Digital Equipment Corp. VAX 6000

In this report:

Product Summary

Editor's Note
Since our last update, Digital has completely revamped the VAX 6000 Series. The family now consists of the VAX 6000 Models 310, 410, 510, 520, 530, 540, 550, and 560. All of these new systems take advantage of the newest I/O controllers and memory arrays to maximize performance and upgrade potential.

Description
The VAX 6000 series implements a platform strategy that features a combination of symmetric multiprocessing (SMP), fast processors, and VAXcluster capability to provide flexible systems that can be upgraded easily and economically. System performance ranges from 3.8 to as much as 72 times the processor performance of the VAX-11/780 computer.

Strengths
Any VAX 6000 system can be upgraded to the latest CPU, I/O, and memory performance levels. The 6000 series continues to fare well in price/performance comparisons.

Limitations
The new VAX 6000 Model 500 systems do not support ULTRIX. ULTRIX is supported on the current 310 and 410 as well as the earlier 6000 models.

Competition
IBM's new ES/9000 family and the Hewlett-Packard 3000 Series high-end systems.

Vendor
Digital Equipment Corp.
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Price
$66,000 to $811,000.

GSA Schedule
Yes.

—By Alyn J. Gorman
Managing Editor

Analysis

Product Strategy

Hardware

Digital's VAX 6000 Systems are general-purpose, mid-range systems and servers that are used in a variety of applications. They can be used in a VAXcluster configuration to handle vital transaction processing applications in a data center, or in a networked configuration to provide timesharing access to a large department. They also function well as server systems in the client/server environment of a large, data-intensive workgroup.

This new VAX 6000 product line offers 85 to 100 percent faster CPU performance, greatly improved price/performance than the previously marketed models; a new, more powerful I/O capability is built into every system. Memory capacity has been doubled, I/O performance tripled, and disk capacity has been quadrupled. The new Model 500 systems, with 85 to 100 percent more performance, are priced at only 16 to 18 percent more than their predecessors.

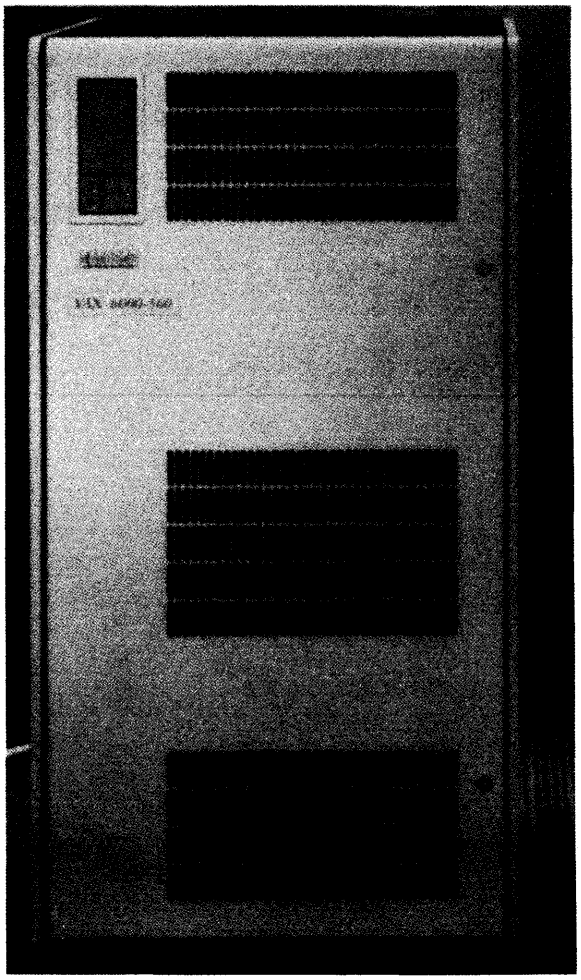
The Model 210 has been replaced by the new Model 310 at the price of the 210; the new Model 410 is now available at the previous price of the Model 310; and the Models 420, 430, 440, 450, and 460 have been replaced by the Models 520, 530, 540, 550, and 560, respectively. Models 420 through 460 remain available for special situations.

According to Digital, the VAX 6000 systems are Digital's fastest selling systems ever on a dollar basis, with more than 10,000 systems sold in less than 30 months. Compatibility is key with the VAX 6000 series. This family of VAX systems supports the same I/O devices, systems options, and software. The platform strategy provides an extra measure of investment protection.

All the new VAX 6000 systems feature the XMI high-speed system interconnect as a streamlined I/O path. The XMI has not changed, but using it as an I/O path provides three times the I/O throughput of earlier systems with the VAXBI bus. The VAXBI bus is available as an option on all systems to support additional Digital and third-party devices.

VAXserver 6000 models 310, 410, 510, and 520 are designed for large or data intensive work groups and support large, mixed workstation environments of VMS, ULTRIX, UNIX, OS/2, Macintosh, and MS-DOS clients. They are available as base systems and are priced lower than their timesharing counterparts.

VAX 6000 Models 310, 410, 510, 520, 530, 540, 550, and 560 VMS systems can serve as interactive departmental or company-wide timesharing



The VAX 6000 Series Model 500 offers enhancements in I/O performance, CPU performance, and memory and disk capacities. For departmental and data center computing, these new systems feature symmetric multiprocessing and a high-speed interconnect as a streamlined I/O path that provides three times the I/O throughput of earlier systems with the VAXBI bus.

systems and can be integrated into an existing information-processing environment with DECnet, Ethernet, and VAXcluster systems. They are available as BASE Systems or Preconfigured Systems. Base systems can be configured to add memory, I/O controllers, or load devices as desired. Preconfigured systems are configured to be more complete by including a proper amount of memory, disk storage, and special features such as the Infoserver 100 load device and VAX Performance Advisor (VPA) software licenses. Preconfigured systems are priced at 8 to 13 percent less than the sum-of-the-pieces.

Three preconfigured VAXcluster Systems based on dual VAX 6000 Model 410, 510, and 520 systems offer higher availability and larger shared databases than standalone VAX 6000 systems and offer less-than-sum pricing.

Operating System

Digital's VAX VMS Operating System runs on all VAX hardware, thus protecting all application program investments. VMS provides support for all major programming languages, and connectivity to all other major operating systems. In all, according to Digital, VMS today supports or has support under development for more than 25 of the computer industry's standards specifications in areas ranging from application and data portability to user interfaces.

Applications

Digital offers both proprietary and third-party applications packages for the VAX 6000 systems. Third-party software is sold via Digital's External Applications Software (EAS) Library service. They are also involved in two types of agreements with a range of software vendors. Through its Cooperative Marketing Program (CMP), Digital joins forces with independent software vendors in sales calls, trade shows, and technical demonstrations, recommending each other's products to prospective buyers. System Cooperative Marketing Programs (SCMPs) are agreements through which Digital works with OEMs to market, demonstrate, and sell turnkey systems incorporating Digital hardware and the vendors' products.

Competitive Position

The new VAX 6000 systems enhance an already impressive price/performance lineup, particularly against competing IBM offerings. Even at the lower end of the line, Digital's departmental machines have demonstrated a marked cost advantage over comparable IBM offerings. The new VAX 6000 Model 500 systems are targeted mainly at the IBM's former 4381 systems and the new ES/9000 family. Earlier 6000 systems were also targeted to the IBM AS/400 Series, but Digital now views the VAX 4000, introduced in July, as its AS/400 competitor.

User Opinion

Responses to Datapro's 1990 Computer Users Survey included returns from 43 users of the VAX 6000 systems; 77 percent were used as organizational systems, the balance as departmental systems. Of the users surveyed, 68 percent purchased their systems from Digital, 22 leased from Digital, and 10 leased from a third party. The average length of installation for the systems was 15.5 months. Most of the users were running business and administrative computing applications. Of the VAX 6000 system customers surveyed, 56 percent have accounting/billing applications; 37 percent have order processing/inventory applications; 35 percent have payroll and personnel applications; and 35 percent have purchasing system applications. Database management applications were listed as an application for the VAX 6000 system by 65 percent of the respondents. Only 21 percent of these users cited mathematics/statistics as an application.

The following table shows how the 43 respondents rated their VAX 6000 systems:

Ease of operation	8.4
Operating System	8.6
Compiler and Assemblers	8.3
Programming Ease	8.4
Ease of Installation	7.5
Ease of Conversion	8.1
Reliability	
Central Computer	9.1

Company Profile
Digital Equipment Corp.

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Officers
President: Kenneth H. Olsen
Senior Vice President, Engineering, Manufacturing, and Product Marketing: John F. Smith
President and CEO, European Operations: Pier Carlo Falotti

Company Background
Year Founded: 1957
No. Employees: 125,000
No. Systems Sold (cumulative): More than 500,000

Led by Kenneth H. Olsen, three engineers founded Digital Equipment Corporation in 1957. Using their own money in addition to funding from a Boston venture-capital firm, they set up operations in an old brick wool mill in Maynard, MA.

Digital's first product was a set of electronic modules for computer test equipment. Three years after its founding, Digital introduced its first computer, the Programmed Data Processor Model 1, or PDP-1. In 1963, the company introduced its landmark PDP-8, the first successful minicomputer.

The PDP-8 established a whole new market for smaller computers and made Digital a rising star within an industry then dominated by mainframe vendors. Digital's smaller machines soon became a price/performance alternative to big mainframes and also introduced the concept of distributed processing.

In 1977, Digital introduced the VAX (virtual address extension) Series of 32-bit minicomputers, one of the most successful product launches in computer industry history. Since introducing the first VAX, the 11-780, Digital has continued to enhance the basic VAX architecture and VAX/VMS operating system with announcements of new and more powerful VAX models over the years.

The current VAX family consists of VAXstation desktop workstations; MicroVAX departmental systems; VAXft 3000 fault-tolerant model; VAX 4000, designed for server applications; VAX 6000 Series medium-range systems; and VAX 9000 Series high-end mainframes.

In addition to the VAX family, Digital offers DECsystems which use reduced instruction set computing (RISC) technology and operate under ULTRIX, Digital's implementation of the UNIX operating system.

To support its systems, Digital offers disk, storage array, and solidstate memory products; optical disks; tape devices; and printers. Besides hardware and software, Digital offers a range of communications and networking products and services.

Business Overview
Digital likes to characterize itself as the world's leading supplier of networked computer systems, as well as a leader in systems integration. To remain a leader, particularly in these specific areas, the company believes it must support openness and industry standards to remain competitive in the 1990s. The company is a key participant in industry standards organizations such as the

Peripherals	8.4
Maintenance Service (mfr.)	
Responsiveness	8.6
Effectiveness	8.5
Technical Support (mfr.)	
Troubleshooting	7.7
Education	7.6
Documentation	7.7
Price Performance Value	8.0
Overall Satisfaction	8.6

Note: Average based on a scale from 1 (Poor) to 10 (Excellent).

Sales and Distribution

Digital markets its products and services via direct and indirect sales channels. Worldwide sales offices concentrate on three major business segments: *Business Week* 1000 companies; small establishments and institutions; and business centers, dealers, distributors, system houses, and retailers who then sell to end users. The indirect sales channels include business centers, office equipment dealers/distributors, system houses, OEMs, and retailers.

Open Systems Foundation (OSF), an industry group founded in 1988 to develop industry recognized specifications for UNIX. UNIX will be the standard operating system for users who prefer open systems rather than proprietary systems.

Network Application Support (NAS), a new Digital strategic direction addressing VAX compatibility and multivendor connectivity, will let users integrate desktop systems and large system resources involving both Digital and non-Digital systems.

In 1988, Digital introduced Enterprise Management Architecture (EMA), an integrated network management strategy.

Financial Profile

Digital continues to rank as the second largest U.S. computer company as measured by total revenues. While Digital enjoyed record revenue and profit growth through the 1980s—largely on the strength of its VAX platform and networking architecture—sales and profits have been sluggish within the last couple of years.

It is evident from the company's report of an 80 percent drop in earnings for the first quarter of 1991 that Digital continues to undergo pain. For the first quarter of fiscal 1991, ended September 30, Digital reported revenue of $3.09 billion, down 1.2 percent from $3.13 billion for the same period last year. Net income was $26.18 million, a staggering 82.6 percent drop from $150.78 million in the year-ago period. Digital blamed the profit drop on an economy that is teetering on the brink of a recession and lower demand for high-margin products. Like major competitors, Digital continues to do better internationally.

Second-quarter 1991, ended December 29, 1990, reported revenues of $3.35 billion, up five percent from second-quarter 1990. Net income was $111.2 million. According to Digital, the company began to see the benefits of investments, cost-control efforts, and an improved revenue growth.

In moves designed to reduce expenses, last summer Digital announced that it would begin shifting 4,000 manufacturing employees to other jobs and offered severance packages to 700 manufacturing and administrative employees.

Management Statement

Digital is making a $1.5 billion investment toward new product development. According to the president's letter, Digital is "continuing to invest heavily in VAX and RISC-based systems and VMS and UNIX software." Within the next year, "Digital's strategy is to focus on the computing environment of the 1990s. Digital will offer the widest selection of technology and continue to make significant investments in R&D and new products in response to dynamically changing customer needs."

Decision Points

Strengths

Full, bottom-to-top upgrading is a feature of the VAX 6000 line, in addition to the availability of VAXcluster systems as an upgrade mechanism. Through clustering, a system can gain additional computing power and throughput, in addition to enhanced load balancing.

VAXclustered systems can also provide fault tolerance through processor switchover and an automatic dual-ported disk switchover, in case of failure, through the Hierarchical Storage Controllers (HSCs) it employs. In addition, the VMS operating system supports Volume Shadowing software, writes data to two disks simultaneously, preserving data if one disk fails.

VAXclusters linked by Ethernet LANs can now access large clusters of VAX superminis, providing the greater computational and storage resources of the bigger clusters.

Single and dual vector processing modules are available on Model 500 systems for numerically intensive Fortran applications. With up to 180 MFLOPs (single precision) peak performance, they deliver up to 400 times the MFLOP performance of the VAX 11/780. According to Digital, speedups of 3 to 20 times scalar processing, depending on the application, are typical.

Digital's VMS operating system is one of the VAX line's greatest strengths. VMS provides a uniform operating environment from the desktop to the data center. Users can thus migrate applications upward without conversion and share applications across networks.

Table 1. System Comparison

Model	310	410	510	520
System Characteristics				
Date of introduction	October 1990	October 1990	October 1990	October 1990
Date of first delivery	October 1990	October 1990	October 1990	October 1990
Performance (VAX-11/780)	3.8	7.0	13.0	Up to 25
SPECmark	3.8	7.1/10.2*	13.2/16.3*	—
SPECthruput†	—	1 @ 7.1	1 @ 12.9	2 @ 12.3**
Aggregate SPECthruput	—	7.1	12.9	24.6
ALL-IN-1 subscribers	152	216	408	624
Processors	1	1	1	2
Cache per processor (bytes on chip/on board)	1K/256K	1K/128K	2K/512K	2K/512K
Cycle time (ns.)	60	28	16	16
Vector processors	0	1	1	2
In-cabinet expansion	To Models 410-560	To Models 510-560	To Models 520-560	To Models 530-560
Memory and I/O				
Memory (bytes)	32M-512M	32M-512M	64M-512M	128M-512M
Max. I/O bandwidth (MBS)	80	80	80	80
VAXBI channels	Up to 5	Up to 5	Up to 5	Up to 5
Max. disk in-cabinet (bytes)	3G	3G	3G	3G
Max. disk HSC (bytes)	Over 5T	Over 5T	Over 5T	Over 5T
Ethernet controllers	Up to 6	Up to 6	Up to 6	Up to 6
VAXcluster controllers	Up to 4	Up to 4	Up to 4	Up to 4
System Pricing***				
VMS	$66,000	$124,000	$227,000	$393,000
ULTRIX	$162,960	$214,935	Not applicable	Not applicable

**10.2 is the SPECmark for a Model 410 with vector processor; 16.3 is the SPECmark for a Model 510 with vector processor.*
***Estimated SPECmark.*
****All prices are U.S. list prices with standard warranty for base systems with paid-up licenses.*
†First number indicates number of processors. Number of processors times SPEC thruput equals aggregate SPECthruput.
Note: A dash (—) in a column indicates that the information is unavailable from the vendor.

Digital has announced that VMS will be regularly enhanced in its compliance with industry-standard languages, interfaces, and protocols. Digital will support an open systems strategy that promises support for standards being developed by three groups:

- Posix standards now under development by the Institute of Electrical and Electronics Engineers, Inc. Next quarter Digital will test standards that cover applications interface, shell utilities, and real-time processing.
- Support for key standards developed by the Open Software Foundation (OSF) for its Distributed Computing Environment. VMS DECwindows Version 3 will include OSF/Motif, the group's graphical user interface.
- Open Systems Interconnection (OSI) is the International Standards Organization (ISO) model for multivendor computer networking. VMS supports significant elements of OSI, and has announced additional future support for OSI as part of DECnet-VAX Phase V.

Limitations

The new VAX 6000 Model 500 systems do not support ULTRIX. ULTRIX is currently supported by the 310 and 410 and on the earlier 6000 models. Digital has said that a future release of ULTRIX will support the VAX 6000 Model 500 systems; this future release will also support the new Models 310 and 410.

Characteristics

Systems Overview

The VAX Systems run varied applications, from office automation in departmental environments to complex

Table 1. System Comparison (Continued)

Model	530	540	550	560
System Characteristics				
Date of introduction	October 1990	October 1990	October 1990	October 1990
Date of first delivery	October 1990	October 1990	October 1990	October 1990
Performance (VAX-11/780)	Up to 37.0	Up to 49.0	Up to 61.0	Up to 72.0
SPECmark	—	—	—	—
SPECthruput†	3 @ 12.2*	4 @ 12.2*	5 @ 12.2*	6 @ 12.0*
Aggregate SPECthruput	36.6*	48.8*	60.0*	72.0*
ALL-IN-1 subscribers	—	888	—	—
Processors	3	4	5	6
Cache per processor (bytes on chip/on board)	2K/512K	2K/512K	2K/512K	2K/512K
Cycle time (ns.)	16	16	16	16
Vector processors	1	1	0	0
In-cabinet expansion	To Models 540-560	To Models 540-560	To Model 560	Not applicable
Memory and I/O				
Memory (bytes)	128M-512M	128M-512M	128M-512M	128M-512M
Max. I/O bandwidth (MBS)	80	80	80	80
VAXBI channels	Up to 5	Up to 5	Up to 5	Up to 5
Max. disk in-cabinet (bytes)	3G	3G	3G	3G
Max. disk HSC (bytes)	Over 5T	Over 5T	Over 5T	Over 5T
Ethernet controllers	Up to 6	Up to 6	Up to 6	Up to 6
VAXcluster controllers	Up to 4	Up to 4	Up to 4	Up to 4
System Pricing**				
VMS	$523,000	$649,000	$742,000	$811,000
ULTRIX	Not applicable	Not applicable	Not applicable	Not applicable

**Estimated SPECmark.*
***All prices are U.S. list prices with standard warranty for base systems with paid-up licenses.*
†First number indicates number of processors. Number of processors times SPEC thruput equals Aggregate SPECthruput.
Note: A dash (—) in a column indicates that the information is unavailable from the vendor.

engineering and scientific applications in research centers. The family now includes multiprocessor models distinguished by symmetric multiprocessor systems (SMPs) that permit multistream computing and parallel execution of Fortran applications. With SMP, up to six processors can be placed in the same CPU cabinet. Digital's VAX Systems are frequently configured in multinode VAXcluster configurations with high-performance I/O controllers.

Specifications

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. See Table 1 for system characteristics and base pricing. For additional information concerning preconfigured package specifications and pricing, see the equipment price list at the end of this report.

Main Storage

New 32M-byte, 64M-byte, and 128M-byte memory arrays, using high-density 4M-bit DRAMS, are available for all VAX 6000 systems for a maximum capacity of 512M bytes of memory per system.

Storage Protection

The system's memory management logic divides memory into 512-byte pages. A protection code specifies the access modes that have read or write access to each page. In addition, fault detection hardware causes a memory error-correcting code to detect all double-bit errors and correct all single-bit errors. Each VAX System features a 7-bit error-correcting code per 32-bit longword.

An 8-bit ECC code with its own controller protects each VAX 6000 main memory module. A battery option protects memory during power fluctuations.

Central Processor

All VAX CPUs feature virtual memory management facilities, bootstrap loader, cache memory, programmable realtime clock, time-of-year clock with battery backup, control store, and console subsystem. All VAX 6000 Models employ CMOS technology.

Registers and Addressing

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. 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.

Table 2. Disk Storage

Model	RA90	RA82	SA482	SA600
Type	Winchester	Winchester	Storage Array	Storage Array
Controller model	UDA50, KDA50, KDB50, HSC5X-BA (on HSC70 or HSC50)	UDA50, KDA50, KDB50, HSC5X-BA (on HSC70 or HSC50)	UDA50, KDA50, KDB50, HSC5X-BA (on HSC70 or HSC50)	UDA50, KDA50, KDB50, HSC5X-BA (on HSC70 or HSC50)
Drives per subsystem/controller	6	4	1-8	1-8
Formatted capacity/drive (bytes)	1.2G	622M	1.244G-2.488G	9.7G
Number of usable surfaces	7	7	32	13
Bytes/sector	512	512	512	512
Average seek time (ms.)	18.5	24	24/spindle	18.5/spindle
Average rotational/relay time (ms.)	8.3	8.3	8.3/spindle	8.3/spindle
Average access time (ms.)	32.3	32.3	32.3/spindle	32.3/spindle
Data transfer rate (MBS)	2.8	2.4	2.4/spindle	2.4/spindle
Supported by system models	All	All	All	All
Purchase price	$27,500-$145,000	$17,801-$54,621	$36,414-$70,686	$27,500-$189,000
Comments			Comprises 2 to 4 RA82s.	Not supported as system disk; data transfer device only.

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.

Each VAX processor recognizes 32 priority interrupt levels—16 for hardware, 15 for software, and one for normal user software, which runs at the process level (interrupt priority level zero).

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

Configuration Rules

VAX Systems are available in basic systems, preconfigured systems, and VAXcluster configurations. All systems include VMS or ULTRIX-32 (on the 310 and 410) operating system and DECnet networking software licenses.

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

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

A VAXcluster Console System, linked to nodes in the cluster through fiber optic facilities, is available for VAXclusters. 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 configuration rules provided here are for VAX 6000 VMS Systems. Systems operating under ULTRIX-32 use the same components, but configurability is more limited.

VAX 6000 systems use the XMI high-speed system interconnect as the system bus. The total number of XMI modules cannot exceed 14. The XMI options and general rules are as follows:

- Up to six processors (Model 560)
- Maximum one vector processor for Models 410, 510, 530, 540, and 560; one or two per Model 520
- Maximum 512M bytes of memory per system
- Maximum of four CIXCDs per system; CIXCDs and CIBCAs cannot be configured in the same system
- Maximum of six DEMNA Ethernet controllers per system
- Up to three KDM70 disk/tape controllers per system
- Up to five XMI-to-VAXBI interfaces per system

Table 3. Workstations

Model	VT320	VT300	VT340
Display Parameters			
Max. chars./screen	3,168	3,168	3,168
Buffer capacity	—	19K characters	19K characters
Screen size (lines x chars.)	24 x 80 or 132	24 x 80 or 132	24 x 80 or 132
Tilt/swivel screen	Optional	Standard	Standard
Symbol formation	7 or 12 x 7 dot matrix	8 or 9 x 11 (80 col.); 4 or 5 x 9 (132 col.)	8 or 9 x 11 (80 col.); 4 or 5 x 9 (132 col.)
Character phosphor	White, green, or amber	White, green, or amber	White, green, or amber
Total colors/no. simult. displayed	Not applicable	4 shades of gray	4,096/16
Keyboard Parameters			
Style	Typewriter	Typewriter	Typewriter
Character/code set	ASCII, NRCS, ISO Latin 1, Digital Special Graphics and Supplemental	ASCII, NRCS, ISO Latin 1	ASCII, NRCS, ISO Latin 1
Detachable	Yes	Yes	Yes
Program function keys	15	15	15
Terminal Interface	DEC-423, RS-232-C	DEC-423, RS-232-C	DEC-423, RS-232-C
Purchase Price	$599	$1,795	$2,595
Comments	1200-by-300 pixel resolution.	800-by-500 pixel graphics array; supports split-screen viewing, ReGIS, Sixels, Tektronix 4010/4014.	800-by-500 pixel graphics array; supports split-screen viewing, ReGIS, Sixels, Tektronix 4010/4014.

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

Peripherals

Input/Output Control

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

The new VAX 6000 systems feature the 100M-byte per second *XMI High-Speed System Interconnect* as a streamlined I/O path. The XMI has not changed, but using it as an I/O path provides three times the I/O throughput of earlier systems with the VAXBI bus. XMI controllers include: a VAXcluster controller, a disk/tape controller, and an Ethernet controller. These high-performance controllers can be added to the XMI high-speed system bus along with up to five VAXBI buses to meet additional demands. Each controller has its own high-speed processor to increase the I/O speed. Up to four VAXcluster controllers and six Ethernet controllers are supported. The VAXBI bus is available as an option on all systems to support additional Digital and third-party devices.

The *VAX Bus Interconnect (VAXBI)*, a 32-bit synchronous bus, serves only as the I/O bus; all systems employ a high-speed memory interconnect as the system bus.

In the VAXBI bus, all arbitration, address, and data transmissions are time multiplexed over 32 data lines.

The VAXBI provides connections for up to 16 VAXBI nodes, each of which is an interface occupying a logical position on a VAXBI bus; the node can be a mix of processors, memory upgrades, and adapters. The VAX 6000 Series computers deliver aggregate throughput of up to 60M bytes per second.

All VAX Systems support the *UNIBUS*, an asynchronous, bidirectional bus, which controls all Digital- and user-developed realtime peripherals other than high-speed disk drives and magnetic tape transports. The UNIBUS is connected to the system or I/O bus through the UNIBUS adapter, which handles priority arbitration among devices on the UNIBUS.

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

The *Hierarchical Storage Controller (HSC)* family is a series of intelligent servers for high-speed disks and tapes, primarily in VAXclusters. The HSC connects to the host system through Digital's Computer Interconnect (CI), a serial bus with a bandwidth of 70M bytes per second; the CI features a dual-path interface to hosts in a cluster. The port onto the CI bus can support a sustained 4.2M bytes per second transfer rate.

Based on PDP-11 microprocessors, the HSC servers use the Standard Disk Interconnect (SDI) and the Standard Tape Interconnect (STI) to attach disk drives and tape formatters. The SDI and STI buses both support burst transfer rates up to 3.1M bytes per second.

The HSC70 allows up to eight data channels, providing direct support for up to 32 SDI disk drives (32 RA-series or eight SA482 storage arrays) or a combination of SDI disk drives and up to 24 TA-Series tape

Table 4. Printers

Model	LPS20	LP37	LP29	LG01/LG02	LG31
Type	Laser	Band	Band	Matrix	Dot matrix
Speed	20 ppm	1,200 lpm	2,000 lpm	600 lpm	300 lpm
Bidirectional printing	Not applicable	Not applicable	Not applicable	—	—
Paper size (inches)	7.5 to wide; 10.5 to 17 long	Up to 18.75	—	4 to 16 wide, 3 to 20 long	Up to 15 wide
Character formation	Electrophotographic	Full	Full	Dot matrix	Dot matrix
Horizontal character spacing (char./inch)	Variable	10	Variable	Variable	5 to 16.7
Vertical line spacing (char./inch)	Variable	6 or 8	—	—	—
Character set	29 resident typefaces	64/96	96 ASCII or 64 upper case	64 (data proc. mode)	7- or 8-bit, ANSI/ISO-compatible
Controller/interface	—	LP11, DMF32, DMB32	LP11, DMB32, DMF32	RS-232-C, Dataproducts parallel	RS-232-C interface
Printer dimensions (inches, h x w x d)	—	—	—	38 x 33.5 x 22.3	—
Graphics capability	No	No	Not applicable	LG02 only	Not applicable
Purchase Price	$20,045	$23,625	$36,645	$11,539 (LG01); $13,639 (LG02)	$8,390
Comments	Ethernet-based print server.			LG01 text printer upgradable to LG02 text/graphics printer.	Prints Code 39 and Interleaved 2 of 5 bar codes.

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

drives. Through six data channels, the HSC50 can directly support up to 24 SDI disk drives (including six SA482 Storage Arrays) or 16 SDI drives and eight TA Series tape drives.

Both HSC controllers support volume shadowing through specialized VMS software. That feature, which provides a measure of fault tolerance, allows all data written to a disk to be duplicated on compatible disk volumes.

Disk Storage

The KDM70 Disk and Tape Controller is an XMI-based intelligent disk and tape controller that supports eight ports, including up to four ESE20 Solid State Disks, up to eight SDI disk drives from the SA or RA families, and up to two master TA-series tapes.

The KDB50 disk controller consists of two VAXBI modules. Each controller can attach up to four radially connected RA series SDI disk drives, up to four ESE20 Electronic Storage Elements, or any four RA components drives in a storage array.

The Electronic Storage Element (ESE20) is a solid-state disk device that offers 120M bytes of semiconductor storage configured as a non-volatile disk device. In VAX 6000 Model 500 environments, when utilized with the KDM70 controller, the ESE20 can service more than 1200 I/O requests per second.

See Table 2 for specifications for the disk storage devices used on the VAX 6000.

Workstations

Digital contends that the number of users supported by any system depends on the type of application and the associated demands on the processor and bus. Moreover, company spokespersons almost invariably contend that the maximum number of locally connectable terminals is a false limit, because frequently VAX systems employ Ethernet terminal servers; theoretically, each system can be connected to over 1,000 servers. Generally, Digital provides either the number of asynchronous local lines supported or, in some cases, the range of users typically supported on a given system across a spectrum of applications.

Digital also provides ranges of support for users of the ALL-IN-1 integrated office system, which many VAX users employ as the primary application umbrella for their organizations. See Table 3 for specification for the workstations available for use with the VAX 6000 system.

Printers

Each VAX System can support up to 16 line printers. Each printer must connect to an asynchronous line or to

Table 4. Printers (Continued)

Model	LN03	LN03 Plus	ScriptPrinter (LN03R)	PrintServer 40 (LPS40)
Type	Laser	Laser	Laser	Laser
Speed	8 ppm	8 ppm	8 ppm	40 ppm
Bidirectional printing	Not applicable	Not applicable	Not applicable	Not applicable
Paper size (inches)	Up to 8.3 x 11.7	Up to 8.3 x 11.7	Up to 8.3 x 11.7	7.5 to 11 wide; 10.5 to 17 long
Character formation	300 x 300 dpi	300 x 300 dpi	300 x 300 dpi	Electrophotographic
Horizontal character spacing (char./inch)	Variable	Variable	Variable	Variable
Vertical line spacing (char./inch)	Variable	Variable	Variable	Variable
Character set	ASCII; 16 resident Courier/ Elite fonts	ASCII; technical; 17 resident fonts	29 resident fonts	29 resident typefaces
Controller/interface	RS-232-C interface	RS-232-C interface	RS-232-C interface	—
Printer dimensions (inches, h x w x d)	15 x 21 x 23.5	15 x 21 x 23.5	15 x 21 x 23.5	40.4 x 60 x 28.4
Graphics capability	150 dpi (average)	300 x 300 dpi	300 x 300 dpi	300 x 300 dpi
Purchase Price	$3,040	$4,195	$5,495	$52,395
Comments		Includes PLOTLN software and 2 EPROMs.	Supports PostScript page description language.	Ethernet-based print server suitable for local area networks.

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a DMF32 or DMB32 port. Each system can use a maximum of two DMF32 or DMB32 printer ports. See Table 4 for the specifications of the printers available with the VAX 6000 systems.

Magnetic Tape

The principal locally connectable tape device for the VAX Systems is Digital's TU81-Plus and TA series tape drives. See Table 5 for the specifications of the magnetic tape units used with the VAX 6000.

Other Peripherals

VAX systems also support an optical storage system, printing terminals, and a voice synthesis module.

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

The *LA100* is a microprocessor-controlled hard copy terminal and printer; it can print up to 240 cps in draft mode, 30 cps in letter-quality mode, and 80 cps in memo mode. The *LA120* is a 180 cps printing terminal. Those two printing terminals can be used as consoles for VAX Systems.

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

Software

Operating Systems

Operating systems for the VAX systems are the general-purpose VMS and ULTRIX-32, Digital's version of Berkeley UNIX. ULTRIX-32 is supported by the 310 and 410 and by the older Models 420 through 460.

VMS

VMS (also known as VAX/VMS) is a general-purpose operating system that provides the environment for the concurrent execution of multi-user 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.

Table 5. Magnetic Tape Equipment

Model	TA79	TU79	TA81	TU81-Plus	TK50
Type	Reel to reel	Reel to reel	Streaming	Streaming	Cartridge
Format					
Number of tracks	9	9	9	9	22
Recording density, bits per inch	1600/6250	1600/6250	1600/6250	1600/6250	6667
Recording mode	PE/GCR	PE/GCR	PE/GCR	PE/GCR	Serial (serpentine)
Characteristics					
Controller model	HSC5X-CA (on HSC70 or HSC50)	TA79 master (on HSC5X-CA)	HSC5X-CA (on HSC70 or HSC50)	UNIBUS or VAXBI adapter	UNIBUS interface
Drives per controller	4 per HSC5X-CA	3 per TA79	4 per HSC5X-CA	1	1
Storage capacity, bytes	40M PE, 145M GCR	40M PE, 145M GCR	40M PE, 145M GCR	40M PE, 145M GCR	95M
Tape speed, inches per second	125	125	75	75	75
Data transfer rate, units per second	200KB PE; 781KB GCR	200KB PE; 781KB GCR	468KB	468KB	45KB
Streaming technology	No	No	Yes	Yes	Yes
Start/stop mode; speed	Not applicable	Not applicable	Yes; 25 ips	Yes; 25 ips	—
Switch selectable	Yes	Yes	—	Not applicable	Not applicable
Purchase Price	$70,000	$35,000	$37,084	$34,755 (UNIBUS); $35,543 (VAXBI)	$4,015

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VMS provides symmetric multiprocessing (SMP) support for all VAX 6000 systems. In SMP, a form of tightly coupled multiprocessing, all processors perform operations simultaneously in all VAX access modes (including user, supervisor, executive, and kernel). For example, processors in an SMP system can simultaneously execute user mode programs, execute system services, and initiate I/O. Actual parallel computing (in which all processors work simultaneously on parts of the same application) is supported only through the VAX Fortran compiler.

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

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

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

ULTRIX-32

ULTRIX-32 is Digital's native-mode implementation of the UNIX operating system. It is based on the University of California at Berkeley's Fourth Berkeley Software Distribution (4BSD) and is compatible with AT&T's UNIX System V, Release 2.0. It does not comply fully with AT&T's System V Interface Definition (SVID). ULTRIX-32 cannot yet be used on VAX symmetric multiprocessor systems. Depending upon the application, ULTRIX-32 can support over 64 users.

Database Management

The database management facilities available for the VAX 6000 systems are part of a larger scheme called VAX Information Architecture—a collection of database 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 specifying the means to access it, such as the file type and keys.

The lowest level consists of four online, multiuser data management facilities: VAX Rdb/VMS, VAX DataBase Management System (DBMS), VAX Application Control and Management System (ACMS), and VAX TDMS. The first two products, discussed below, are the actual database management systems for the VAX 6000 systems.

VAX Rdb/VMS

VAX Rdb/VMS is a relational database management system. Unlike VAX DBMS (detailed below), which is designed for highly structured databases, Rdb/VMS is designed for applications in which data items and relationships among records change frequently. Rdb/VMS conforms to the Digital Standard Relational Interface (DSRI) and is now Digital's premier DBMS product.

In Rdb/VMS, data is independent of application programs; users can change definitions without modifying or recompiling their programs. The product can retrieve and update information from both local and remote databases 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 database interactively; it can also work in conjunction with other VAX information management tools.

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

VAX DBMS

VAX DBMS is a multiuser, general-purpose, Codasyl-compliant database management system based on the March 1981 Working Document of the ANSI Data Definition Committee. VAX DBMS administers databases 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 databases through DECnet networking software.

Languages

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

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

Communications

Digital Network Architecture (DNA)

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. Digital announced DNA Phase V which, as of 1990, embraces even more of the standards established by the International Standards Organization (ISO) Open Systems Interconnect (OSI) networking model than the earlier phases of DNA.

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

DECnet-VAX

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

DECnet-ULTRIX

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

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

Other Communications Products

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

Digital's *Internet* family of products supports the interconnection of Digital computers and Digital networks to systems built by IBM and other manufacturers. The most important members of the Digital-to-IBM portion of the family are DECnet/SNA Gateway and VMS/SNA.

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

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

Both DECnet/SNA Gateway and VMS/SNA require installation of appropriate *DECnet/SNA Access Routines and Programming Interfaces* on host systems.

Utilities

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, are available for the VAX 6000. More specialized products include a code management system, a UNIX-like command line interpreter, a spreadsheet package, a ReGIS graphics library (RGL) package, and a graphical kernel system. These tools are available to the programmer through the VMS command language.

Office Automation

VAX ALL-IN-1 Integrated Office and Information System is a menu-oriented software package that includes electronic mail; word and document processing; calendar, time, and desk management; electronic filing; communications; and forms development on VMS-based systems. The system also features voice messaging support, DECtalk mail access through Touch-tone telephones, and integrated computer-based instruction for all major functions. A flow-control facility allows a user at a VT100, VT200, or VT300 family terminal to select from an option menu, moving from one application to another. The ALL-IN-1 software requires a VMS-based system with at least 2M bytes of dedicated main memory.

Application

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 sells it through the company's software distribution channels. Digital tests Software for operation, documentation, and ease of installation prior to being included in the EAS Library. Software products from the EAS Library are sold on an "as is" unsupported basis, although the author of the software may offer a separate maintenance agreement.

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

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

Pricing and Support

Pricing

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

Digital software is licensed rather than sold. Users purchase licenses and distribution rights separately. A license can either be purchased outright or obtained via Digital's Periodic Payment License (PPL) option, through which the user pays an initial license fee and then makes monthly payments thereafter. The software is licensed with a 90-day cancellation option.

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

Product Support

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

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

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, seven days a week. The vendor bills customers for time and materials; charges are portal-to-portal, with labor, parts, and travel expenses rated separately.

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

Off-site maintenance is available through Digital's Customer Returns Center, Product Repair Center, and Digital Servicenters, which are all equipped with parts inventories, special diagnostic systems, and repair kits.

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

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

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

Digital's *Software Services* organization provides software support; installation, training, telephone support, newsletter, and on-site support services are available.

Digital also offers the *DECompatible Service* program, through which the company's Field Service organization provides maintenance for over 120 specific non-Digital hardware products linked to Digital systems.

The company claims that the designated products receive the same response time and service coverage as Digital hardware under standard service agreements.

Under Digital's software support policy, all warranted VAX software products are covered under a policy guaranteeing that the product conforms to the Software Product Description (SPD) shipped with it. Most VAX software products include the warranty at no extra charge. Delivery of the warranty is provided through automated and manual problem reporting. Customers can purchase added-value services such as installation, training, telephone support, newsletters, and on-site support separately, or they can select a System Startup Service Package.

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

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

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

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

Training

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

Equipment Prices

		Purchase Price ($)	Basic Service (Mo.) ($)	DEC-serv. (Mo.) ($)
VAX 6000 Model 310 Systems				
63AMH-AE	VAX 6000 Model 310 System with DEMNA XMI Ethernet Adapter, VMS Operating System license, DECnet Full-Function license	66,000	405	482
63AMB-BE	VAX 6000 Model 310 System with one 32MB memory module, two VAXBI Adapters, KDB50 Disk Controller, DEBNA VAXBI Ethernet Adapter, TK70 296MB Console Tape, ULTRIX license 64-users, DECnet ULTRIX	162,960	500	595
SV-6B02-AK	VAX 6000 Model 310 System with one 32MB memory module, DEMNA XMI Ethernet Adapter, Infoserver 100, KDM70 Disk Controller, two RA92 1.5GB Disk Drives, VT420 Terminal, LA75 Console Printer, VMS Operating System license, DECnet Full-Function license, VAX Performance Advisor	174,000	862	1,026
63APH-AE	VAXserver 6000 Model 310, DEMNA XMI Ethernet Adapter, VMS server license, DECnet Full-Function license	47,000	405	482
VAX 6000 Model 410 Systems				
64AMH-AE	VAX 6000 Model 410 System, DEMNA Ethernet Adapter, VMS Operating System license, DECnet Full-Function license	100,000	405	482
64AMA-BE	VAX 6000 Model 410 System, one 32MB memory module, two VAXBI Adapters, KDB50 Disk Controller, DEBNI VAXBI Ethernet Adapter, TK70 296MB Console Tape, ULTRIX license 64-users, DECnet ULTRIX	214,935	500	595
64AMA-EE	VAX 6000 Model 410 System, one 32MB memory module, two VAXBI Adapters, KDB50 Disk Controller, DEBNI VAXBI Ethernet Adapter, TK70 296MB Console Tape, initial fee and one year periodic payment license fee for ULTRIX 64-users, DECnet ULTRIX	202,335	500	595
64APH-AE	VAX 6000 Model 410 System, DEMNA Ethernet Adapter, VMS Operating System license, DECnet Full-Function license	67,000	405	482
VAX 6000 Model 500 Systems				
65AMA-AE	VAX 6000 Model 510 System, DEMNA Ethernet Adapter, VMS Operating System license, DECnet Full-Function license	186,000	405	482
65AMB-BE	VAX 6000 Model 510 System, DEMNA XMI Ethernet adapter, one VAXBI adapter, 12-slot BI, TK70 296MB console tape, ULTRIX 64-User license, DECnet ULTRIX	163,000	490	583
65BMA-AE	VAX 6000 Model 520 System, DEMNA Ethernet Adapter, VMS Operating System License, DECnet full-Function license	261,000	489	582
65CMA-AE	VAX 6000 Model 530 System, DEMNA Ethernet Adapter, VMS Operating System License, DECnet Full-Function License	336,000	573	682
65CMB-BE	VAX 6000 Model 530 System, DEMNA XMI Ethernet Adapter, one VAXBI Adapter, 12-slot BI, TK70 296MB Console Tape, ULTRIX 64-User License, DECnet ULTRIX	313,000	658	783
65DMA-AE	VAX 6000 Model 540 System, DEMNA Ethernet Adapter, VMS Operating System License, DECnet Full-Function License	411,000	657	782
65DMB-BE	VAX 6000 Model 540 System, DEMNA XMI Ethernet Adapter, one VAXBI Adapter, 12-slot BI, TK70 296MB Console Tape, ULTRIX 64-User License, DECnet ULTRIX	388,000	742	883
65EMA-AE	VAX 6000 Model 550 System, DEMNA Ethernet Adapter, VMS Operating System License, DECnet Full-Function License	486,000	741	882
65EMB-BE	VAX 6000 Model 550 System, DEMNA XMI Ethernet Adapter, one VAXBI Adapter, 12-slot BI, TK70 296MB Console Tape, ULTRIX 64-User License, DECnet ULTRIX	463,000	826	983
65FMA-AE	VAX 6000 Model 560 System, DEMNA Ethernet Adapter, VMS Operating System License, DECnet Full-Function License	561,000	825	982
65FMB-BE	VAX 6000 Model 560 System, DEMNA XMI Ethernet Adapter, one VAXBI Adapter, 12-slot BI, TK70 296MB Console Tape, ULTRIX 64-User License, DECnet ULTRIX	538,000	910	1,083

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Call Service is available on a best-efforts basis 24 hours a day, seven days a week. The vendor bills customers for time and materials; charges are portal-to-portal, with labor, parts, and travel expenses rated separately.

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

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The company claims that the designated products receive the same response time and service coverage as Digital hardware under standard service agreements.

Under Digital's software support policy, all warranted VAX software products are covered under a policy guaranteeing that the product conforms to the Software Product Description (SPD) shipped with it. Most VAX software products include the warranty at no extra charge. Delivery of the warranty is provided through automated and manual problem reporting. Customers can purchase added-value services such as installation, training, telephone support, newsletters, and on-site support separately, or they can select a System Startup Service Package.

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

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

Equipment Prices

		Purchase Price ($)	Basic Service (Mo.) ($)	DEC-serv. (Mo.) ($)
VAX 6000 Model 310 Systems				
63AMH-AE	VAX 6000 Model 310 System with DEMNA XMI Ethernet Adapter, VMS Operating System license, DECnet Full-Function license	66,000	405	482
63AMB-BE	VAX 6000 Model 310 System with one 32M-byte memory module, two VAXBI Adapters, KDB50 Disk Controller, DEBNA VAXBI Ethernet Adapter, TK70 296MB Console Tape, ULTRIX license 64-users, DECnet ULTRIX	162,960	500	595
SV-6B02-AK	VAX 6000 Model 310 System with one 32M-byte memory module, DEMNA XMI Ethernet Adapter, Infoserver 100, KDM70 Disk Controller, two RA92 1.5GB Disk Drives, VT420 Terminal, LA75 Console Printer, VMS Operating System license, DECnet Full-Function license, VAX Performance Advisor	174,000	862	1,026
63APH-AE	VAXserver 6000 Model 310, DEMNA XMI Ethernet Adapter, VMS server license, DECnet Full-Function license	47,000	405	482
VAX 6000 Model 410 Systems				
64AMH-AE	VAX 6000 Model 410 System, DEMNA Ethernet Adapter, VMS Operating System license, DECnet Full-Function license	124,000	405	482
64AMA-BE	VAX 6000 Model 410 System, one 32M-byte memory module, two VAXBI Adapters, KDB50 Disk Controller, DEBNI VAXBI Ethernet Adapter, TK70 296MB Console Tape, ULTRIX license 64-users, DECnet ULTRIX	214,935	500	595
64AMA-EE	VAX 6000 Model 410 System, one 32M-byte memory module, two VAXBI Adapters, KDB50 Disk Controller, DEBNI VAXBI Ethernet Adapter, TK70 296MB Console Tape, initial fee and one year periodic payment license fee for ULTRIX 64-users, DECnet ULTRIX	202,335	500	595
64APH-AE	VAX 6000 Model 410 System, DEMNA Ethernet Adapter, VMS Operating System license, DECnet Full-Function license	84,000	405	482
VAX 6000 Model 500 Systems				
65AMA-AE	VAX 6000 Model 510 System, DEMNA Ethernet Adapter, VMS Operating System license, DECnet Full-Function license	227,000	405	482
SV-6E02A-AK	VAX 6000 Model 510 System, one 64M-byte memory module, DEMNA XMI Ethernet Adapter, KDM70 Disk Controller, SA800 Storage Array with four RA92 1.5G-byte Disk Drives, Infoserver 100, VT420 Console Terminal, LA75 Console Printer, VMS Operating System license, DECnet Full-Function license, VAX Performance Advisor	388,000	1,060	1,262
SV-6E02A-BK	VAX 6000 Model 520 System, two 64M-byte memory modules, DEMNA XMI Ethernet Adapter, KDM70 Disk Controller, SA800 Storage Array with six RA92 1.5G-byte Disk Drives, TA81 Tape Drive, Infoserver 100, VT420 Console Terminal, LA75 Console Printer, VMS Operating System license, DECnet Full-Function license, VAX Performance Advisor	654,000	1,342	1,598
SV-6E91A-CK	VAX 6000 Model 530 System, two 64M-byte memory modules, DEMNA XMI Ethernet Adapter, CIXCD Cluster Adapter, HSS70 Cluster Starter Package, one HSC5X Data Channel, SA800 Storage Array with eight RA92 Disk Drives, Infoserver 100, TA90E Tape Drive, VT420 Console Terminal, LA75 Console Printer, VMS Operating System license, DECnet Full-Function license, Cluster license, VAX Performance Advisor	930,000	1,559	1,856
SV-6E91A-DK	VAX 6000 Model 540 System, two 128M-byte memory modules, DEMNA XMI Ethernet Adapter, CIXCD Cluster Adapter, HSS70 Cluster Startup Package, one HSC5X Data Channel, SA800 Storage Array with 10 RA92 1.5G-byte Disk Drives, Infoserver 100, TA90E Tape Drive, VT420 Console Terminal, LA75 Console Printer, VMS Operating System license, DECnet Full-Function license, Cluster license, VAX Performance Advisor	1,205,000	1,886	2,245
SV-6E91A-EK	VAX 6000 Model 550 System, two 128M-byte memory modules, DEMNA XMI Ethernet Adapter, CIXCD XMI Cluster Adapter, HSS70 Cluster Startup Package, two HSC5X Data Channels, SA800 Storage Array with 10 RA92 1.5G-byte Disk Drives, Infoserver 100, TA90E Tape Drive, VT420 Console Terminal, LA75 Console Printer, VMS Operating System license, DECnet Full-Function license, Cluster license, VAX Performance Advisor	1,290,000	1,970	2,345
SV-6E91A-FK	VAX 6000 Model 560 System, two 128M-byte memory modules, DEMNA XMI Ethernet Adapter, HSS70 Cluster Startup Package, CIXCD XMI Cluster Adapter, three HSC5X Data Channels, SA800 Storage Array with 16 RA92 1.5G-byte Disk Drives, Infoserver 100, TA90E Tape Drive, VT420 Console Terminal, LA75 Console Printer, VMS Operating System license, DECnet Full-Function license, Cluster license, VAX Performance Advisor	1,470,000	2,693	3,206