

# DEC VAX 8000 Systems

## MANAGEMENT SUMMARY

In the first months of 1986, Digital Equipment Corporation has almost completely revamped the VAX family, introducing four new models that effectively displace the older VAX-11 systems. The new computers join the VAX 8600 and 8650 in a rejuvenated product line targeted not only at supermini rival Data General's Eclipse MV/Family, but also, and perhaps more significantly, at IBM's 370-based superminis and mainframes. (Even though they have been superseded, the VAX-11/750, 11/780, and 11/785 are still marketed; their final demise, however, appears imminent.)

The four newest models—VAX 8200, 8300, 8500, and 8800—employ a new bus technology that promises to be a Digital standard for the next decade. The VAX Bus Interconnect (VAXBI), a 32-bit synchronous bus, serves as a combination system and I/O bus on the VAX 8200 and 8300, and as the I/O bus only on the 8500 and 8800. (The last two systems employ a high-speed memory interconnect as a system bus.)

The VAXBI features a maximum data transfer rate of 13.3MB per second and provides connection for up to 16 VAXBI nodes. A VAXBI node is an interface that occupies one of 16 logical locations on a VAXBI bus; it can be a mix of processors, memories, and adapters. Mass storage, bus, and communications adapters are supported.

Digital Equipment Corporation's VAX 8000 systems are intended for use in a range of environments, from office automation to compute-intensive engineering and scientific applications. The most recently introduced models feature a new bus architecture, but still support the Unibus peripherals used by older VAX machines. United by the VAX/VMS operating system, the VAX 8000s can be used as standalone processors or can be configured in multinode VAXclusters for enhanced power, mass storage, and availability.

**MODELS:** VAX 8200, 8300, 8500, 8600, 8650, and 8800.

**MAIN MEMORY:** 4MB to 68MB.

**DISK CAPACITY:** 205MB to 218.8GB.

**WORKSTATIONS:** Up to 512 directly attached.

**PRICE:** \$79,000 to \$699,000 (base configuration prices).

## CHARACTERISTICS

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



*Digital Equipment Corporation's VAX 8200 is the successor to the widely installed and highly regarded VAX-11/780. Providing the same power as its predecessor, the VAX 8200 is intended as a department-level processor in office automation, commercial, and manufacturing applications.*

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CHART A. SYSTEM COMPARISON

MODEL	VAX 8200	VAX 8300	VAX 8500	VAX 8600	VAX 8650	VAX 8800
<b>SYSTEM CHARACTERISTICS</b>						
Date of introduction	January 1986	January 1986	April 1986	October 1984	December 1985	January 1986
Date of first delivery	January 1986	2nd quarter 1986	May 1986	April 1985	1st quarter 1986	2nd quarter 1986
Operating system	VAX/VMS, Ultrix-32	VAX/VMS	VAX/VMS	VAX/VMS, Ultrix-32	VAX/VMS, Ultrix-32	VAX/VMS
Upgradable from	Not applicable	VAX 8200	Not applicable	Not applicable	VAX 8600	Not applicable
Upgradable to	VAX 8300	Not applicable	Not applicable	VAX 8650	Not applicable	Not applicable
MIPS	1.06 (approx.)	1.6-2.0 (approx.)	3.1 (approx.)	4.4 (approx.)	6.3 (approx.)	9.5-12.7 (approx.)
Relative performance (based on a rating of the VAX 8200 at 1.0)	1.0	1.6-1.9	3.0	4.2	6.0	9.0-12.0
<b>MEMORY</b>						
Minimum capacity, bytes	4M	4M	20M	4M	16M	32M
Maximum capacity, bytes	16M	14M	20M	68M	68M	32M
Type	MOS	MOS	MOS	MOS	MOS	MOS
Cache memory	8KB	8KB per CPU	64KB	16KB	16KB	64KB per CPU
Cycle time, nanoseconds	600	600 to 1600	135 to 1260	560	384	135 to 1260
Bytes fetched per cycle	—	—	—	8	—	—
<b>INPUT/OUTPUT CONTROL</b>						
Number of channels	2	2	2	11	12	6
High-speed buses	1 VAXBI	1 VAXBI	2 VAXBI	4 Massbus	4 Massbus	4 VAXBI
Low-speed buses	1 Unibus	1 Unibus	Not applicable	7 Unibus	7 Unibus	2 Unibus
MINIMUM DISK STORAGE	205MB	205MB	205MB	205MB	205MB	205MB
MAXIMUM DISK STORAGE	3.6GB local; 164GB in VAXcluster	1.8GB local; 164GB in VAXcluster	5.4GB local; 164GB in VAXcluster	25.5GB local; 164GB in VAXcluster	25.5GB local; 218.8GB in VAXcluster	7.2GB local; 218.8GB in VAXcluster
NUMBER OF WORKSTATIONS	16-64 (typical)	16-64 (typical)	32-200 (typical)	512 (56-256 typical)	512 (56-256 typical)	72-320 (typical)
<b>COMMUNICATIONS PROTOCOLS</b>						
	Bisync, DNA, Ethernet, SNA, 2780/3780, 3271, X.25, X.400, LU6.2, TCP/IP	Bisync, DNA, Ethernet, SNA, 2780/3780, 3271, X.25, X.400, LU6.2, TCP/IP	Bisync, DNA, Ethernet, SNA, 2780/3780, 3271, X.25, X.400, LU6.2, TCP/IP	Bisync, DNA, Ethernet, SNA, 2780/3780, 3271, X.25, X.400, LU6.2, TCP/IP	Bisync, DNA, Ethernet, SNA, 2780/3780, 3271, X.25, X.400, LU6.2, TCP/IP	Bisync, DNA, Ethernet, SNA, 2780/3780, 3271, X.25, X.400, LU6.2, TCP/IP

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

➤ All systems except the 8500—which is completely VAXBI-based—also support Digital's adapters for Digital's Unibus, the principal I/O bus on the VAX-11 systems.

Positioned at the low end of the VAX 8000 family is the VAX 8200, which delivers VAX-11/780 performance in one third the size at half the price. Designed for growing departments, the VAX 8200 is a general-purpose system intended for office automation, distributed banking and financial applications, and other commercial applications, as well as for manufacturing applications, such as material requirements planning.

According to Digital, the VAX 8200 complements the company's MicroVAX II, providing users with expansion capabilities and features not available on that supermicro. The VAX 8200's CPU is similar in design to that of the VAX-11/780, but is available on one 9-inch by 8-inch module, compared to 24 modules on the 11/780. The VAX 8200 is upgradable to the 8300.

The VAX 8300 uses the same technologies as the VAX 8200, but delivers higher performance in compute-intensive applications by using tightly coupled dual 8200 processors. Each CPU contains an 8KB cache memory; main memory is shared through the VAXBI bus. According to Digital, the 8300 provides up to 1.9 times the power (2 MIPS) of the VAX 8200 or VAX-11/780 and is designed

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### 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 eight bytes long; the third type—F—is four bytes long; the last type—H—is 16 bytes long. Data type F is single-precision; type D is double-precision.

A Floating-Point Accelerator (FPA) is standard on the 8200, 8300, and 8800; it is optional on the 8600 and 8650. The FPA executes in parallel with the base CPU, taking advantage of the CPU's instruction buffer to prefetch instructions and of the memory cache to access main memory. Once the CPU has the required data, the FPA overrides the normal execution flow of the standard floating-point microcode and forces use of its own code. Then, while the FPA is executing, the CPU can be performing other operations in parallel.

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▷ for department-level computing in CPU-intensive applications, such as simulation, image processing, and computer-aided design. The VAX-11/782 effectively displaces the dual-processor VAX 11/782.

The mid-range VAX 8500 is the effective replacement for the VAX-11/785. A uniprocessor system, the 8500 provides up to twice the performance of the VAX-11/785 (approximately 3.1 MIPS) at the same price. (Actually, the basic 8500 system costs only as much as an 11/785 with options added.) The VAX 8500 also delivers about three times the power of the VAX-11/780. The computer is housed in a compact package occupying 5.6 square feet of floor space—the same footprint as the 11/750, and one third that of the VAX-11/785, according to Digital.

Digital intends the VAX 8500 to be used as a general-purpose system, useful for a variety of applications, including factory automation, process control, computer-aided design, simulation, office automation, data base manipulation, and software development. Company officials have stated that the 8500 supports about 80 concurrent users of the ALL-IN-1 office automation system.

The new top-of-the-line VAX is the 8800, which features dual processors that share 32MB of main memory. The VAX 8800 utilizes a 60MB-per-second memory interconnect for high-speed processor and memory transfers; up to four VAXBI buses can be used for up to 30MB-per-second input/output transfers. Despite its power, the 8800 occupies only 15.5 square feet of floor space.

Designed for large, computation-intensive applications, the VAX 8800 reportedly delivers up to 12.7 MIPS—that is, 12 times the power of the VAX-11/780 and twice that of the VAX 8650. The VAX 8800 is specifically designed for use in such application areas as seismic analysis, image processing, artificial intelligence, circuit design, high-energy physics, simulation, and econometric modeling.

According to Digital, the two VAX 8800 CPUs can be programmed to act in parallel, although implementation of parallel processing necessitates some software overhead; application programs must be “decomposed” before they can function effectively in a parallel environment.

The VAX 8200, 8300, 8500, and 8800 CPUs each incorporate a hot floating-point accelerator. Each system also includes an interface for connection to Ethernet local area networks and a DECnet software license.

All four VAXBI-based systems come with a one-year, on-site warranty on CPU components. (The standard 90-day warranty applies for integral controllers, as well as for storage devices and peripherals.) The VAX/VMS operating system and layered software are offered under a newly established Monthly License Program (also called a Periodic Payment License), which requires an initial fee, with monthly payments thereafter. The software is licensed with a 90-day cancellation option. The outright license purchase, previously the standard option for VAX systems, remains available.

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

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

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

**MAIN STORAGE**

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

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

**CAPACITY:** Main memory capacities range from 4MB to 68MB. All VAX systems provide up to 4GB of virtual memory space. For the main memory capacities of specific VAX 8000 systems, please refer to Chart A.

**CHECKING:** Information unavailable from the vendor.

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

Battery backup is standard on the VAX 8600, 8650, and 8800.

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

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

**CENTRAL PROCESSOR**

**GENERAL:** The VAX 8500, 8600, 8650, and 8800 CPUs employ Emitter Coupled Logic (ECL) gate array circuitry; the 8200 and 8300 use ZMOS technology. All VAX 8000 CPUs feature virtual memory management facilities, bootstrap loader, cache memory, programmable realtime clock, time-of-year clock with battery backup, control store, and console subsystem.

The VAX 8200 and 8300 feature 200-nanosecond cycle times. The 8200 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 diagnos-

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CHART B. MASS STORAGE

MODEL	RA60	RA80	RA81	RLO2	RC25
Type	Removable	Winchester	Winchester	Cartridge	Fixed/Removable
Controller model	UDA50, KDA50, KDB50, HSC5X-BA (on HSC70 or HSC50)	UDA50, KDA50, KDB50, HSC5X-BA (on HSC70 or HSC50)	UDA50, KDA50, KDB50, HSC5X-BA (on HSC70 or HSC50)	Integrated	Integrated
Drives per subsystem/controller	4	4	4	4	2
Formatted capacity per drive, megabytes	205	121	456	10.4	26/26
Number of usable surfaces	6	7	7	2	—
Number of sectors or tracks per surface	1600 tracks	1092 tracks	2496 tracks	512 tracks	—
Bytes per sector or track	512/sector	512/sector	512/sector	256/sector	—
Average seek time	41.7 ms	25 ms	28 ms	55 ms	35 ms
Average rotational/relay time	8.3 ms	8.3 ms	8.3 ms	12.5 ms	10.5 ms
Average access time	50 ms	33.3 ms	36.3 ms	67.5 ms	45.5 ms
Data transfer rate	1.98MB/sec.	1.2MB/sec.	2.2MB/sec.	512KB/sec.	1.25MB/sec.
Supported by system models	All	8600, 8650	All	8600, 8650	All
Comments				Not supported as system disk; data transfer device only	Not supported as system disk; data transfer device only

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

➤ The other two systems in the VAX 8000 family are the VAX 8600 and the VAX 8650. Positioned between the VAX 8500 and the VAX 8800, the two systems employ the older Unibus/Massbus I/O technology used by the high-end VAX-11 systems. Both employ the same Emitter Coupled Logic (ECL) macrocell gate array circuits in the CPU. They also feature four-stage instruction pipelining; a two-way associative write-back cache memory, which involves a different kind of memory write than that provided by the write-through cache on other VAX systems; and a dedicated memory bus.

In the newer VAX 8650 (announced less than two months earlier than the four VAXBI-based systems), the VAX 8600's 17 CPU boards have been changed, decreasing CPU cycle time from 80 to 55.5 nanoseconds. Performing at 6.4 MIPS, the VAX 8600 is 44 percent more powerful than the VAX 8600 and up to six times more powerful than the VAX 8200. The VAX 8600 is upgradable to the VAX 8650.

The two 8600-series systems are designed to provide power in applications requiring increased performance, large memory (up to 68MB), or multiple Unibus/Massbus channels—including computer-integrated manufacturing, transaction processing, and larger scale office automation, as well as the scientific, engineering, and research applications for which VAX systems have traditionally been used.

The VAX systems are tied together through Digital's VAX/VMS operating system. VAX/VMS is a general-purpose operating system that provides the environment for the concurrent execution of multiuser timesharing, batch, and time-critical applications.

VAX/VMS also includes support for VAXclusters. A VAXcluster is a multiprocessing system composed of one or more VAX 8000 (and/or VAX-11/750, 11/780, and 11/785) processors and/or Hierarchical Storage Controllers (HSCs) running under VAX/VMS and connected by a high-speed Computer Interconnect bus. Each processor or HSC in the configuration is considered a node. (An HSC is

➤ tic facilities. The 8300 is a dual-CPU system that delivers up to 1.9 times the performance of the 8200. It is basically the same as the 8200, except that it incorporates a second CPU module and VAX/VMS support facilities. Main memory is sharable by both processors over the VAXBI system bus.

The VAX 8500 employs four-stage pipelining and includes a hot floating-point facility. A three-way interleaved memory controller and private memory bus reportedly provide average read and write bandwidths in excess of 50MB per second. Internal diagnostic facilities, invoked either locally through the system console or remotely from a Digital Service Center, are intrinsic to the system.

The VAX 8600 and 8650 CPUs also employ four-stage pipeline processing. The VAX 8600 achieves a CPU cycle time of 80 nanoseconds; the cycle time of the VAX 8650 is 55 nanoseconds. The CPU of each system features a virtual memory management facility; bootstrap loader; 16KB write-back cache memory; programmable realtime clock; time-of-year clock with battery backup; writable control store; memory controller with battery backup; modem for remote diagnosis; and console subsystem (without terminal) with 10MB of storage.

The VAX 8600 and 8650 CPUs interface to their respective memory controllers through a dedicated memory bus called the MD-Bus. The memory controller in turn interfaces to the main memory arrays over the Array Bus. The CPU also features a system diagnostic bus and incorporates self-monitoring and error-testing programs.

The VAX 8800, comprising two tightly coupled CPUs sharing a memory controller, uses a five-stage pipelining scheme to deliver a CPU speed of 45 nanoseconds. The internal CPU-to-memory bus transfers data at 60MB per second. The system incorporates a hot floating-point facility. The 8800 includes the same types of diagnostic facilities available for the VAX 8500. In case one of the VAX 8800 processors fails or suffers intermittent faults, the system can be reconfigured as a uniprocessor until remedial maintenance is performed.

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

- VAX 8200—15K 40-bit words of ROM, plus 1K 40-bit words of RAM.
- VAX 8300—Same as 8200 for each processor.

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▷ not required for the cluster; local disks can be shared by nodes through a software server facility.)

According to Digital, a single application can be used across every processor in a VAXcluster, with shared files. The company also claims that the addition of nodes to a VAX-cluster causes little performance degradation. Digital maintains that clustering provides a measure of fault tolerance through processor failover and automatic dual-ported disk failover for HSC storage controllers.

Digital also offers Ultrix-32 as an alternative to VAX/VMS for specialized applications on the VAX 8200, 8600, and 8650. (Ultrix support on the 8500 is said to be forthcoming.) Ultrix-32 is a native-mode implementation of the Unix operating system based on the University of California at Berkeley's Fourth Berkeley Software Distribution (4BSD). It is an interactive, timesharing system that employs a demand-paging scheme to take advantage of the virtual memory architecture of VAX systems.

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

Two of Digital's newest communications products conform to the international reference model for intersystem communication. The VAX OSI Transport Service (VOTS) is an implementation of the International Standards Organization/Open Systems Interconnection (ISO/OSI) Transport and Network layers, providing VMS users with a program-to-program interface for exchanging data between a local VAX/VMS system and one or more remote VAX or non-VAX systems using 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 conforming to the CCITT 1984 X.400 Recommendations for Message Handling Systems; the Gateway allows users of mail agents to send messages to other X.400 mail systems in other networks or within the same network.

Also available for the VAX systems are a wide variety of system software packages, including VAX DBMS, a Coda-syl-compliant data base management system, and VAX Rdb/VMS, a relational data base management product. Along with a range of program development tools, Digital offers a range of languages for the VAX computers, including Fortran, Cobol, Basic, RPG II, and Lisp. A large number of proprietary and third-party applications are available for VAX systems.

### COMPETITIVE POSITION

With the introduction of the VAX 8200, 8300, 8500, 8650, and 8800, Digital has completed the modernization of the VAX line begun with the VAX 8600 at the high end and continued with the addition of the MicroVAX II supermi-

- ▶ • VAX 8500—16K 144-bit words writable and 1K 144-bit words user-accessible.
- VAX 8600/8650—8K 86-bit words.
- VAX 8800—16K 143-bit words.

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

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

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

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

**ADDRESSING:** The processor's addressing modes allow almost any operand to be in a register or in memory, or used as an immediate constant. There are nine basic addressing modes that use the general registers to identify the operand location: Register; Register Deferred; Autodecrement; Autoincrement; Immediate; Autoincrement Deferred; Absolute; Displacement; and Displacement Deferred. The processor also provides Literal Mode addressing.

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

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

**OPERATING ENVIRONMENT:** The VAX 8200 and 8300 are both 42 inches (106 cm) high, 22 inches (54 cm) wide, and 32 inches (81 cm) deep, and weigh a maximum of 550 pounds (250 kg). Each system has a power requirement of 92 to 132 VAC or 184 to 264 VAC, 47 to 63 Hz, single-phase. Maximum AC power consumption is 1.69 kilowatts. Maximum heat dissipation is 5,760 Btu per hour.

▶ The VAX 8500 is 60 inches (152 cm) high, 27 inches (68.5 cm) wide, and 30 inches (76 cm) deep; it weighs 650 pounds ▶

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CHART C. WORKSTATIONS

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

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

cro at the low end. (The MicroVAX II is covered in a separate report in the "Supermicrocomputer Systems" tab in this volume of DATAPRO REPORTS ON MINICOMPUTERS.) The wholesale replacement of the aging VAX-11 machines enhances Digital's credibility as a purveyor of up-to-date technology and solidifies the company's position as the leading supplier of superminis.

Certainly the 8200, 8300, and 8500 provide a far better price/performance ratio than the systems they replace. In the most dramatic example, a System Building Block for the 2-MIPS VAX 8300, with paid-up VAX/VMS and DECnet licenses, Ethernet support, floating-point accelerator, and 12MB of shared memory, is priced at \$146,000; the SBB for the 1.9-MIPS 11/782, providing only 8MB of memory and a VAX/VMS license, used to cost \$320,000. That works out to \$73,000 per MIPS for the VAX 8300, compared to \$168,400 per MIPS for the older system. Going by the basic prices for similarly configured SBBs, the 8200 represents a \$6,600 per MIPS reduction over the VAX-11/780, while the 8500 provides a saving of \$49,500 per MIPS over the 11/785.

Data General, with its Eclipse MV/Family, is usually considered Digital's primary rival among traditional supermini manufacturers; in fact, the recent realignment of the VAX family followed hard upon DG's announcement of the high-end MV/20000, and was viewed as a response in some circles. However, Digital, which generally refuses to acknowledge DG as a competitor, is targeting the VAX 8000 family primarily against IBM systems. The 8200 and 8300 are aimed squarely at the 4361 Model Group 5—intended, like the Digital systems, for department-level applications, particularly engineering/scientific—and the 8500 is targeted at the 4381 Model Groups 12 and 13.

Digital even goes so far as to pit the higher end 8000 systems against IBM's mainframes. For instance, Digital claims that the 8500 can also compete against Model CX1

(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 3.5 kilowatts; maximum heat dissipation is 12,000 Btu per hour. The system occupies 5.6 square feet of space; noise level is 6.2 Db.

The VAX 8600 stands 60.5 inches (153.7 cm) high, 73.5 inches (186.7 cm) wide, and 30 inches (76.2 cm) deep. It weighs 1,725 pounds (784 kg). Power requirements are 120/208 VAC, 47 to 63 Hz, triple-phase. Power of 240/415 VAC, 50 Hz is also available. Maximum AC power consumption is 6.5 kilowatts, and heat dissipation is 22,200 Btu per hour. Maximum noise generated is 60 Db. The VAX 8600 can be positioned on either a solid or raised floor, because it can draw air under the skirt of the machine as well as through a floor.

The VAX 8650 differs from the 8600 only in the following respects: it is 46.5 inches (118.1 cm) wide, weighs 1,700 pounds (773 kg), and dissipates heat at a rate of 23,000 Btu per hour. No data is available from Digital on the decibel level of the VAX 8650.

The VAX 8800 is 60.5 inches (118.1 cm) high, 74 inches (188 cm) wide, and 30 inches (76.2 cm) deep; it occupies 15.5 square feet of space. Weight with a 60-Hz power supply is 1,555 pounds (703.6 kg); a 50-Hz system weighs 1,849 pounds (837.6 kg). Power requirements for the VAX 8800 are 156 to 220 VRMS, 59 to 61 Hz, or 360 to 443 VRMS, 49 to 51 Hz, triple-phase. Surge current is 500 amp for 60 Hz and 250 amp for 50 Hz. Maximum power consumption is 9.2 kilowatts. Maximum heat dissipation is 26,750 Btu per hour.

Operating temperature for all VAX 8000 systems is 59 to 90 degrees Fahrenheit (15 to 32 degrees Celsius). Relative operational humidity for the 8200, 8300, 8600, and 8650 is 20 to 80 percent, noncondensing; that for the 8500 and 8800 is 10 to 90 percent, noncondensing. (A VAX 8200 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 VAX/VMS; Ultrix-32 systems use the same

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### CHART D. PRINTERS

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

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

### CHART D. PRINTERS (Continued)

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

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

▷ of the 3083 mainframe. The 8800, the company contends, can go up against the 3083-JX; a three-processor 8800 VAXcluster, Digital claims, can rival the 3090 in power. In noncluster situations, the 8800 is sure to come up against the approximately 7-MIPS 4381 Model Group 14, which IBM markets as a supermini, but which some pundits regard as a mainframe.

Certainly, Digital has a good chance at competing effectively with IBM at the upper end of the medium systems market and in the large systems area as well. Digital's systems are intrinsically powerful, and the VAXcluster concept permits incremental construction of multiprocess- ing systems.

Digital's networking products are more sophisticated and varied than IBM's. Also, the four newest VAX 8000 systems have Ethernet interfaces as standard components; IBM's 370 systems will not connect to that company's token-ring LAN until 1987. Digital markets a number of IBM/SNA connectivity products—in fact, it has become something of an axiom in the industry that Digital's systems communicate more easily with IBM systems than IBM's do.

▶ I/O control devices, but are more restricted as to the number that can be configured.

The *VAX Bus Interconnect (VAXBI)*, a 32-bit synchronous bus, serves as a combination system and I/O bus on the VAX 8200 and 8300, and as the I/O bus only on the 8500 and 8800. (The last two 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 1GB. The maximum data transfer rate, as implemented by the BIIC, is 13.3MB per second for 16-byte transfers.

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

Types of VAXBI adapters include mass storage adapters, which provide high-speed data transfers to and from VAXBI memory nodes; bus adapters, which permit connections to

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CHART E. MAGNETIC TAPE EQUIPMENT

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

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

CHART E. MAGNETIC TAPE EQUIPMENT (Continued)

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

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

➤ However, one significant advantage that the IBM systems have over Digital's VAX 8000s is disk storage capacity. While the VAXes can support over 200 billion bytes (giga-bytes) of disk through VAXclustering with HSC intelligent servers, IBM's systems can support from 600 gigabytes to over a trillion bytes of fixed disk storage through its single- and dual-density 3380 drives. For the VAX 8000s to achieve maximum effectiveness in applications requiring large amounts of storage and to compete on a completely equal footing with large IBM systems, Digital will have to develop higher capacity storage devices.

The foregoing discussion has concentrated primarily on the VAX 8200, 8300, 8500, and 8800. While the 8600 and 8650 are still viable members of the VAX 8000 family, they appear to be headed for extinction in the not-too-distant future. Their Unibus/Massbus architecture does not jibe with the VAXBI architecture of the new machines, which is destined to be Digital's standard well into the 1990s. Speculation throughout the industry is that the systems will be

➤ Digital's Unibus options, to VAXclusters, and to the private memory interconnects on other VAX processors; and communications adapters, which link the VAXBI to Ethernet local area networks and provide communications between modems and terminals in VAXBI systems.

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

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

The VAXBI supports the following adapters:

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

- **DB88**—interface between the VAX 8800's Memory Inter-

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➤ replaced by a uniprocessor version of the VAX 8800. Still, the two 8600 machines are powerful systems and estimable competitors against machines like Data General's 5-MIPS Eclipse MV/20000 Model 1.

Besides the IBM and Data General systems already mentioned, competition for the VAX 8000 is supplied by Prime Computer's 50 Series, Harris Corporation's H Series and Unix-based HCX-7, Concurrent Computer Corporation's (formerly Perkin-Elmer's) Series 3200 and XF (Unix-based) superminis, and, particularly in the office, Wang Laboratories' VS Systems.

## ADVANTAGES &amp; RESTRICTIONS

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

The availability of the Unix-based Ultrix-32 operating system for the 8200, 8600, and 8650 (and, in the future, 8500) systems is also advantageous, for it allows users to choose between the realtime VMS and timesharing Unix environments, depending upon their application requirements. Ultrix-32 has features that provide compatibility with AT&T's Unix System V—the version of Unix around which most supermicro, mini, and supermini vendors are converging. Thus, it increases the possibility of application portability between Ultrix-based VAX systems and System V-based computers.

Conversely, the lack of Ultrix support on the dual-processor VAX 8300 and 8800 prevents Unix compatibility throughout the entire product line. Berkeley Unix functionality would certainly be desirable in the compute-intensive environments for which the 8300 and 8800 are intended. It is possible that the product may not have been qualified on those two systems. However, Ultrix-32 is also unavailable for VAXclusters, and was never marketed for the old dual-processor VAX-11/782, so it may be that multiprocessor implementation of the Ultrix system is problematic.

Another potential drawback is the limited hardware upgradability available in the VAX 8000 family. Only the 8200 can be upgraded to the dual-processor 8300, and the 8600 to the 8650. The VAX 8000 systems do demonstrate a high degree of peripheral transportability, however; the VAXBI-based 8200, 8300, and 8800 support adapters that permit attachment of the Unibus peripherals common to the older VAX systems, so anyone converting from such a system can port devices to the VAX 8000 series. The only

➤ connect (MI) bus and the VAXBI bus. The DB88 is the VAX 8800's principal I/O path to VAXBI-based disk storage, terminals, and other peripheral devices. The VAX 8800 can have two DB88s, supporting up to four independent VAXBI systems.

- *DMB32 Communications Adapter*—transfers data between host processors on the VAXBI bus and various communications interfaces. For further details on the DMB32, see the "Communications Control" section of this report.
- *DWBUA*—VAXBI-to-Unibus adapter; transfers data between the high-speed, synchronous VAXBI and the asynchronous Unibus. Maximum data transfer rate is approximately 1MB per second.
- *KDB50*—an intelligent disk controller that connects up to four Standard Disk Interconnect (SDI) drives to VAXBI systems. The KDB50 provides throughput rates as high as 1MB per second.
- *KLESI-B*—connects a host to a tape or disk device (such as Digital's TU81 streamer or RC25 Winchester disk) using the Low End Storage Interconnect (LESI).

The VAXBI provides a bandwidth of 13.3MB per second on the VAX 8200 and 8300. The VAX 8500 supports two VAXBI channels, which endow it with an I/O rate in excess of 16MB per second. The VAX 8800 permits configuration of four VAXBI channels and delivers a usable I/O bandwidth of more than 30MB per second.

All VAX systems except the 8500 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 memory interconnect through the Unibus adapter. The Unibus adapter handles priority arbitration among devices on the Unibus. Unibus adapters may be placed on the memory interconnect as follows: one on the VAX 8200 and 8300; up to seven on the VAX 8600 and 8650; and up to two on the VAX 8800.

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

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

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

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

➤ The HSC servers use the Standard Disk Interconnect and the Standard Tape Interconnect (STI) to attach disk drives ➤

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▷ exception is the VAX 8500, for which Unibus adapters were not available at announcement; however, Digital has stated that such devices would be available in the third quarter of 1986. Any failure on the company's part to deliver such devices for the 8500 would, of course, restrict the migration path for users of older, Unibus VAX systems.

The cross-system peripheral compatibility, combined with the VAXclustering concept, compensates somewhat for the lack of direct system upgradability, allowing the incremental development of more powerful multisystem configurations and homogenous networks.

It is also worth noting that Digital is licensing the VAXBI technology to interested third-party developers, ensuring the development of special-purpose hardware and software for data collection, instrument control, and other functions.

Digital's emphasis on communications is also a distinct advantage for the VAX 8000 systems. The company's IBM/SNA connectivity products and other networking software provide VAX users with gateways to IBM mainframes and strengthen the position of department-level VAX 8000 systems as intermediaries between mainframe and personal computers. Digital also provides a product that implements the LU6.2 protocol, seen by some analysts as the future linchpin in peer-to-peer communications with IBM systems and among all types of hardware.

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

Digital's new leasing scheme for VMS software on the 8200, 8300, 8500, and 8800 is a very good feature, for it gives VAX users an alternative to outright purchase. Leasing permits the distribution of costs at regular intervals over a period of time; in addition, the 90-day cancellation provision allows users to try software before committing to it. To make policy consistent for all members of the line, however, Digital should extend the lease-or-purchase option to the 8600 and 8650, at least until such time as comparable or replacement VAXBI systems are introduced.

On the hardware service side, the one-year warranty on 8200, 8300, 8500, and 8800 CPU components is also valuable, deferring the time users must begin paying maintenance fees; the previous warranty period for VAX systems—still in effect for the 8600 and 8650—is 90 days. In addition, Digital's guaranteed two-hour service response for the 8600, 8650, and 8800 is commendable, signaling the company's commitment to providing maximum uptime for its large-system users.

▶ and tape formatters. The SDI and STI buses both support burst transfer rates up to 3.1MB per second.

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

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

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

### CONFIGURATION RULES

*System Building Blocks (SBBs)* are available for the VAX 8200, 8300, 8500, 8600, and 8650. SBBs begin with a core of components: CPU; main memory; cabinet; disk/tape controllers, and, in some cases, other controllers; and VAX/VMS or Ultrix-32 operating system license. (VMS SBBs are available for all the aforementioned systems; Ultrix SBBs are currently available only for the 8600 and 8650.) To the core of the SBB the user must add selections from the mass storage (system device and load device), communications interface, and console terminal menus; selections from the software and software services menus are optional. (See EQUIPMENT PRICES, at the end of this report, for further details on SBBs.)

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

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

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

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## USER REACTION

Datapro's 1986 Computer Users Survey received responses for five VAX 8600s; the 8600 was the only VAX 8000 system generally available at the time the survey was conducted. Four of the systems had been purchased from Digital Equipment, while one was rented or leased from the manufacturer.

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

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

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

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

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

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

To supplement the ratings, we contacted two users by telephone in June 1986 for amplifying comments.

The first user we contacted was affiliated with a manufacturer of communications equipment in the Southeast. He

► The VAX 8200 is also available in several preconfigured systems.

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

The VAX 8200 and 8300 SBBs both include a KDB50 disk controller, Unibus adapter, and Ethernet interface. The CPU cabinet contains 12 VAXBI slots; six are available for additional options, along with 25 panel units. One Unibus cabinet is integral to the system; a second can be added. Up to three Unibus interfaces can be supported on the system. Main memory can be expanded in 2MB increments to 16MB on the 8200 and to 14MB on the 8300.

The 8200 and 8300 also support up to two DMF32 8-line communications controllers, two DMZ32 24-line communications controllers, four DHU11 16-line communications controllers, and two DMR11 synchronous interfaces. They also support 8-line Ethernet terminal servers.

The VAX 8500 SBB includes the maximum 20MB of main memory, one VAXBI channel, a KDB50 disk controller, and an Ethernet interface. A second VAXBI channel can be configured. Two more KDB50s can also be added; they must be placed on the second VAXBI channel. The system can support two DMB32 communications controllers, as well as 8- and 32-line Ethernet terminal servers.

The VAX 8600 and 8650 SBBs comprise a CPU cabinet and a CPU front end cabinet. The CPU cabinet contains the processor, the memory controller, 16MB of memory, one DW780 Unibus adapter, one DB86 SBI adapter, and an RB86 integrated disk and tape controller. The CPU cabinet contains dedicated space for a CI780 Computer Interconnect, an FP86 floating-point accelerator, a second Unibus adapter, and a second SBI adapter. Up to eight adapters can be connected to the second SBI. The front end cabinet includes the console disk and a Unibus expansion box.

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

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

The VAX 8800 includes a VAXcluster port and an Ethernet communications interface. Two VAXBI channels and one Unibus channel are standard on the system; two more VAXBI channels and an additional Unibus channel can be configured. Two slots in the first VAXBI channel are used for the Computer Interconnect port; one slot in the second VAXBI channel is used for the DWBUA Unibus interface. One DWBUA is allowed on any given VAXBI channel. The 8800 can also support two DMF32 communications controllers, one DR11 Unibus interface, and one DMR11 synchronous interface.

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

## DEC VAX 8000 Systems

▷ said that the 8600 was chosen primarily because the organization was already a Digital shop and was looking to upgrade its equipment; those making the buying decision felt that the ALL-IN-1 and electronic mail applications they wanted to run would perform best on Digital's newest and most powerful machine.

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

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

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

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

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

The second user said he was "very satisfied" with the 8600, characterizing it as "a great system." He said that he is impressed with the power of the system, especially compared to that of the 11/780. He also praised the 8600s for their reliability. He said that during a recent power outage, the 11/780s in the cluster went down. While the 8600s lost their system disks for six minutes, the computers stayed up; processes were suspended for the duration of the outage, but resumed when the power came back on.

When asked about the growth path that Digital provides him, the user expressed mixed feelings. He said that the introduction of the newer, VAXBI-based 8000 systems ▷

▶ range of different applications. Refer to Chart A for the range for each system.

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

**DISK STORAGE:** The VAX 8200 allows two KDB50 controllers per system; each supports up to four RA60 (205MB fixed/removable) and RA81 (456MB Winchester) drives in any combination. The 8300 permits configuration of one KDB50. One KDB50 is integral to the VAX 8500; two more can be added on the second VAXBI channel.

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

The VAX 8800 supports two KDB50 disk drives per VAXBI channel, and a total of four per system. Each KDB50 supports four RA60 and RA81 drives in any combination.

The intelligent HSC70 and HSC50 storage controllers can be attached to the VAX 8000 systems through the Computer Interconnect. The HSC70 supports eight HSC5X-BA disk and HSC5X-CA tape interfaces (32 devices) in any combination; the HSC50 supports six (24 devices). Each HSC5X-BA disk interface supports up to four RA60 and RA81 drives in any combination.

**MAGNETIC TAPE:** The VAX 8200 and 8300 each support two TU80/TU81 Unibus tape drives. The 8500 allows configuration of two TU81 VAXBI tape units.

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

Tape devices on the VAX 8800 must be connected through the HSC70 and HSC50.

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

**PRINTERS:** Up to 16 line printers can be supported on each VAX 8000 system. On the VAX 8200, 8300, 8500, and 8800, each printer must connect to an asynchronous line or to a DMF32 (on the 8200, 8300, or 8800) or DMB32 (on the 8500) controller. A maximum of two DMF32 or DMB32 printer ports can be used per system.

### MASS STORAGE

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

### INPUT/OUTPUT UNITS

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

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▷ “decreases flexibility,” because it renders his older systems somewhat incompatible. Despite the Unibus compatibility provided on the newer systems, he feels that the older systems do not fit totally into Digital’s current architectural scheme; thus, he may have to get rid of them.

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

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

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

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

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

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

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

### COMMUNICATIONS CONTROL

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

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

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

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

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

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

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

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

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

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

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

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

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

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

### SOFTWARE

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

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

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

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

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

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

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

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

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

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

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

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

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

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

- Distributed File System, which manages all files in the VAXcluster as a single entity.
- Distributed Lock Manager, which synchronizes resource use across the VAXcluster.
- Terminal Server support, allowing terminals to be connected flexibly to VAXcluster systems and providing load balancing and availability features.
- Cluster Operator support, enabling a single person to manage an entire VAXcluster.
- Mass Storage Control Protocol server, which allows disks connected locally to a system to be accessed from anywhere in the cluster.
- Cluster-wide balancing, through the Job Controller, of the number of jobs per system.

*Ultrix-32* is Digital's native-mode implementation of the Unix operating system. It is based on the University of California at Berkeley's Fourth Berkeley Software Distribution (4BSD), and is compatible with AT&T's Unix System V, Release 2.0. Ultrix-32 can be used on the VAX 8200, 8600, and 8650. Depending upon the application, Ultrix-32 can support over 64 users (on the 8600-series systems).

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.

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► 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, and System V interprocess communications mechanisms.

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

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

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

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

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

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

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

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

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

**VAX DBMS** is a multiuser, general-purpose, Codasyl-compliant data base management system based on the March 1981 Working Document of the ANSI Data Definition

Committee. VAX DBMS is used to administer data bases ranging from simple hierarchies to complex, multisystem networks with multilevel relationships. The VAX Information Architecture allows DBMS data to be accessed directly from programming languages through VAX Datatrieve or DBMS utilities. VAX DBMS can operate in a VAXcluster environment and can access remote data bases through DECnet networking software.

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

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

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

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

Fortran and Lisp are available for the Ultrix-32 operating system.

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

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

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

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

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

Some of the DNA protocols and their functions are:

- Network Information and Control Exchange protocol (NICE), which defines mechanisms for exchanging network, node, and configuration data and for servicing requests from modules residing in the Network Management Layer.
- The Data Access Protocol (DAP), which defines mechanisms for performing remote file access and remote file transfer on behalf of software modules residing in the Network Management Layer.
- The Network Services Protocol (NSP), which defines a mechanism for creating and maintaining logical links between modules of higher level that reside in the same or different nodes.
- The transport protocol (Transport), which defines a mechanism for dispatching data to any node in the network via the best possible route.
- The Maintenance Operation Protocol (MOP), which defines mechanisms for transmitting data over a communications channel for downline loading of a remote node, upline dumping from a remote node, testing a node and network connections, and starting up an unattended remote node.
- The Digital Data Communications Message Protocol (DDCMP), which defines a mechanism for ensuring the integrity and sequentiality of data transmitted over a communications channel.

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

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

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

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

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

For terminal-to-terminal communication, a DECnet/VAX utility enables a user to send messages to any VAX system.

Messages can be directed to any specific terminal or to the operator's console at the destination node.

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

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

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

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

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

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

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

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

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

The *VAX 2780/3780 Protocol Emulator* allows data files to be transferred between VAX systems and other host com-

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puter systems capable of using 2780 or 3780 communications protocol. VAX 2780/3780 emulates binary synchronous communications (BSC) protocol, appearing to be an actual IBM 2780 or 3780 remote batch terminal on a point-to-point line. The product can run concurrently on up to four lines, each with a different set of attributes at speeds up to 9600 bps per line.

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

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

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

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

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

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

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

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

*Message Router X.400 Gateway* is a layered VMS application that provides a communications path between a message router-based network and any other message transport

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

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

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

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

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

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

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

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

*WPS-Plus/VMS*, an ALL-IN-1 application, provides users with DECmate-style "gold key" full-function word processing. It includes scientific/technical character sets accessible

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► from a word processing keyboard and a standard two-dimensional text editor that allows building and editing of equations, diagrams, matrices, and charts. It also incorporates the DECspell spelling checker with advanced linguistics.

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

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

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

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

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

### PRICING

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

Digital software is licensed rather than sold. Users purchase licenses and distribution rights separately. A license can be purchased outright for all systems. A licensing option available for the 8200, 8300, 8500, and 8800 is the Periodic Payment License. Through this option the user pays an initial license fee, then makes monthly payments thereafter. The software is licensed with a 90-day cancellation option. The monthly licensing option applies to all Digital-engineered VMS-compatible software.

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

party Unix licenses can order the Ultrix-32 license as an add-on product.

**SUPPORT:** The VAX 8200, 8300, 8500, and 8800 each come with a one-year on-site warranty on CPU components.

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

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

- On-call remedial maintenance from 8 a.m. to 5 p.m., Monday through 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.

DECservice is available in the United States without distance restrictions.

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

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

An optional adjunct to Digital's on-site field service, Recover-all, provides full product repair or replacement for equipment damage caused by accidents or incidents normally not

## DEC VAX 8000 Systems

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

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

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

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

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

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

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

Another software support service is the Digital Software Information Network, which enables customers to access informational data bases for help with software problems. The network provides messages that alert users to critical software problems and their solutions, a symptom/solution data base to answer questions on software problems, and a means of submitting questions to Digital support personnel.

The network is available at no extra charge to customers in the United States with systems currently under warranty or covered by a DECsupport or Basic Support service contract.

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

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

TYPICAL CONFIGURATIONS: Sample configurations for the VAX 8200, 8500, and 8800 are provided in the following tables. Complete hardware and software prices follow these configurations.

## VAX 8200:

821BA-AE VAX/VMS System Building Block; includes CPU; 4MB main memory; hot floating-point; Ethernet interface; KDB50 disk controller; Unibus adapter, cabinet, box, and backplanes; 1-year hardware warranty; paid-up VAX/VMS and DECnet licenses	\$ 98,000
LA100-BA hardcopy console terminal	2,195
RA81-AA(AD) 456MB fixed disk drive	19,000
TU81-AA 75-ips streaming tape drive	25,500
DHU11-M 16-line communications controller	3,420
16 VT220-A2(A3) terminals/keyboards	17,520
LG01-AA 600-lpm matrix text printer	11,950
<b>TOTAL PURCHASE PRICE:</b>	<b>\$177,585</b>

## VAX 8500:

851BA-AE VAX/VMS System Building Block; includes CPU; 20MB main memory; hot floating-point; KDB50 disk controller; one VAXBI channel; Ethernet communications interface; console; one-year hardware warranty; paid-up VAX/VMS and DECnet licenses	\$299,000
RA81-EA(ED); three 456MB fixed disk drives in cabinet	50,000
TU81E-BA; TU81-Plus 75-ips streaming tape drive	27,500
Five DMB32 8-line communications controllers	16,750
40 VT220-A2(A3) terminals/keyboards	43,800
Two LG02-AA 600-lpm matrix text/graphics printers	28,000
<b>TOTAL PURCHASE PRICE:</b>	<b>\$465,050</b>

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▶ <b>VAX 8800:</b>		<b>RA81-JA(JD); four 456MB fixed disk drives in cabinet</b>	<b>68,000</b>
<b>882CA-AP VAXcluster System Building Block; includes dual CPU; 32MB main memory; battery backup; hot floating-point; two VAXBI channels; VAXcluster port and Computer Interconnect cables; Ethernet communications interface; Unibus adapter, box, and backplanes; console; 1-year hardware warranty; paid-up VAX/VMS and DECnet licenses</b>	<b>\$ 650,000</b>	<b>HSC5X-CA tape interface</b>	<b>9,500</b>
<b>SC008-AC Star coupler</b>	<b>8,250</b>	<b>TA81-AA(AB); two 75-ips streaming tape drives</b>	<b>59,000</b>
<b>HSC70-AA(AB) intelligent storage controller</b>	<b>51,600</b>	<b>Two DMF32-M 8-line communications controllers</b>	<b>5,630</b>
<b>HSC5X-BA(BB) disk interface</b>	<b>9,500</b>	<b>Two DECSA-DA 32-line Ethernet terminal servers with software licenses</b>	<b>42,050</b>
		<b>Two 4005-A Ethernet interfaces</b>	<b>600</b>
		<b>60 VT220-A2(A3) terminals/keyboards</b>	<b>65,700</b>
		<b>20 VT241-AA color terminals</b>	<b>59,600</b>
		<b>Two LG02-AA 600-lpm matrix text/graphics printers</b>	<b>28,000</b>
		<b>LN01B 12-ppm laser printer</b>	<b>13,995</b>
		<b>TOTAL PURCHASE PRICE:</b>	<b>\$1,071,425</b>

## EQUIPMENT PRICES

### VAX SYSTEM BUILDING BLOCKS (SBBs)

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

Purchase Price (\$)	Basic Service (Monthly) (\$)	DECserv. (Monthly) (\$)
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### VAX 8650 SBBs

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

### VAX 8600 SBBs

861XA-AE(AJ)	VAX 8600 CPU; 4MB ECC MOS memory; RB86-AA integrated disk and tape controller; VAX/VMS operating system license and warranty	350,000	785	935
861XA-BE(BJ)	Same as 861XA-AE (AJ), but with Ultrix-32 license and warranty for 1 to 32 users	350,000	785	935

### VAX 8500 SBBs

851BA-DE(DJ)	VAX 8500 CPU; 20MB of 256K-bit ECC MOS memory; integral hot floating-point; KDB50 disk controller; VAXBI channel; Ethernet communications interface; console; one-year hardware warranty; and one-year VAX/VMS and DECnet licenses	260,000	*	*
851BA-AE(AJ)	Same as 851BA-DE(DJ), but with paid-up VMS and DECnet licenses	299,000	*	*

### VAX 8300 SBBs

831BA-DE(DJ)	VAX 8300 CPU; 12MB of 256K-bit ECC MOS memory; integral hot floating-point; Ethernet communications interface; KDB50 disk controller; Unibus adapter, cabinet, box, and backplanes; one-year hardware warranty; and one-year VAX/VMS and DECnet licenses	122,000	603	718
831BA-AE(AJ)	Same as 831BA-DE(DJ), but with paid-up VMS and DECnet licenses	146,000	603	718

### VAX 8200 SBBs

821BA-DE(DJ)	VAX 8200 CPU; 4MB of 256K-bit ECC MOS memory; integral hot floating-point; Ethernet communications interface; KDB50 disk controller; Unibus adapter, cabinet, box, and backplanes; one-year hardware warranty; and one-year VAX/VMS and DECnet licenses	79,000	401	477
821BA-AE(AJ)	Same as 821BA-DE(DJ), but with paid-up VAX/VMS and DECnet licenses	98,000	401	477

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

## DEC VAX 8000 Systems



Purchase Price (\$)	Basic Service (Monthly) (\$)	DECserv. (Monthly) (\$)
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**VAXCLUSTER SBBs**

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

**VAX 8800 VAXcluster SBBs**

882CA-DP(DT)	VAX 8800 CPU; 32MB of 256K-bit ECC MOS memory; battery backup; integral hot floating-point; two VAXBI channels; VAXcluster port and set of Computer Interconnect cables; Ethernet communications interface; Unibus adapter, box, and backplanes; console; one-year hardware warranty; and one-year VAX/VMS and DECnet licenses	650,000	*	*
882CA-AP(AT)	Same as 882CA-DP(DT), but with paid-up VAX/VMS and DECnet licenses	699,000	*	*

**VAX 8650 VAXcluster SBB**

865CD-AP(AT)	VAX 8650 CPU; 32MB memory; Ethernet port; VAX/VMS license and warranty; and DECnet full-function license	445,000	*	*
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**VAX 8600 VAXcluster SBBs**

861CC-AE(AJ)	VAX 8600 CPU; 16MB ECC MOS memory; Computer Interconnect; Star Coupler; HSC50 intelligent I/O controller and interfaces for up to four RA disks and four TA tapes; cables; DEUNA Ethernet-to-Unibus controller; VAX/VMS license and warranty; and DECnet full-function license	456,000	1,271	1,513
861CC-AP(AT)	VAXcluster Upgrade SBB: VAX 8600 CPU; 16MB ECC MOS memory; Computer Interconnect; cables; DEUNA Ethernet-to-Unibus controller; VAX/VMS license; and DECnet full-function VAXcluster license	395,000	1,096	1,305

**VAX 8500 VAXcluster SBBs**

851CA-DP(DT)	VAX 8500 CPU; 20MB of 256K-bit ECC MOS memory; integral hot floating-point; VAXcluster port and Computer Interconnect cables; expansion cabinet for VAXcluster port; one VAXBI channel; Ethernet communications interface; console; one-year hardware warranty; and one-year VAX/VMS and DECnet licenses	286,000	*	*
851CA-AP(AT)	Same as 851CA-DP(DT), but with paid-up VAX/VMS and DECnet licenses	324,000	*	*

**VAX 8300 VAXcluster SBBs**

831CA-DP(DT)	VAX 8300 CPU; 12MB of 256K-bit ECC MOS memory; integral hot floating-point; VAXcluster port and set of Computer Interconnect cables; Ethernet communications interface; Unibus adapter, cabinet, box, and backplanes; one-year hardware warranty; and one-year VAX/VMS and DECnet licenses	132,000	718	855
831CA-AP(AT)	Same as 831CA-DP(DT), but with paid-up VAX/VMS and DECnet licenses	156,000	718	855

**VAX 8200 VAXcluster SBBs**

821CA-DP(DT)	VAX 8200 CPU; 8MB of 256K-bit ECC MOS memory; integral hot floating-point; VAXcluster port and Computer Interconnect cables; Ethernet communications interface; Unibus adapter, cabinet, box, and backplanes; one-year hardware warranty; and one-year VAX/VMS and DECnet licenses	104,000	572	681
821CA-AP(AT)	Same as 821CA-DP(DT), but with paid-up VAX/VMS and DECnet licenses	123,000	572	681

**VAX 8500 PRECONFIGURED SYSTEMS**

SV-85EEA-EL	VAX 8500 preconfigured system: CPU, 20MB main memory, disk controller, RA81 456MB disk drive, TU81-Plus 1600-/6250-bpi tape drive, Ethernet port, DMB32 communications controller, console, VAXBI I/O channel, one-year hardware warranty, and VAX/VMS DECnet monthly software licenses	\$299,000	*	*
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\*Contact vendor.

NA—Not applicable.

NC—No charge.



## DEC VAX 8000 Systems



		Purchase Price (\$)	Basic Service (Monthly) (\$)	DECserv. (Monthly) (\$)
<b>VAX 8200 PRECONFIGURED SYSTEMS</b>				
SV-82EPA-GK(GN)	VAX 8200 CPU; 8MB of 256K-bit ECC MOS memory; integral hot floating-point; disk controller; communications controller; Ethernet communications interface; Unibus adapter, cabinet, box, and backplanes; LA100 console terminal with stand; one RA60 and two RA81 disk drives; 90-day warranty on disk drives and one-year warranty on other hardware; one-year VAX/VMS and DECnet licenses	154,000	837	996
SV-82EPC-GK(GN)	Same as SV-82EPA-GK(GN), but with paid-up VAX/VMS and DECnet licenses	173,000	837	996
SV-82EDA-GK(GN)	VAX 8200 CPU; 8MB of 256K-bit ECC MOS memory; integral hot floating-point; disk controller; communications controller; Ethernet communications interface; Unibus adapter, cabinet, box, and backplanes; LA100 console terminal with stand; RA81 disk drive and TU80 tape drive; 90-day warranty on disk and tape drives and one-year warranty on other hardware; one-year VAX/VMS and DECnet licenses	127,000	726	864
SV-82EDC-GK(GN)	Same as SV-82EDA-GK(GN), but with paid-up VAX/VMS and DECnet licenses	146,000	726	864
SV-82EEA-GK(GN)	VAX 8200 CPU; 8MB of 256K-bit ECC MOS memory; integral hot floating-point; disk controller; communications controller; Ethernet communications interface; Unibus adapter, cabinet, box, and backplanes; LA100 console terminal with stand; RA81 disk drive and TU81 tape drive; 90-day warranty on disk and tape drives and one-year warranty on other hardware; one-year VAX/VMS and DECnet licenses	139,000	777	925
SV-82EEC-GK(GN)	Same as SV-82EEA-GK(GN), but with paid-up VAX/VMS and DECnet licenses	158,000	777	925
<b>UPGRADE KITS</b>				
861UP-AA	VAX 8600-to-8650 upgrade kit	95,000	NA	NA
<b>CPU OPTIONS</b>				
<b>VAX 8600/8650 Options</b>				
FP86-AA	Floating-Point Accelerator	28,000	65	77
DR780-FA(FB)	General-purpose intelligent interface	18,700	92	110
DW780-AA(AB)	Unibus adapter	12,900	41	49
DW780-MB	Second Unibus adapter	12,900	39	46
DB86-AA	Second SBI adapter	10,000	30	36
<b>VAX 8200/8300 Options</b>				
H7231-L	Battery backup	1,800	16	19
<b>MEMORY EXPANSION OPTIONS</b>				
<b>VAX 8600/8650 Options</b>				
MS86-AA	4MB ECC MOS (256K-chip) memory module	28,800	84	100
MS86-CA	16MB ECC MOS (256K-chip) memory module	64,000	336	400
<b>VAX 8200/8300 Options</b>				
MS820-AA	2MB ECC MOS (256K-chip) memory module with controller	6,900	28	33
<b>VAXcluster OPTIONS</b>				
CI780-MA	Computer Interconnect adapter for VAX 8600 and 8650	21,450	150	179
SC008-AC	Star Coupler; 8-node with cabinet; for all VAX 8000 systems	8,250	23	27
SC008-AD	Upgrade to Star Coupler; for 9 to 16 nodes	6,050	23	27
BNCIA-10	CI cable set; 32 ft. (10 m.)	600	NC	NC
BNCIA-20	CI cable set; 65 ft. (20 m.)	830	NC	NC
BNCIA-45	CI cable set; 145 ft. (45 m.)	1,460	NC	NC
<b>MASS STORAGE</b>				
HSC50-AA(AB)	HSC50 intelligent I/O server with space for six HSC5X; cables not included	34,500	100	119
HSC5X-BA(BB)	Data channel interface for interfacing up to four disk drives	9,500	45	54
HSC5X-EA(EB)	Second power supply for over three HSC5X on the HSC50	3,000	26	31
HSC70-AA(AB)	HSC70 Computer-Interconnect-based intelligent controller; includes space for eight HSC5X-BA; cables not included	51,600	200	238

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



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MASS STORAGE (Continued)		Purchase Price (\$)	Basic Service (Monthly) (\$)	DECserv. (Monthly) (\$)
RB86-AA	RB86 integrated disk and tape controller; for VAX 8600/8650	18,400	110	131
KDB50-A	KDB50 VAXBI controller with 8-ft. cable	8,000	60	71
KDB50-B	KDB50 VAXBI controller with 15-ft. cable	8,000	60	71
UDA50-A	Unibus controller; allows attachment of up to four disk drives	5,500	53	63
RA60-AA(AD)	205MB rack-mounted RA60 drive (no cabinet); requires controller and mounting cabinet	17,500	105	125
RA60-CA(CD)	205MB cabinet-mounted RA60-AA add-on drive	20,000	105	125
RA60-EA(ED)	Three 205MB RA60 drives in cabinet	49,000	315	375
RA60-JA(JD)	Four 205MB RA60 drives in cabinet	66,000	420	500
RA60-UA	RA60 reconfiguration kit; for remounting RA60s originally configured in an H9642 cabinet in an H9646 cabinet	400	NA	NA
RA80-AA(AD)	121MB rack-mounted RA80 drive; requires controller and mounting cabinet	14,000	85	101
RA80-CA(CD)	121MB cabinet-mounted RA80 drive; requires controller	16,500	85	101
RUA80-UA(UD)	UDA50 controller for dual-porting RA80, RA81, and RA60 disks; includes cable	5,500	32	38
RA81-AA(AD)	456MB RA81 rack-mounted drive; requires controller and mounting cabinet	19,000	95	113
RA81-CA(CD)	456MB cabinet-mounted RA81 drive; requires controller	21,500	95	113
RA81-EA(ED)	Three 456MB RA81 drives mounted in a cabinet; requires controller	50,000	284	338
RA81-FA(AD)	456MB RA81 cabinet-mounted drive; requires controller	23,000	95	113
RA81-HA(HD)	456MB RA81 rack-mounted drive; requires controller, cabinet, and cable	18,640	95	113
RA81-JA(JD)	Four cabinet-mounted 456MB RA81 disk drives; requires controller	68,000	380	452
RA81-UA	RA81 reconfiguration kit; required for remounting RA81s originally configured in an H9642 cabinet; not required for RA81-AA	400	NA	NA
RL211-AK	10.4MB RLO2 top-loading, rack-mounting, removable cartridge drive and controller with interconnect cabling	7,900	75	89
RL02-AK	10.4MB RLO2 add-on cartridge drive; requires RL211-AK	4,200	72	86
RL02K-DC	10.4MB cartridge for the RLO2	230	NA	NA
RUC25-AA(AB)	Tabletop 26MB/26MB RC25 fixed/removable disk drive with Unibus adapter	6,250	39	46
RUC25-BA(BB)	Rack-mounted 26MB/26MB RC25 fixed/removable disk drive with Unibus adapter	6,250	39	46
RC25-DA(DB)	Tabletop add-on RC25 disk drive	5,500	33	39
RC25-EA(EB)	Rack-mounted add-on RC25 disk drive	5,500	33	39
RC25K-DC	Removable 26MB RC25 cartridge	299	NA	NA

## MAGNETIC TAPE EQUIPMENT

HSC70-AA(AB)	HSC70 Computer-Interconnect-based intelligent controller; includes space for eight HSC5X-CA; cables not included	51,600	200	238
HSC5X-CA	Tape interface for HSC50 I/O controller	9,500	45	54
TA78-BF(BJ)	TA78 PE/GCR tape subsystem; requires HSC50 with HSC5X-CA	52,000	357	425
TA81-AA(AB)	TA81 magnetic tape subsystem	29,500	150	179
TU81-AA(AB)	TU81 9-track streaming tape subsystem	25,500	140	167
TU81E-BA(BB)	TU81-Plus 1600-/6250-bpi, 75-ips streaming tape drive	27,500	*	*
TU80-AA(AB)	TU80 9-track magnetic tape subsystem in cabinet	12,500	89	106
TU78-AB(AD)	TU78 magnetic tape transport and formatter; requires TM78-C for dual-porting capability	48,000	322	383
TU78-AF(AJ)	TU78 magnetic tape transport without formatter; requires TU78 master	25,500	196	233
TM78-C	TU78 dual-port kit containing drive logic and cables to provide dual-porting capability	5,150	21	25
TU77-AF(AJ)	TU77 magnetic tape transport	23,800	222	264
TSU05-AA(AB)	Unibus TS05 magnetic tape subsystem with hardware for rack-mounting, control module, and cables; also available in 100 VAC (-AC) and 220 VAC (-AD) models	13,500	89	106
TK50-DA/-DB	TK50 desktop cartridge tape drive (120/240 VAC); includes 9-ft. cable	3,095	22	26
TK50-RA/-RB	TK50 rack-mounted cartridge tape drive (120/240 VAC); includes 9-ft. cable	3,095	22	26
TK50-K	CompactTape cartridge for TK50	29	NA	NA
TUK50-AB	Unibus controller for TK50-DX/RX drives; includes cabinet and bulkhead plate	1,895	8	10

## EXPANSION OPTIONS

DB88-AE	Third VAXBI channel for VAX 8800; requires BA32-BA/BB VAXBI expansion box and space in H9652-EC/ED expansion cabinet	14,500	—	—
DWBUA-CA	VAX 8800 Unibus adapter; requires BA11-AW/AX expansion box and space in H9652-EC/ED expansion cabinet	6,000	40	48
DB88-AD	Fourth VAXBI channel for VAX 8800 or second VAXBI channel for VAX 8500; same requirements as DB88-AE	14,500	—	—
H9652-EC(ED)	VAX 8800/8500 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 8500; includes 37 panel units	5,000	NC	NC

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

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		Purchase Price (\$)	Basic Service (Monthly) (\$)	DECserv. (Monthly) (\$)
<b>EXPANSION OPTIONS (Continued)</b>				
BA32-BA(BB)	VAX 8800/8500 rack-mountable VAXBI expansion box with slides for H9652-EC(ED) expansion cabinet; provides five VAXBI mounting slots (with a sixth slot used for VAXBI system interface)	6,000	*	*
H9652-FA(FB)	VAX 8600/8650 expansion cabinet; includes one BA11-A box and 40 panel units; can be expanded with a second BA11-A; requires DD11-DK/CK backplanes	7,200	NC	NC
H9652-FC(FD)	VAX 8600/8650 Unibus expansion cabinet; includes two BA11-A boxes and 40 panel units; requires DD11-DK/CK backplanes	10,700	NC	NC
H9652-FE (FF)	VAX 8600/8650 Unibus expansion cabinet; customer-configurable	3,700	NC	NC
H9652-CA(CB)	VAX 8600/8650 SBI expansion cabinet; provides four option panel spaces	5,000	NC	NC
H9642-FC(FD)	VAX 8200 and 8300 Unibus expansion cabinet; fully shielded; contains controller, I/O connector panel, and space for BA11-A expander box	2,050	NC	NC
BA11-AL(AM)	Rack-mountable expansion box with slides for VAX 8600/8650 Unibus expansion cabinets; provides mounting space for six system units and is compatible with DD11-DK/CK expansion backplanes	3,500	25	30
BA11-AW(AX)	Rack-mountable expansion box with slides for VAX 8800, 8300, and 8200 Unibus expansion cabinets; provides mounting space for six system units and is compatible with DD11-DK(CK) expansion backplanes	3,500	25	30
DB11-MP	Unibus repeater; adds 19 unit bus loads and up to 50 ft. (15.2 m.) of additional Unibus length to the system	2,240	8	10
H9646-CA	60-inch standalone communications cabinet	1,630	NA	NA
H9646-DA	Same as H9646-CA, but without end panels	1,256	NA	NA
H9544-MK	Shelf assembly for H9646 cabinet	54	NA	NA
H9544-JD	60-inch to 40-inch joiner panel to mount H9642	235	NA	NA
DD11-CK	Expansion backplane mounting for BA11 box; provides for two hex- and two quad-slot modules; mounts in one system unit	470	NC	NC
DD11-DK	Same as DD11-CK except for providing seven hex- and two quad-slot modules; mounts in two system units	940	NC	NC

### UNIBUS ASYNCHRONOUS OPTIONS

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

### UNIBUS SYNCHRONOUS OPTIONS

DMR11-M	Single-line interface for EIA/CCITT devices; base module only; requires appropriate external cable and cabinet kit	4,975	41	49
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### ETHERNET COMMUNICATIONS

DEUNA-M	Ethernet-to-Unibus synchronous communications controller	3,775	44	52
H4000	Ethernet transceiver	325	4	5
DELUA-M	Ethernet/IEEE 802.3 Unibus single-line interface communications controller	3,275	33	39
H4005	Ethernet/IEEE 802.3; version A has heartbeat, version B has not	300	*	*
DELNI-AA	Local Network Interconnect; supports up to eight Ethernet-compatible, nonterminal devices	1,275	10	12
DECSA-DA	32-line terminal server with 16 DCSAX-LC line cards	20,000	354	421
DECSK-AA	U.S. country kit for DECSA-DA; includes power cord, hardware manuals, and labels with front panel display; required	25	NC	NC
DCSAX-LC	Two-line asynchronous EIA RS-232-C/CCITT V.28 line card	375	7	8
DSRVA-AA	Eight-line DECserver 100, 120 V; includes U.S. country kit	2,950	30	36

### REALTIME OPTIONS

DR11-W	General-purpose Unibus DMA digital interface; requires appropriate cables and cabinet kit	1,350	14	17
DR11-WC	Longline, general-purpose interface; includes differential adapter module, interconnect cables, test connectors, and FCC-compliant user I/O panel	3,295	42	50
DR11-WD	Long-line upgrade kit for DR11-W; includes all items in DR11-WC except DR11-W interface module	1,795	24	29

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

## DEC VAX 8000 Systems



REALTIME OPTIONS (Continued)		Purchase Price (\$)	Basic Service (Monthly) (\$)	DECserv. (Monthly) (\$)
<b>BAND PRINTERS</b>				
LP11-AA	132-column, 64-character LP25 Unibus band printer; 300 lpm	8,350	105	125
LP11-BA	132-column, 64- and 96-character LP25 Unibus band printer; 300/215 lpm	8,950	105	125
LP32-AA	132-column, 64-character LP25 printer and universal power supply, 300 lpm; prerequisite, DMF32 Unibus controller	8,350	98	117
LP32-BA	Same as LP32-AA, but can also operate at 215 lpm with a 96-character set	8,950	98	117
LSP25-CA	Longline LP25 Unibus printer, 300/215 lpm; includes U.S./U.K. bands, universal power supply, and 50-ft. cable	9,990	119	142
LP11-EA	LP26 Unibus band printer, 600 lpm	13,600	150	179
LP11-EB	LP26 Unibus band printer, 600/445 lpm; includes both 64- and 96-character sets	14,400	150	179
LP32-EA	LP26 Unibus band printer, 600 lpm; includes 30-ft. cable; requires DMF32 controller	13,600	143	170
LP32-EB	LP26 Unibus band printer, 600/445 lpm; includes both 64- and 96-character sets and 30-ft. cable; requires DMF32 controller	14,400	143	170
LSP26-CA	Longline LP26 Unibus band printer, 300/215 lpm; includes U.S./U.K. bands, universal power supply, and 50-ft. cable	15,600	172	205
LP27-UA(UB)	LP27 Unibus band printer, 1200/800 lpm	29,990	259	308
LP27-DA(DB)	Longline LP27 Unibus band printer, 1200/800 lpm	32,990	310	369
LP27-VA(VB)	LP27 Unibus band printer with 30-ft. data cable and controller; requires DMF32	28,990	252	300
<b>MATRIX LINE PRINTERS</b>				
LG01-AA	600-lpm matrix text printer with 64-character data processing mode; Unibus device	11,950	128	152
LG01-CA	Same type as LG01-AA, but requires DMF32 controller	11,950	118	140
LG02-AA	600-lpm matrix text and graphics printer with 64-character data processing mode; Unibus device	14,000	128	152
LG02-CA	Same type as LG02-AA, but requires DMF32 controller; includes 30-ft. cable	14,000	118	140
LG02-DA	Same type as LG02-AA, but requires DMF32 controller and RS-232-C serial interface; includes 25-ft. cable	14,000	118	140
LG01-UG	Upgrade kit to convert LG01 to LG02	3,500	NA	NA
<b>LASER PRINTERS</b>				
LN01S-CA	12-ppm laser printer with LP11 interface and 30-ft. cable	19,995	353	420
LN01S-DA	Same as LN01S-CA, but with DMF32-compatible interface	19,995	353	420
LN01B-CA(CB)	12-ppm laser printer; includes PLOTLN VMS software, EPROMs, LP11 interface, and 30-ft. cable	13,995	310	369
LN01B-DA(DB)	Same as LN01B-CA(CB), but with DMF32 interface	13,995	310	369
LN01K-AA	Parallel longline kit for operation up to 1,000 ft. from CPU; cables not included	1,995	20	24
LN01K-LS	Serial RS-232-C kit	495	5	6
LN03-AA	8-ppm desktop laser printer; includes two toner cartridges, organic photo receptor (OCP) cartridge, AC power cord, toner collection bottle, 250 sheets of letter-size paper, and documentation	3,495	49	58
<b>PRINTERS/PLOTTERS</b>				
LXY12-CA(CB)	Freestanding line printer/plotter, 170/240/300 lpm; with LP11 controller for Unibus interface, 30-ft. cable, pedestal with basket, and paper guide	11,250	104	124
LXY12-DA(DB)	Same type as LXY12-CA(CB), but with RS-232-C interface cable, pedestal with basket, and paper guide	11,250	104	124
LXY12-EA(EB)	Same type as LXY12-CA(CB), but with DMF32 interface cable, pedestal with basket, and paper guide	11,250	104	124
LXY22-CA(CB)	Freestanding line printer/plotter, 320/465/600 lpm; with LP11 controller for Unibus interface, 30-ft. cable, pedestal with basket, and paper guide	15,800	135	161
LXY22-DA(DB)	Same type as LXY22-CA(CB), but with RS-232-C interface cable, pedestal with basket, and paper guide	15,800	135	161
LXY22-EA(EB)	Same type as LXY22-CA(CB), but with DMF32 interface cable, pedestal with basket, and paper guide	15,800	135	161
<b>COLOR GRAPHICS PEN PLOTTER</b>				
LVP16-AA	Six-color graphics pen plotter, 15 ips; includes RS-232-C interface, documentation, and initial supplies; requires interface cable	1,995	10	12

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



## DEC VAX 8000 Systems

		Purchase Price (\$)	Basic Service (Monthly) (\$)	DECserv. (Monthly) (\$)
<b>COLOR PRINTER</b>				
LCP01-AA	Inkjet color printer with graphics processor	14,595	125	149
<b>RECEIVE-ONLY PRINTING TERMINAL</b>				
LA120-RA	DECprinter III, 180 cps; for use with 1- to 6-part forms	2,420	39	46
<b>CONSOLE TERMINALS</b>				
LA100-BA	KSR 30/80/240 cps hardcopy terminal with keyboard, numeric keypad, tractors, cable, ribbon cartridge, package of paper, and Courier-10/Orator-10 fonts in U.S./U.K. character sets only	2,195	27	32
LA120-DA	Freestanding DECwriter III KSR hardcopy terminal; 180 cps bidirectional	2,800	34	40
<b>TERMINALS</b>				
VT220-A2(A3)	VT220 terminal with white phosphor, nonglare screen	880	12	14
VT220-B2(B3)	VT220 terminal with green phosphor, nonglare screen	880	12	14
VT220-C2(C3)	VT220 terminal with amber phosphor, nonglare screen	880	12	14
VT22K-AA	Data entry keyboard for VT220	215	NC	NC
VT22K-BA	Word processing keyboard for VT220	215	NC	NC
VT22X-AA	Integral 300-/1200-baud auto-answer modem for VT220 series	395	6	7
VT240-A2(A3)	VT240 text/graphics terminal; includes monochrome monitor, system box with logic and power supply, and keyboard; white phosphor, nonglare screen	1,980	19	23
VT240-B2(B3)	VT240 terminal with green phosphor, nonglare screen	1,980	19	23
VT240-C2(C3)	VT240 terminal with amber phosphor, nonglare screen	1,980	19	23
VT241-AA	VT241 color text/graphics terminal; includes monitor, system box with logic and power supply, and keyboard	2,980	26	31
VT24K-AA	Data entry keyboard for VT240/VT241 terminals	215	NC	NC
VT24K-BA	Word processing keyboard for VT240/VT241 terminals	215	NC	NC
VT24X-AA	300-/1200-baud autodial integral modem for VT240 series	495	6	7
<b>VOICE SYNTHESIS MODULE</b>				
DTC01-AA	Single-line DECTalk text-to-speech unit; includes cable	4,000	22	26
DTC03-AA	8-channel DECTalk text-to-speech unit; cables not included	24,000	500	595
*Contact vendor. NA—Not applicable. NC—No charge.				

## SOFTWARE PRICES

### VAX/VMS SOFTWARE

VMS system and layered software licenses for the VAX 8600 and 8650 are available for purchase only. Licenses for VAX 8200, 8300, 8500, and 8800 software are available either for purchase or for monthly rental. Contact Digital Equipment for monthly rental prices.

**License  
Fee\*  
(\$)**

#### Communications

Q5D05-UZ	DECnet-VAX for VAX 8200	6,591
Q7D05-UZ	DECnet-VAX for VAX 8300	6,591
Q9D05-UZ	DECnet-VAX for VAX 8500	8,850
QKD05-UZ	DECnet-VAX for VAX 8600/8650	8,850
QMD05-UZ	DECnet-VAX for VAX 8800	13,275
Q5545-UZ	DECnet/SNA Gateway for VAX 8200	3,120
Q7545-UZ	DECnet/SNA Gateway for VAX 8300	3,120
Q9545-UZ	DECnet/SNA Gateway for VAX 8500	4,000
QK545-UZ	DECnet/SNA Gateway for VAX 8600/8650	4,000
QM545-UZ	DECnet/SNA Gateway for VAX 8800	6,000
Q5727-UZ	DECnet Router/X.25 Gateway for VAX 8200	4,150
Q7727-UZ	DECnet Router/X.25 Gateway for VAX 8300	4,150
QK725-UZ	DECnet Router Server for VAX 8600/8650	5,320
Q5044-UZ	DECnet/SNA VMS Printer Emulator for VAX 8200	1,560
Q7044-UZ	DECnet/SNA VMS Printer Emulator for VAX 8300	1,560
Q9044-UZ	DECnet/SNA VMS Printer Emulator for VAX 8500	2,000
QK044-UZ	DECnet/SNA VMS Printer Emulator for VAX 8600/8650	2,000

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

DEC VAX 8000 Systems

Communications (Continued)		License Fee* (\$)
QM044-UZ	DECnet/SNA VMS Printer Emulator for VAX 8800	3,000
Q5070-UZ	Mux200/VAX for VAX 8200	9,048
Q7070-UZ	Mux200/VAX for VAX 8300	9,048
Q5708-UZ	DECdx/VMS for VAX 8200	3,666
Q7708-UZ	DECdx/VMS for VAX 8300	3,666
Q9708-UZ	DECdx/VMS for VAX 8500	4,700
QK708-UZ	DECdx/VMS for VAX 8600/8650	4,700
QM708-UZ	DECdx/VMS for VAX 8800	7,050
QK071-UZ	VAX Packetnet System Interface (PSI) and PSI Access for VAX 8600/8650	3,000
Q5111-UZ	VAX 2780/3780 Protocol Emulator for VAX 8200	8,268
Q7111-UZ	VAX 2780/3780 Protocol Emulator for VAX 8300	8,268
QK111-UZ	VAX 2780/3780 Protocol Emulator for VAX 8600/8650	9,800
QM111-UZ	VAX 2780/3780 Protocol Emulator for VAX 8800	14,700
Q5112-UZ	VAX 3271 Protocol Emulator for VAX 8200	9,984
Q7112-UZ	VAX 3271 Protocol Emulator for VAX 8300	9,984
QK112-UZ	VAX 3271 Protocol Emulator for VAX 8600/8650	11,600
QM112-UZ	VAX 3271 Protocol Emulator for VAX 8800	17,400
Q5730-UZ	VMS Message Router for VAX 8200	3,432
Q7730-UZ	VMS Message Router for VAX 8300	3,432
Q9730-UZ	VMS Message Router for VAX 8500	4,400
QK730-UZ	VMS Message Router for VAX 8600/8650	4,400
QM730-UZ	VMS Message Router for VAX 8800	6,600
Q5416-UZ	VAX Bisynchronous Terminal Support (BTS) for VAX 8200	2,340
Q7416-UZ	VAX BTS for VAX 8300	2,340
Q9416-UZ	VAX BTS for VAX 8500	3,000
QK416-UZ	VAX BTS for VAX 8600/8650	2,250
QM416-UZ	VAX BTS for VAX 8800	3,375
Q5726-UZ	Ethernet Terminal Server for VAX 8200	1,000
Q7726-UZ	Ethernet Terminal Server for VAX 8300	1,000
Q9726-UZ	Ethernet Terminal Server for VAX 8500	1,000
QK726-UZ	Ethernet Terminal Server for VAX 8600/8650	2,000
QM726-UZ	Ethernet Terminal Server for VAX 8800	1,000
Q5925-UZ	DECserver 100 Terminal Server for VAX 8200	150
Q7925-UZ	DECserver 100 Terminal Server for VAX 8300	150
Q9925-UZ	DECserver 100 Terminal Server for VAX 8500	150
QK925-UZ	DECserver 100 Terminal Server for VAX 8600/8650	300
QM925-UZ	DECserver 100 Terminal Server for VAX 8800	150

Data Base Management/Data Management

Q5897-UZ	VAX Common Data Dictionary (CDD) for VAX 8200	2,059
Q7897-UZ	VAX CDD for VAX 8300	2,059
Q9897-UZ	VAX CDD for VAX 8500	2,640
QK897-UZ	VAX CDD for VAX 8600/8650	2,640
QM897-UZ	VAX CDD for VAX 8800	3,960
Q5898-UZ	VAX Datatrieve for VAX 8200	10,296
Q7898-UZ	VAX Datatrieve for VAX 8300	10,296
Q9898-UZ	VAX Datatrieve for VAX 8500	13,200
QK898-UZ	VAX Datatrieve for VAX 8600/8650	13,200
QM898-UZ	VAX Datatrieve for VAX 8800	19,800
Q5899-UZ	VAX DBMS for VAX 8200; requires VAX CDD	20,592
Q7899-UZ	VAX DBMS for VAX 8300; requires VAX CDD	20,592
Q9899-UZ	VAX DBMS for VAX 8500; requires VAX CDD	26,400
QK899-UZ	VAX DBMS for VAX 8600/8650; requires VAX CDD	26,400
QM899-UZ	VAX DBMS for VAX 8800; requires VAX CDD	39,600
Q5706-UZ	VAX Terminal Data Management System (TDMS) for VAX 8200	4,290
Q7706-UZ	VAX TDMS for VAX 8300	4,290
Q9706-UZ	VAX TDMS for VAX 8500	5,500
QK706-UZ	VAX TDMS for VAX 8600/8650	5,500
QM706-UZ	VAX TDMS for VAX 8800	8,250
Q5079-UZ	VAX Application Control and Management System (ACMS) for VAX 8200	15,444
Q7079-UZ	VAX ACMS for VAX 8300	15,444
Q9079-UZ	VAX ACMS for VAX 8500	19,800
QK079-UZ	VAX ACMS for VAX 8600/8650	19,800
QM079-UZ	VAX ACMS for VAX 8800	29,700
Q5354-UZ	VAX Rdb/VMS for VAX 8200	14,040
Q7354-UZ	VAX Rdb/VMS for VAX 8300	14,040
Q9354-UZ	VAX Rdb/VMS for VAX 8500	18,000
QK354-UZ	VAX Rdb/VMS for VAX 8600/8650	18,000
QM354-UZ	VAX Rdb/VMS for VAX 8800	27,000

Languages

Q5056-UZ	VAX Ada for VAX 8200	38,844
Q7056-UZ	VAX Ada for VAX 8300	38,844
Q9056-UZ	VAX Ada for VAX 8500	49,800
QK056-UZ	VAX Ada for VAX 8600/8650	49,800
QM056-UZ	VAX Ada for VAX 8800	56,025

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

## DEC VAX 8000 Systems

Languages (Continued)		License Fee* (\$)
Q5020-UZ	VAX APL for VAX 8200	12,433
Q7020-UZ	VAX APL for VAX 8300	12,433
Q9020-UZ	VAX APL for VAX 8500	15,940
QK020-UZ	VAX APL for VAX 8600/8650	15,940
QM020-UZ	VAX APL for VAX 8800	23,910
Q5095-UZ	VAX Basic for VAX 8200	8,268
Q7095-UZ	VAX Basic for VAX 8300	8,268
Q9095-UZ	VAX Basic for VAX 8500	10,600
QK095-UZ	VAX Basic for VAX 8600/8650	10,600
QM095-UZ	VAX Basic for VAX 8800	15,900
Q5014-UZ	VAX Bliss-16 for VAX 8200	8,580
Q7014-UZ	VAX Bliss-16 for VAX 8300	8,580
Q5106-UZ	VAX Bliss-32 for VAX 8200	9,009
Q7106-UZ	VAX Bliss-32 for VAX 8300	9,009
Q9106-UZ	VAX Bliss-32 for VAX 8500	11,550
QK106-UZ	VAX Bliss-32 for VAX 8600/8650	11,550
QM106-UZ	VAX Bliss-32 for VAX 8800	17,325
Q5015-UZ	VAX C for VAX 8200	7,371
Q7015-UZ	VAX C for VAX 8300	7,371
Q9015-UZ	VAX C for VAX 8500	9,450
QK015-UZ	VAX C for VAX 8600/8650	9,450
QM015-UZ	VAX C for VAX 8800	14,175
Q5099-UZ	VAX Cobol for VAX 8200	12,433
Q7099-UZ	VAX Cobol for VAX 8300	12,433
Q9099-UZ	VAX Cobol for VAX 8500	15,940
QK099-UZ	VAX Cobol for VAX 8600/8650	15,940
QM099-UZ	VAX Cobol for VAX 8800	23,910
Q5018-UZ	VAX Dibol for VAX 8200	6,474
Q7018-UZ	VAX Dibol for VAX 8300	6,474
Q9018-UZ	VAX Dibol for VAX 8500	8,300
QK018-UZ	VAX Dibol for VAX 8600/8650	8,300
QM018-UZ	VAX Dibol for VAX 8800	12,450
Q5130-UZ	VAX Digital Standard Mumps (DSM) for VAX 8200	14,040
Q7130-UZ	VAX DSM for VAX 8300	14,040
Q9130-UZ	VAX DSM for VAX 8500	18,000
QK130-UZ	VAX DSM for VAX 8600/8650	18,000
QM130-UZ	VAX DSM for VAX 8800	27,000
Q5100-UZ	VAX Fortran for VAX 8200	8,065
Q7100-UZ	VAX Fortran for VAX 8300	8,065
Q9100-UZ	VAX Fortran for VAX 8500	10,340
QK100-UZ	VAX Fortran for VAX 8600/8650	10,340
QM100-UZ	VAX Fortran for VAX 8800	15,510
Q9107-UZ	Fortran IV/VAX-to-RSX Cross Compiler for VAX 8500	1,400
QK107-UZ	Fortran IV/VAX-to-RSX Cross Compiler for VAX 8600/8650	1,400
QM107-UZ	Fortran IV/VAX-to-RSX Cross Compiler for VAX 8800	2,100
Q5917-UZ	VAX Lisp for VAX 8200	12,480
Q7917-UZ	VAX Lisp for VAX 8300	12,480
Q9917-UZ	VAX Lisp for VAX 8500	16,000
QK917-UZ	VAX Lisp for VAX 8600/8650	16,000
QM917-UZ	VAX Lisp for VAX 8800	24,000
Q5913-UZ	VAX OPS5 for VAX 8200	7,800
Q7913-UZ	VAX OPS5 for VAX 8300	7,800
Q9913-UZ	VAX OPS5 for VAX 8500	10,000
QK913-UZ	VAX OPS5 for VAX 8600/8650	10,000
QM913-UZ	VAX OPS5 for VAX 8800	15,000
Q5126-UZ	VAX Pascal for VAX 8200	7,371
Q7126-UZ	VAX Pascal for VAX 8300	7,371
Q9126-UZ	VAX Pascal for VAX 8500	9,450
QK126-UZ	VAX Pascal for VAX 8600/8650	9,450
QM126-UZ	VAX Pascal for VAX 8800	14,175
Q5114-UZ	VAX PL/1 for VAX 8200	12,433
Q7114-UZ	VAX PL/1 for VAX 8300	12,433
Q9114-UZ	VAX PL/1 for VAX 8500	15,940
QK114-UZ	VAX PL/1 for VAX 8600/8650	15,940
QM114-UZ	VAX PL/1 for VAX 8800	23,910
Q5631-UZ	VAX RPG II for VAX 8200	4,914
Q7631-UZ	VAX RPG II for VAX 8300	4,914
Q9631-UZ	VAX RPG II for VAX 8500	6,300
QK631-UZ	VAX RPG II for VAX 8600/8650	6,300
QM631-UZ	VAX RPG II for VAX 8800	9,450
<b>ULTRIX-32 SOFTWARE</b>		
Q5716-UZ	DECnet-Ultrix for VAX 8600/8650	5,310
Q5917-UZ	VAX Lisp-Ultrix for VAX 8200	12,480
Q9917-UZ	VAX Lisp-Ultrix for VAX 8500	16,000
QK917-UZ	VAX Lisp-Ultrix for VAX 8600/8650	16,000

\*Non-hardware-dependent, single-use license and warranty. ■