

# DEC MicroVAX Family

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**Product Summary**

**Editor's Note**

Digital Equipment Corporation has enhanced its MicroVAX family with an overhaul of the low- and high-end models. The new MicroVAX 3100 replaces the MicroVAX II and MicroVAX 2000 at the low end. The MicroVAX 3800 and MicroVAX 3900 replace the MicroVAX 3500 and MicroVAX 3600 at the high end. The improved price/performance of the new MicroVAX models, plus the addition of new disk drives and enhanced upgrade packages, greatly strengthens the entire MicroVAX family.

The MicroVAX Family comprises the MicroVAX 3100, 3300, 3400, 3800, and 3900.

**Description**

The MicroVAX Family is Digital's low-end multiuser VAX system. MicroVAX systems are targeted toward departmental, workgroup, and branch office computing, and feature full software compatibility with the entire VAX Family in either the proprietary VMS or the UNIX-based ULTRIX-32 operating environment.

**Strengths**

The primary advantages of the MicroVAX Family are its VAXcluster networking capabilities and the large applications base available for the systems.

**Limitations**

Product line turnover.

**Competition**

IBM AS/400 and 9370, Hewlett-Packard HP 3000 and HP 9000, and NCR Tower Systems.

**Vendor**

Digital Equipment Corp. (DEC)  
 146 Main Street  
 Maynard, MA 01754-2571  
 (508) 493-5111

**Price**

List prices range from \$8,480 to \$248,900. Also standard prices range from \$9,500 to \$260,554.

**GSA Schedule**

Yes.

# Analysis

## Product Strategy

Since our last report, Digital has enhanced the MicroVAX Family with three new offerings: MicroVAX 3100, MicroVAX 3800, and MicroVAX 3900. The new MicroVAX 3100 replaces the MicroVAX II and MicroVAX 2000 at the low end of the line. MicroVAXs 3800 and 3900 replace the MicroVAX 3500 and 3600 at the high end. The new product line offers improved memory and performance. The MicroVAX Family now comprises the MicroVAX 3100, 3300, 3400, 3800, and 3900.

## MicroVAX 3000 Family

The MicroVAX Family has evolved over the years to become a high-performance entry point to VAX computing. Just three years ago the MicroVAX 3000s were considered the high end of the family; now they comprise the *entire* MicroVAX Family. Digital is expected before long to produce a MicroVAX 4000 family to further enhance MicroVAX performance.

*The current MicroVAX Family comprises the MicroVAX 3100, 3300, 3400, 3800, and 3900.*

## Improved High End

The MicroVAX 3800 and 3900 offer up to one and a half times the performance of the MicroVAX 3500 and 3600—the former high end models they replace.

Both new models take advantage of the improved CVAX chip technology used in VAX 6000 systems.

The new models provide increased mass storage as well. The MicroVAX 3800 has a storage capacity of 7.2G bytes. The MicroVAX 3900, using the new 1.2G-byte RA90 disks, has a storage capacity of 9.7G bytes.

## New Entry Point

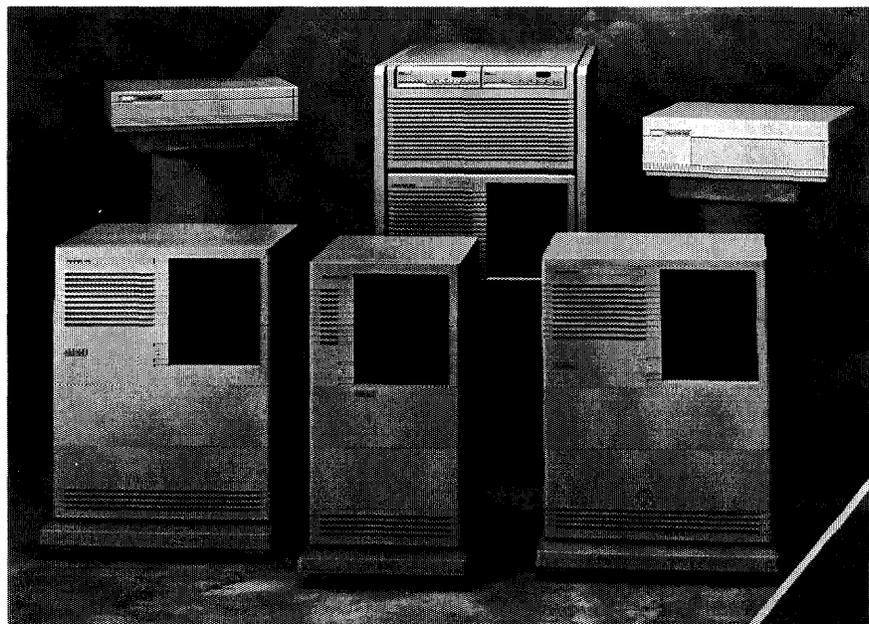
The MicroVAX 3100—replacing both the MicroVAX 2000 and MicroVAX II at the low end—more than doubles the computing power of the low end.

The low-end models have been the most popular MicroVAX models for Digital, and the improved price/performance of the MicroVAX 3100 indicates that it too will sell well.

The MicroVAX 3100 uses the same microprocessor chip as the midrange MicroVAX 3300 and 3400.

## Discontinued Models

The MicroVAX 2000, MicroVAX II, MicroVAX 3500, and MicroVAX 3600 are no longer in production. Selected models of the MicroVAX II—



**Table 1. System Comparison**

Model	MicroVAX 3100	MicroVAX 3300	MicroVAX 3400	MicroVAX 3800	MicroVAX 3900
<b>System Characteristics</b>					
Date of introduction	7/89	10/88	10/88	4/89	4/89
Microprocessor type	CVAX	CVAX	CVAX	CVAX	CVAX
Microprocessor cycle time	90 ns.	100 ns.	100 ns.	60 ns.	60 ns.
Operating system	VMS, ULTRIX, VAXELN	VMS, ULTRIX, VAXELN	VMS, ULTRIX, VAXELN	VMS, ULTRIX, VAXELN	VMS, ULTRIX, VAXELN
Upgradable from	MV2000, Mi- croVAX II, PDP-11	MicroVAX II, PDP-11	MicroVAX II, PDP-11	MicroVAX II, 3300, 3400, 3500, 3600	MicroVAX II, 3800
Upgradable to	Not applicable	MicroVAX 3800	MicroVAX 3800	MicroVAX 3900	Not applicable
Number of serial/parallel I/O ports	4-12 serial, 2 synchronous	40 serial w/modem control, 80 without	40 serial w/modem control, 80 without	—	—
Number of backplane slots	none	6	12	12	12
<b>Memory</b>					
Minimum capacity (bytes)	4M	4M	4M	16M	32M
Maximum capacity (bytes)	32M	52M	52M	64M	64M
<b>Disk Storage</b>					
Minimum capacity (bytes)	104M	150M	300M	400M	1.2G
Maximum capacity (bytes)	2.9G	6.3G	7.2G	7.2G	9.7G
Number of Workstations	44 active	75 (48 active)	90 (48 active)	152 (76 active)	152 (76 active)
<b>Communications Protocols</b>					
	DDCMP; Ethernet; SNA; X.25; 2780/3780; TCP/IP; 3271; LU6.2; X.400				
<b>Purchase Price (\$)</b>					
(base configurations)	From 8,480	From 25,000	From 45,350	From 81,000	From 120,200

such as the realtime and VAXlab systems—will continue to be available. The discontinued models were effectively replaced by the newest MicroVAX systems.

### New Competition

Digital has been busy making improvements to its entire VAX line in the face of new competition, specifically from Hewlett-Packard. While the MicroVAX has compared favorably against IBM's AS/400 line, Digital is struggling to keep up with HP. The latest announcements of HP 3000 and HP 9000 multiuser systems pose a challenge to the MicroVAX Family; there are now more competing products than ever before.

Digital has proven its commitment to low-end VAX computing; customers can be assured that Digital will continue to enhance the performance of the MicroVAX Family.

### UNIX Not a Factor

While Digital is committed to ULTRIX-32, its implementation of UNIX, ULTRIX has not been a major factor in MicroVAX sales. Digital's VMS operating system has become as much (if not more) of an advantage. Most MicroVAXs are sold and will continue to sell with VMS.

Digital offers other product lines, particularly workstations, that are targeted more toward the UNIX market.

### Leasing Options

Digital has developed a new program called the Technology Migration Option Leasing Program. Customers can choose from a variety of leasing options for MicroVAX 3300, 3400, 3800, and 3900 systems. The program allows the customer to trade up to larger MicroVAX or VAX systems after the first year of the lease and provides a purchase

# Company Profile

## Digital Equipment Corporation

### Corporate Headquarters

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Maynard, MA 01754-2571  
(508) 493-5111

### In Canada

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

### 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; VAX 6000 Series medium-range systems; and VAX 9000 Series high-end mainframes.

In addition to the VAX family, Digital offers DEC-systems 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.

option as well. A less expensive option than purchasing a system, leasing is an ideal solution for smaller businesses looking for the power of VAX computing.

### Applications

Applications for the MicroVAX Family range from general-purpose transaction processing, project management, and program development to more technical applications such as computer-aided engineering, inventory control, database distribution, and office automation.

MicroVAX systems are used in a variety of industries including manufacturing, banking, business, government, and education.

Digital, which relies heavily on third-party software vendors for specialized applications, claims there are over 6,000 programs available for the MicroVAX.

### Realtime

Special configurations of MicroVAX systems are available for realtime applications such as data acquisition, flight simulation, process control, and utility management.

Most realtime systems are sold through third-party resellers who take a basic system and dedicate it to specialized applications. Lower-priced diskless configurations are popular for realtime computing because storage is not as important as I/O handling.

### **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 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 Equipment 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 years.

For fiscal 1989, ended June 30, Digital reported net earnings of \$1.1 billion, down 18 percent from the \$1.3 billion earned in 1988. Revenues for 1989 were \$12.7 billion, up 11 percent from the \$11.5 of the previous year.

Earnings for the second fiscal quarter, ended December 30, 1989, were \$155.4 million compared with \$279 million for the same period last year, a 44 percent drop. (See graph for revenue and earning trends over the last several years.)

Digital blamed the profit drop on flat U.S. sales and lower demand for high-margin products. Like major competitors, Digital continues to do better internationally.

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 dollar 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."

### **Competitive Position**

The MicroVAX Family faces stiff competition in the departmental computer systems market. Digital's primary competitors are Hewlett-Packard, IBM, NCR, and Sun Microsystems.

The MicroVAX Family compares favorably in both price and performance to IBM's low-end AS/400 and 9370 models; the MicroVAXs also do well against the NCR Tower Series. The MicroVAX 3100 offers more memory and storage than the Sun SPARCstation 1GX.

Hewlett-Packard is a different story. While Digital's MicroVAX can be compared to the low-end HP 3000 and HP 9000 models, it is obvious that HP's reduced instruction set computing (RISC) technology is posing a problem for Digital. Improvements in both price and performance are easier and faster on RISC systems, and Digital may

soon find it hard to keep up. Digital's only entry into the RISC market thus far has been its DECsystems and DECstations.

### **User Opinion**

Responses to Datapro's 1989 Computer Users Survey included returns from 26 MicroVAX users. Of the users surveyed, 73 percent purchased their systems from Digital, 23 percent leased from a third party, and only 4 percent leased from Digital. The average length of installation for the systems was just over two years. Despite Digital's reputation as an engineering/scientific-oriented system vendor, most of the users are running business and administrative applications. Of the MicroVAX system customers surveyed, 42 percent have accounting/billing applications; 27 percent have educational administration applications; and 23 percent have payroll and personnel applications. In contrast,

**Table 2. Mass Storage Devices**

Model	RA90	RF71	RZ23	RZ55	RF30
Type		Integrated (ISE)	Integrated (ISE)	Integrated Winchester	Winchester
Size (inches)	9	5¼	3½	5¼	5¼
Number of surfaces	13/drive	—	—	—	—
Formatted capacity per drive (bytes)	1.2G	400M	104M	332M	150M
Interface/controller	—	NA	—	—	DSA
Number of drives per interface/controller	1	NA	—	—	1
Average access time	—	29.3 ms.	33.4 ms.	24.3 ms.	29.3 ms.
Data transfer rate (bytes/second)	2.8M	1.5M	1.25M	1.25M	1.5M
Bytes per sector/track	512/sector	512/sector	512/sector	512/sector	512/sector
Supported by Models	MV 3900	MV3300, 3400, 3800	MV3100	MV3100	MV3300, 3400, 3800
Purchase price (\$)	28,340	11,420	2,240	6,160	5,828

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

only 19 percent have engineering/scientific, and 15 percent have mathematical/statistical applications.

For applications, 50 percent of programming is performed by in-house personnel. Other methods of obtaining applications software are independent suppliers (40 percent), purchasing packaged programs from Digital (26 percent), and contract programming (8 percent).

The following table shows how the 26 respondents rated their MicroVAX systems:

	Ratings for Micro-VAX Systems*
Ease of operation	8.3
Reliability of system	9.2
Reliability of peripherals	8.5
Maintenance service:	
Responsiveness	8.5
Effectiveness	8.6
Technical support:	
Troubleshooting	8.1
Education	8.0
Documentation	7.6
Vendor's software:	
Operating system	8.7
Compilers & assemblers	8.5
Application programs	7.8
Ease of programming	8.1
Ease of conversion	7.8
Overall satisfaction	8.5

\*Average based on a scale from 1 (Poor) to 10 (Excellent).

MicroVAX users were very satisfied with their systems. In fact, 89 percent said that their computers performed as expected and 92 percent would recommend the system to another user. Users' plans for acquisition and implementation included expansion of present hardware (58 percent), expansion of data communications facilities (31 percent), proprietary software from other suppliers (39 percent), and additional software from the manufacturer (15 percent).

## Decision Points

### Strengths

#### Applications Base

A major advantage of the MicroVAX Family (and other VAX systems) is the large applications base. Over 6,000 applications are available for MicroVAX systems. The success of VAX computers and the VMS operating system has led many third-party software vendors to develop applications for these systems.

### VAXcluster Networking Capabilities

Digital continues to offer innovative networking schemes for its MicroVAX systems and other computers—a significant advantage where sharing computational and peripheral resources is critical. Up to 96 MicroVAX and VAXstation nodes can be connected over Ethernet in a configuration called a Local Area VAXcluster (LAVc). In LAVcs, servers provide boot services, computational facilities, and disk storage far exceeding those available to individual stations.

### VMS Operating System

The compatibility provided under the VMS environment allows software to be transported between systems; for example, under VMS Version 5.2 (the latest release), a Fortran program written on a MicroVAX can be sent to a VAX 6200 or 8800 Series system that uses the Symmetrical Multiprocessor (SMP) architecture and can be executed in parallel.

### Limitations

#### Product Line Turnover

As was the case with the VAXstation line, Digital's continual improvements to the MicroVAX Family has resulted in a complete turnover of the product line in a relatively short period of time. This policy can be troublesome for potential customers looking for long-term solutions.

Digital recognizes this problem and provides upgrade packages for nearly all the MicroVAX systems that allow the customer to take advantage of the new technology. Digital's continual enhancements and the availability of upgrade options provide features and performance that compensate for the interim product line instability.

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### Cross-Reference

For details on VAXclusters, refer to the "DEC VAX 6000 Systems" report on Page M11-325-501 in *Datapro Reports on Minicomputers*.

# Characteristics

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## System Overview

The MicroVAX Family is Digital Equipment Corporation's strategic low-end multiuser system. The MicroVAX has an installed base of over 150,000 systems and continues to sell well as the entry point to VAX computing. Targeted toward corporate departments, workgroups, and branch offices, the MicroVAX systems feature full software compatibility with Digital's VAX superminis and VAX 9000 mainframes in either the proprietary VMS or the UNIX-based ULTRIX-32 operating environment.

## Specifications

### Data Formats

**Basic Format:** 32-bit word.

**Internal Code:** ASCII for text-oriented data; binary for calculations.

**Instruction Set:** The MicroVAXs feature a 304-instruction set, similar to but implemented differently from that used by larger VAX systems.

### Main Storage

Memory for the MicroVAX 3100 is dynamic parity MOS RAM. Main memory increments are 4M, 8M, and 16M bytes. Maximum main memory is 32M bytes.

The MicroVAX 3300 and 3400 include 4M bytes of error checking and correcting (ECC) system memory on the CPU board; memory can be expanded to 52M bytes in 8M- and 16M-byte increments.

The MicroVAX 3800 and 3900 also support error checking and correcting (ECC) system memory. 16M- and 32M- byte memory increments allow these systems to expand to 64M bytes.

Like all VAX systems, the MicroVAXs provide up to 4G bytes of virtual memory space.

### Processing Components

The MicroVAX 3300, 3400, 3800, and 3900 use the CVAX CPU chip and CVAX floating-point unit (FPU). The use of advanced CMOS technology in the CPU and floating-point unit on the 3800 and 3900 results in a more efficient processor-board layout that enables the implementation of dual-level cache memory. The CPU chip holds 1K byte of cache memory, and an additional

64K bytes reside on the CPU board. The CPU features a cycle time of 60 nanoseconds.

The MicroVAX 3300 and 3400 CPU complex—called the KA640—includes 4M bytes of main memory; an Ethernet controller; and an adapter for the RF30 Integrated Storage Element (ISE), the system's primary disk storage device.

### Input/Output Control

I/O on the MicroVAX 3800 and 3900 is handled through the 22-bit extended Q-bus (also called the Q22). The Q-bus provides 22-bit addressing and four interrupt levels; it also performs block-mode DMA data transfers at up to 3M bytes per second.

The MicroVAX 3300 and 3400 also employ the Q-bus, but strictly for high-throughput I/O. The disk controller, on the Q-bus in the other systems, is embedded in the RF30 ISE storage element, the system's primary disk drive. An Ethernet controller and an ISE adapter reside in the CPU module itself.

The MicroVAX 3100 has a busless architecture and no expansion slots. It is equipped with a modified Small Computer System Interface (SCSI) port to connect TK50 tape drives; external disks are connected through an ST506 interface.

### Configuration Rules

The MicroVAX 3100 comes in a choice of two enclosures. The Model 10 is a compact box with room for up to three storage devices; the Model 20 is slightly larger and can hold up to five storage devices. A basic configuration of either model includes 4M bytes of memory, an RZ23 104M-byte disk drive, SCSI controllers, four serial lines, and operating system license.

The MicroVAX 3300 and 3400 CPU complex—called the KA640—includes 4M bytes of main memory; an Ethernet controller; and an adapter for the RF30 Integrated Storage Element (ISE), the system's primary disk storage device. The MicroVAX 3300 comes with one 150M-byte RF30 and has a five-slot enclosure for addition of Q-bus options. The 3400, which uses the 11-slot BA213 enclosure, includes two RF30s. Addition of an expansion pedestal enclosure allows up to three RF30s to be added to the 3300 and 3400.

Using the Digital Storage System Interconnect (DSSI) and Local Area VAXcluster software (discussed in detail in the **Software** section of this report), up to six RF30s can be accessed by two hosts for high data availability. If one host fails, users' requests for data access are automatically routed through the other system.

The MicroVAX 3800, in a basic configuration, is available in the 27-inch BA213 pedestal enclosure, and includes 16M bytes of main memory (expandable to 64M bytes); a 400M-byte RF71 disk drive; a 296M-byte TK70 cartridge tape drive; an Ethernet controller; operating system software (a 1-to-20 user VMS license or 2-to-65 user ULTRIX-32 license); a DECnet End-Node license; and, with the VMS operating system, a VMS Services for MS-DOS license. Two additional RF71 disk

drives can be configured in the base cabinet of the MicroVAX 3800. Additional drives in an expansion cabinet can raise total storage to 7.2G bytes.

The basic MicroVAX 3900 system is available in a cabinet enclosure and includes 32M bytes of main memory, a 1.2G-byte RA90 disk drive; a 296M-byte TK70 cartridge tape drive, an Ethernet controller, operating system software (a 1-to-20 user VMS license or 2-to-65 user ULTRIX-32 license), a DECnet end node or full-function license, and a VMS Services for MS-DOS license (with VMS operating system only). One additional RA90 and two RA70 disk drives can be configured in the main cabinet for a total of 3G bytes of storage. Additional RA disks in separate cabinets can be configured on the system for a total of 9.7G bytes of storage.

### Dual-host Configurations

Several MicroVAX models are available as dual-host systems. A dual-host configuration is made up of two MicroVAX systems in which the storage devices are linked by a Digital Storage Systems Interconnect (DSSI) bus cable. This configuration maximizes data access and disk storage, and is ideal for applications needing access to crucial data.

### VAXlabs

Specialized VMS-based realtime workstation systems, called VAXlabs, are offered for laboratory data acquisition and experiment control applications.

### VAXservers

Specialized configurations of Digital's MicroVAX systems, called VAXservers, are available as boot nodes and application servers for distributed workstations, PCs, and terminals in network and Local Area VAXcluster environments. (For details on LAVCs, see the **Software** section below.) The servers are the VAXserver 3100, 3300, 3400, 3800, and 3900.

### Realtime

Special configurations of MicroVAX systems are available for realtime applications such as data acquisition, flight simulation, process control, and utility management.

### Input/Output Units

Refer to Table 2 for mass storage devices, Table 3 for workstations, and Table 4 for printers.

**Magnetic Tape:** The TK70 streaming cartridge tape drive comes bundled with the MicroVAX 3300, 3400, 3800, and 3900 systems. The 48-track TK70 employs a 5¼-inch form factor and features a streaming speed of 100 ips and density of 10,000 bpi. The TK70 uses 296M-byte, ½-inch CompacTape-II tape cartridges (developed by Digital in conjunction with the 3M Company) which hold the entire contents of the 280M-byte RA70 disk drive. The TK70 transfers data at 90K bytes per second and features ECC, CRC, and a read-after-write procedure to verify data.

**Table 3. Terminals**

Model	VT320	VT330	VT340
<b>Display Parameters</b>			
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	9 or 15 x 12 dot matrix	10 x 20 dot matrix	10 x 20 dot matrix
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
<b>Keyboard Parameters</b>			
Style	Typewriter	Typewriter	Typewriter
Character/code set	ASCII, NRCS	ASCII, NRCS	ASCII, NRCS
Detachable	Yes	Yes	Yes
<b>Terminal Interface</b>			
	RS-232-C, RS-423	RS-232-C, RS-423, and 20 mA standard	RS-232-C, RS-423, and 20 mA standard
<b>Purchase Price (\$)</b>	561	2,023	2,907
<b>Comments</b>			
		800 x 500 pixel graphics array; supports split- screen viewing	800 x 500 pixel graphics array; supports split- screen viewing

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

The TZ30 streaming tape drive is a 5¼-inch, half-height cartridge unit. A single cartridge can back up any of the Winchester disks used on a MicroVAX 3100. This SCSI drive has a maximum storage capacity of 95M bytes and achieves read/write speed of 75 ips in streaming mode. The TZ30 has a peak data transfer rate of 62.5K bytes per second. The TZ30 is fully read/write compatible with the TK50 drive.

Additionally, the MicroVAX 3900 supports the TU81-Plus tape subsystem, which is also employed by Digital's VAXBI-based VAX systems and UNIBUS PDP-11 computers. The TU81-Plus is designed for applications requiring sustained input/output, such as disk backup, data archiving, data interchange, and recording of data from high-speed test equipment. This PE/GCR unit features a 256K-byte buffer, 1600/6250 bpi recording densities, and a streaming speed of 75 ips. A nine-track unit that employs ½-inch tape, the TU81-Plus also features a 25-ips start/stop speed and storage capacities of 145M bytes in GCR mode and 40M bytes in PE mode. Data transfer speed is 468K bytes per second.

**Other Peripherals:** The RRD40 Compact Disk Reader system is a read-only laser disk drive employing a compact, removable, 600M-byte Compact Disk Read-Only Memory (CD-ROM) optical disk. The disk itself is 4.7 inches (120 mm.) in diameter. The drive's average access time is 1.5 seconds; average data transfer rate is 150K bytes per second.

The RV20 write-once, read-many (WORM) optical disk drive is a 2G-byte device featuring a data transfer rate of 262K bytes per second and an access time of 212.5 milliseconds. Four RV20 controllers can be configured per MicroVAX CPU, with four transports per controller. The RV20 drive comes in a separate storage cabinet (40 inches high, 19 inches wide). A single cabinet can contain up to four RV20 drives (one master and three slaves).

DECTalk, a single-line (DTC01) or Multiline (DTC03) speech synthesis unit, converts standard ASCII text into speech output; it has an RS-232-C interface and modular telephone connections. It allows users to access a data base with a standard touch-tone telephone.

### Communications

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.

The MicroVAX systems also participate in LAVCs as either boot or satellite members. Up to 96 MicroVAX and VAXstation Family members (satellites) are interconnected through ThinWire Ethernet to two central MicroVAXs, VAXservers, or other VAX systems acting as servers (boot nodes). The servers manage system software, applications, and a shared common file system. Satellite members share system resources.

### Software

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

### VMS

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

The VMS operating system for the MicroVAX systems (formerly called MicroVMS) is the same as that

**Table 4. Printers**

Model	LA75	LA324	LJ252	LN03 Plus	LG02
Type	Dot matrix	Dot matrix	Ink Jet	Laser	Matrix
Speed	32/42/125/ 250 cps	100/300 cps	160 cps text	8 ppm	600 lpm
Paper size	4¼ to 10 inches wide	Up to 17 inches wide	8.5-inch wide	8.5 x 11 inches	4-16 inches wide; 3-20 inches long
Character formation	36 x 18/36 x 17/24 x 9/12 x 9 dot matrix	180 x 180 dpi	—	300 x 300 dpi	200 x 200 dpi
Horizontal character spacing (char./inch)	10, 12, 16.5, 17.1 or 5, 6, 8.25, 8.55	—	—	Variable	Variable
Vertical line spacing (lines/inch)	2, 3, 4, 6, 8, 12	—	—	Variable	Variable
Character set	U.S. ASCII, 8 others	Variable	DEC techni- cal, NCR, ISO-Latin, line drawing	ACII, techni- cal; 17 resi- dent fonts	Multiple
Controller/Interface	RS-423	Serial and parallel	Parallel	RS-232-C	RS-232-C, parallel
No. of printers per controller/ interface	1	—	—	1	—
Printer dimensions, in. (h x w x d)	4.8 x 16.8 x 13.6	—	—	15.0 x 21.0 x 23.5	38.0 x 33.5 x 22.3
Graphics capability	180 x 144 dpi	180 x 180 dpi	180 x 180 dpi (7 colors), 90 x 90 dpi (255 colors)	300 x 300 dpi	200 x 200 dpi
Purchase price (\$)	891	2,331	1,827	4,739	14,406
Comments	Built-in LA50, LA100, LA210, IBM Proprinter emulation.	Built-in IBM Proprinter emulation.	Supports HP- PCL for PC applications.	Provides bit mapped, Tek- tronix 4010- /4014-com- patible graphics.	Text and graphics ca- pabilities.

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

which runs on the VAX superminis. Consequently, the MicroVAX computers can run the same system and applications software as the larger VAX computers without recompilation or relinking, subject to the limitations of peripheral support.

Version 5.2, the current release of VMS, includes the following new features:

- An increase in the maximum number of computers in a VAXcluster system from 42 to 96
- VAXcluster support for the license management facility (LMF)
- Backup and security enhancements
- Increased centralized system management capabilities

### ULTRIX

**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 on the application, **ULTRIX-32** can support over 64 users.

### VAXeln

**VAXeln**, which is not so much an operating system as a development tool and specialized runtime environment, acts as a compatible subsystem to the VMS operating system for development of applications in realtime control and distributed computing environments. It consists of development utilities for creating target applications and a runtime kernel of device drivers and service code that becomes a part of each application. After development, **VAXeln** applications run standalone on MicroVAX target systems without the host operating system. **VAXeln** applications are written in an optimizing version of Pascal or C.

### Database Management

The MicroVAXs employ the VAX database management or information management architecture, which is arranged in layers above the operating system.

Digital's DBMS products figure prominently in **DECtp**, a largely software-based systems environment

that integrates facilities for developing distributed transaction processing applications: databases, storage systems, data interoperability products, transaction processing monitors, and support programs. These products run on most MicroVAX (including VAXstation) and VAX Systems. DECtp includes the following major software components:

- DECintact Version 1, a transaction processing (TP) monitor intended for high-volume applications requiring transaction integrity, application availability, and transaction system recovery.
- VAX Rdb/VMS Version 3, an enhanced version of Digital's relational database management system (RDBMS).
- VAX SQL Version 2, Digital's implementation of the Structured Query Language (SQL) database facility.
- VAX CDD/Plus Common Data Dictionary Version 4, which provides a single, logical repository for data definitions (metadata) and descriptions in a distributed environment.
- VAX Rally Version 2, a fourth-generation tool for VAX Rdb/VMS database applications.
- VAX DBMS Version 4, a general-purpose, Codasyl-compliant network database management system (DBMS) designed to handle high transaction volumes for numerous, concurrent users.
- VAX Data Distributor Version 2, which allows relational databases to be replicated across a distributed TP environment.
- VAX ACMS Version 3, an enhanced version of Digital's ACMS TP monitor and fourth-generation language facility.
- VAX TDMS Version 1.8, which enables TP system users to manage forms and other data presentation facilities by separating forms data from application code.
- DEClink software, which provides access to IBM databases. One component package, VAXlink, bridges Digital's Rdb/VMS data bases and IBM's IMS and VSAM structures so that data can be copied from IBM mainframes into distributed VMS environments. VIDA with IDMS/R, the other constituent DEClink package, allows users on a VAX system to log on to a central IBM system through an SNA gateway and use data in CA-IDMS/DB databases.

### Other Software

**Languages:** Programming languages available for the MicroVAXs include Ada, APL, Basic, Bliss-32, C, Cobol, Dicol, Digital Standard Mumps (DSM), Fortran, OPS5 (for artificial intelligence applications), Pascal, PL/1, RPG II, and Lisp.

**Communications:** Like the larger VAX systems, the MicroVAXs support the *Digital Network Architecture (DNA)*,

a set of protocols governing the format, control, and sequencing of message exchange for all DECnet implementations.

### Network Applications Support (NAS)

As another part of its strategy for multivendor networking, Digital provides *Network Applications Support (NAS)* products that allow common access to services on DECnet/OSI networks. Those products provide application access, business communications, and information/resource sharing services for Digital's VT Series terminals, based on VAX Systems running either VMS or UNIX, Apple Macintosh microcomputers, and MS-DOS- and OS/2-based PCs. NAS provides common services across VMS and ULTRIX. For example, DECwindows allows users to access applications running on both operating systems. Digital's Compound Document Architecture (CDA) allows all types of data (including text and graphics) to be shared across VMS and ULTRIX systems.

Digital provides toolkits, documentation, and training for CDA application developers. Over time, the toolkit and documentation will become standard components of all VMS- and ULTRIX-32-based systems. The company has also published a manual of specifications for the Digital Document Interchange Format (DDIF); a technical description of CDA toolkit routines; and information on the CDA Converter, which is designed to simplify development of software converters.

Digital is committed to its NAS strategy for the 1990s, and plans to announce new and enhanced NAS services to continually enhance the NAS platform.

**VMS/ULTRIX Connection**—available for the MicroVAX 3800 and larger VAX systems—provides VMS services to UNIX clients by adding TCP/IP and NFS to VMS. (For example, on larger VAX systems, it allows a VMS-based VAXcluster system to act as an NFS server to UNIX workstations; the UNIX systems can thus take advantage of VAXcluster data management features, such as volume shadowing for data preservation.)

**ULTRIX Mail Connection Version 1 (V1)** provides ULTRIX-based systems with access to Digital's MAIL-bus enterprise-wide message transfer service. This connection allows ULTRIX Mail users to exchange messages with users of Digital's ALL-IN-1 and VMS Mail; other X.400 systems; IBM PROFS and DISOSS/Personal Services; and non-Digital, UNIX mail systems.

**Local Area VAXcluster (LAVC)** software allows the interconnection through Ethernet of up to 42 VAXstation and MicroVAX systems. At least one system must serve as a boot node; all others can be configured as satellites. The LAVC creates a unified system, allowing all participating nodes to remain independent while equally sharing resources, such as disks, tapes, and printers, and to employ a single distributed file system that manages access of files at the record level. A single system manager can perform all necessary management functions for all members of an LAVC from any member system. Utilities are provided to allow the manager to add, delete, and manage the client systems.

Server systems can support large disks, permitting workstation users to access and share data and applications that cannot be stored locally. The client systems can be diskless, allowing the central server to maintain all data locally and to manage data and file backups to enhance system security and reduce individual management tasks.

LAVCs also permit integration of terminal servers, allowing users who do not require workstations to access the data and resources of the cluster transparently across Ethernet.

**LAVC Phase II** (also called LAVC 2) allows LAVCs to be connected over Ethernet to VAXclusters of VAX superminis and Hierarchical Storage Controllers (HSCs) linked by Digital's Computer Interconnect (CI). The workstations and supermicros thus have access to the far greater computational and storage facilities offered by the larger VAX systems.

LAVC 2 creates a so-called mixed interconnect VAXcluster in which the CI- and HSC-connected VAX systems service boot and I/O requests from the computers in the LAVC. **Remote System Manager (RSM)**, layered on top of Digital's DECnet software, is a central management facility for distributed systems. It permits a MicroVAX or a VAX running RSM server software, to perform system management functions for MicroVAX systems running RSM *client* software in an Ethernet LAN. The number of clients supported varies with the size, power, and storage of the server. According to Digital, the range runs from a minimum of 5 MicroVAX systems under a MicroVAX II server to a maximum of 40 VAXstations with a VAX server.

Because RSM software is layered over DECnet, it provides a complete range of DECnet functionality, including electronic mail, file transfer, network management, and multivendor interconnect capabilities.

The MicroVAXs support Digital's **Internet** products, which connect VMS-based Digital computers and Digital networks to systems built by IBM and other manufacturers.

**DECnet/SNA Gateway-Channel Transport (CT)** and Gateway-Synchronous Transport (ST) provide users of IBM's SNA with a network-to-network interface to Digital applications. Using either gateway, users can simultaneously perform large quantity processing functions, such as terminal emulation, file transfer, and mail and document exchange; they can also distributed applications between Digital and SNA systems.

Also available are two other access products: **DECnet/SNA RJE Facility**, which allows a MicroVAX to function as a remote SNA batch workstation, and **DECnet/SNA 3270 Terminal Emulator**, which provides access to 3270 programs, principally those executing under IMS or CICS.

**VMS/SNA** layered software enables individual MicroVAX systems to connect directly to an IBM SNA network; it does not require a gateway or participation in a DECnet environment.

**VAX File Transfer and Access Management (FTAM)** software allows transparent file transfer and management between a DECnet/OSI-based network

and any system that complies to the FTAM Open Systems Interconnection (OSI) specification. VAX FTAM protects the semantics and structure of the file data exchanged between open systems.

**VMS Services for MS-DOS** is a software product that allows a MicroVAX (or a larger VAX) to act as a server for a group of VAXmate PCs in a DECnet Thin-Wire network. The product allows resource sharing between VMS and MS-DOS and permits server-based licensing of MS-DOS applications.)

**VAX VIDA** is a software component in a VAX- or MicroVAX-to-IBM interconnect system; it permits access to IBM mainframe data bases. VIDA conforms to a read-only subset of the Digital Standard Relational Interface (DSRI) architecture.

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

### Applications

More than 6,000 applications can run unmodified on the MicroVAX systems. Digital also relies heavily on third-party software vendors to provide specialized applications software for various industries and marketplaces. Digital enters into Cooperative Marketing Program (CMP) relationships with firms that are leading application solutions suppliers in specific vertical market segments. System Cooperative Marketing Program (SCMP) participants are OEMs that offer their applications products in combination with Digital hardware.

### Operating Environment

All MicroVAXs operate between 50 and 90 degrees Fahrenheit and within a humidity range of 20 to 80 percent (noncondensing). The physical and environmental specifications of the MicroVAX Family are highlighted in the following tables.

#### Physical Specifications

Model	Height (in.)	Width (in.)	Depth (in.)	Weight (lb.)
3100-10	4.07	18.26	15.52	—
3100-20	5.9	18.26	15.75	—
3300	27.0	13.6	17.8	85.0
3400	27.0	21.0	17.8	140.0
3800	27.0	21.0	17.8	129.0
3900	41.6	21.25	32.5	450.0

#### Electrical Specifications

Model	Voltage	Amperage	Power Consumption (watts)
3100-10	110/240	2.8/1.5	190
3100-20	110/240	4.5/2.3	300
3300	120/240	4.4/2.4	340

**Electrical Specifications**

Model	Voltage	Amperage	Power Consumption (watts)
3400	120/240	8.6/4.7	670
3800	120/240	12/6	670
3900	120/240	24/12	1200

**Support Services**

**Documentation:** Hardware documentation is included with each MicroVAX. The documentation consists of owner and technical manuals. Documentation kits are optionally available for selected software packages; the kits include reference manuals, user's guides, and other instructional materials.

**Training/Education:** Digital maintains over 25 training centers worldwide. Courses covering both Digital-related and non-product-related topics are offered. A variety of instructional methods is used, including instructor-led courses and self-paced instruction. Digital's Educational Services division publishes a digest listing available courses four times a year. On-site training at the customer's installation can also be provided.

**Warranty:** The MicroVAXs, as well as all peripherals, are covered by a one-year warranty with different levels of service. The minimum option—List Price Warranty—features one year of "return to Digital" support for parts and one year of conformance warranty for software. The alternative System Warranty Support is offered at an increased price, and includes Basic Support Service. Standard Warranty Support prices are generally 10 to 20 percent higher than List Price Warranties. Warranty coverage can be extended for up to three years.

**Maintenance:** Digital's Field Service organization offers both on-site and off-site support services for the MicroVAX Family. Services include the Basic Service Agreement, Recover-All service, and per-call service. 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.

**Pricing**

**Policy:** Digital provides the MicroVAX 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. The company provides a number of licensing options for VMS software, including Clusterwide licensing. ULTRIX-32 software users receive an AT&T UNIX binary license directly from Digital.

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

Digital offers a Volume Software Pricing program that allows users to acquire large numbers of licenses for a single product at a discount; options for a single software product run from 8-license to 160-license bundles.

Prices for MicroVAX hardware and related software are provided in the following Equipment Prices.

**NOTE:** The prices listed are for Standard Warranty Support. List Warranty prices, which do not include Basic Service Support, are generally 10-20 percent less. Operating system upgrades for ULTRIX-32 are not listed. ULTRIX-32 upgrades are available and range in price from \$1,071 to \$13,549. Contact the manufacturer for more information on pricing and support.

**Equipment Prices**

		Standard Purchase Price (\$)	Basic Service Price (Monthly) (\$)
<b>MicroVAX Systems</b>			
DU/DV-31ATB-AA	MicroVAX 3100 system Model 10; includes 4M-byte memory, Ethernet port, two SCSI controllers, four asynchronous lines, RZ23 104M-byte disk drive, 1-5 user VMS or 1-8 user ULTRIX-32 operating system license, DECnet End Node license	9,500	85
DU/DV-31BTB-AA	MicroVAX 3100 system Model 20; includes 4M-byte memory, Ethernet port, two SCSI controllers, four asynchronous lines, RZ23 104M-byte disk drive, 1-5 user VMS or 1-8 user ULTRIX-32 operating system license, DECnet End Node license	11,000	85
DU-31CT2-AA	MicroVAX 3100 system Model 20; includes 8M-byte memory, Ethernet port, two SCSI controllers, four asynchronous lines, two RZ23 104M-byte disk drives, TK50 95M-byte cartridge tape drive, VT320-AA console terminal, 1-16 user ULTRIX-32 operating system license, DECnet End Node license	23,620	145

NA—Not applicable.  
NC—No charge.

		Standard Purchase Price (Monthly) (\$)	Basic Service Price (Monthly) (\$)
DV-31CT2-ZA	MicroVAX 3100 system Model 20; includes 8M-byte memory, Ethernet port, two SCSI controllers, four asynchronous lines, two RZ23 104M-byte disk drives, TK50 95M-byte cartridge tape drive, VT320-AA console terminal, 1-10 user VMS operating system license, DECnet End Node license, VAX WAN Drivers license	24,236	148
DU/DV-330T1-AA	MicroVAX 3300 system; includes 12M-byte memory, Ethernet port, DSSI adapter, BA215 Pedestal enclosure, RF30 150M-byte disk drive, TK70 296M-byte cartridge tape, 1-10 user VMS or 1-32 user ULTRIX-32 operating system license, DECnet End Node license, documentation, and diagnostics	38,807	290
DU/DV-340T1-BA	MicroVAX 3400 system; includes 12M-byte memory, Ethernet port, DSSI adapter, BA213 Pedestal enclosure, RF71 400M-byte disk drive, TK70 296M-byte cartridge tape, 1-10 user VMS or 1-32 user ULTRIX-32 operating system license, DECnet End Node license, documentation, and diagnostics	50,254	315
DV-340T3-BA	MicroVAX 3400 dual-host timesharing system; each system includes 12M-byte memory, Ethernet port, DSSI adapter, BA213 Pedestal enclosure, RF71 400M-byte disk drive, 1-10 user VMS operating system license; system includes DECnet Full-Function license, DECnet End Node license, TK70 296M-byte cartridge tape, documentation, and diagnostics	99,528	590
DU/DV-380T1-AA	MicroVAX 3800 system; includes 16M-byte memory, Ethernet port, BA213 Pedestal enclosure, DSSI adapter, RF71 400M-byte disk drive, TK70 296M-byte cartridge tape, 1-40 user VMS or 1-64 User ULTRIX-32 operating system license, DECnet End Node license, documentation, and diagnostics	88,272	523
DV-380T3-AA	MicroVAX 3800 dual-host timesharing system; each system includes 16M-byte memory, Ethernet port, BA213 Pedestal enclosure, DSSI adapter, RF71 400M-byte disk drive, unlimited-user VMS operating system license, DECnet Full-Function license, DECnet End Node license, VMS services for MS-DOS; system includes TK70 296M-byte cartridge tape, documentation, and diagnostics	179,830	1,006
DU/DV-390T1-AA	MicroVAX 3900 system; includes 32M-byte memory, Ethernet port, H9644 cabinet enclosure, disk controller, RA90 1.2G-byte disk drive, TK70 296M-byte cartridge tape, unlimited-user VMS or 1-64 user ULTRIX-32 operating system license, DECnet End Node license, documentation, and diagnostics	128,180	582
DU-390T3-AA	MicroVAX 3900 system; includes 48M-byte memory, Ethernet port, H9644 cabinet enclosure, two disk controllers, two RA90 1.2G-byte disk drives, TK70 296M-byte cartridge tape, TU81E 6250 bpi tape drive, 65+ user ULTRIX-32 operating system license, DECnet End Node license, documentation, and diagnostics	240,554	858
DV-390T3-AA	MicroVAX 3900 system; includes 48M-byte memory, Ethernet port, H9644 cabinet enclosure, two disk controllers, two RA90 1.2G-byte disk drives, TK70 296M-byte cartridge tape, TU81E 6250 bpi tape drive, unlimited-user VMS operating system license, DECnet End Node license, VMS services for MS-DOS, documentation, and diagnostics	260,554	858
<b>RTVAX Systems</b>			
DW-330R1-AA	rtVAX 3300 system; includes BA215 pedestal enclosure, 4M-byte memory, Ethernet port, ISE controller, VAXELN Runtime license, documentation set	14,248	80
DW-340R1-AA	rtVAX 3400 system; includes BA213 pedestal enclosure, 4M-byte memory, Ethernet port, ISE controller, VAXELN Runtime license, documentation set	18,808	85
DW-380R1-AA	rtVAX 3800 system; includes BA213 pedestal enclosure, 16M-byte memory, Ethernet port, VAXELN Runtime license, documentation, and diagnostics	33,820	152
<b>Memory</b>			
MS42-AB	4M-byte parity memory increment for MV3100	2,400	NC
MS42-BA	12M-byte parity memory increment for MV3100	7,200	NC
MS42-CA	16M-byte parity memory increment for MV3100	9,600	NC
MS62A-AB	32M-byte ECC memory increment	29,900	NC
MS630-BB	4M-byte expansion memory increment	2,400	NC
MS630-CA	8M-byte parity memory increment	6,000	NC
MS650-AA/AF	8M-byte ECC memory increment for MV3xxx	6,120	NC
MS650-BA/BF	16M-byte ECC memory increment for MV3xxx	12,000	NC
<b>Mass Storage</b>			
RA90-CA	1.2G-byte disk drive in cabinet for MV3900	28,340	59
RA90-HA	(4) 1.2G-byte disk drives in cabinet for MV3900	102,372	236
RF71-RA	Removable 400M-byte Winchester Integrated Storage Element (ISE) in canister for MV3400, MV3800	12,628	44
RF71E-SA	400M-byte ISE for MV3400, MV3800	11,420	35
RF30-RA	Removable 150M-byte Winchester ISE in canister	5,828	19
RZ23-EF	104M-byte disk drive for MV3100	2,240	20
RZ55-FA	332M-byte disk drive in expansion box for MV3100	6,160	55

NA—Not applicable.  
 NC—No charge.

		<b>Standard Purchase Price (\$)</b>	<b>Basic Service Price (Monthly) (\$)</b>
<b>Optical Disk</b>			
RRD40-FA	600M-byte Compact Disk Read-Only Memory (CD-ROM) disk drive with cables in desktop enclosure for MV3100	1,864	22
RRD40-SA	600M-byte Compact Disk Read-Only Memory (CD-ROM) disk drive with cables in desktop enclosure for MV3300, MV3400, MV3800. Power cord included.	2,812	26
RSV20-PA/PD	2G-byte WORM optical disk drive with BA213 KLES1	38,100	200
RV20-B	RV20 slave drive with cabling	27,924	170
<b>Magnetic Tape</b>			
TZ30-EG	TZ30 95M-byte tape drive	3,980	40
TQK50-AA	TK50 controller with cables for BA23 enclosure	1,333	8
TQK50-BA	TK50 controller with cables for BA123 enclosure	1,333	8
TK50-AA	TK50 95M-byte cartridge streaming tape drive	3,413	22
TK70E-AA/SA	296M-byte TK70 tape drive for BA23/BA123	4,960	30
TU81E-DA(DD)	TU81-Plus 1600/6250 bpi PE/GCR tape drive	35,104	140
<b>Printers</b>			
LA75-CA	32/42/125/250 cps dot matrix tabletop printer	891	8
LA324-CA	100/300 cps dot matrix printer	2,331	28
LJ252-CA	160 cps color dot matrix tabletop printer	1,827	11
LG02-DA	600 lpm text and graphics printer	14,406	118
LN03S-AA	LN03 Plus 8-ppm desktop graphics laser printer; includes 1M-byte RAM, Modern Gothic typeface, two toner cartridges, organic photoreceptor cartridge, AC power cord, toner collection bottle, 250 sheets of letter-size paper, and documentation	4,739	62
<b>Workstations/Terminals</b>			
VT320-AA	White text terminal with standard keyboard	561	3
VT320-BA	Green text terminal with standard keyboard	561	3
VT330-AA	White graphics terminal with standard keyboard	2,023	19
VT330-CA	Amber graphics terminal with standard keyboard	2,023	19
VT340-AA	Color graphics terminal with standard keyboard	2,907	26
VT340-DA	Color graphics terminal with word processing keyboard	2,907	26
<b>Voice Synthesis</b>			
DTC01-AA	Single-line DECTalk text-to-speech unit; includes cables	4,548	22
DTC03-AM	Add-on single-channel board for dual-line DECTalk; requires power and mechanical mounting (user supplied)	4,025	32
<b>Communications/Networking</b>			
DHQ11-M	DHQ11 eight-line asynchronous Q-bus communications controller	2,043	15
DZQ11-M	DZQ11 four-line asynchronous multiplexer; requires cable	1,081	11
DPV11-M	DPV11 single-line synchronous interface; requires cable	1,413	14
DPV11-SA	Single-line synchronous interface for BA21x	1,668	14
DMV11-M	DMV11 single-line synchronous interface; requires cable	4,167	41
DELQA-M	DELQA Ethernet-to-Q-bus high-performance synchronous communications controller; requires cable	2,930	15
DELUA-M	Ethernet/IEEE 802.3 to Unibus single-line interface	5,496	33
DESVA-AA	Ethernet to MicroVAX 2000 synchronous communications controller	1,483	12
CXA16-AA	16-line asynchronous interface RS-423-A	2,941	15
CXY08-AA	8-line asynchronous interface RS-232-C	2,101	15

NA—Not applicable.

NC—No charge.

**Software Prices****License  
Fee  
(\$)****Operating System Upgrades**

QL-001AP-BW	VMS (6-10 user) upgrade license for MicroVAX 3100	2,678
QL-001AP-BU	VMS (11-15 user) upgrade license for MicroVAX 3100	2,678
QL-001AP-BV	VMS (16-Unlimited user) upgrade license for MicroVAX 3100	2,678
QL-001AS-BW	VMS (6-10 user) upgrade license for MicroVAX 3300/3400	4,016
QL-001AS-B2	VMS (11-20 user) upgrade license for MicroVAX 3300/3400	8,033
QL-001AS-BX	VMS (21-30 user) upgrade license for MicroVAX 3300/3400	8,033
QL-001AS-BY	VMS (31-Unlimited user) upgrade license for MicroVAX 3300/3400	8,033
QL-001AB-B2	VMS (11-20 user) upgrade license for MicroVAX 3800/3900	7,500
QL-001AB-B3	VMS (21-40 user) upgrade license for MicroVAX 3800/3900	15,000
QL-001AB-B4	VMS (41-Unlimited user) upgrade license for MicroVAX 3800/3900	10,000
QL-001AB-DA	VMS (1-10 user) PRI-PPL	383

**Communications**

QL-D04A -AA	DECnet End Node License	
P-AA	for MicroVAX 3100	868
S-AA	for MicroVAX 3300/3400	1,735
B-AA	for MicroVAX 3800/3900	2,892
QL-D05A -AA	DECnet Full Function License	
P-AA	for MicroVAX 3100	2,174
S-AA	for MicroVAX 3300/3400	4,338
B-AA	for MicroVAX 3800/3900	7,229
QL-D09A -AA	DECnet End Node to Full Function License Upgrade	
P-AA	for MicroVAX 3100	1,564
S-AA	for MicroVAX 3300/3400	3,127
B-AA	for MicroVAX 3800/3900	5,205
QL-455A9-J	DECnet/SNA VMS Application Programming Interface (API)	
-JC	for MicroVAX 3100	913
-JE	for MicroVAX 3300/3400	1,826
-JG	for MicroVAX 3800/3900	4,255
QL-022A9-J	DECnet/SNA VMS APPC/LU6.2 Programming Interface	
-JC	for MicroVAX 3100	1,159
-JE	for MicroVAX 3300/3400	2,317
-JG	for MicroVAX 3800/3900	5,402
QL-454A9-J	DECnet/SNA VMS 3270 Terminal Emulator	
-JC	for MicroVAX 3100	490
-JE	for MicroVAX 3300/3400	980
-JG	for MicroVAX 3800/3900	2,294
QL-453A9-J	DECnet/SNA VMS Remote Job Entry (RJE)	
-JC	for MicroVAX 3100	490
-JE	for MicroVAX 3300/3400	980
-JG	for MicroVAX 3800/3900	2,294
QL-044A9-J	DECnet/SNA VMS Printer Emulator	
-JC	for MicroVAX 3100	490
-JE	for MicroVAX 3300/3400	980
-JG	for MicroVAX 3800/3900	2,294
QL-042A9-J	DECnet/SNA VMS DISOSS Document Exchange Facility	
-JC	for MicroVAX 3100	735
-JE	for MicroVAX 3300/3400	1,471
-JG	for MicroVAX 3800/3900	3,441
QL-732A9-J	VAX Message Router Base	
-JC	for MicroVAX 3100	669
-JE	for MicroVAX 3300/3400	1,336
-JG	for MicroVAX 3800/3900	3,119
QL-362A -AA	VMS/SNA	
P-AA	for MicroVAX 3100	1,760
S-AA	for MicroVAX 3300/3400	3,509
B-AA	for MicroVAX 3800/3900	5,848

**Database Management**

QL-898A9-J	VAX Datatrieve	
-JC	for MicroVAX 3100	2,740
-JE	for MicroVAX 3300/3400	5,480
-JG	for MicroVAX 3800/3900	12,787

NA—Not applicable.

NC—No charge.

		<b>License Fee (\$)</b>
QL-899A9-J	VAX DBMS	
-JC	for MicroVAX 3100	7,760
-JE	for MicroVAX 3300/3400	15,519
-JG	for MicroVAX 3800/3900	36,210
QL-897A9-J	VAX CDD/PLUS	
-JC	for MicroVAX 3100	775
-JE	for MicroVAX 3300/3400	1,552
-JG	for MicroVAX 3800/3900	3,627
QL-D07A9-J	VAX Rdb/ELN	
-JC	for MicroVAX 3100	2,506
-JE	for MicroVAX 3300/3400	5,023
-JG	for MicroVAX 3800/3900	11,706
QL-VD2A9-J	VAX Rdb/VMS Full Development Option	
-JC	for MicroVAX 3100	5,783
-JE	for MicroVAX 3300/3400	11,567
-JG	for MicroVAX 3800/3900	26,989
QL-130A9-J	VAX DSM	
-JC	for MicroVAX 3100	3,008
-JE	for MicroVAX 3300/3400	6,026
-JG	for MicroVAX 3800/3900	14,045
<b>Languages</b>		
QL-018A9-J	VAX DIBOL	
-JC	for MicroVAX 3100	1,393
-JE	for MicroVAX 3300/3400	2,774
-JG	for MicroVAX 3800/3900	6,472
QL-100A9-J	VAX Fortran	
-JC	for MicroVAX 3100	1,726
-JE	for MicroVAX 3300/3400	3,453
-JG	for MicroVAX 3800/3900	8,064
QL-917A -AA	VAX Lisp for VMS Systems	
P-AA	for MicroVAX 3100	2,707
S-AA	for MicroVAX 3300/3400	5,413
B-AA	for MicroVAX 3800/3900	9,022
QL-418A -AA	VAX Lisp/Ultrix	
P-AA	for MicroVAX 3100	2,673
S-AA	for MicroVAX 3300/3400	5,347
B-AA	for MicroVAX 3800/3900	15,276
QL-126A9-J	VAX Pascal	
-JC	for MicroVAX 3100	1,582
-JE	for MicroVAX 3300/3400	3,152
-JG	for MicroVAX 3800/3900	7,362
QL-114A9-J	VAX PL/1	
-JC	for MicroVAX 3100	2,662
-JE	for MicroVAX 3300/3400	5,324
-JG	for MicroVAX 3800/3900	12,430
QL-015A9-J	VAX C	
-JC	for MicroVAX 3100	1,597
-JE	for MicroVAX 3300/3400	3,183
-JG	for MicroVAX 3800/3900	7,433
QL-099A9-J	VAX Cobol	
-JC	for MicroVAX 3100	2,662
-JE	for MicroVAX 3300/3400	5,324
-JG	for MicroVAX 3800/3900	12,430
QL-056A9-J	VAX Ada	
-JC	for MicroVAX 3100	8,440
-JE	for MicroVAX 3300/3400	16,881
-JG	for MicroVAX 3800/3900	39,388
QL-020A9-J	VAX APL	
-JC	for MicroVAX 3100	2,662
-JE	for MicroVAX 3300/3400	5,324
-JG	for MicroVAX 3800/3900	12,408
QL-095A9-J	VAX Basic	
-JC	for MicroVAX 3100	1,771
-JE	for MicroVAX 3300/3400	3,542
-JG	for MicroVAX 3800/3900	8,265

NA—Not applicable.

NC—No charge.

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QL-106A9-J	VAX BLISS-32 Implementation Language	
-JC	for MicroVAX 3100	1,927
-JE	for MicroVAX 3300/3400	3,854
-JG	for MicroVAX 3800/3900	9,000
QL-913A -AA	VAX OPS5	
P-AA	for MicroVAX 3100	6,240
S-AA	for MicroVAX 3300/3400	6,240
B-AA	for MicroVAX 3800/3900	11,232
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<b>Utilities and Tools</b>		
QL-425A9-J	VAX ADE	
-JC	for MicroVAX 3100	903
-JE	for MicroVAX 3300/3400	1,804
-JG	for MicroVAX 3800/3900	4,210
QL-AAA9-J	ALL-IN-1	
-JC	for MicroVAX 3100	9,456
-JE	for MicroVAX 3300/3400	18,912
-JG	for MicroVAX 3800/3900	44,128
QL-007A9-J	VAX DEC/Code Management System (CMS)	
-JC	for MicroVAX 3100	2,896
-JE	for MicroVAX 3300/3400	5,792
-JG	for MicroVAX 3800/3900	13,522
QL-310A9-J	VAX DECalc	
-JC	for MicroVAX 3100	1,136
-JE	for MicroVAX 3300/3400	2,272
-JG	for MicroVAX 3800/3900	5,302
QL-360A9-J	VAX DECgraph	
-JC	for MicroVAX 3100	835
-JE	for MicroVAX 3300/3400	1,671
-JG	for MicroVAX 3800/3900	3,899
QL-361A9-J	VAX DECslide	
-JC	for MicroVAX 3100	835
-JE	for MicroVAX 3300/3400	1,671
-JG	for MicroVAX 3800/3900	3,899
QL-706A9-J	VAX TDMS	
-JC	for MicroVAX 3100	1,381
-JE	for MicroVAX 3300/3400	2,762
-JG	for MicroVAX 3800/3900	6,438
QL-382A9-J	VAX-11 RSX	
-JC	for MicroVAX 3100	1,336
-JE	for MicroVAX 3300/3400	2,684
-JG	for MicroVAX 3800/3900	6,248
QL-375A9-J	VAXELN Toolkit	
-JC	for MicroVAX 3100	2,239
-JE	for MicroVAX 3300/3400	4,489
-JG	for MicroVAX 3800/3900	10,459
QL-810A9-J	DEC GKS for VMS	
-JC	for MicroVAX 3100	2,024
-JE	for MicroVAX 3300/3400	4,049
-JG	for MicroVAX 3800/3900	9,446

NA—Not applicable.  
 NC—No charge. ■