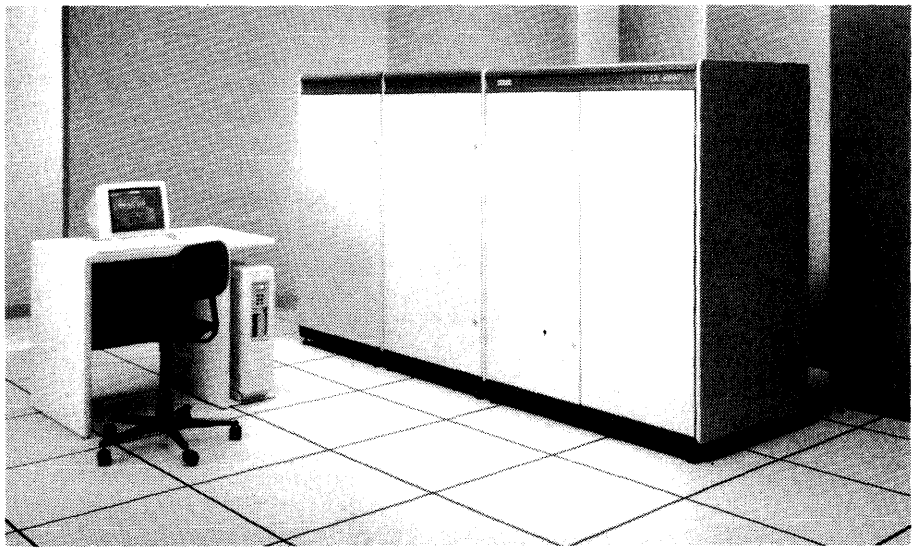
The VAX Systems are targeted at a range of applications, from office automation in departmental environments to complex engineering and scientific computations. The family includes both uniprocessor and multiprocessor models—the latter distinguished by recently added symmetric multiprocessor systems (SMPs) that permit multistream computing and parallel execution of Fortran applications. Digital's VAX Systems are frequently configured in multinode VAXcluster configurations with high-performance I/O controllers.

MODELS: VAX 8250, 8350, 6210, 6220, 6230, 6240, 8550, 8810, 8820, 8830, 8840, 8842, 8974, and 8978.
MAIN MEMORY: 16M bytes to 4096M bytes.
DISK CAPACITY: 205M bytes to 298.5G bytes.
WORKSTATIONS: Up to 2,560 (practical limit).
PRICE: $72,450 to $5,502,000 (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.



The VAX 8840, Digital's top-of-the-line VAX standalone system, employs a symmetric multiprocessor architecture that enables it to deliver up to 24 times the performance of the VAX-11/780 (long recognized as the standard of supermini performance). The 8840 and forthcoming follow-on systems represent Digital's best chance to challenge IBM's 3090 in the large-scale systems arena.

DEC VAX Systems

CHART A. SYSTEM COMPARISON

MODEL	VAX 8250	VAX 8350	VAX 6210	VAX 6220	VAX 6230
SYSTEM CHARACTERISTICS					
Date of introduction	March 1987	March 1987	April 1988	April 1988	April 1988
Date of first delivery	March 1987	March 1987	May 1988	May 1988	May 1988
Operating system	VMS, ULTRIX-32	VMS, ULTRIX-32	VMS	VMS	VMS
Upgradable from	8200	8200 and 8250	Not applicable	6210	6210, 6220
Upgradable to	8350	Not applicable	6220, 6230, 6240	6230, 6240	6240
MIPS	1.2	Up to 2.4	2.9	5.8	8.7
Relative performance (based on a rating of the VAX-11/780 at 1.0)	1.2	2.3	2.8	5.5	8.3
MEMORY					
Minimum capacity, bytes	16M	32M	32M	64M	64M
Maximum capacity, bytes	128M	128M	256M	256M	256M
Type	MOS	MOS	MOS	MOS	MOS
Cache memory	8KB	8KB per CPU	1KB on chip, 256KB on board	1KB on chip per CPU, 256KB on board per CPU	1KB on chip per CPU, 256KB on board per CPU
Cycle time, nanoseconds	600	600 to 1600	448	448	448
INPUT/OUTPUT CONTROL					
Number of channels	2	2	7	7	6
High-speed buses	1 VAXBI	1 VAXBI	6 VAXBI	6 VAXBI	6 VAXBI
Low-speed buses	1 UNIBUS	1 UNIBUS	1 UNIBUS (limited)	1 UNIBUS (limited)	None
MINIMUM DISK STORAGE	205MB	205MB	205MB	205MB	205MB
MAXIMUM DISK STORAGE	10GB local; 298.5GB via HSC I/O servers	10GB local; 298.5GB via HSC I/O servers	20GB local; 298.5GB via HSC I/O servers	20GB local; 298.5GB via HSC I/O servers	20GB local; 298.5GB via HSC I/O servers
NUMBER OF WORKSTATIONS	16-64 (typical)	24-96 (typical)	128 local	128 local	128 local
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	Bisync, DNA, Ethernet, SNA, 2780/3780, 3271, X.25, X.400, LU6.2	Bisync, DNA, Ethernet, SNA, 2780/3780, 3271, X.25, X.400, LU6.2
PURCHASE PRICE (Base Configurations)*	$72,450 to $153,450	$98,700 to $184,950	$131,600 to $586,100	$242,500 to $368,800	$326,000 to $471,700
COMMENTS	1-CPU system	2-CPU system	1-CPU system	2-CPU symmetrical multiprocessor	3-CPU symmetrical multiprocessor

**Digital raised quoted prices about 3.5 percent on June 10, 1988, due to a shortage of DRAM chips for embedded memory.*

(SMP) architecture permits each CPU to initiate instructions independently and run multiple applications simultaneously. Similarly, each processor can initiate I/O calls without having to rely on a master processor; the master/slave relationship is employed in Digital's older multiprocessors, such as the 8350, and in the company's multiprocessor VAXclusters (combinations of VAX CPUs and high-performance storage controllers).

The SMP scheme speeds throughput and allows linear growth in processor power as new CPUs are added. For example, Digital states that the low-end VAX 6210 delivers up to 2.8 times the power of the VAX-11/780 for multistream (multiple application) computing, with the power increasing to 5.5, 8.3, and 11 times as one, two, or three processors are added. No such linear incremental growth was previously possible on Digital's asymmetrical multiprocessor systems—which allowed at most two processors—or on the VAXclusters, in which every CPU operates out of its own pool of memory and runs its own copy of the operating system.

The new systems can even execute Fortran programs in parallel through a facility in the new Fortran compiler for VMS Version 5.0; that is, a program can be split up and worked on simultaneously by several processors. It is imperative that Digital begin delivering such functionality; competing minisupercomputer vendors like Alliant and Convex have been providing parallelism for quite a while

DATA FORMATS

BASIC UNIT: 32-bit word.

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 8 bytes long; the third type—F—is 4 bytes long; the last type—H—is 16 bytes long. Data type F is single precision; type D is double precision. Type H is emulated by software in VAX 6200 Series systems.

A Floating-Point Accelerator (FPA) is standard on VAX 6200s, 8800s, and 8550s and optional on all other VAX 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 the 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.

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CHART A. SYSTEM COMPARISON (Continued)

MODEL	VAX 6240	VAX 8550	VAX 8810	VAX 8820	VAX 8830
SYSTEM CHARACTERISTICS					
Date of introduction	April 1988	August 1986	March 1988	March 1988	March 1988
Date of first delivery	May 1988	—	March 1988	March 1988	March 1988
Operating system	VMS	VMS, ULTRIX-32, VAXELN	VMS, ULTRIX-32, VAXELN	VMS	VMS
Upgradable from	6210, 6220, 6230	8530	Not applicable	8810	8810, 8820
Upgradable to	Not applicable	Not applicable	8820, 8830, 8840	8830, 8840, 8842	8840
MIPS	11.6	6.3	6.3	Up to 12.0	Up to 17.8
Relative performance (based on a rating of the VAX-11/780 at 1.0)	11.0	6.0	6.0	Up to 11.4	Up to 16.8
MEMORY					
Minimum capacity, bytes	128M	48M	48M	128M	128M
Maximum capacity, bytes	256M	320M	512M	512M	512M
Type	MOS	MOS	MOS	MOS	MOS
Cache memory	1KB on chip per CPU, 256KB on board per CPU	64KB	64KB per CPU	64KB per CPU	64KB per CPU
Cycle time, nanoseconds	448	495	135-495	135-495	135-495
INPUT/OUTPUT CONTROL					
Number of channels	6	3	6	7	7
High-speed buses	6 VAXBI	2 VAXBI	4 VAXBI	6 VAXBI	6 VAXBI
Low-speed buses	None	1 UNIBUS	2 UNIBUS	1 UNIBUS	1 UNIBUS
MINIMUM DISK STORAGE	205MB	205MB	205MB	205MB	205MB
MAXIMUM DISK STORAGE	20GB local; 298.5GB via HSC I/O servers	10GB local; 298.5GB via HSC I/O servers	20GB local; 298.5GB via HSC I/O servers	20GB local; 298.5GB via HSC I/O servers	20GB local; 298.5GB via HSC I/O servers
NUMBER OF WORKSTATIONS	128 local	72-370 (typical)	128 local	128 local	128 local
COMMUNICATIONS PROTOCOLS	Bisync, DNA, Ethernet, SNA, 2780/3780, 3271, X.25, X.400, LU6.2	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	Bisync, DNA, Ethernet, SNA, 2780/3780, 3271, X.25, X.400, LU6.2
PURCHASE PRICE (Base Configurations)*	$470,600 to $635,200	$351,000 to $547,000	$543,900 to $645,750	$833,700 to $885,150	$1,062,000 to $1,162,000
COMMENTS	4-CPU symmetrical multiprocessor	1-CPU system	1-CPU system	2-CPU symmetrical multiprocessor	3-CPU symmetrical multiprocessor

**Digital raised quoted prices about 3.5 percent on June 10, 1988, due to a shortage of DRAM chips for embedded memory.*
Note: A dash (—) in a column indicates that the information is unavailable from the vendor.

and have been capturing market share in the scientific applications area in which Digital once held almost undisputed primacy.

In the larger sense, symmetrical multiprocessing gives Digital greater credibility as a purveyor of large systems. It is no secret that the company intends to use the SMP architecture as a basis for mainframe-class computers. William Demmer, Digital's Midrange Systems VP, has said that the SMP will "probably" allow more than four processors in the future. In Datapro's opinion, Digital must exceed the current four-processor limit to achieve its implicit goal of delivering high-throughput engines that challenge IBM's 3090 machines (single-image systems permitting up to six processors).

As previously noted, the software that drives the SMP is Digital's proprietary VMS operating system. ULTRIX-32, the company's implementation of the UNIX operating system, currently runs only on the single-processor 8250, 8550, and 8810, as well as on the asymmetrical 8350 (rumored to be made symmetrical sometime this summer). In fact, company officials have said that support for future releases of ULTRIX-32 (with one due this summer) on multiprocessor systems will be for asymmetrical processing only.

Digital's insistence on making VMS the sole engine for its most strategic processor technology lends some credence

In conjunction with a software executive running in native mode, the VAX processors can concurrently execute a compatibility-mode instruction set, which is a subset of the Digital Equipment PDP-11 instruction set. The execution is is not achieved 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 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: The VAX Systems employ both 1M-bit and 256K-bit error correcting and checking (ECC) MOS RAM chips.

CYCLE TIME: Depending on the operation, main memory cycle times on VAX Systems ranges from 135 to 1600 nanoseconds. (For example, a quadword write on the 6200 Series takes 448 nanoseconds, while an octaword write takes 512.) Refer to Chart A for the cycle times of individual machines.

CAPACITY: Main memory capacities range from 16M to 4G bytes. All VAX Systems provide up to 4G bytes of virtual memory space. For the main memory capacities of specific VAX Systems, refer to Chart A.

CHECKING: Information unavailable from the vendor.

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CHART A. SYSTEM COMPARISON (Continued)

MODEL	VAX 8840	VAX 8842	VAX 8974	VAX 8978
SYSTEM CHARACTERISTICS				
Date of introduction	March 1988	March 1988	January 1987	January 1987
Date of first delivery	March 1988	March 1988	—	—
Operating system	VMS	VMS	VMS	VMS
Upgradable from	8810, 8820, 8830	8820	Not applicable	8974
Upgradable to	Not applicable	Not applicable	8978	Not applicable
MIPS	Up to 23.5	Up to 23.5 per 8820	25.4	50.8
Relative performance (based on a rating of the VAX-11/780 at 1.0)	Up to 22.2	Up to 22.2 per 8820	24.0	48.0
MEMORY				
Minimum capacity, bytes	128M	256M	192M	384M
Maximum capacity, bytes	512M	1024M	2048M	4096M
Type	MOS	MOS	MOS	MOS
Cache memory	64KB per CPU	64KB per CPU	64KB per CPU	64KB per CPU
Cycle time, nanoseconds	135-495	135-495	495	495
INPUT/OUTPUT CONTROL				
Number of channels	7	7/8820	24	48
High-speed buses	6 VAXBI	6 VAXBI/8820	16 VAXBI	32 VAXBI
Low-speed buses	1 UNIBUS	1 UNIBUS/8820	8 UNIBUS	16 UNIBUS
MINIMUM DISK STORAGE	205MB	456MB	2.5GB	5GB
MAXIMUM DISK STORAGE	20GB local; 298.5GB via HSC I/O servers	Up to 258.7GB via HSC I/O servers	Up to 238.8GB via HSC I/O servers	Up to 159.2GB via HSC I/O servers
NUMBER OF WORKSTATIONS	128 local	256 local	288-1,280 (typical)	576-2,560 (typical)
COMMUNICATIONS PROTOCOLS	Bisync, DNA, Ethernet, SNA, 2780/3780, 3271, X.25, X.400, LU6.2	Bisync, DNA, Ethernet, SNA, 2780/3780, 3271, X.25, X.400, LU6.2	Bisync, DNA, Ethernet, SNA, 2780/3780, 3271, X.25, X.400, LU6.2	Bisync, DNA, Ethernet, SNA, 2780/3780, 3271, X.25, X.400, LU6.2
PURCHASE PRICE (Base Configurations)*	$1,473,000 to $1,590,000	$1,618,000 to $1,735,000	$2,698,500 to $2,950,500	$5,031,600 to $5,502,000
COMMENTS	4-CPU symmetrical multiprocessor	2 VAXclustered 8820s	4 VAXclustered 8810 systems	8 VAXclustered 8810 systems

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to the charge that the company is not honestly interested in UNIX. Some critics leveled that accusation at Digital when it joined IBM, Hewlett-Packard, Apollo, and other vendors in the Open Software Foundation, which is intended to wrest sole control of the future of UNIX away from the AT&T/Sun Microsystems coalition. However, Digital's commitment to VMS over UNIX is not as exclusive as some critics would have us believe.

The standard that the OSF sponsors have endorsed is the IEEE's POSIX, which is not an operating system standard but a definition of the interface at the functional level between an operating system and application software. The most succinct definition we've heard comes from Roger Martin, manager of software engineering at the National Bureau of Standards, which is about to adopt POSIX as a Federal Information Processing Standard (FIPS), that is, a purchasing requirement for environments where application portability is a must. POSIX, Martin says, is the definition of "a generic way for operating systems and applications to communicate; it defines how an application should request specific services from an operating system."

At the moment, the POSIX standard applies to the UNIX operating system and applications written in the C language. Because it is a broad interface definition, however, any operating system and software in any language can

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 System features a 7-bit error-correcting code per 32-bit longword.

Each VAX 6200 main memory module is protected by an 8-bit ECC code with its own controller.

Battery backup is standard on the 8800 Series and on the 8974 and 8978; it is optional on the 8250, 8350, and 8550, as well as on the 6200 Series.

RESERVED STORAGE: Information unavailable from the vendor.

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

CENTRAL PROCESSOR

GENERAL: All VAX 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 8550, 8800 Series, 8974, and 8978 CPUs employ Emitter Coupled Logic (ECL) gate array circuitry. The 8250 and 8350 use ZMOS technology, while the 6200 Series CPUs employ CMOS.

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CHART B. MASS STORAGE

MODEL	RA60	RA81	RA82	SA482	RC25
Type	Removable	Winchester	Winchester	Storage Array	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, HSC5X-BA (on HSC70 or HSC50)	Integrated
Drives per subsystem/controller	4	4	4	1 to 8	2
Formatted capacity per drive, megabytes	205	456	622	1.244-2.488GB	26/26
Number of usable surfaces	6	7	7	32	—
Bytes per sector or track	512/sector	512/sector	512/sector	512/sector	—
Average seek time	41.7 ms	28 ms	24 ms	24 ms/spindle	35 ms
Average rotational/relay time	8.3 ms	8.3 ms	8.3 ms	8.3 ms/spindle	10.5 ms
Average access time	50 ms	36.3 ms	32.3 ms	32.3 ms/spindle	45.5 ms
Data transfer rate	1.98MB/sec	2.2MB/sec	2.4MB/sec	2.4MB/sec/spindle	1.25MB/sec
Supported by system models	All	All	All	All	All
Purchase price	$20,340 to $77,000	$17,640 to $74,970	$17,000 to $51,000	$34,000 to $66,000	$6,195
Comments				Comprises 2 to 4 RA82s	Not supported as system disk; data transfer device only

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

conceivably be modified for compliance to it, thus opening up the prospect of true cross-architectural and cross-system portability, which will allow users to port their software from one vendor's architecture to another without the need for costly and time-consuming conversions.

All that by way of saying we believe Digital is waiting until it has a POSIX-compliant ULTRIX-32 (or a differently named, OSF-engendered equivalent) to support SMP in the UNIX environment. The company will certainly have to provide support for SMP beyond the proprietary VMS realm, because the majority of its rivals offer UNIX to drive their multiprocessor architectures (whether conventionally symmetric or parallel). Even IBM offers an implementation of its AIX, derived from UNIX, on the 3090 and other high-end 370s. At the OSF announcement, Digital's Engineering Systems Group VP Don McInnis stated that ULTRIX-32 could be made compliant with the OSF's Level 0 application environment within "six to nine months" of the May 17 announcement. We suspect that SMP support will follow by mid-1989.

Through its participation in OSF, then, Digital has shown that it is committed to UNIX at least in the broad sense, insofar as UNIX is the symbol and operating core of an open, portable, multivendor software environment and the germinating environment for the POSIX standard. Actually, Digital has amply demonstrated its UNIX interest in the narrow sense, as well. According to research firm International Data Corporation (Framingham, Massachusetts), Digital shipped over $1 billion of computer systems based on UNIX in fiscal 1987. Further, Digital's Don McInnis has asserted that R&D expenditures for the ULTRIX-32 are now "pretty much equal" to those for VMS. All that research has to be leading somewhere.

The POSIX scenario opens up new possibilities for the proprietary VMS environment as well. Informed rumor has it that Digital is working to make VMS POSIX compliant. If that reported effort comes to fruition, a day will come when VMS users will easily port applications from POSIX-compliant UNIX environments to VMS, and vice versa. In short, VMS would shed its strictly proprietary

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 VMS support facilities. Main memory is sharable by both processors over the VAXBI system bus. The coupling of the dual processors on the 8350 is asymmetrical, or master-slave; only one of the processor can initiate I/O activities.

The VAX 6200 Series employs the CVAX processor chipset used in Digital's MicroVAX 3000 and VAXstation 3000 systems. The entire processor complex, including FPA and cache memory (1K byte on the CVAX chipset and 256K bytes on board), fits on a single board module. Each module includes bootstrap/diagnostic ROM, electrically erasable ROM used by the console and diagnostics, time-of-year clock, and a full set of console logic. The VAX 6210 is a uniprocessor system; the 6220, 6230, and 6240 feature two, three, and four processors, respectively.

The 6220, 6230, and 6240 employ a symmetric multiprocessing architecture, which allows dynamic load balancing among processors. The processors run a single, memory-resident version of the Digital's VMS operating system. Each CPU in a multiprocessor configuration can initiate its own I/O.

Running under VMS Version 5.0, the multiprocessor VAX 6200s can execute Fortran applications in parallel. Under the parallel processing scheme, single jobs can be decomposed into multiple subtasks that can run independently on the multiple processors, increasing overall execution speed. (For details on the role of VMS in parallel processing, refer to the SOFTWARE section of this report.)

The VAX 6200 processors have special data integrity features. Each module or subsystem in runs a power-up self test to ensure data integrity; the LA100 console terminal and LED indicators show whether errors have occurred. If a processor or memory module in a multiprocessor 6200 fails at power-up or restart, it is dropped from the configuration and the system runs with available processors and memory. VAX 6200 memory controllers feature command queuing and support eight-way interleaving.

The VAX 6200 systems employ a multiple bus architecture. A 100M-byte-per-second, 64-bit internal system interconnect manages the high-speed traffic among the CPUs,

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CHART C. WORKSTATIONS

MODEL	VT320	VT330	VT340
DISPLAY PARAMETERS			
Max. chars./screen	3,168	3,168	3,168
Buffer capacity	—	19K characters	19K characters
Screen size (lines x chars.)	24 x 80 or 132	24 x 80 or 132	24 x 80 or 132
Tilt/swivel screen	Optional	Standard	Standard
Symbol formation	7 or 12 x 7 dot matrix	8 or 9 x 11 (80 col.); 4 or 5 x 9 (132 col.)	8 or 9 x 11 (80 col.); 4 or 5 x 9 (132 col.)
Character phosphor	White, green, or amber	White, green, or amber	White, green, or amber
Total colors/no. simult. displayed	Not applicable	4 shades of gray	4,096/16
KEYBOARD PARAMETERS			
Style	Typewriter	Typewriter	Typewriter
Character/code set	ASCII, NRCS, ISO Latin 1, Digital Special Graphics and Supplemental	ASCII, NRCS, ISO Latin 1	ASCII, NRCS, ISO Latin 1
Detachable	Yes	Yes	Yes
Program function keys	15	15	15
TERMINAL INTERFACE	DEC-423, RS-232-C	DEC-423, RS-232-C	DEC-423, RS-232-C
PURCHACE PRICE	$545	$1,990	$2,935
COMMENTS	1200-by-300 pixel resolution	800-by-500 pixel graphics array; supports split-screen viewing, ReGIS, Sixels, Tektronix 4010/4014	800-by-500 pixel graphics array; supports split-screen viewing, ReGIS, Sixels, Tektronix 4010/4014

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

image, and VAX users in either the UNIX or VMS environment would have access to a vast applications library far exceeding the considerable range of offerings already available to them.

Digital's commitment to openness also seems to be the vehicle by which the company intends to convince users that it can deliver a PC with sizzle. In January 1988, Digital announced an agreement with Apple Computer through which the two vendors will develop products that link Macintoshes in AppleTalk networks to DECnet-based VAX systems. Although the linkage with Apple is in a larger sense an extension of Digital's Network Applications Support strategy, which provides common access to services on DECnet/OSI networks (i.e., those conforming to the International Organization for Standardization Reference Model for Open Systems Interconnection, generally referred to as ISO/OSI), in which Apple participates, it is also a marriage of convenience bordering on necessity for the two firms.

Digital's two-year-old, MS-DOS-compatible VAXmate PC, designed to be networked to VAX servers, has never gained the acceptance Digital hoped it would. By aligning itself with Apple, Digital is associating itself closely with a PC product that is not only famous for its user-friendliness but is also more palatable to corporate users now that it is MS-DOS compatible. Certainly, the Macintosh's user-friendliness and flexibility make it attractive at least for desktop publishing and specialized office applications, in which low-end VAXs are frequently used.

While the Apple/Digital agreement involves no merger between the two, it demonstrates Digital's seriousness about remaining in the PC market. Another indication of that interest may be seen in Digital's inclusion of VMS

main memory, and multiple VAXBI I/O channels. (For details on the VAXBI, refer to the INPUT/OUTPUT CONTROL section of this report.) Processors, memories, and VAXBI adapters are options on the system interconnect, and each consists of a single module. The interconnect supports up to four processors, eight 32M-byte memory modules, and six VAXBI adapters.

The single-processor VAX 8550 employs five-stage pipelining. A three-way interleaved memory controller and private memory bus reportedly provide average read and write bandwidths in excess of 50M bytes per second.

The five-model VAX 8800 Series employs Digital's VAX 8700 processor enhanced for expandability beyond the previous two-processor limit. The 8810 is a uniprocessor system, while the 8820, 8830, and 8840 employ two, three, and four processors, respectively. The 8842 comprises two clustered 8820 systems, along with a 2.48G-byte SA482 storage array and an HSC70 storage controller. (For a detailed discussion of VAXclustering, see the CONFIGURATION RULES section of this report.)

The multiprocessor systems in the 8800 Series, like those in the VAX 6200 Series, are symmetric multiprocessors able to execute Fortran applications in parallel under VMS Version 5.0.

The processor that forms the basis for the 8800 Series features five-stage pipelining and a 45-nanosecond cycle time. It includes virtual memory management facilities, bootstrap loader, a 64K-byte direct-mapped write-through cache memory, programmable realtime clock, time-of-year clock with battery backup, control store, memory controller, and memory battery backup.

The internal system interconnect on the VAX 8800 Series features a bandwidth of 60M bytes per second. According to company spokespersons, Digital has no plans to retrofit the newer, 100M-byte-per-second 6200 Series interconnect onto the 8800 Series.

The VAX 8800 Series multiprocessor systems can be reconfigured in case of a processor error to run without that

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CHART D. PRINTERS

MODEL	LXY12	LP25	LP27	LP29	LG01/LG02
Type	Dot matrix	Band	Band	Band	Matrix
Speed	300 lpm	300 or 300/215 lpm	1,200/800 lpm	1,500/2,000 lpm	600 lpm
Bidirectional printing	No	Not applicable	Not applicable	Not applicable	—
Paper size	—	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	Variable	Variable
Vertical line spacing (char./inch)	—	6 or 8	6 or 8	—	—
Character set	96 or 192	64 or 64/96	64/96	96 ASCII or 64 upper case	64 (data proc. mode)
Controller/Interface	LP11, RS-232-C, DMF32, DMB32	LP11, DMF32, DMB32	Integrated, DMF32, DMB32	LP11, DMB32, DMF32	RS-232-C, Dataproducts parallel
Printer dimensions, in. (h x w x d)	46.5 x 30 x 24.3	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	Not applicable	LGO2 only
Purchase price	$13,335	$9,645 to $12,180	$29,950	$38,500	$13,545 (LGO1); $16,695 (LGO2)
Comments					LGO1 text printer upgradable to LGO2 text/graphics printer

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

CHART D. PRINTERS (Continued)

MODEL	LG31	LN03	LN03 Plus	ScriptPrinter (LN03R)	PrintServer 40 (LPS40)
Type	Dot matrix	Laser	Laser	Laser	Laser
Speed	300 lpm	8 ppm	8 ppm	8 ppm	40 ppm
Bidirectional printing	—	Not applicable	Not applicable	Not applicable	Not applicable
Paper size	Up to 15 in wide	Up to 8.3 x 11.7 in	Up to 8.3 x 11.7 in	Up to 8.3 x 11.7 in	7.5 to 11 in wide; 10.5 to 17 in long
Character formation	Dot matrix	300 x 300 dots/in	300 x 300 dots/in	300 x 300 dots/in	Electrophotographic
Horizontal character spacing (char./inch)	5 to 16.7	Variable	Variable	Variable	Variable
Vertical line spacing (char./inch)	—	Variable	Variable	Variable	Variable
Character set	7- or 8-bit, ANSI/ISO-compatible	ASCII; 16 resident Courier/Elite fonts	ASCII; technical; 17 resident fonts	29 resident fonts	29 resident typefaces
Controller/Interface	RS-232-C interface	RS-232-C interface	RS-232-C interface	RS-232-C interface	—
Printer dimensions, in. (h x w x d)	—	15 x 21 x 23.5	15 x 21 x 23.5	15 x 21 x 23.5	40.4 x 60 x 28.4
Graphics capability	Not applicable	150 dpi (average)	300 x 300 dpi	300 x 300 dpi	300 x 300 dpi
Purchase price	$8,450	$2,895	$3,995	$5,495	$49,900
Comments	Prints Code 39 and Interleaved 2 of 5 bar codes		Includes PLOTLN software and 2 EPROMs	Supports PostScript page description language	Ethernet-based print server suitable for local area networks

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

Services for MS-DOS in each DECnet license. Those facilities make any VAX DECnet node a licensed PC server. Because a DECnet license is included with all base VAX configurations, every VAX is in effect a server. That's an important strategy in the departmental computing environment, where Digital has had its greatest success and where powerful engines to link desktop systems are increasingly in demand.

We would not be surprised if, in the near future, Digital actually builds further on that strategy by actively selling Macintoshes. Digital claims that 36 percent of its VAX sites use Macintoshes; it would be natural for Digital to attempt to capitalize on that captive market and to increase the VAXs' attractiveness as PC servers by providing adjunct PCs more attractive than those Digital has been selling.

COMPETITIVE POSITION

Digital's announcements of products and strategic alliances over the last six months have occurred at a dizzying

CPU. The multiprocessor systems employ an intelligent, MicroVAX II-based console that performs system powerup, diagnostics, monitoring, and control. (The uniprocessor 8810's console is PDP-11-based.) An Environmental Monitoring subsystem within the system cabinet constantly monitors temperatures and voltages throughout the CPU and reports status and conditions through the console. Users can also use the console to perform automatic hardware and software revision level compatibility checks.

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

- **VAX 8250 and 8350—15K 40-bit words of ROM, plus 1K 40-bit words of RAM, per processor**
- **VAX 6200 Series—1.6K 41-bit words of ROM, nonwritable**
- **VAX 8550—16K 144-bit words writable and 1K 144-bit words user accessible.**
- **VAX 8800 Series, 8974, and 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

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CHART E. MAGNETIC TAPE EQUIPMENT

MODEL	TA79	TU79	TA81	TU80	TU81-Plus	TK50
TYPE	Reel to reel	Reel to reel	Streaming	Streaming	Streaming	Cartridge
FORMAT						
Number of tracks	9	9	9	9	9	22
Recording density, bits per inch	1600/6250	1600/6250	1600/6250	1600	1600/6250	6667
Recording mode	PE/GCR	PE/GCR	PE/GCR	PE	PE/GCR	Serial (serpentine)
CHARACTERISTICS						
Controller model	HSC5X-CA (on HSC70 or HSC50)	TA79 master (on HSC5X-CA)	HSC5X-CA (on HSC70 or HSC50)	UNIBUS adapter	UNIBUS or VAXBI adapter	UNIBUS interface
Drives per controller	4 per HSC5X-CA	3 per TA79	4 per HSC5X-CA	1	1	1
Storage capacity, bytes	40M PE, 145M GCR	40M PE, 145M GCR	40M PE, 145M GCR	40M	40M PE, 145M GCR	95M
Tape speed, inches per second	125	125	75 and 25 (streaming)	25 and 100 (streaming)	75 ips	75
Data transfer rate, units per second	200KB PE; 781KB GCR	200KB PE; 781KB GCR	468KB	160KB	468KB	45KB
Streaming technology	No	No	Yes	Yes	Yes	Yes
Start/stop mode; speed	Not applicable	Not applicable	Yes; 25 ips	Yes; 25 ips	Yes; 25 ips	—
Switch selectable	Yes	Yes	—	No	Not applicable	Not applicable
PURCHASE PRICE	$59,430	$29,400	$34,625	$14,994	$30,098 (UNIBUS); $30,765 (VAXBI)	$3,749

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

pace. Such speed is necessary, for Digital's growth is slowing for the first time in several years. Even though the company's net income for the first nine months of fiscal 1988 (which ended March 31 of this year) was up 19 percent over that realized in the same period last year, income for the third quarter was down $2.4 million compared to third-quarter 1987.

Those lower figures doubtless stem from general market saturation and slowed capital expenditures for computers in the wake of the financial downturn of October 1987. If Digital is to maintain its footing in this turbulent economic climate, it must continually enhance the flagship VAX line and demonstrate its utility in a wide variety of functions and in diverse operating environments. To coin a phrase, as the VAX goes, so goes Digital.

The VAXs certainly continue to do very well in price/performance comparisons, particularly against competing IBM offerings. For example, Digital's 12-MIPS 8820, even with a recent price increase due to increased cost for DRAM memory chips, prices out to $76,344 per MIPS; that's $25,000 less per MIPS than IBM's new high-end, dual-CPU 4381-92E, whose basic model includes only 64M bytes of main memory, versus the 128M bytes of storage and basic I/O channeling that come with the Digital system.

Even at the lower end of the line, Digital's departmental machines have demonstrated a marked cost advantage over comparable IBM offerings. For example, a 1987 study performed by an independent agency for *Computer Economics Report* found that a VAX 8250 installation typically requires four support staffers at an average annual salary outlay of $116,571. IBM's System/38, on the other hand, typically requires a 6.7-person staff at an average annual salary cost of $191,278.

That equation may start to change, however, with IBM's delivery of the new AS/400 (the much-discussed Silverlake), the follow-on to the System/38 and System/36. The

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 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 processor recognizes 32 priority interrupt levels—16 for hardware, 15 for software, and

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AS/400 Model 60 surpasses IBM's 9377 Model 90—a direct VAX competitor—in performance as measured by the RAMP-C commercial standard. The new 48-bit machine bids to challenge low-end uniprocessors like the VAX 8250 and 6210. Although the respective $101,067 and $176,467 price tags of the two Digital machines (adjusted for recent DRAM price increases) are a good deal lower than the $229,500 cost of the Model 60, IBM could end up cutting prices or delivering even higher powered models that will make Digital sweat. Certainly, the AS/400 now looms as the migration target of choice for the estimated 300,000 System/3X users who previously might have been more inclined to look to the VAX line than to IBM's more expensive 370 line when considering an upgrade.

The across-the-board increase in system prices that Digital has had to make due to the industry-wide shortage of DRAM memory chips could not have come at a less opportune time: just as Digital is trying to get the SMP systems off the ground and simultaneously facing a low-end challenge from IBM. Digital needs every economic advantage it can get, and the price increase is surely a detriment to the price/performance curve. We can't help wondering whether Digital will lower VAX prices once the crisis is over if sales of the systems continue to be brisk.

ADVANTAGES AND RESTRICTIONS

Despite the competitive challenges that face it, the VAX line offers users many more benefits than drawbacks. VAXclustering—which allows configuration of up to 16 processors and intelligent storage subsystems—has proven popular with users. In fact, Digital pushes clustering harder with each announcement. Certainly, the scheme provides an innovative mechanism for upgrading systems and for addressing the hardware migration gaps within the VAX family.

There are, of course, in-group migration options within the VAX line. The 6210, for example, can be upgraded to any other 6200; likewise, the 8810 can be upgraded to other 8800 Series processors. But no 6200 can be physically converted to an 8800. Through clustering, though, a system can gain additional computing power and throughput. Because the clustering scheme does not provide symmetrical multiprocessing, computing power does not expand in linear or near-linear increments. Still, VAXclustering delivers enhanced load balancing and gives users access to far more disk storage than is available through local system connections.

VAXclustering can also provide a measure of fault tolerance through processor switchover and automatic dual-ported disk switchover in case of failure, through the Hierarchical Storage Controllers (HSCs) it employs. In addition, the VMS operating system supports Volume Shadowing software, which allows data to be written to two disks simultaneously so that data is preserved in case one for normal user software, which runs at the process level (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 (106 cm) high, 29 inches (73 cm) wide, and 32 inches (81 cm) deep and weighs 500 pounds (230 kg). Each system has a power requirement of 92 to 132 VRMS or 184 to 264 VRMS, 47 to 63 Hz, single-phase. Maximum AC power consumption is 1.69 kilowatts. Maximum heat dissipation is 5,760 Btu per hour.

The systems in the VAX 6200 Series stand 60.5 inches (154 cm) high, 30.5 inches (78 cm) wide, and 30 inches (76 cm) deep. Each weighs 700 pounds (318 kg). Power requirements are 208 VRMS at 60 Hz or 380/416 VRMS at 50 Hz, triple-phase. Frequency tolerance is 47 to 63 Hz. Maximum AC power consumption is 1.6 kilowatts. Maximum heat dissipation is 5,440 Btu per hour.

The VAX 8550 is 60 inches (152 cm) high, 27 inches (68.5 cm) wide, and 30 inches (76 cm) deep and weighs 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 systems in the VAX 8800 Series all stand 60 inches (152 cm) high and 30 inches (76.2 cm) deep. The VAX 8810 is 74 inches (188 cm) wide, while each of the other systems is 106 in. (270 cm) wide. *Note: Except for weight, values provided for the VAX 8842 are for each constituent VAX 8820 system.*

The 8810 takes up 15.5 (1.44 square meters) feet of space, while the other 8800s occupy 22.2 square feet (2.0 square meters). The weight of the 8810 with a 60-Hz power supply is 1,474 pounds (668 kg); a 50-Hz system weighs 1,769 pounds (802 kg). The 8820 weighs 2,750 pounds (1,247 kg); the 8830, 2,810 pounds (1,275 kg); the 8840, 2,870 pounds (1,302 kg); and the 8842, 5,500 pounds (2,494 kg). Power requirements for the VAX 8810 are 208 VRMS at 59 to 61 Hz, triple-phase, or 240 VRMS, 49 to 51 Hz, triple-phase. Maximum AC power consumption is 3.7 kilowatts.

Power requirements for the other members of the VAX 8800 Series are 208 VRMS at 59 to 61 Hz or 380/416 VRMS at 49 to 51 Hz, triple-phase, with WYE connection. Maximum AC power consumption for each model is as follows: 8820, 8.3 kilowatts; 8830, 9.9 kilowatts; 8840, 11.5 kilowatts; and 8842, 8.3 kilowatts per 8820.

Maximum heat dissipation for all members of the VAX 8800 Series is 33,800 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

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one disk fails. (For information on the VAXcluster from a user perspective, see the USER REACTION section of this report.)

VAXclustering, in fact, is a major mechanism for connectivity among Digital's workgroup and departmental systems. Ethernet-based Local Area VAXclusters (LAVCs) of MicroVAX supermicros and VAXstations can now access larger VAXclusters of VAX superminis that center around the Computer Interconnect (CI). Through this linkage—which takes place over Ethernet—LAVCs gain access to the far greater computing and storage resources of the bigger clusters.

Because of its data availability and fault tolerant features, VAXclustering has been Digital's primary mechanism for cracking the financial services market and other vertical areas centering around online transaction processing (OLTP) and will continue to be so as Digital rolls out its DECtp OLTP environment, announced as this report went to press.

Digital's VMS operating system is one of the VAX line's greatest strengths. VMS provides a uniform operating environment from the VAXstation all the way up to the 8978 ("from the desktop to the data center," as Digital has phrased it). Users can thus migrate applications upward without conversion as their computing needs increase or share applications across processor networks.

The networking products that Digital provides for the VAX systems are among the most highly regarded in the computer industry. Adhering to recognized international standards like the ISO/OSI model, Digital's networking products provide connectivity to IBM's SNA environment—a necessity for departmental systems in large companies where corporate mainframes from IBM are the norm—and allow creation of multivendor networks whose members conform to the same standards.

Digital's early delivery of certain networking products has given it a distinct advantage in experience over the competition for a number of years. For example, Digital began supporting Ethernet as its local communications standard long before IBM began using it as an adjunct to its proprietary Token-Ring technology. Moreover, through its delivery of communications software employing IBM's LU6.2 protocol, Digital provided peer-to-peer (non-host based) communications among network nodes over three years ago—IBM announced LU6.2 support through ACF/VTAM on its 370 systems only last year.

Digital's general propensity to deliver new products and turn over its VAX line frequently in response to market demands does result in some shortcomings, however. For example, the SMP architecture on the VAX 6200 and 8800 Series multiprocessors has some restrictions. Parallelism extends only to Fortran programs. While most of the engineering/scientific applications that the SMP systems will be called on to run will undoubtedly be Fortran programs, Digital will have to extend code decomposition

603.25 square feet and weighs 17,410 pounds (7,834.5 kg). Power consumption on the VAX 8974 is 60 kVA, 20 kilowatts; that on the VAX 8978 is 115 kVA, 40 kilowatts. Maximum heat dissipation is 58,860 Btu per hour for the VAX 8974 and 117,720 Btu per hour for the VAX 8978.

Operating temperature for all VAX Systems is 59 to 90 degrees Fahrenheit (15 to 32 degrees Celsius). Relative operational humidity for the 8250, 8350, and 6200 Series is 20 to 80 percent, noncondensing; that for the 8550, 8800 Series, 8974, and 8978 is 10 to 90 percent, noncondensing. (A VAX 8250 not using an RX50 diskette operates at 50 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 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 systems employ the VAXBI (detailed below) as the primary I/O bus. However, all support Digital's older UNIBUS I/O architecture.

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. On the 6200 Series, 8550, 8800 Series, and 897X systems, the VAXBI functions only as the I/O bus; all systems 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 1G bytes. The maximum data transfer rate, as implemented by the Bus Interconnect Interface Chip (BIIC), is 13.3M bytes per second for 16-byte transfers.

The VAXBI provides connections for up to 16 VAXBI nodes, each of which is an interface occupying a logical position on a VAXBI bus; the node 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 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:

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facilities to other compilers, such as Ada, to capture the lucrative government market, or C, if the ULTRIX-32, derived from UNIX, becomes available on the SMP-based computers.

Also, Digital admits that the SMP technology itself is better suited to computation-intensive technical applications; the performance growth attained by adding CPUs is not as linear in I/O-intensive commercial applications. Thus, the strategic SMP architecture demonstrates a limitation in an area where Digital says 46 percent of its VAX systems are installed.

USER REACTION

Datapro recently asked three VAX users to detail their experiences with their systems. All three had responded to Datapro's 1987 Computer Users Survey.

Site One: We first spoke with Terry Combs, systems programming and operations manager at Appalachian State University in Boone, North Carolina. He manages a VAXcluster comprising VAX 8550 and 8650 CPUs (the latter upgraded from the original 8600), dual HSC50 I/O servers, 16 disk drives (twelve 456M-byte RA81 drives and a four-drive, 2.488G-byte SA482 Storage Array), two LP27 1,200 line-per-minute band printers, three TU78 tape drives, and 374 communications ports (212 through DMZ32 asynchronous terminal interfaces and 162 through DECserver 200 Ethernet terminal servers). All disk and tape devices are dual ported to the HSC50s, providing data availability in case one of the controllers goes down. (However, the configuration does not employ Digital's Volume Shadowing software for full data redundancy.)

Appalachian State's VAXcluster, which employs Digital's ALL-IN-1 integrated software, performs all academic and administrative computing for the university. It also functions as a service bureau for local institutions, doing tax processing for a nearby county government and handling patient accounting for a 130-bed local hospital.

The current VAXcluster had its genesis in the VAX 8600 system purchased in 1986. Appalachian State, which had previously used two Sperry systems (a 90/80 and an 1100/61), switched to the Digital machine because state authorities mandated that public educational institutions use an Information Associates software package that required either a VAX system or an IBM 370-class computer. During the selection process the authorities at Appalachian State also considered an IBM 4381 and entertained a Sperry offer to convert the software package for the 1100/61. They chose the VAX 8600 because they felt it would be less expensive to operate and support over five years.

According to Combs, the initial conversion from the Sperry systems was easy and was accomplished with a gradual phase-in over an 18-month period. No disks or terminals could be ported from the older systems, however (the latter because Digital systems require async terminals, and

- ***CIBCA***—**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 2M bytes to 3M bytes per second.**

- ***DB88***—**interface between the Memory Interconnect (MI) bus and the VAXBI bus on the 8550, 8800 Series, 8974, and 8978. On those systems, 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.**

- ***DEBNA***—**a communications controller connecting VAXBI systems to Ethernet/IEEE 802.3 local area networks. For further details on the DEBNA, see the COMMUNICATIONS CONTROL section of this report.**

- ***DMB32/DHB32 communications controllers* and *DRB32* realtime parallel interface—transfer data between host processors on the VAXBI bus and various communications interfaces. For further details on these controllers, 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 1M bytes per second.**

- ***DWMBA***—**adds VAXBI channels to a 6200 Series system.**

- ***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 1M bytes per second.**

- ***TU81-Plus***—**a magnetic tape controller for Digital's Group Code Recording (GCR) drive of the same name.**

The VAXBI provides a bandwidth of 13.3M bytes per second on the VAX 8250 and 8350. The 8550 provides an aggregate I/O rate of up to 16M bytes per second. The VAX 6200 Series computers deliver aggregate throughput of up to 60M bytes per second. All other VAX System provide throughput of up to 30M bytes per second.

As previously mentioned, 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 and magnetic tape transports. The UNIBUS is connected to the system or I/O bus through the UNIBUS adapter, which handles priority arbitration among devices on the UNIBUS.

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 *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 communications among clustered systems.

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the Sperry workstations were synchronous devices); outlays for new terminals and disks were thus required.

Problems arose when the Computer Center upgraded to a VAXcluster by adding an 8550. Combs says that Digital took two weeks to get the 8550 up, due to bad boards. The problem was finally corrected by a veteran Digital technician who identified the source of the problems.

*(**EDITOR'S NOTE:** A Digital spokesman contends that the board problem was intermittent, making it difficult to diagnose; he also claims that no system downtime resulted from the problem.)*

Since then, the VAXcluster has run fairly smoothly. Combs particularly praises its capability to restart itself after a power outage without an operator's presence; the self-restarting option can be activated simply by setting a key.

Despite his overall satisfaction with the operation of the system, Combs mentions that he has encountered several problems with Digital's hardware and software support. Although "most of the time" Digital fixes problems fairly easily, he says that he has been inconvenienced by a "very rigid" hardware maintenance policy.

For example, Combs had to change his six-day-a-week maintenance period from the normal 8 a.m. to 12 p.m. to 7 a.m to 11 p.m. so Digital could come in earlier and cut maintenance-induced downtime. He had to do so, he says, because Digital would have charged extra to perform preventive maintenance on Sunday—the only day on which downtime would not affect the Computer Center's business. Consequently, Combs says, he loses an hour of maintenance coverage off the end of the system operator's scheduled shift.

In short, Combs says that Digital's service organization "treats you more like a VAX-11/730 [i.e., small system] user" than a VAXcluster shop requiring high system availability. As far as Combs is concerned, "Our system can't be down for routine maintenance just because Digital won't change its policies."

*(**EDITOR'S NOTE:** The Digital spokesman said that Digital believed it had been flexible by changing its normal 8 a.m.-to-12 p.m. service hours to accommodate Appalachian State's need for high availability and usage. He also claimed that the 7 a.m.-to-11 p.m. schedule that Combs chose was one of several options that Digital offered.)*

Combs has also been annoyed by Digital's software maintenance policies. He criticizes the company's seeming "reluctance to fix" software bugs in a timely fashion. For example, he says that he experienced a bug in the Cobol compiler under Version 4.0 of the VMS operating system. Digital's Software Performance Report (SPR) document indicated that the problem would be "fixed under the next release of the Cobol compiler," even though he has a software service contract. He feels that such fixes should

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

Based on PDP-11 microprocessors, the HSC servers use the Standard Disk Interconnect (SDI) 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 3.1M bytes per second.

The two principal members of the family are the HSC70 and HSC50. The former is designed for mid-range to high-end cluster configurations and for standalone 8800 Series processors. The latter is intended more for low-end to mid-range VAX processors and clusters.

The HSC70 allows up to eight data channels, providing direct support for up to 32 SDI disk drives (32 RA-series or eight SA482 storage arrays) or a combination of SDI disk drives and up to 24 TA-Series tape drives. Through six data channels, the HSC50 can directly support up to 24 SDI disk drives (including six SA482 Storage Arrays) or 16 SDI drives and eight TA Series tape drives.

Both HSC controllers support volume shadowing through specialized VMS software. That feature, which provides a measure of fault tolerance, allows all data written to a disk to be duplicated on compatible disk volumes. The HSC50 is intended for use when volume shadowing is light to moderate; the HSC70 is intended to suit more strenuous shadowing requirements. The HSC controllers also permit dual porting; a single disk can be attached to two HSC controllers.

Specially packaged versions of the two HSC controllers, the HSS50 and HSS70 VAXcluster Building Blocks, are also available. They include cabling, coupling, and interconnect equipment to streamline ordering of equipment intended for use in VAXclusters.

CONFIGURATION RULES

VAX Systems are available in basic systems, preconfigured systems, and VAXcluster configurations. All systems include VMS or ULTRIX-32 operating system and DECnet networking software licenses.

A *VAXcluster* is a multiprocessing system comprising one or more VMS-based VAX processors and/or Hierarchical Storage Controllers (HSCs) linked by a high-speed Computer Interconnect (CI) bus. Each processor or HSC in the configuration is considered a node. The smallest VAXcluster configuration can be two VAX processors connected by an CI and a Star Coupler. An HSC is not required for a cluster; VMS allows locally connected disks to be shared by VAXcluster users. Up to 16 CI-connected nodes can be configured in a VAXcluster.

VAXclusters differ from SMP systems in that the former is a set of cooperating but independent processors, while the latter is a single-image system composed of multiple processors. Each system in a VAXcluster has its own memory-resident copy of VMS; an SMP system has a single memory-resident copy of VMS shared by all processors. SMP systems can participate in VAXclusters.

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

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be handled immediately and as matter of course; he contends, "We're paying a maintenance fee, not a new release fee." Moreover, to understand the implications of each new release of operating system software, he has to pay $1,200 for a one-week class; he feels that such information should be provided free to customers who already pay for software support.

Still, Combs has not let his problems with Digital's service policies affect his partiality or commitment to the VAXcluster. He says that he has already purchased memory upgrades that will take the 8650 from 92M bytes to 144M bytes and the 8550 from 48M bytes to 112M bytes. He also has another SA482 Storage Array on order.

In addition, Combs intends to add terminal servers, because the DMZ32/terminal server arrangement he currently has is not satisfactory for balancing the load in a VAXcluster environment: there are occasions when 210 users are on the 8650, but only 30 are on the 8550. He is somewhat puzzled as to the exact direction he'll take, however. He feels that Digital's DECserver 500—the logical device to add—accommodates so many users that too many would be taken offline if the server ever went down. Also, he feels that the DECserver 500 is too expensive; he would get no effective per-user price break even with the discount for educational institutions that Appalachian State receives from Digital.

Site Two: The second user we spoke to requested anonymity. He is affiliated with an actuarial and management consulting firm in the Middle Atlantic region. The company uses a VAX 8600 to develop benefits management, actuarial, and human resources information management applications for timesharing or sale to *Fortune* 500 clients. The VAX system was acquired when the user's company bought another firm that specialized in consulting to the insurance industry.

The user's company develops software for PCs and VAXs using the Oracle relational data base management and application development system. The firm also develops software for the IBM 370 environment using IBM's DB2 on a 3090 Model 400, a 4381, and a National Advanced Systems mainframe. Because Oracle is DB2 compatible, the software packages in the VAX and 370 environments can be cross-pollinated.

This user's VAX 8600 employs 24M bytes of main memory and 2G bytes of disk storage. It supports 24 terminals directly connected over serial lines and another 50 to 100 over multiplexed lines. Hewlett-Packard LaserJet printers are also attached to the VAX.

This user is quite pleased with his VAX; he states that it provides his organization's primary cross-system architecture and allows fully distributed software development.

The VAX 8600 is attached to an Ethernet LAN that links it to a MicroVAX, as well as to 10 PCs participating in Novell networks. Communications between the VAX and

performed from any terminal, local or remote, attached to it. The VAXcluster Console System typically comprises a MicroVAX II computer with memory, disk drive, cartridge tape drive, DEQNA Ethernet-to-Q-bus synchronous communications controller, eight serial lines, fiber optic converters and power supply, fiber optic cable, and associated software.

The CI-based VAXclusters can be networked to the Ethernet-based Local Area VAXclusters (LAVCs) in which Digital's MicroVAX and VAXstation systems can be configured. This scheme, called Local Area VAXcluster II (LAVC II), creates a so-called mixed interconnect VAXcluster in which the CI- and HSC-connected VAX Systems service boot and I/O requests from the satellite computers in the LAVC. A mixed interconnect VAXcluster can comprise up to 42 VAX nodes, with the number of CI-based VAX systems not exceeding 16.

GENERAL: The configuration rules provided here are for SBBs under 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. The so-called Configuration One provides a 12-slot backplane; Configuration Two features a 24-slot backplane. On Configuration Two systems, up to 17 of the 24 VAXBI slots provided are available for VAXBI options. Configuration Two systems permit configuration of up to four KDB50 disk controllers and two TU81-Plus tape units per system. Configuration One systems permit attachment of up to two KDB50-As and one TU81-Plus.

Up to seven additional 16M-byte memory increments can be added to the 8250 when battery backup is not installed; when it is, five increments can be added. The 8350 supports up to six expansion memory increments.

In the 6200 Series systems, the total number of processors (up to four), VAXBI channels (up to six) and memory boards (up to eight) cannot exceed 14. Memory can be expanded to 256M bytes in 64M-byte increments comprising two 32M-byte memory boards. Device support on the 6200 Series systems is as follows:

- **Up to six VAXBI channels (occupying five slots each).**
- **Up to eight KDB50 disk controllers. Two can be configured per VAXBI channel, with each taking up two VAXBI slots.**
- **Up to four TU81-Plus tape drives. Two can be configured per VAXBI channel, with each occupying one VAXBI slot.**
- **Up to four DEBNA Ethernet controllers; two can be configured per VAXBI channel.**
- **Up to two DMB32 eight-line or DNB32 16-line communications controllers can be configured per internal VAXBI channel; up to four can be configured per external VAXBI channel. Each device occupies one VAXBI slot.**

Up to 128 asynchronous communications lines can be configured on the 6200s.

The 8550 can support additional 16M-byte or 64M-byte memory increments, as well as up to four KDB50 disk controllers.

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the PCs are handled through Oracle's SQLnet protocol. Applications run on the PCs using Professional Oracle; thus 10 software testers on PCs are able to work from the Oracle data base on the VAX 8600.

This user is pleased, also, with the service he receives from Digital. In fact, he says that at one time the company received service from a Digital VAR but was unhappy enough to return to Digital's service umbrella. Similarly, he says that his company once used third-party memory products but again went back to Digital's offerings because the third-party products were unreliable.

The VAX 8600 user offered an interesting observation about the growth path Digital offers. Even though many critics assail Digital for tying its product offerings too strongly to the proprietary VMS environment, this user indicates that he is comfortable with VMS. He sees Digital's principal operating environment as a strong basis for future growth.

Site Three: The third user we contacted—who also requested anonymity—works for a midwestern service company that provides third-party administration of deferred compensation for self-funded medical groups, HMOs, preferred provider organizations (PPOs), and corporate retirement plans. The company's VAX 8650 runs actuarial evaluation, health care claims management, and salary administration applications.

The VAX 8650 was purchased to replace a VAX-11/750. The company decided to stay with Digital not only because the firm already had a base of VAX software, but also because the administrators were pleased with the price/performance that the 8650 promised, as well as with the prospect of modular growth through VAXclustering. In fact, the user says that he currently has money budgeted to add an HSC for faster I/O and enhanced disk storage.

The user's configuration features 80M bytes of main memory. It supports 5G bytes of disk storage through four of Digital's 456M-byte RA81 disk drives and two Emulex SMD 734s; all drives are attached to Digital UDA50 controllers. The system supports 170 terminals, as well as 10 laser printers; 9 of those printers operate at 8 pages per minute (ppm), while another prints at 26 ppm. Ten more band and chain printers are configured on the VAX 8650.

This user says he is very pleased with his VAX 8650. He particularly likes the "tremendous amount of software" readily available through both Digital and third-party suppliers. "We look to build or buy," he says; "we prefer to buy whenever we can, and there's always something there to meet the need." □

The VAX 8820 through 8842 systems support up to two internal and four external VAXBIs, as well as one UNIBUS (on the 8842 those figures apply for each 8820); the 8810 supports up to four VAXBIs and two UNIBUS channels. Memory on the VAX 8800 Series can be upgraded through addition of 64M-byte increments.

The VAX 8974 and 8978 are complete VAXcluster systems comprising, respectively, four or eight VAX 8810 processors. The are expandable as VAXcluster systems by adding VAX processors and as dual-processor nodes by adding VAX 8800 upgrades. Each CPU can support up to five 16M-byte and three 64M-byte memory expansion increments. When memory is expanded, all CPUs must have an equal amount of memory. Up to four VAXBI and two UNIBUS channels can be configured per CPU. The 8974 supports up to 32 KDB50 disk controllers, while the 8978 supports up to 64.

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. Moreover, company spokesmen almost invariably contend that the maximum number of locally connectable terminals is a false limit, because frequently VAX systems employ Ethernet terminal servers; theoretically, each system can be connected to over 1,000 servers. Generally, Digital provides either the number of asynchronous local lines supported, or, in some cases, the range of users typically supported on a given system across a spectrum of applications. Refer to Chart A for the quoted workstation support figures for each system.

Digital also provides ranges of support for users of the ALL-IN-1 integrated office system, which many VAX users employ as the primary application umbrella for their organizations. For example, the VAX 6210 supports 120 ALL-IN-1 subscribers, the 6220 supports 208, the 6230 supports 296, and the 6240 supports 368; in each case, 50 percent of those subscribers can be concurrently active.

DISK STORAGE: The KDB50 disk controller, which functions as the primary local disk attachment device for VAXBI-based systems, supports up to four RA60 (205M-byte fixed/removable), RA81 (456M-byte Winchester), and RA82 (622M-byte Winchester) drives in any combination. (The KDB50 controls one SA482 Storage Array, which is a specially packaged configuration of four RA82 drives.) See the "General" portion of this section for information on the number of KDB50s configurable on each system.

The intelligent HSC70 and HSC50 storage controllers can be attached to the VAX 8000 systems through the Computer Interconnect. See the INPUT/OUTPUT CONTROL section of this report for a discussion of these units.

MAGNETIC TAPE: The principal locally connectable tape device for the VAX Systems is Digital's TU81-Plus. See the "General" portion of this section for information on the number of those drives locally configurable on each VAX System.

The HSC70 and HSC50 I/O controllers, which attach to all VAX Systems through the Computer Interconnect, also support tape devices. Refer to the INPUT/OUTPUT CONTROL section of this report for information on HSC family tape support.

PRINTERS: Up to 16 line printers can be supported on each VAX System. Each printer must connect to an asynchronous line or to a DMF32 or DMB32 port. 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.

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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 an optical storage system, printing terminals, and a voice synthesis module.

The RV20 laser drive is a Write Once, Read Many (WORM) optical storage device. Average seek time is 150 milliseconds; the continuous data transfer rate is approximately 250K bytes per second for both read and write operations. The RV20 master drive can be daisychained to three slave drives to provide up to 4G bytes of storage. Digital guarantees data readability for 30 years.

The LA100 is a microprocessor-controlled hard copy 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 can be used as consoles for VAX Systems.

DECtalk, a speech synthesis unit, converts standard ASCII text into speech output. The unit features 10 voices (9 predefined and 1 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 VMS operating system allows VAX systems to be connected to other VAX systems, to other Digital systems, and to other manufacturers' computer systems. Synchronous, point-to-point, and multipoint connections are supported for interprocessor communications. 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 VMS-based systems.

The *DEBNA Ethernet Controller* connects VAXBI systems to both Ethernet V.2.0 and IEEE 802.3 local area networks. The DEBNA supports one Ethernet port, providing physical and data link communications layers, and has up to 5M bits per second of peak hardware throughput capability.

The *DELUA Ethernet-/IEEE 802.3-to-UNIBUS Communications Controller* connects UNIBUS VAX 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* 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 H4000 meets Ethernet and IEEE 802.3 LAN specifications.

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.

MUXserver 100/DECmux II Remote Terminal Server connects up to 16 remote asynchronous terminals, PCs, and printers to a local Ethernet through a pair of modems and a leased phone link. MUXserver 100 connects to the Ethernet and acts as a terminal server; DECmux II connects devices at the remote site and works with the MUXserver 100 as a statistical multiplexer.

DECserver 200 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 19.2K bps full-duplex. DECserver 200 supports split-speed (transmit and receive) terminal operation, block-mode transfers, and X-on/X-off handling, among other features. DECserver 200 is available in two versions. DECserver 200/Modem Control (MC) provides modem control and monitoring, an RS-232-C line interface, LED-enhanced visual communications monitors, and connection to non-LAT (Digital's Local Area Transport) hosts. DECserver 200/Data Leads (DL) does not support modems or applications with devices that require modem control signals; it is intended for applications utilizing the DECconnect cabling system.

The *DECserver 500* network terminal switch connects terminals, serial printers, and modems to hosts on an Ethernet. Featuring eight integral card slots, the DECserver 500 supports up to 128 terminal connections. A fully populated device with DEC423 interfaces supports up to 128 terminals; with RS-232-C interfaces, the DECserver 500 supports up to 64 terminals.

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 *DHB32 Asynchronous Communications Controller* enables up to 16 terminals, modems, and serial printers to communicate directly with the VAXBI processor. The DHB32 emulates the asynchronous portion of Digital's DMB32 and operates at speeds up to 38.4K bps per line.

The *DMF32 Communications Controller* is an intelligent device that enables a combination of modems and terminals to communicate with the UNIBUS on 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 (FIFO) 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 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.

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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-W* 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 *DRB32* provides an asynchronous direct memory access (DMA) interface to the VAXBI. Transferring data at up to 6.7M bytes per second, the DRB32 uses a 32-bit, half-duplex, bidirectional I/O path to transfer data to and from the user device and two eight-bit unidirectional paths for control data. One version of the DRB32, compatible with the DR11-W, provides a UNIBUS migration path to the VAXBI.

SOFTWARE

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

VMS (also known as 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.

The most recent release, Version 5.0 (announced in April 1988), provides symmetric multiprocessing (SMP) support for the VAX 6220, 6230, 6240, 8820, 8830, 8840, and 8842 systems. In SMP, a form of tightly coupled multiprocessing, all processors perform operations simultaneously in all VAX access modes (including user, supervisor, executive, and kernel). For example, processors in an SMP system can simultaneously execute user mode programs, execute system services, and initiate I/O. Actual parallel computing (in which all processors work simultaneously on parts of the same application) is supported only through the VAX Fortran compiler (see "Languages," below).

VMS Version 5.0 includes specialized facilities, including Sysman, which centralizes the management of VAXcluster systems (see below for a discussion of VAXcluster support), and the License Management Facility (LMF), a tool that enables a system manager to register, manage, and track software licenses.

Under VMS, applications can be divided into several independent subsystems whose data and code are protected from one another but which have general communications and data sharing facilities. Jobs can communicate using general, group, or local communications facilities.

Jobs can be scheduled as time-critical jobs with strict execution priorities. 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 into 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 data processing. Files can be stored in any of several ways to optimize subsequent processing.

The 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 into 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, 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. (For additional details on the security capabilities of VMS, refer to *Datapro Reports on Information Security*.)

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.

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

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

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- Distributed Lock Manager, which synchronizes resource use across the VAXcluster
- Terminal Server support, which allows terminals to be connected flexibly to VAXcluster systems and provides load balancing and availability features
- Cluster Operator support, which enables a single person to manage an entire VAXcluster
- Mass Storage Control Protocol (MSCP) 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
- Local Area VAXcluster Systems Phase II, which allows the addition of Computer-Interconnect (CI) resources, such as disk drives controlled by the HSC storage controllers, to an Ethernet-based VAXcluster system (that is, a Local Area VAXcluster, or LAVC, in which MicroVAXs and VAXstations can be connected with larger VAX systems)

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. It does not comply fully with AT&T's System V Interface Definition (SVID). ULTRIX-32 cannot yet be used on VAX symmetric multiprocessor 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 ULTRIX-32 file system, as well as 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 intrinsic facilities that permit communications among UNIX and non-UNIX systems, including 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 Digital's Ethernet adapter; ability to communicate with Ethernet networks based on TCP/IP, UDP/IP, ThinWire, and baseband protocols; and a mail utility that allows communications among users in single-user or multinode environments. ULTRIX-32 supports the Digital Network Services Protocol (NSP) if DECnet-ULTRIX is present.

ULTRIX-32 has limited compatibility with ULTRIX-11, the UNIX Version 7-based operating system formerly available for Digital 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-32-developed UNIX images in compatibility mode.

The VAX 8550 and 8810 support a specialized environmental product, *VAXELN*, which acts as a compatible subsystem to the VMS operating system for development of applications in realtime control and distributed computing environments. It consists of development utilities for creating target applications and a runtime kernel of device drivers and service code that becomes a part of each application. Finished programs are entirely memory-resident, although optional disk support is available for data files.

VAXELN applications are written in an optimizing, native-mode version of Pascal. Completed applications can be downline loaded across network (local or wide area) links or transferred to target systems by disk or tape.

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.

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 Rdb/VMS, VAX Data Base Management System (DBMS), VAX Application Control and Management System (ACMS), and VAX TDMS. 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 files and 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 Rdb/VMS is a relational data base management system. Unlike VAX DBMS (detailed below), which is designed for highly structured data bases, Rdb/VMS is designed for applications in which data items and relationships among records change frequently. Rdb/VMS conforms to the Digital Standard Relational Interface (DSRI) and is now Digital's premier DBMS product.

In Rdb/VMS, data is independent of application programs; users can change definitions without modifying or recompiling their programs. The product can retrieve and update information both from local data bases and from remote

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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.

VAX-to-IBM Data Access (VIDA) with IDMS/R enables VAX end users to interactively access data on IBM mainframes. VIDA with IDMS/R permits direct access to data stored in IDMS, IDMS/R, and VSAM files in Cullinet Software's Information Center Management System (C/ICMS). VIDA employs Digital's VAX Information Architecture and SNA Gateway.

VAX Structured Query Language (SQL), Digital's implementation of ANSI standard SQL, is a high-level data base language used as both an interactive and a software development interface for VAX Rdb/VMS and VIDA with IDMS/data bases conforming to the Digital Standard Relational Interface (DSRI). VAX SQL offers an interactive data manipulation language (DML) and a data definition language (DDL) utility. The VAX SQL language preprocessor supports VAX C, Cobol, Fortran, and PL/1; SQL statements can be embedded in source files written in those languages. Embedded SQL statements are expanded in compliance with the specifications of ANSI Standard X3.135-1986. The VAX SQL dynamic interface supports all DSRI data types, as well as the DECIMAL data type used by IBM DB2 data bases.

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.

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.

The specialized VAXELN environmental product, which runs on the VAX 8550 and 8810 (for details see the "Operating System" section above), supports *VAX Rdb/ELN*, a relational data base management system for dedicated or distributed environments. Like VAX Rdb/VMS, VAX Rdb/ELN uses the Digital Standard Relational Interface (DSRI), which allows programs written for either relational product to access data managed by the other. VAX Datatrieve can be used to access VAX Rdb/ELN data bases on the same Ethernet as a VMS system.

LANGUAGES: VMS provides a native programming environment consisting 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, 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.

Two compilers are particularly noteworthy.

VAX Cobol Compiler Version 4.0, based on ANSI 1985 Cobol standard X3.23-1985, has been validated by the Software Standards Validation Group of the National Bureau of Standards for conformance to *FIPS Pub 21-2, Federal Standard Cobol* at the high level. Features enabling conformity to the government standard include NOT conditionals, the REPLACE statement, and the CLASS clause.

VAX Fortran Compiler Version 5.0, announced in April 1988, permits parallel processing on any VAX 6220, 6230, 6240, 8820, 8830, 8840, or 8842 running under VMS Version 5.0. (This compiler is also available for all other VMS-based processors, from the VAXstation up.)

The Version 5.0 Fortran Compiler allows application programmers to perform directed decomposition, i.e., to write statements called directives that tell the Fortran compiler which sections of a program can be run in parallel on a multiprocessor CPU. The indicated sections are "decomposed" at run time and assigned to the various processors.

The Fortran Compiler globally optimizes object code, supports access to ISAM files that use descending keys, and fully supports American National Standards Institute (ANSI), International Standards Organization (ISO), and U.S. government standards for Fortran.

Digital also provides a set of programming tools for development of parallel programs. *VAX Performance and Coverage Analyzer* helps programmers identify bottlenecks and sections of a program that would benefit most from parallel processing. *VAX Debug* allows programmers to find and correct errors caused by data dependencies. *VAX Language-Sensitive Editor* enables a programmer to perform multiple programming tasks in a single session and reduce editing errors.

C, Fortran, and Lisp compilers 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. Further information on DNA is included in the "DEC Digital Network Architecture (DNA) and DECnet" report in *Datapro Reports on Minicomputers*. Since the publication of that report, which discusses DNA development up through Phase IV, Digital has announced the beginning of DNA Phase V, which through 1990 will embrace even more of the standards established by the International Standards Organization (ISO) Open Systems Interconnect (OSI) networking model.

Conforming to the ISO/OSI model, DNA consists of the following seven functional layers (corresponding OSI layers are provided in parentheses): User and Network Management (Application); Network Application

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(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 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 (NICE) protocol, which defines mechanisms for exchanging network, node, and configuration data and for servicing requests from modules residing in the Network Management Layer
- 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
- 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
- Transport protocol, which defines a mechanism for dispatching data to any node in the network via the best possible route
- 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 node and network connections, and starting up an unattended remote node
- 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 VMS-based systems to participate as routing or end nodes in DECnet computer networks. DECnet-VAX was introduced as a Phase IV network product warranted only for use with other Digital Equipment Phase III and Phase IV products. Now that DNA is in Phase V, DECnet will certainly be upgraded for use with Phase III, IV, and V 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 currently 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 VMS.

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

Task-to-task communications 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 communications, a DECnet/VAX utility enables a user to send messages to any VAX system. Messages can be directed to a 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 a 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 communications among Digital systems using DNA Phase III or IV protocols and communications, including electronic mail, with non-Digital systems using TCP/IP protocols. DECnet-ULTRIX will be upgraded to comply with DNA Phase V.

DECnet-ULTRIX allows users to transfer data and files between ULTRIX- and VMS-based systems and also permits DECnet and TCP/IP protocols to share system resources, such as Ethernet communications controllers.

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

DECnet-ULTRIX includes a semitransparent, bidirectional DECnet-Internet gateway. (Details on Internet are provided below.) This gateway, based on the TCP/IP in 4.2 BSD UNIX, provides network access between DECnet and Internet systems, allowing users to communicate through their respective file transfer, remote login, and mail capabilities.

For multivendor networking, Digital provides *Network Applications Support* products that allow common access to services on DECnet/OSI networks. Those products provide application access, business communications, and information/resource sharing services for Digital's VT Series terminals, based on VMS and UNIX VAX Systems, Apple Macintosh microcomputers, and MS-DOS- and OS/2-based PCs.

Digital's *Internet* family of products supports the interconnection of Digital computers and Digital networks to systems built by IBM and other manufacturers. The most

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important members of the Digital-to-IBM portion of the family are DECnet/SNA Gateway and VMS/SNA.

DECnet/SNA Gateway allows a DECnet network and an IBM Systems Network Architecture (SNA) network to be connected. IBM operating systems and subsystems supported by DECnet/SNA Gateway include MVS, MVS/SP, MVS/XA, VM/SP, DOS/VSE/SP, CICS/VS, IMS/VS, ACF/VTAM, and ACF/NCP. One version of DECnet/SNA Gateway links Digital local area networks to SNA networks and another connects Digital wide area networks to SNA nets.

VMS/SNA allows VAX systems to directly participate in an IBM SNA network. A VAX running VMS/SNA appears to the SNA network as a remote Physical Unit Type 2 node, providing access to IBM applications programs or other system resources and allowing the VAX to act as a 3270 display station exchanging documents and electronic mail between the VMS operating system and IBM's DISOSS.

Both DECnet/SNA Gateway and VMS/SNA require installation of appropriate *DECnet/SNA Access Routines and Programming Interfaces* on host systems. Those products include the following:

- DECnet/SNA Gateway Management
- DECnet/SNA VMS 3270 Terminal Emulator (3270 TE)
- DECnet/SNA VMS Remote Job Entry (RJE)
- DECnet/SNA Data Transfer Facility
- DECnet/SNA VMS DISOSS Document Exchange Facility (DDXF)
- Message Router/S Gateway
- EDE with IBM DISOSS
- DECnet/SNA VMS Distributed Host Command Facility (DHCF)
- DECnet/SNA VMS Advanced Program-to-Program Communication (APPC)/LU6.2 Programming Interface
- DECnet/SNA VMS Printer Emulator (PrE)
- DECnet/SNA VMS 3270 Data Stream (3270 DS) Programming Interface
- DECnet/SNA VMS Application Programming Interface

DECnet/SNA Gateway Management controls, monitors, and troubleshoots the gateway from a network node. The management routines provide configuration and initialization facilities, allow a VMS operator to bootstrap or restart a gateway, and provide event logging and error counters.

DECnet/SNA VMS 3270 Terminal Emulator (3270 TE) allows a VT200 or VT300 Series terminal (or other device operating in VT100 emulation mode) to interact with programs on an IBM system written for 3270 display stations.

DECnet/SNA VMS Remote Job Entry (RJE) allows suitably configured VAX systems to act as SNA/RJE workstations that can submit batch jobs to an IBM host and receive job output.

DECnet/SNA Data Transfer Facility (DTF) provides bidirectional data transfer between an MVS-based IBM system in an SNA network and and one or more VMS-based VAX systems in a DECnet network.

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 Distributed Office Support System (DISOSS) environment. It allows both Digital and IBM users to participate in a common office network in which documents can be transferred, edited, and deleted.

Message Router/S Gateway allows transparent exchange of electronic mail, messages, revisable and final form documents, and MS-DOS files between Digital and IBM office networks. For further details, see the "Office Automation" subsection below.

External Document Exchange (EDE) with IBM DISOSS allows DECdx/VMS and ALL-IN-1 Office Menu software users to search for, retrieve, file, edit, or delete text contained in an IBM Distributed Office Support System (DISOSS) document library. Documents can also be created on VAX systems, transformed into IBM final or revisable Document Content Architecture (DCA) DISOSS documents, and filed in an IBM host document library. Final form and revisable IBM documents can be accessed through EDE menus; those menus can also be integrated into the ALL-IN-1 Office Menu or invoked from the Digital Command Language (DCL) system prompt when used with DECdx/VMS.

EDE with IBM DISOSS provides an interface conforming to Document Interchange Architecture (DIA)/DCA using Logical Unit 6.2, IBM's peer-to-peer communications capability. EDE with IBM DISOSS requires the DDXF access routine.

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-Digital equivalent of 3270 terminal emulation. Through this connection, an IBM network manager can control both the IBM and Digital networks from an IBM display; IBM users can also access mail and perform program development tasks on a VAX system.

DECnet/SNA VMS Advanced Program-to-Program Communications (APPC)/LU6.2 Programming Interface 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.

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.

In *DECnet/SNA VMS Application Programming Interface (API)*, SNA functionality is apparent to the user. The API product is a collection of routines that allow 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 application programming with SNA resources and requiring a flexible interface to an IBM application system.

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

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.

VAX Bisync Terminal Support (BTS) is a VAX-based software package that enables 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 standards 8072, 8073, and 8473. VOTS provides VMS users with a program-to-program interface for exchanging data between a local 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.

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.

VAX/VMS Services for MS-DOS is a software product that allows a VAX or a MicroVAX to act as a server for a group of VAXmate PCs in a DECnet Thinwire network. The product allows resource sharing between VMS and MS-DOS and permits server-based licensing of MS-DOS applications. (Through server-based licensing, Digital licenses applications for a specific number of users on a single server; only one license per server need be purchased, rather than one license per user.) All DECnet-VAX licenses include a license for VMS for MS-DOS, making every VAX System running DECnet a licensed PC server.

A PC-based product, *DECnet-DOS*, allows IBM PCs to participate as peers in DECnet networks. DECnet-DOS provides utilities for file transfer, remote file access, network management, terminal emulation, remote resource sharing, and troubleshooting. It also contains programming libraries that can be used to develop distributed applications using task-to-task communications.

DECnet System Services (DSS) is a set of products that facilitate access to distributed information and peripherals within a network environment. DSS consists of *VAX Distributed File Service (DFS)*, which provides users with transparent access to files stored on remote systems in a DECnet network; *VAX Distributed Queuing Service (DQS)*, which allows any VMS user on any system in a DECnet network to access any printer located anywhere in the network; and *VAX Distributed Name Service (DNS)*, which provides consistent network-wide naming of network resources, allowing DFS users to refer to network resources using the same name from any system on the network.

UTILITIES: Available for the VAX 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 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 the development and execution of applications for Digital's PDP-11 minicomputers; *Fortran IV/VAX-to-RSX Cross Compiler*, for the development and execution of RSX Fortran programs for 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, as well as for public utility, telecommunications, and government applications.

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OFFICE AUTOMATION: *VAX ALL-IN-1 Integrated Office and Information System* is a menu-oriented software package that provides office applications such as electronic mail; word and document processing; calendar, time, and desk management; electronic filing; communications; and forms development on 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, VT200, or VT300 family terminal to select from an option menu, moving from one application to another. The ALL-IN-1 software requires a VMS-based 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.

MAILbus is a set of distributed applications software that links Digital's ALL-IN-1 users, IBM SNA Distribution Services (SNADS) and DISOSS users, and users of other X.400-compliant mail systems into a global electronic messaging network. Among other products, MAILbus comprises VAX Message Router Version 3.0, VAX Message Router/S Gateway, and VAX Message Router/P Gateway.

VAX Message Router Version 3.0 provides store-and-forward message transfer. It consists of the Message Router Base, which contains the message transfer system, a gateway directory service, and management services; the Message Router VMSmail Gateway, which interfaces VMSmail to Message Router, supporting VMS-style addressing and converting incoming Digital DX format and WPS-Plus documents into ASCII before delivering them to the VMS user; and the Message Router Programmer's Kit, which provides a set of high-level interfacing routines for writing a user agent, gateway, or other application to run on the Message Router.

Message Router/S Gateway allows transparent exchange of electronic mail messages, revisable and final form documents, and MS-DOS files among users of Digital and IBM office automation systems networks. It also provides a network server function for the interchange of electronic information between Digital's messaging service and an IBM SNADS environment.

Message Router/P Gateway allows transparent exchange of electronic mail messages and final and revisable form documents between users of Digital electronic mail and IBM PROFS or VM/CMS systems.

VAX DECmail is a standalone, single-node mail and filing system that runs under the 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.

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.

Digital is also involved in two types of cooperative marketing agreements with a range of software vendors. In a Cooperative Marketing Program (CMP), Digital and the independent software vendor combine forces in sales calls, trade shows, and technical demonstrations, recommending each other's products to prospective buyers. Digital has CMPs with vendors in a range of application areas, including petroleum/geotechnical, investment management, office automation (based on UNIX), and human resources management (payroll/personnel).

System Cooperative Marketing Programs (SCMPs) are agreements through which Digital works with OEMs to market, demonstrate, and sell turnkey systems incorporating Digital hardware and the vendors' products. Among the areas Digital's SCMP program program encompasses are manufacturing resource planning (MRP), mechanical computer-aided design (MCAD), electronic computer-aided engineering (CAE), and health care/medical information management.

PRICING

POLICY: Digital provides the 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 either be purchased outright for or obtained through Digital's Periodic Payment License (PPL) option, through which the user pays an initial license fee and then makes monthly payments thereafter. The software is licensed with a 90-day cancellation option.

The price of a VAX System includes operating system and DECnet licenses. The PPL option for those products includes the initial license charge and 12 months of PPL fees for both products.

Digital also offers VAXcluster software pricing options based on system capacity ratings; those ratings equalize the cost between a standalone computer and a VAXcluster of equivalent capacity. Under this scheme, the cost of a layered software product used in a VAXcluster does not increase incrementally as new processors are added. A user-based pricing scheme for some layered software is also available, in which reduced prices are offered for low-usage situations.

Customers ordering the ULTRIX-32 product receive a UNIX binary license directly from Digital. For new VAX System purchasers, an ULTRIX-32 license is included in the price of the system. Current users of Digital's 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 7 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.

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The VAX 8820, 8830, and 8840 include an integrated warranty support package providing the following in addition to the usual one-year hardware and software warranty:

- Software installation
- 24-hour-a-day, 7-day-a-week on-site hardware service
- 24-hour-a-day hardware and software telephone support
- Preinstallation site audit
- Phone and electronic mail access to an assigned account manager at the Customer Support Center in Colorado
- Access to Digital's Performance Reporting service

The 8840 and the VAXcluster-based 8842 are eligible for two additional service packages. The Solution Start-Up and Service Package, designed to simplify implementation of the system, includes an additional SA482 storage array and a tape drive; VAXcluster system console and VAX Performance Advisor system management tools; education credits; a resident software engineer for an additional six months; presite planning, software installation, and DECstart Plus—on-site startup consulting services from a Digital Software Specialist.

The High Data Availability Package includes an additional HSC70 storage controller with dual porting capability and VAX Volume Shadowing software for creating duplicates of selected disk volumes to safeguard data.

Special support features are also included with the VAX 8974 and 8978. Those features include 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 education credits. DECservice is available in the United States without distance restrictions.

The warranty scheme for the VAX 6200 Series includes 24-hour hardware service seven days a week.

Digital is committed to two-hour service response for all systems in and above the 6200 Series; the 8250 and 8350 are guaranteed a four-hour response. Response time guarantees are available at no charge to customers located up to 50 road miles from any of Digital's 166 United States service locations.

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

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

The *Customer Returns Center*, in Woburn, Massachusetts, provides service for all products under return-to-factory warranties, as well as for products requiring postwarranty 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.

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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.

Under Digital's *software support* policy, 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. 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. 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.

Because Digital's VAX Systems are designed for use in networks, the company offers three special *Network Services*, including NETplan, for network planning and design; NETstart, for implementation and startup; and NETsupport, for ongoing operational support.

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 training centers worldwide. Courses covering both Digital equipment-related and non-product-related topics are offered. Digital's Educational Services division publishes a digest listing available courses four times a year.

TYPICAL CONFIGURATIONS: Sample configurations of the VAX 8250, 6240, and 8840 are provided in the following tables. Complete hardware and software prices follow these configurations.

Note: The system and VAXcluster prices quoted in the following configurations were raised about 3.5 percent on June 10, 1988, due to a shortage of DRAM chips for embedded memory.

VAX 8250:

824BC-AE VMS System; includes CPU; 16M bytes of main memory; integral floating-point; Ethernet interface; KDB50 disk controller; one-year hardware warranty; paid-up VMS and DECnet licenses	$ 92,400
LA100-BA hard copy console terminal	2,640
RA81-AA 456M-byte Winchester disk drive	17,640
TU81E-BA; TU81-Plus 75-ips streaming tape drive	30,765
DHB32-M 16-line asynchronous communications controller	6,200
16 VT320-BA terminals with keyboards and tilt/swivel bases	9,040
LG01-AA 600-lpm matrix text printer and LP11 controller	13,545
TOTAL PURCHASE PRICE:	$172,230

VAX 6240:

62DMA-AE VMS System; includes CPU; 128M bytes of main memory; integral floating-point; KDB50 disk controller; two VAXBI channels; DEBNA Ethernet controller; 95M-byte TK50 cartridge tape drive; one-year hardware warranty; paid-up VMS and DECnet licenses	$537,400
SA482-LA 1.866G-byte Storage Array	51,000
TU81E-BA; TU81-Plus 75-ips streaming tape drive	30,765
Three DHB32-M 16-line asynchronous communications controllers	18,600
30 VT320-BA terminals with keyboards and tilt/swivel bases	16,950
18 VT330-BA graphics terminals with keyboards	35,820
Two LG02-AA 600-lpm matrix text/graphics printers	33,390
TOTAL PURCHASE PRICE:	$723,925

VAX 8840:

888CC-AW VAXcluster System; includes CPU; 128M bytes of main memory; battery backup; integral floating-point; two VAXBI channels; VAXBI expansion cabinet; VAXcluster port and interconnect cables; HSC70 Storage Controller; HSC5X-BA disk interface; SA482 2.488G-byte Storage Array; Two VAXBI Ethernet interfaces; console subsystem; one-year hardware warranty; paid-up VMS, VAXcluster, and DECnet licenses	$1,590,000
SC008-AC Star Coupler	9,095
HSC70-AA intelligent storage controller	58,765

DEC VAX Systems

HSC5X-BA disk interface	10,500	Four CXY08-AA 8-line RS-232-C signalling units for terminal server	7,540
SA482-AA 2.488G-byte Storage Array	66,000	48 VT320-BA terminals with keyboards and tilt/swivel bases	27,120
HSC5X-CA tape interface	10,500	48 VT330-BA graphics terminals with keyboards	95,520
Two TA81-AA 75-ips streaming tape drives	69,250	Three LG02-AA 600-lpm matrix text/graphics printers	50,085
Four DHB32-M 16-line communications controllers	24,800		
DSRVS-BA DECserver 500 Ethernet terminal server with software license	15,950	TOTAL PURCHASE PRICE:	$2,035,125

EQUIPMENT PRICES

		Purchase Price ($)*	Basic Service (Monthly) ($)	DECserv. (Monthly) ($)
VAX 8250 SYSTEMS				
824BC-DE	VAX 8250 CPU; 16M bytes of ECC MOS memory; integral floating-point; DEBNA Ethernet communications interface; KDB50 disk controller; one-year on-site hardware warranty; one-year VMS and DECnet licenses; 12-slot VAXBI	72,450	394	469
824BC-AE	Same as 824BC-DE (12-slot VAXBI), but with paid-up VMS and DECnet licenses	92,400	394	469
824BC-EE	Same as 824BC-DE (12-slot VAXBI), but with one-year ULTRIX-32 and DECnet licenses	72,450	394	469
824BC-BE	Same as 824BC-DE (12-slot VAXBI), but with paid-up ULTRIX-32 and DECnet licenses	92,400	394	469
825BB-DE	Same as 824BC-DE, but with 24-slot VAXBI	77,700	469	558
825BB-AE	Same as 824BC-DE, but with 24-slot VAXBI and paid-up VMS and DECnet licenses	97,650	469	558
825BB-EE	Same as 824BC-DE, but with 24-slot VAXBI and one-year ULTRIX-32 and DECnet licenses	77,700	469	558
825BB-BE	Same as 824BC-DE, but with 24-slot VAXBI and paid-up ULTRIX-32 and DECnet licenses	97,650	469	558
VAX 8250 VAXCLUSTER SYSTEMS				
824CC-DP/DT	VAX 8250 CPU; 16M bytes of ECC MOS memory; integral floating-point; CIBCA VAXcluster port and Computer Interconnect cables; DEBNA Ethernet communications interface; one-year hardware warranty; one-year VMS and DECnet licenses; and 12-slot VAXBI	76,650	474	564
824CC-AP/AT	Same as 824CC-DP/DT (12-slot VAXBI), but with paid-up VMS and DECnet licenses	96,600	474	564
825CD-DP	Same as 824CC-DP/DT, but with 24-slot VAXBI	81,900	549	654
825CD-AP	Same as 824CC-DP/DT, but with 24-slot VAXBI and paid-up VMS and DECnet licenses	101,850	549	654
VAX 8250 PRECONFIGURED SYSTEMS				
SV-8A47A-GL	VAX 8250 CPU; 16M bytes of ECC MOS memory; integral floating-point; KDB50 disk controller; DEBNA Ethernet communications interface; LA100 console terminal with stand; RA82 disk drive and TU81-Plus tape drive; one-year hardware warranty; one-year VMS and DECnet licenses; 12-slot VAXBI	123,000	620	738
SV-8A47A-GK	Same as SV-8A47A-GL (12-slot VAXBI), but with paid-up VMS and DECnet licenses	142,950	620	738
SV-8A47N-GL	Same as SV-8A47A-GL, but with 24-slot VAXBI	133,500	742	883
SV-8A47N-GK	Same as SV-8A47A-GL, but with 24-slot VAXBI and paid-up VMS and DECnet licenses	153,450	742	883
VAX 8350 SYSTEMS				
834BB-DE	VAX 8350 CPU; 32M bytes of ECC MOS memory; integral floating-point; DEBNA Ethernet communications interface; KDB50 disk controller; one-year on-site hardware warranty; one-year VMS and DECnet licenses; 12-slot VAXBI	98,700	484	576
834BB-AE	Same as 834BB-DE (12-slot VAXBI), with paid-up VMS and DECnet licenses	123,900	484	576
834BB-BE	Same as 834BB-DE (12-slot VAXBI), but with paid-up ULTRIX-32 and DECnet licenses	123,900	484	576

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NA—Not applicable.
NC—No charge.

DEC VAX Systems

		Purchase Price ($)*	Basic Service (Monthly) ($)	DECserv. (Monthly) ($)
834BB-EE	Same as 834BB-DE (12-slot VAXBI), but with one-year ULTRIX-32 and DECnet licenses	98,700	484	576
835BB-DE	Same as 834BB-DE, but with 24-slot VAXBI	103,950	559	665
835BB-AE	Same as 834BB-DE, but with 24-slot VAXBI and paid-up VMS and DECnet licenses	129,150	559	665
835BB-EE	Same as 834BB-DE, but with 24-slot VAXBI	103,950	559	665
835BB-BE	Same as 834BB-DE, but with 24-slot VAXBI and paid-up ULTRIX-32 and DECnet licenses	129,150	559	665
VAX 8350 VAXCLUSTER SYSTEMS				
834CC-DP	VAX 8350 CPU; 32M bytes of ECC MOS memory; integral floating-point; CIBCA VAXcluster port and set of Computer Interconnect cables; DEBNA Ethernet communications interface; one-year hardware warranty; one-year VMS and DECnet licenses; and 12-slot VAXBI	102,900	564	671
834CC-AP	Same as 834CC-DP (12-slot VAXBI), but with paid-up VMS and DECnet licenses	128,100	564	671
835CC-DP	Same as 834CC-DP, but with 24-slot VAXBI	108,150	639	761
835CC-AP	Same as 834CC-DP, but with 24-slot VAXBI and paid-up VMS and DECnet licenses	133,350	639	761
VAX 8350 PRECONFIGURED SYSTEMS				
SV-8B47A-GL	VAX 8350 CPU; 32M bytes of ECC MOS memory; integral floating-point; KDB50 disk controller; DEBNA Ethernet communications interface; UNIBUS adapter, cabinet, box, and backplanes; LA100 console terminal with stand; RA82 disk drive and TU81 tape drive; one year-warranty; one-year VMS and DECnet licenses; 12-slot VAXBI	149,250	710	845
SV-8B47A-GK/GN	Same as SV-8B47A-GL (12-slot VAXBI), but with paid-up VMS and DECnet licenses	174,450	710	845
SV-8B47N-GL/GM	Same as SV-8B47A-GL, but with 24-slot VAXBI	159,750	832	990
SV-8B47N-GK/GN	Same as SV-8B47A-GL, but with 24-slot VAXBI and paid-up VMS and DECnet licenses	184,950	832	990
VAX 6200 ENTRY VAXCLUSTER SYSTEMS				
SV-6A47B-AL	Two 6210 VAXcluster Base Systems (each with 32M bytes of 1M-chip ECC MOS memory; integral floating-point; two VAXBI channels; CIBCA VAXcluster port and CI cables; DEBNA Ethernet controller; TK50 tape drive; one-year VMS, VAXcluster, DECnet and VAX Performance Advisor licenses); two LA100 console terminals; HSS70 Storage Building Block; HSC5X-CA tape interface; 1.244G-byte SA482 Storage Array; TA79 tape drive; one-year warranty	479,100	2,484	2,957
SV-6A47B-AK	Same as SV-6A47B-AL, but with paid-up software licenses	586,100	2,484	2,857
VAX 6210 VMS BASE SYSTEMS				
62AMA-DE	VAX 6210 CPU; 32M bytes of 1M-chip ECC MOS memory; integral floating-point; two VAXBI channels; KDB50 disk controller; DEBNA Ethernet controller; TK50 tape drive; one-year warranty; one-year VMS and DECnet end-node licenses	131,600	732	871
62AMA-AE	Same as 62AMA-DE, but with paid-up VMS and DECnet licenses	170,500	732	871
VAX 6210 VAXCLUSTER SYSTEMS				
62ACA-DP	VAX 6210 CPU; 32M bytes of 1M-chip ECC MOS memory; integral floating-point; two VAXBI channels; CIBCA VAXcluster port and CI cables; DEBNA Ethernet controller; TK50 tape drive; one-year warranty; one-year VMS, VAXcluster, and DECnet licenses	146,600	811	965
62ACA-AP	Same as 62ACA-DP, but with paid-up VMS, VAXcluster, and DECnet licenses	191,700	811	965
VAX 6210 VMS PRECONFIGURED SYSTEMS				
SV-6A47A-AL	VAX 6210 CPU; 32M bytes of 1M-chip ECC MOS memory; integral floating-point; two VAXBI channels; KDB50 disk controller; DEBNA Ethernet controller; LA100 console, TK50 tape drive; RA82 disk drive; TU81-Plus tape drive; one-year warranty; one-year VMS and DECnet end-node licenses	180,400	958	1,140
SV-6A47A-AK	Same as SV-6A47A-AL, but with paid-up VMS and DECnet end-node licenses	219,300	958	1,140

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DEC VAX Systems

		Purchase Price ($)*	Basic Service (Monthly) ($)	DECserv. (Monthly) ($)
VAX 6220 VMS BASE SYSTEMS				
62BMA-DE	VAX 6220 CPU; 64M bytes of 1M-chip ECC MOS memory; integral floating-point; two VAXBI channels; KDB50 disk controller; DEBNA Ethernet controller; TK50 tape drive; one-year warranty; one-year VMS and DECnet licenses	242,500	912	1,086
62BMA-AE	Same as 62BMA-DE, but with paid-up VMS and DECnet licenses	293,400	912	1,086
VAX 6220 VAXCLUSTER SYSTEMS				
62BCA-DP	VAX 6220 CPU; 64M bytes of 1M-chip ECC MOS memory; integral floating-point; two VAXBI channels; CIBCA VAXcluster port and CI cables; DEBNA Ethernet controller; TK50 tape drive; one-year warranty; one-year VMS, VAXcluster, and DECnet licenses	257,400	992	1,181
62BCA-AP	Same as 62BCA-DP, but with paid-up VMS, VAXcluster, and DECnet licenses	316,000	992	1,181
VAX 6220 VMS PRECONFIGURED SYSTEMS				
SV-6A47A-BL	VAX 6220 CPU; 64M bytes of 1M-chip ECC MOS memory; integral floating-point; two VAXBI channels; KDB50 disk controller; DEBNA Ethernet controller; LA100 console, TK50 tape drive; 1.244G-byte SA482 Storage Array; TU81-Plus tape drive; one-year warranty; one-year VMS and DECnet licenses	317,900	1,197	1,425
SV-6A47A-BK	Same as SV-6A47A-BL, but with paid-up VMS and DECnet licenses	368,800	1,197	1,425
VAX 6230 VMS BASE SYSTEMS				
62CMA-DE	VAX 6230 CPU; 64M bytes of 1M-chip ECC MOS memory; integral floating-point; two VAXBI channels; KDB50 disk controller; DEBNA Ethernet controller; TK50 tape drive; one-year warranty; one-year VMS and DECnet licenses	326,000	1,030	1,226
62CMA-AE	Same as 62CMA-DE, but with paid-up VMS and DECnet licenses	388,800	1,030	1,226
VAX 6230 VAXCLUSTER SYSTEMS				
62CCA-DP	VAX 6230 CPU; 64M bytes of 1M-chip ECC MOS memory; integral floating-point; two VAXBI channels; CIBCA VAXcluster port; DEBNA Ethernet controller; TK50 tape drive; one-year warranty; one-year VMS, VAXcluster, and DECnet licenses	340,900	1,110	1,321
62CCA-AP	Same as 62CCA-DP, but with paid-up VMS, VAXcluster, and DECnet licenses	414,500	1,110	1,321
VAX 6230 VMS PRECONFIGURED SYSTEMS				
SV-6A47A-CL	VAX 6230 CPU; 64M bytes of 1M-chip ECC MOS memory; integral floating-point; two VAXBI channels; KDB50 disk controller; DEBNA Ethernet controller; LA100 console, TK50 tape drive; 1.866G-byte SA482 Storage Array; TU81-Plus tape drive; one-year warranty; one-year VMS and DECnet licenses	408,800	1,373	1,635
SV-6A47A-CK	Same as SV-6A47A-CL, but with paid-up VMS and DECnet licenses	471,700	1,373	1,635
VAX 6240 VMS BASE SYSTEMS				
62DMA-DE	VAX 6240 CPU; 128M bytes of 1M-chip ECC MOS memory; integral floating-point; two VAXBI channels; KDB50 disk controller; DEBNA Ethernet controller; TK50 tape drive; one-year warranty; one-year VMS and DECnet licenses	470,600	1,147	1,366
62DMA-AE	Same as 62DMA-DE, but with paid-up VMS and DECnet licenses	537,400	1,147	1,366
VAX 6240 VAXCLUSTER SYSTEMS				
62DCA-DP	VAX 6240 CPU; 128M bytes of 1M-chip ECC MOS memory; integral floating-point; two VAXBI channels; CIBCA VAXcluster port and CI cables; DEBNA Ethernet controller; TK50 tape drive; one-year warranty; one-year VMS, VAXcluster, and DECnet licenses	486,400	1,227	1,461
62DCA-AP	Same as 62DCA-DP, but with paid-up VMS, VAXcluster, and DECnet licenses	563,700	1,227	1,461

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NA—Not applicable.
NC—No charge.

DEC VAX Systems

		Purchase Price ($)*	Basic Service (Monthly) ($)	DECserv. (Monthly) ($)
VAX 6240 VMS PRECONFIGURED SYSTEMS				
SV-6A47A-DL	VAX 6240 CPU; 128M bytes of 1M-chip ECC MOS memory; integral floating-point; two VAXBI channels; KDB50 disk controller; DEBNA Ethernet controller; LA100 console, TK50 tape drive; 2.488G-byte SA482 Storage Array; TU81-Plus tape drive; one-year warranty; one-year VMS and DECnet licenses	568,400	1,551	1,846
SV-6A47A-DK	Same as SV-6A47A-DL, but with paid-up VMS and DECnet licenses	635,200	1,551	1,846
VAX 8550 SYSTEMS				
855BC-AE	VAX 8550 CPU; 48M bytes of 256K-bit ECC MOS memory, floating-point, VAXBI channel, KDB50 disk controller, VAXBI Ethernet interface, console terminal, one-year hardware warranty, and paid-up VMS and DECnet licenses	400,000	1,407	1,675
855BC-DE	Same as 855BC-AE, but with one-year VMS and DECnet licenses	351,000	1,407	1,675
855BC-BE	Same as 855BC-AE, but with paid-up ULTRIX-32, 65+ user, and DECnet-ULTRIX licenses	400,000	1,407	1,675
855BC-EE	Same as 855BC-AE, but with one-year ULTRIX-32, 65+ user, and DECnet-ULTRIX licenses	351,000	1,407	1,675
855BB-HE	Same as 855BC-AE, but with paid-up ALL-IN-1, VMS, and DECnet licenses	547,050	1,407	1,675
855BB-JE	Same as 855BB-HE, but with one-year ALL-IN-1, VMS, and DECnet licenses	463,050	1,407	1,675
VAX 8550 VAXCLUSTER SYSTEMS				
855CD-AP	VAX 8550 CPU; 48M bytes of 256K-bit main memory; integral floating-point; VAXBI channel; VAXBI Ethernet interface; console; CIBCA VAXcluster port and set CI cables; one-year hardware warranty; and paid-up VMS and DECnet licenses	422,000	1,487	1,770
855CD-DP	Same as 855CD-AP, but with one-year VMS and DECnet licenses	369,000	1,487	1,770
VAX 8550 PRECONFIGURED SYSTEMS				
SV-8E47B-EK	VAX 8550 CPU; 48M bytes of 256K ECC MOS memory; floating-point; VAXBI channel; KDB50 disk controller; RA82 622MB disk drive; TU81-Plus streaming tape drive; Ethernet interface; console terminal; DMB32 communications controller; one-year hardware warranty; and paid-up VMS and DECnet licenses	453,000	1,653	1,968
SV-8E47B-EL	Same as SV-8E47B-EK, but with one-year VMS and DECnet licenses	404,000	1,653	1,968
VAX 8810 SYSTEMS				
871BE-EE	VAX 8810 CPU; 48M bytes of 256K ECC MOS memory; battery backup; integral floating-point; one VAXBI channel; KDB50 disk controller; VAXBI Ethernet interface; console subsystem; one-year warranty; one-year ULTRIX-32 65+ user and DECnet-ULTRIX licenses	543,900	1,784	2,124
871BE-BE	Same as 871BE-EE, but with paid-up ULTRIX-32 65+ user and DECnet-ULTRIX licenses	592,200	1,784	2,124
871BE-DE	Same as 871BE-EE, but with one-year VMS and DECnet licenses	543,900	1,784	2,124
871BE-AE	Same as 871BE-EE, but with paid-up VMS and DECnet licenses	592,200	1,784	2,124
8810 VAXCLUSTER SYSTEMS				
871CD-DP	VAX 8810 CPU; 48M bytes of 256K ECC MOS memory; battery backup; integral floating-point; one VAXBI channel; VAXcluster port and CI cables; VAXBI Ethernet interface; console subsystem; one-year warranty; one-year VMS and DECnet licenses	562,800	1,864	2,219
871CD-AP	Same as 871CD-DP, but with paid-up VMS and DECnet licenses	615,300	1,864	2,219
8810 VMS PRECONFIGURED SYSTEMS				
SV-8747B-EL	VAX 8810 CPU; 48M bytes of 256K ECC MOS memory; battery backup; integral floating-point; one VAXBI channel; KDB50 disk controller; VAXBI Ethernet interface; DMB32 communications controller; console subsystem; RA82 disk drive; TU81-Plus tape unit; one-year warranty; one-year VMS and DECnet licenses	597,450	2,030	2,417
SV-8747B-EK	Same as SV-8747B-EL, but with paid-up VMS and DECnet licenses	645,750	2,030	2,417

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NC—No charge.

DEC VAX Systems

		Purchase Price ($)*	Basic Service (Monthly) ($)	DECserv. (Monthly) ($)
VAX 8820 VAXCLUSTER SYSTEMS				
886CA-AP	VAX 8820 CPU; 128M bytes of 1M-chip ECC MOS memory; battery back-up; integral floating-point; VAXBI expansion cabinet; two VAXBI channels; one VAXcluster port and CI cables; VAXBI Ethernet interface; console subsystem with LA75 printer; paid-up VMS, VAXcluster, and DECnet licenses	885,150	2,529	3,011
886CA-DP	Same as 886CA-AP, except one-year VMS, VAXcluster, and DECnet licenses	883,700	2,529	3,011
VAX 8830 VAXCLUSTER SYSTEMS				
887CB-AW	VAX 8830 CPU; 128M bytes of 1M-chip ECC MOS memory; battery back-up; integral floating-point; VAXBI expansion cabinet; two VAXBI channels; one VAXcluster port and CI cables; two VAXBI Ethernet interfaces; console subsystem with LA75 printer; paid-up VMS, VAXcluster, and DECnet licenses	1,162,000	3,203	3,813
887CB-DW	Same as 886CB-AW, but with one-year VMS, VAXcluster, and DECnet licenses	1,062,000	3,203	3,813
VAX 8840 VAXCLUSTER SYSTEMS				
888CC-AW	VAX 8840 CPU; 128M bytes of 1M-chip ECC MOS memory; battery back-up; integral floating-point; VAXBI expansion cabinet; two VAXBI channels; one VAXcluster port; one HSC70 storage controller; one 2.488G-byte SA482 Storage Array; one HSC5X-BA disk interface; two VAXBI Ethernet interfaces; console subsystem; paid-up VMS, VAXcluster, and DECnet licenses	1,590,000	4,349	5,177
888CC-DW	Same as 888CC-AW, but with one-year VMS, VAXcluster, and DECnet licenses	1,473,000	4,349	5,177
VAX 8842 VAXCLUSTER SYSTEMS				
889CD-AP	Two 8820 CPUs (each with 128M bytes of 1M-chip ECC MOS memory; battery backup; integral floating-point; VAXBI expansion cabinet; two VAXBI channels; one VAXcluster port and CI cables; one VAXBI Ethernet interface; console subsystem include LA75 printer); one HSC70 storage controller; one 2.488G-byte SA482 Storage Array; one HSC5X-BA disk interface; paid-up VMS, VAXcluster, and DECnet licenses	1,735,000	—	—
889CC-DP	Same as 889CD-AP, but with one-year VMS, VAXcluster, and DECnet licenses	1,618,000	—	—
VAX 897X PRECONFIGURED SYSTEMS				
894CB-DP	VAX 8974 with four VAX 8700 processors; 192M bytes of main memory; VAXcluster connection and Ethernet adapter in each processor; four VAXBIs; two HSC70s; one dual-ported 2.488G-byte SA482 Storage Array; console; star coupler; one DELNI local network interconnect; VAXcluster console; DECserver 200 terminal server; TA79 tape drive; one-year warranty; and one-year VMS and DECnet licenses	2,698,500	9,724	11,576
8944CB-AP	Same as 8974CB-DP, but with paid-up VMS and DECnet licenses	2,950,500	9,724	11,576
898CB-DP	VAX 8978 with eight VAX 8700 processors; 384M bytes of main memory; VAXcluster connection and Ethernet adapter in each processor; eight VAXBIs; four HSC70s; two dual-ported 2.488G-byte SA482 Storage Arrays; console; star coupler; two DELNI local network interconnects; VAXcluster console; two DECserver 200 terminal servers; two TA79 tape drives; one-year warranty; and one-year VMS and DECnet licenses	5,031,600	19,136	22,781
898CB-AP	Same as 898CB-DP, but with paid-up VMS and DECnet licenses	5,502,000	19,136	22,781
UPGRADE KITS				
835UD-AE	8250 to 8350 upgrade kit; one CPU board, 16M bytes of memory, one-year hardware warranty, and paid-up VMS license	44,000	90	107
835UD-BE	8250 to 8350 upgrade kit; same as 835UD-AE, but with paid-up ULTRIX-32 license	44,000	90	107
835UD-DE	8250 to 8350 upgrade kit; same as 835UD-AE, but with VMS initial license fee	38,000	90	107
835UD-EE	8250 to 8350 upgrade kit; same as 835UD-AE, but with ULTRIX-32 initial license fee	38,000	90	107
835UE-AJ	8250 to 8350 upgrade kit; same as 835UD-AE, but also with 456M-byte RA81-A disk drive	60,000	185	220
835UE-DJ	8250 to 8350 upgrade kit; same as 835UD-AE, but with VMS initial license fee; also with RA81-A disk drive	54,000	185	220

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DEC VAX Systems

		Purchase Price ($)*	Basic Service (Monthly) ($)	DECserv. (Monthly) ($)
835US-AE	8200 to 8350 upgrade kit; two CPU boards, 16M bytes of memory, one-year warranty, paid-up VMS license; requires return of 8200 CPU board	53,000	180	214
835US-BE	8200 to 8350 upgrade kit; same as 835US-AE, but with paid-up ULTRIX-32 license	53,000	180	214
835US-DE	8200 to 8350 upgrade kit; same as 835US-AE, but with VMS initial license fee	47,000	180	214
835US-EE	8200 to 8350 upgrade kit; same as 835US-AE, but with ULTRIX-32 initial license fee	47,000	180	214
835UT-AE	8200 to 8350 upgrade kit; same as 835US-AE, but also with RA81-A disk drive	69,000	275	327
835UT-DE	8200 to 8350 upgrade kit; same as 835US-AE, but with VMS initial license fee, also an RA81-A disk drive	63,000	275	327
62DUB-DE	6230 to 6240 upgrade kit for systems with VMS PPL licenses; includes two MS62A-AB 32M-byte memory modules	173,500	118	140
62DUB-AE	Same as 62DUB-DE, except with paid-up VMS license	178,300	118	140
62BUA-AE	6210 to 6220 upgrade kit for systems with VMS paid-up license; includes an MS62A-AB 32M-byte memory modules	147,400	181	215
62CUA-AE	6220 to 6230 upgrade kit for systems with VMS paid-up license	114,500	118	140
855UB-AE	8500/8530 to 8550 upgrade kit; one CPU board, 16M bytes of memory, one-year on-site warranty, paid-up VMS license; requires return of CPU board	179,000	NA	NA
855UB-BE	8500/8530 to 8550 upgrade kit; same as 855UB-AE, but with paid-up ULTRIX-32 license	179,000	NA	NA
855UB-DE	8500/8530 to 8550 upgrade kit; same as 855UB-AE, but with VMS initial license fee	166,000	NA	NA
855UB-EE	8500/8530 to 8550 upgrade kit; same as 855UB-AE, but with ULTRIX-32 initial license fee	166,000	NA	NA
855UC-AE	8500/8530 to 8550 upgrade kit; same as 855UB-AE, but also with RA81-A disk drive	213,500	NA	NA
855UC-DE	8500/8530 to 8550 upgrade kit; same as 855UB-AE, but with VMS initial license fee, also with an RA81-A disk drive	200,500	NA	NA
882UB-AE	8700 to 8800 upgrade kit; 8800 CPU module set, 16MB of memory, one-year on-site warranty, paid-up VMS license	280,350	644	767
882UB-BE	8700 to 8800 upgrade kit; same as 882UB-AE, but with paid-up ULTRIX-32 license	267,000	644	767
882UB-DE	8700 to 8800 upgrade kit; same as 882UB-AE, but with VMS initial license fee	280,350	644	767
882UB-EE	8700 to 8800 upgrade kit; same as 882UB-AE, but with ULTRIX-32 initial license fee	267,000	644	767
882UC-AE	8700 to 8800 upgrade kit; same as 882UB-AE, but also with SA482-AD storage array	364,350	880	1,048
882UC-DE	8700 to 8800 upgrade kit; same as 882UB-AE, but with VMS initial license fee and also an SA482-AD storage array	364,350	880	1,048

CPU OPTIONS

VAX 8250/8350 Options

H7231-L	Battery backup	1,800	16	19

VAX 8800 SERIES Options

889CH-DP/DT	High data availability package; includes one HSC70 storage controller, four HSC5X disk interfaces, one HSC5X tape interface, and one-year VAX volume shadowing software license	125,146	445	530
889CH-AP/AT	Same as 889CH-DP/DT, but with paid-up software license	156,420	445	530
H7318-HD	Power conditioning system plus; supports 75kVA load	26,995	—	126

VAX 6200 SERIES Options

HS62A-AL/AM	Full data redundancy option; includes HSC70-AA/AB storage controller, three HSC5X-BA disk interfaces, HSC5X-CA tape interface, two RA82-AA/AD disk drives, and two one-year VAX volume shadowing software licenses	134,800	518	617
HS62A-AK/AN	Same as H562A-AL/AM, but with paid-up software licenses	138,800	518	617
H7231-N	Battery backup	1,800	16	19

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DEC VAX Systems

		Purchase Price ($)*	Basic Service (Monthly) ($)	DECserv. (Monthly) ($)
MEMORY EXPANSION OPTIONS				
MS62A-AB	32M bytes of ECC MOS memory for 6200 series	23,900	NC	NC
MS88-CA	16M bytes (256K-chip) ECC MOS memory module for 8550, 8810, 8974, 8978	12,000	NC	NC
MS88-DA	64M-byte (1M-chip) ECC MOS memory module for 8550, 8810, 8820, 8830, 8840, 8842, 8974, and 8978	25,000	NC	NC
MS820-BA	4M-byte (256K-chip) memory for 8250, 8350	4,000	NC	NC
MS820-CA	16M-byte (1M-chip) ECC MOS memory for 8250, 8350	8,000	NC	NC
VAXCLUSTER OPTIONS				
CIBCA	VAXBI to Computer Interconnect (CI) interface	22,575	140	167
SC008-AC	Star Coupler; 8-node with cabinet; for all VAX 8000 systems	9,095	23	27
SC008-AD	Upgrade to Star Coupler; for 9 to 16 nodes	6,670	23	27
BNCIA-10	CI cable set; 32 ft (10 m)	630	NC	NC
BNCIA-20	CI cable set; 65 ft (20 m)	872	NC	NC
BNCIA-45	CI cable set; 145 ft (45 m)	1,533	NC	NC
EXPANSION OPTIONS				
DB88-AB	First VAXBI channel expansion for VAX 8800	315	20	24
DB88-AE	Third VAXBI channel for VAX 8800; requires BA32-BA/BB VAXBI expansion box and space in H9652-EC/ED expansion cabinet	15,225	60	71
DB88-AC	Internal second VAXBI channel for VAX 8700	15,985	40	48
DB88-AD	External second or fourth VAXBI channel for VAX 8700/8800 or second external VAXBI channel for 8550; requires DB88-AB/AE and BA32-BA/BB; requires BA32-BA/BB on 8550	15,985	20	24
DB88-BC	Third or fifth VAXBI channel for VAX 8800; requires H9657-EU	15,225	58	69
H9657-EA/EB	VAXBI expansion cabinet for 8800	15,750	63	75
H9657-EU	VAXBI expansion kit for 8800; adds VAXBI channels/slots in H9657-EA/EB cabinet	2,730	25	30
DWBUA-CA	VAX 8800 UNIBUS adapter; requires BA11-AW/AX expansion box and space in H9652-EC/ED expansion cabinet	6,600	40	48
DWBUA-FA/FB	VAXBI-to-UNIBUS adapter for 8250/8350	13,650	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	5,512	NC	NC
BA32-BA/BB	VAX 8800/8530 rackmountable 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)	6,615	75	89
DWMUA-AA/AB	UNIBUS expansion option for 6200 Series	29,200	192	229
DWMBA-BA/BB	External third VAXBI channel for 6200 Series	24,600	63	75
DWMBA-CA	External fourth, fifth, or sixth VAXBI channel for 6200 Series	11,200	25	30
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	2,153	NC	NC
BA11-AW/AX	Rackmountable 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	3,994	25	30
DD11-CK	Expansion backplane mounting for BA11 box; provides for two hex- and two quad-slot modules; mounts in one system unit	519	NC	NC
DD11-DK	Same as DD11-CK, except for providing seven hex- and two quad-slot modules; mounts in two system units	1,036	NC	NC
ASYNCHRONOUS OPTIONS				
DMB32-M	Eight-line asynchronous multiplexer with single-line synchronous interface and dual-purpose parallel interface; for VAXBI	3,695	47	56
DMF32-M	Eight-line asynchronous multiplexer with single-line synchronous interface and dual-purpose parallel interface; for UNIBUS	4,615	58	69
DHB32-M	16-line asynchronous communications controller	6,200	40	48
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	4,955	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	3,679	90	107
DMZ32-N	Base module, modem control upgrade kit	801	NA	NA

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DEC VAX Systems

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SYNCHRONOUS OPTIONS				
DMR11-M	Single-line interface for EIA/CCITT devices; base module only; requires appropriate external cable and cabinet kit	7,758	41	49
DUP11-M	Single-line interface for EIA/CCITT devices; base module only; requires appropriate external cable and cabinet kit	2,516	13	15
ETHERNET COMMUNICATIONS				
DEBNA-M	DEBNA VAXBI Ethernet controller	3,900	30	36
DEUNA-M	Ethernet-to-UNIBUS synchronous communications controller	2,975	44	52
H4000	Ethernet transceiver	315	4	5
DELUA-M	Ethernet/IEEE 802.3 UNIBUS single-line interface communications controller	4,354	33	39
DELNI-AA	Local Network Interconnect; supports up to eight Ethernet-compatible, nonterminal devices	1,444	10	12
DSRVB-AA	DECserver 200; supports eight RS-232 ports; includes country kit	3,806	37	44
DSRVB-BA	DECserver 200; supports eight DECconnect ports; includes country kit	3,360	37	44
DSRVS-BA	DECserver 500 floormount Ethernet terminal server; 120 V; includes license to run DECserver 500 software; must be ordered with at least two CXA16 or CXY08 communications controllers in any combination	15,950	165	196
DSRVS-BB	Same as DSRVS-BA, but 240 V	15,950	165	196
CXA16-AA	Factory-installed 16-line asynchronous communications controller for DEC423 signalling standard	2,725	15	18
CXA16-AF	Same as CXA16-AA, but field installed	2,725	15	18
CXY08-AA	Factory-installed eight-line asynchronous communications controller for RS-232-C signalling standard	1,885	15	18
CXY08-AF	Same as CXY08-AA, but field installed	1,885	15	18
DSRZA-BA	MUXserver 100 remote terminal server	6,248	49	58
DFMZA-BA	DECMUX II remote 8-line asynchronous statistical multiplexor	3,124	28	33
REALTIME OPTIONS				
DR11-W	General-purpose UNIBUS DMA digital interface; requires appropriate cables and cabinet kit	1,489	14	17
DR11-WC	Longline, general-purpose interface; includes differential adapter module, interconnect cables, test connectors, and FCC-compliant user I/O panel	3,460	42	50
DR11-WD	Longline upgrade kit for DR11-W; includes all items in DR11-WC, except DR11-W interface module	1,885	24	29
DRB32-M	VAXBI parallel interface	5,250	50	60
MASS STORAGE				
HSC50-AA/AB	HSC50 intelligent I/O server with space for six HSC5X-BA; BNCIA-XX cable required to connect to SC008-AC/AD; cable not included	40,360	155	185
HSC5X-EA/EB	Second power supply for over three HSC5X-BA on the HSC50	3,465	26	31
HSC70-AA/AB	HSC70 Computer Interconnect-based intelligent controller; includes space for eight HSC5X-BA; BNCIA-XX cable required to connect to SC008-AC/AD; cables not included	58,765	220	262
HSS70-AA/AB	HSC70-AA/AB I/O server, HSC5X-BA disk interface, SC008-AC Star Coupler, and BNCIA-20 cable set	74,310	288	343
HSC5X-BA	Data channel interface for interfacing up to four SDI disk drives (on HSC50 or HSC70) or one SA482 (on HSC70)	10,500	45	54
HSS50-AA/AB	HSC50-AA/AB I/O server, HSC5X-BA disk interface, SC008-AC Star Coupler, and BNCIA-20 cable set	57,210	223	265
KDB50-A	DSA VAXBI disk controller for 1-4 SDI drives (8-ft internal cable)	8,800	60	71
KDB50-B	DSA VAXBI disk controller for 1-4 SDI drives (15-ft internal cable)	8,800	60	71
UDA50-A	DSA UNIBUS controller for 1-4 SDI drives	6,510	53	63
RA60-FA/FD	RA60 disk drive with a 4-HI cabinet	24,650	105	125
RA60-P	Removable 205M-byte cartridge	965	NA	NA
RA60-AA	205M-byte RA60 rackmountable disk drive with one BC26V-12 cable; requires controller and mounting cabinet	20,340	105	125
RA60-CA/CD	205M-byte RA60 disk drive in an H9642 (3-HI) cabinet	23,000	105	125
RA60-EA/ED	Three 205M-byte RA60 disk drives mounted in an H9642 (3-HI) cabinet	57,275	315	375
RA60-JA/JD	Four 205M-byte RA60 disk drives mounted in an H9646 (4-HI) cabinet	77,000	420	500
RA60-UA	RA60 reconfiguration kit; for remounting RA60s originally configured in a 3-HI H9642 cabinet; not required for RA60-AA in either cabinet	420	NA	NA
RA81-AA/AD	456M-byte RA81 rackmountable disk drive with cable; requires any SDI controller and a cabinet for mounting	17,640	95	113
RA81-CA/CD	456M-byte RA81 disk drive mounted in an H9642 (3-HI) cabinet with cable; requires any SDI controller	20,400	95	113

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RA81-EA/ED	Three 456M-byte RA81 disk drives mounted in a H9642 (3-HI) cabinet; requires any SDI controller	55,125	285	339
RA81-FA/FD	456M-byte RA81 disk drive mounted in an H9646 (4-HI) cabinet; requires any SDI controller	22,050	95	113
RA81-JA/JD	Four 456M-byte RA81 disk drives mounted in an H9646 (4-HI) cabinet; requires any SDI controller	74,970	380	452
RA81-UA	RA81 reconfiguration kit; required for remounting RA81s originally configured in an H9642 (3-HI) cabinet; not required for RA81-AA	440	NA	NA
RA82-AA	622M-byte 120-V/60-Hz rackmountable disk drive with cable; requires existing SDI controller	17,000	59	70
RA82-AD	622M-byte 240-V/60-Hz rackmountable disk drive with cable; requires existing SDI controller	17,000	59	70
RA82-CA	One RA82-AA mounted in an H9642 (3-HI) cabinet; requires existing SDI controller	17,000	59	70
RA82-CD	One RA82-AD mounted in an H9642 (3-HI) cabinet; requires existing SDI controller	17,000	59	70
RA82-DA	Two RA82-AAs mounted in an H9642 (3-HI) cabinet with two BC26V-12 cables; requires existing SDI controller	34,000	118	140
RA82-DD	Two RA82-ADs mounted in an H9642 (3-HI) cabinet with two BC26V-12 cables; requires existing SDI controller	34,000	118	140
RA82-EA	Three RA82-AAs mounted in an H9642 (3-HI) cabinet with three BC26V-12 cables; requires existing SDI controller	51,000	177	211
RA82-ED	Three RA82-ADs mounted in an H9642 (3-HI) cabinet with three BC26V-12 cables; requires existing SDI controller	51,000	177	211
RUC25-AA/AB	Tabletop 26M-byte/26M-byte RC25 fixed/removable disk drive with UNIBUS adapter	13,650	114	136
RUC25-BA/BB	Rackmountable 26M-byte/26M-byte RC25 fixed/removable disk drive with UNIBUS adapter	13,650	114	136
RC25-DA/DB	Tabletop add-on RC25 disk drive	6,195	85	101
RC25-EA/EB	Rackmountable add-on RC25 disk drive	6,195	85	101
RC25K-DC	Removable 26M-byte RC25 cartridge	330	NA	NA
SA482-AA/AD	2.488G-byte Storage Array; requires any SDI controller or I/O server	66,000	236	281
SA482-HA/HD	1.244G-byte Storage Array building block; requires any SDI controller or I/O server	34,000	118	140
SA482-LA/LD	1.866G-byte Storage Array building block; requires any SDI controller or I/O server	51,000	177	211
RBV20-PA	RV20 laser drive master; includes RV20-A drive, H9643-BC cabinet; 60 Hz	37,500	200	238
RBV20-A	RV20 slave laser drive	32,500	200	—
MAGNETIC TAPE EQUIPMENT				
HSC70-AA/AB	HSC70 Computer Interconnect-based intelligent controller; includes space for eight HSC5X-CA; BNCIA-XX cable required to connect to SC008-AC/AD; cables not included	58,765	220	262
HSC5X-CA	Tape interface for HSC50 I/O controller; data channel for interfacing up to four DSA tape formatters	10,500	45	54
H9302	Rackmount installation kit for two 5.25-in. storage devices	182	NC	NC
TA81-AA/AB	TA81 magnetic tape subsystem; includes two SDI cables	34,625	150	179
TU81E-AA/AB	TU81-Plus magnetic tape subsystem, UNIBUS interface	30,098	140	167
TU81E-UG	TU81 to TU81E upgrade kit	3,308	NA	NA
TA81-UG	TU81 or TU81E to TA81 upgrade kit	6,615	NA	NA
TU81E-BA/BB	TU81-Plus 1600/6250 bpi, 75-ips streaming tape drive; VAXBI interface	30,765	140	167
TU80-AA/AB	TU80 9-track magnetic tape subsystem in a cabinet with controller	14,994	89	106
TU79-AF/AJ	TU79 magnetic, add-on tape transport (without formatter)	29,400	196	233
TA79-BF/BJ	TA79 high-density magnetic tape subsystem; requires HSC50 or HSC70 with HSC5X-CA	59,430	357	425
TK50-DA/DB	TK50 desktop cartridge tape drive (120/240 V AC); requires an H9302 rackmount installation kit; includes nine-foot cable	3,749	22	26
TK50-K	CompacTape cartridge, 95M-byte capacity	30	NA	NA
TK50-RA/RB	TK50 rack-mounted cartridge tape drive (120/240 V AC); requires an H9302 rackmount installation kit	3,749	22	26
TUK50-AB	UNIBUS TMSCP controller for TK50-DX/RX drives; includes cabinet and bulkhead plate used on all 16- and 32-bit systems except PDP-11/84; requires MR11/FA upgrade	2,200	8	10
BAND PRINTERS				
LP11-AA	132-column, 64-character LP25 UNIBUS band printer; 300 lpm	9,645	175	208
LP11-BA	132-column, 64- and 96-character LP25 UNIBUS band printer; 300/215 lpm	10,340	175	208
LP29-UA/U3	Shortline 1,500-/2,000-lpm LP29 UNIBUS printer with LP11 controller; 10-ft cable, bulkhead, and 30-ft (9.5-m) data cable; includes powered paper stacker	38,500	395	470

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LP29-VA/V3	Shortline 1,500-/2,000-lpm LP29 printer with 30-ft (9.5-m) data cable and powered paper stacker; requires DMB32 or DMF32 controller	38,500	385	458
LP29-SA/S3	Shortline 1,500-/2,000-lpm LP29 system printer with LPV11-SA controller; 30-ft (9.5-m) data cable and powered paper stacker	38,500	400	476
LP32-AA	132-column LP25 printer and universal power supply; requires DMF32 UNIBUS controller; 30-ft cable is included	9,645	98	117
LP32-BA	Same as LP32-AA, but includes DMF32 UNIBUS controller	10,340	98	117
LSP25-CA	Longline LP25 UNIBUS lineprinter, 300/215 lpm; includes U.S./U.K. bands, universal power supply, and 50-ft cable included	12,180	119	142
LP27-UA/UB	Shortline LP27 UNIBUS band printer system option with LP11 controller; 10-ft internal cable, bulkhead, and 30-ft (9.5-m) data cable; 1,200/800 lpm	29,950	259	308
LP27-DA/DB	Longline LP27 UNIBUS band printer system option with controller and internal cabling, bulkhead, and (16-m) data cable; BN27D-LL optional longline cables available up to 300 meters; 1,200/800 lpm	29,950	310	369
LP27-VA/VB	LP27 UNIBUS system printer with 30-ft (9.5-m) cable; requires a DMB32 or DMF32 controller	29,950	252	300
MATRIX LINE PRINTERS				
LG01-AA	600-lpm UNIBUS matrix text printer with M7258 controller; 64-character data processing mode; 10-ft internal cable, bulkhead, and 30-ft data cable	13,545	128	152
LG01-CA	Text printer with M7258 controller; 64-character data processing mode; 30-ft data cable; requires DMB32 or DMF32; UNIBUS device	13,545	118	140
LG01-DA	Text printer with RS-232 serial interface and 25-ft cable; standard baud rate 1200 to 19,200, selectable from the printer control panel	13,545	118	140
LG01-UG	Upgrade kit converts LG01 into LG02	3,850	NA	NA
LG02-AA	600-lpm matrix text and graphics printer with M7258 controller ; 10-ft internal cable, bulkhead, and 30-ft data cable; 64-character data processing mode; UNIBUS device	16,695	128	152
LG02-CA	Same type as LG02-AA, but requires DMF32 controller; includes 30-ft cable	16,695	118	140
LG02-DA	Text and graphics printer with RS-232 serial interface and 25-ft cable	16,695	118	140
LG31-A2	300-lpm enhanced text line dot matrix impact lineprinter with RS-232 serial interface and 25-ft cable	8,450	85	101
LASER PRINTERS				
LN03-AA	8-ppm desktop laser printer; includes RS-232-C serial interface, organic photo receptor (OCP) cartridge, AC power cord, toner collection bottle, 250 sheets of letter-size paper and documentation; 150-dpi graphics capability; three character sets in 16 fonts for portrait and landscape printing	2,895	49	58
LN03S-AA	LN03 Plus 8-ppm laster printer providing Digital and Tektronix graphic compatibility; same as LN03-AA, but also including 1M-byte RAM and additional 14-point mono-spaced Modertn Gothic type font	3,995	56	67
LN03R-AA	Script Printer; 8-ppm laser printer supporting PostScript page description language; includes RS-232-C serial interface and 250-sheet input tray	5,495	56	67
LPS40-AA	PrintServer 40, 40-ppm Ethernet printer, 220/240 V, 60 Hz; attached power cord	49,900	475	565
PRINTERS/PLOTTERS				
LXY12-CA/CB	Freestanding, dot matrix graphics lineprinter/plotter with M7258 controller and BC27A-30 30-ft (9.2-m) cable; 240/300 lpm; pedestal with basket and paper guide included	13,335	104	124
LXY12-DA/DB	Same type as LXY12-CA/CB, but with BC22D-25 25-ft cable for interfacing to an RS-232-C serial port	13,335	104	124
LXY12-EA/EB	300-lpm dot matrix graphics lineprinter with BC27A-30 30-ft cable for interfacing to a DMB32 or DMF32	13,335	104	124
COLOR PRINTERS				
LCG01-AA	Ink jet color printer with graphics processor (includes RS-232 serial interface)	17,490	125	149
LJ250-CA	167 cps text/graphics printer with DEC423 and RS-232-C serial interface	1,695	11	13
LJ252-CB	167 cps text graphics printer with Centronics-type parallel interface	1,695	11	13

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CONSOLE TERMINALS				
LA100-BA	KSR 40/80/240 cps hard copy terminal with keyboard, numeric keypad, tractors, BC22D-10 cable, ribbon cartridge, one package of paper, and Courier-10/Orator-10 fonts in U.S./U.K. character sets only	2,640	27	32
LA100-CA	KSR hard copy terminal with keyboard, tractors, BC22D-10 cable, ribbon cartridge, one package of paper, Courier-10/Orator-10 fonts in U.S/U.K. character sets only, and multiple font option	2,750	27	32
LA120-DA	KSR hard copy terminal, 1-6 part forms	3,197	34	40
LA12X-AL	20 MA interface for LA120	147	3	4
LA12X-LT	LA120 low-tear tractor	310	NA	NA
LAXX-FD	Acoustic cover	408		
TERMINALS				
VT320-AA	VT320 monochrome text terminal, white phosphor display	545	3	4
VT320-BA	VT320 monochrome text terminal, green phosphor display	545	3	4
VT320-CA	VT320 monochrome text terminal, amber phosphor display	545	3	4
VT320-DA	VT320 monochrome WPS terminal, white phosphor display	545	3	4
VT320-EA	VT320 monochrome WPS terminal, green phosphor display	545	3	4
VT320-FA	VT320 monochrome WPS terminal, amber phosphor display	545	3	4
VT330-BA	VT330 graphic terminal, green phosphor display, USA keyboard	1,990	19	23
VT330-AA	VT330 graphic terminal, white phosphor display, USA keyboard	1,990	19	23
VT2XX-AA	VT200/VT300 family system stand	240		
VSXXX-AA	Mouse (VT330/VT340 only)	195	NC	NC
VSXXX-AB	Graphics tablet (VT330/VT340 only)	1,095	8	10
VT330-DA	VT330 graphic WPS terminal, white phosphor display, USA keyboard	1,990	19	23
VT330-EA	VT330 graphic WPS terminal, green phosphor display, USA keyboard	1,990	19	23
VT330-FA	VT330 graphic WPS terminal, amber phosphor display, USA keyboard	1,990	19	23
VT340-AA	VT340 color graphics terminal, USA keyboard	2,935	26	31
VT340-DA	VT340 color graphics WPS terminal, USA keyboard	2,935	26	31
VT3XX-CA	Tilt/swivel base for VT320	20	NA	NA
VOICE SYNTHESIS MODULE				
DTC01-AA	Single-line DECtalk text-to-speech unit; includes cable	4,200	22	26
DTC03-AA	Multiline DECtalk, 8-channel text-to-speech unit; requires eight modem cables	28,560	250	298

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SOFTWARE PRICES

		Paid-up License Primary Sys. ($)	Initial License Fee ($)	Periodic Payment Primary Sys. ($)	Per-sys. Paid-up Cluster Lic. ($)
VMS SOFTWARE					
Communications					
Q5D05	DECnet-VAX for VAX 8250	9,335	788	182	NA
Q7D05	DECnet-VAX for VAX 8350	10,742	788	182	NA
Q2D05	DECnet-VAX for VAX 8550	18,165	788	285	NA
QL-D05AD	DECnet-VAX for VAX 6240/8820	24,791	934	334	11,319
QL-D05AU	DECnet-VAX for VAX 8830	26,723	850	362	NA
QL-D05AV	DECnet-VAX for VAX 8840, 8842, 8974	28,581	908	383	NA
QL-D05A2	DECnet-VAX for VAX 6210	10,260	750	212	6,160
QL-D05A3	DECnet-VAX for VAX 6220	15,803	1,019	366	9,492
QL-D05A4	DECnet-VAX for VAX 6230	18,858	1,113	399	11,319
Q2D05-U3/13/J3	DECnet-VAX for VAX 8978	107,720	6,321	2,041	NA
Q5545	DECnet/SNA Gateway for VAX 8250	2,520	788	69	1,512
Q7545	DECnet/SNA Gateway for VAX 8350	3,276	788	69	1,966
Q2545	DECnet/SNA Gateway for VAX 8550	5,544	788	111	3,329
QL-545AD	DECnet/SNA Gateway for VAX 6240/8820	7,560	787	137	4,536
QL-545AU	DECnet/SNA Gateway for VAX 8830	8,148	787	178	4,893
QL-545AV	DECnet/SNA Gateway for VAX 8840, 8842, 8974	8,715	787	201	5,229

NA—Not applicable.

DEC VAX Systems

		Paid-up License Primary Sys. ($)	Initial License Fee ($)	Periodic Payment Primary Sys. ($)	Per-sys. Paid-up Cluster Lic. ($)
QL-545A2	DECnet/SNA Gateway for VAX 6210	6,000	750	81	3,600
QL-545A3	DECnet/SNA Gateway for VAX 6220	9,240	788	214	5,544
QL-545A4	DECnet/SNA Gateway for VAX 6230	11,025	788	233	6,615
Q2545-U3/13/J3	DECnet/SNA Gateway for VAX 8978	9,975	788	221	NA
Q5727	DECnet Router/X.25 Gateway for VAX 8250	4,358	788	103	NA
Q7727	DECnet Router/X.25 Gateway for VAX 8350	4,358	788	103	NA
Q5071	VAX Packetnet System Interface (PSI) and PSI Access for VAX 8250	2,363	788	44	1,134
Q7071	VAX PSI and PSI Access for VAX 8350	3,071	788	44	1,470
Q9071	VAX PSI and PSI Access for VAX 8550	5,198	788	76	2,499
QL071AD	VAX PSI and PSI Access for VAX 6240/8820	5,670	787	94	3,402
QL071AU	VAX PSI and PSI Access for VAX 8830	6,111	787	137	3,644
QL071AV	VAX PSI and PSI Access for VAX 8840/8842/8974	6,541	787	150	3,927
QL071A2	VAX PSI and PSI Access for VAX 6210	2,700	750	54	1,620
QL071A3	VAX PSI and PSI Access for VAX 6220	4,158	788	97	2,499
QL071A4	VAX PSI and PSI Access for VAX 6230	4,967	788	105	2,982
Q2071-U3/13/J3	VAX PSI and PSI Access for VAX 8978	7,476	788	158	NA
Q5111	VAX 2780/3780 Protocol Emulator for VAX 8250	7,676	788	235	4,599
Q7111	VAX 2780/3780 Protocol Emulator for VAX 8350	9,975	788	235	5,985
Q2111	VAX 2780/3780 Protocol Emulator for VAX 8550	16,884	946	340	10,101
Q2111-U3/13/J3	VAX 2780/3780 Protocol Emulator for VAX 8978	30,377	1,670	601	NA
Q5112	VAX 3271 Protocol Emulator for VAX 8250	10,322	819	290	6,195
Q7112	VAX 3271 Protocol Emulator for VAX 8350	13,419	819	290	8,054
Q2112	VAX 3271 Protocol Emulator for VAX 8550	22,701	1,142	412	13,587
Q2112-U3/13/J3	VAX 3271 Protocol Emulator for VAX 8978	40,845	2,016	726	NA
Q5730	VMS Message Router for VAX 8250	2,772	788	80	1,670
Q7730	VMS Message Router for VAX 8350	3,604	788	80	2,162
Q2730	VMS Message Router for VAX 8550	6,101	788	126	3,665
Q2730-U3/13/J3	VMS Message Router for VAX 8978	10,973	788	246	NA
Q5726	Ethernet Terminal Server for VAX 8250	1,089	NA	NA	NA
Q7726	Ethernet Terminal Server for VAX 8350	1,100	NA	NA	NA
Q2726	Ethernet Terminal Server for VAX 8550	1,100	NA	NA	NA
Q2726-U3	Ethernet Terminal Server for VAX 8978	1,050	NA	NA	NA
Data Base Management/Data Management					
Q5897	VAX Common Data Dictionary (CDD) for VAX 8250	2,867	788	83	1,722
Q7897	VAX CDD for VAX 8350	3,727	788	83	2,236
Q2897	VAX CDD for VAX 8550	6,311	788	131	3,781
QL-897AD	VAX CDD for VAX 6240/8820	8,600	787	160	5,156
QL-897AU	VAX CDD for VAX 8830	9,272	787	191	5,565
QL-897AV	VAX CDD for VAX 8840/8842/8974	9,912	787	222	5,943
QL-897A2	VAX CDD for VAX 6210	4,100	750	96	2,460
QL-897A3	VAX CDD for VAX 6220	6,311	788	146	3,791
QL-897A4	VAX CDD for VAX 6230	7,539	788	160	4,526
Q2897-U3/13/J3	VAX CDD for VAX 8978	11,351	788	255	NA
Q5898	VAX Datatrieve for VAX 8250	10,333	1,029	372	6,196
Q7898	VAX Datatrieve for VAX 8350	13,430	1,029	372	8,064
Q2898	VAX Datatrieve for VAX 8550	22,733	1,460	527	13,610
QL-898AD	VAX Datatrieve for VAX 6240/8820	30,996	1,722	620	18,596
QL-898AU	VAX Datatrieve for VAX 8830	33,411	2,005	722	20,066
QL-898AV	VAX Datatrieve for VAX 8840/8842/8974	35,732	2,279	821	21,441
QL-898A2	VAX Datatrieve for VAX 6210	14,760	1,140	410	8,860
QL-898A3	VAX Datatrieve for VAX 6220	22,733	1,460	527	13,650
QL-898A4	VAX Datatrieve for VAX 6230	27,122	1,596	573	16,286
Q2898-U3/13/J3	VAX Datatrieve for VAX 8978	40,898	2,583	930	NA
Q5899	VAX DBMS for VAX 8250; requires VAX CDD	22,953	825	459	13,776
Q7899	VAX DBMS for VAX 8350; requires VAX CDD	29,812	2,289	825	17,887
Q2899	VAX DBMS for VAX 8550; requires VAX CDD	50,453	3,245	1,170	30,272
QL-899AD	VAX DBMS for VAX 6240/8820; requires VAX CDD	68,796	3,822	1,375	41,276
QL-899AU	VAX DBMS for VAX 8830; requires VAX CDD	74,141	4,452	1,606	44,478
QL-899AV	VAX DBMS for VAX 8840/8842/8974; requires VAX CDD	79,307	5,061	1,823	47,575
QL-899A2	VAX DBMS for VAX 6210; requires VAX CDD	32,760	2,457	885	19,660
QL-899A3	VAX DBMS for VAX 6220; requires VAX CDD	50,453	3,245	1,170	30,282
QL-899A4	VAX DBMS for VAX 6230; requires VAX CDD	60,197	3,539	1,273	36,131
Q2899-U3/13/J3	VAX DBMS for VAX 8978; requires VAX CDD	90,762	5,733	2,064	NA
Q5354	VAX Rdb/VMS for VAX 8250	14,879	1,491	536	8,936
Q7354	VAX Rdb/VMS for VAX 8350	19,328	1,491	536	11,597
Q2354	VAX Rdb/VMS for VAX 8550	32,708	2,111	758	19,625
Q2354-U3/13/J3	VAX Rdb/VMS for VAX 8978	58,853	3,717	1,338	NA
Q5Z96	VAX Data Distributor for VAX 8250	11,351	1,134	408	6,815
Q7Z96	VAX Data Distributor for VAX 8350	14,742	1,134	408	8,845
Q2Z96	VAX Data Distributor for 8550	22,680	1,607	579	13,608
Q2Z96-U3/13/J3	VAX Data Distributor for 8978	44,888	2,835	1,021	NA

NA—Not applicable.

DEC VAX Systems

		Paid-up License Primary Sys. ($)	Initial License Fee ($)	Periodic Payment Primary Sys. ($)	Per-sys. Paid-up Cluster Lic. ($)
Languages					
Q5056	VAX Ada for VAX 8250	31,406	3,140	1,130	18,848
Q7056	VAX Ada for VAX 8350	40,786	3,140	1,130	24,471
Q2056	VAX Ada for VAX 8550	61,215	3,927	1,412	36,729
QL-056AU	VAX Ada for VAX 8830	76,073	4,568	1,648	45,643
QL-056AV	VAX Ada for VAX 8840/8842/8974	81,375	5,198	1,871	48,825
QL-056A2	VAX Ada for VAX 6210	44,820	3,460	1,246	26,890
QL-056A3	VAX Ada for VAX 6220	61,215	3,927	1,412	36,729
QL-056A4	VAX Ada for VAX 6230	82,362	4,841	1,741	49,413
Q2056-U3/13/J3	VAX Ada for VAX 8978	110,145	6,962	2,504	NA
Q5095	VAX Basic for VAX 8250	6,679	788	235	4,011
Q7095	VAX Basic for VAX 8350	8,683	788	235	5,208
Q2095	VAX Basic for VAX 8550	14,690	945	340	8,790
QL-095AU	VAX Basic for VAX 8830	21,588	1,302	466	12,967
QL-095AV	VAX Basic for VAX 8840/8842/8974	23,100	1,480	530	13,860
QL-095A2	VAX Basic for VAX 6210	9,540	750	265	5,720
QL-095A3	VAX Basic for VAX 6220	14,690	945	340	8,810
QL-095A4	VAX Basic for VAX 6230	17,535	1,029	371	10,511
Q2095-U3/13/J3	VAX Basic for VAX 8978	26,439	1,670	601	NA
Q5015	VAX C for VAX 8250	5,954	788	207	3,571
Q7015	VAX C for VAX 8350	7,739	788	207	4,641
Q2015	VAX C for VAX 8550	13,094	840	303	7,844
QL-015AU	VAX C for VAX 8830	19,247	1,155	416	11,560
QL-015AV	VAX C for VAX 8840/8842/8974	20,591	1,313	474	12,358
QL-015A2	VAX C for VAX 6210	8,510	750	233	5,110
QL-015A3	VAX C for VAX 6220	13,104	840	303	7,875
QL-015A4	VAX C for VAX 6230	15,635	924	331	9,387
Q2015-U3/13/J3	VAX C for VAX 8978	23,562	1,491	536	NA
Q5099	VAX Cobol for VAX 8250	10,039	1,008	361	6,027
Q7099	VAX Cobol for VAX 8350	13,052	1,008	361	7,833
Q2099	VAX Cobol for VAX 8550	22,092	1,428	512	13,222
Q2099-U3/13/J3	VAX Cobol for VAX 8978	39,753	2,510	860	NA
QL-099AU	VAX Cobol for VAX 8830	32,466	1,953	701	19,499
QL-099AV	VAX Cobol for VAX 8840/8842/8974	34,734	2,216	798	20,843
QL-099A2	VAX Cobol for VAX 6210	14,350	1,110	399	8,610
QL-099A3	VAX Cobol for VAX 6220	22,103	1,428	512	13,262
QL-099A4	VAX Cobol for VAX 6230	26,366	1,554	558	15,824
Q5018	VAX Dibol for VAX 8250	5,230	788	177	3,140
Q7018	VAX Dibol for VAX 8350	6,794	788	177	4,074
Q2018	VAX Dibol for VAX 8550	11,508	788	265	6,889
Q2018-U3/13/J3	VAX Dibol for VAX 8978	20,696	1,313	470	NA
Q5100	VAX Fortran for VAX 8250	6,511	788	229	3,907
Q7100	VAX Fortran for VAX 8350	8,473	788	229	5,082
Q2100	VAX Fortran for VAX 8550	14,333	924	332	8,579
Q2100-U3/13/J3	VAX Fortran for VAX 8978	25,788	1,628	586	NA
QL-100AU	VAX Fortran for VAX 8830	21,063	1,271	455	12,652
QL-100AV	VAX Fortran for VAX 8840/8842/8974	22,533	1,438	518	13,513
QL-100A2	VAX Fortran for VAX 6210	9,310	750	257	5,590
QL-100A3	VAX Fortran for VAX 6220	14,343	924	333	8,610
QL-100A4	VAX Fortran for VAX 6230	17,105	1,008	361	10,269
Q5917	VAX Lisp for VAX 8250	10,091	1,008	363	6,059
Q7917	VAX Lisp for VAX 8350	13,104	1,008	363	7,862
Q2917	VAX Lisp for VAX 8550	22,176	1,428	515	13,304
Q2917-U3/13/J3	VAX Lisp for VAX 8978	39,900	2,520	907	NA
QL-917AU	VAX Lisp for VAX 8830	32,592	1,953	705	19,572
QL-917AV	VAX Lisp for VAX 8840/8842/8974	34,860	2,226	801	20,916
QL-917A2	VAX Lisp for VAX 6210	14,400	1,155	420	8,640
QL-917A3	VAX Lisp for VAX 6220	22,176	1,428	515	13,304
QL-917A4	VAX Lisp for VAX 6230	26,460	1,554	560	15,876
Q5126	VAX Pascal for VAX 8250	5,954	788	207	3,571
Q7126	VAX Pascal for VAX 8350	7,739	788	207	4,641
Q2126	VAX Pascal for VAX 8550	13,094	840	303	7,844
Q2126-U3/13/J3	VAX Pascal for VAX 8978	23,562	1,491	536	NA
QL-126AU	VAX Pascal for VAX 8830	19,247	1,155	416	11,560
QL-126AV	VAX Pascal for VAX 8840/8842/8974	20,591	1,313	474	12,358
QL-126A2	VAX Pascal for VAX 6210	8,510	750	233	5,110
QL-126A3	VAX Pascal for VAX 6220	13,104	840	303	7,875
QL-126A4	VAX Pascal for VAX 6230	15,635	924	331	9,387

NA—Not applicable.