

Software Product Description

PRODUCT NAME: OpenVMS VAX Operating System, Version 5.5-2

SPD 25.01.36

Note: Digital bases a great deal of software development on national and international standards. To emphasize this commitment to software standards, Digital has revised the name of the VMS Operating System. **OpenVMS VAX** is the new title for the VMS software that runs on Digital's VAX processors. All references to VMS in this SPD pertain to the new title **OpenVMS VAX**.

DESCRIPTION*

VMS is a general-purpose multiuser operating system that supports VAX, MicroVAX, VAXstation, and VAXserver series computers in both development and production environments. VMS can be tuned to perform well in a wide variety of applications, including compute-intensive, Input/Output (I/O)-intensive, real-time, and combinations of those and other environments. (Actual performance depends on the type of VAX computer, available physical memory, and the number and type of disk and tape drives on the system.)

VMS has well-integrated networking, distributed computing, multiprocessing, and windowing capabilities. VMS contains extensive features that promote ease-of-use, improve the productivity of programmers, and facilitate system management.

POSIX Support

VMS also supports a large number of industry standards, facilitating application portability and interoperability. This standards support now extends to POSIX (Portable Operating System Interface). POSIX defines a set of interface standards for various parts of an operating system. The POSIX standards and draft standards have been generated by the Institute of Electrical and Electronic Engineers (IEEE) and are supported by organizations such as the International Organization for Standardization (ISO).

* "Licensee agrees to only execute Display PostScript® on those Digital computer systems identified as licensed systems in this Software Product Description, and that in any event licensee agrees not to make use of the software directly or indirectly, to print bitmap images with print resolutions greater than 150 DPI, or to generate fonts or typefaces for use other than with the Digital licensed system." (Terms and Conditions for Display PostScript can be found in *Appendix C* of this Software Product Description (SPD).)

The VMS Version 5.5-2 environment with VMS POSIX installed includes support for the standards and draft standards for the system application programming interface (POSIX 1003.1), shell and utilities (P1003.2), and real-time programming (P1003.4).

VMS POSIX V1.0 was granted National Institute of Standards and Technology (NIST) certification in January 1992. This means that VMS POSIX has passed the POSIX Conformance Test Suite (PCTS) that tests for conformance to NIST's Federal Information Processing Standard (FIPS 151-1), which is based on POSIX 1003.1-1988. VMS POSIX conforms to the POSIX 1003.1-1988 standard as required by FIPS 151-1.

XPG3 BASE Branding

The VMS V5.5-2 environment with VMS POSIX Version 1.1 and VAX C Version 3.2 installed extends the support for POSIX standards and draft standards to include the X/Open BASE specifications defined in the X/Open Portability Guide, Issue 3 (XPG3). The XPG3 BASE specifications extend the system application programming interface and shell and utilities offered in the IEEE POSIX standards and draft standards. XPG3 also includes standards-based internationalization support.

The VMS environment with VMS POSIX and VAX C installed has been awarded the X/Open XPG3 BASE brand. Platforms and components that successfully complete the branding process and pass X/Open Verification Test Suite for XPG3 (VSX3) are awarded the X/Open XPG3 brand. Components must pass a series of more than 5500 tests in VSX3 to earn the X/Open BASE Brand. These tests ensure users that the VMS environment with VMS POSIX and VAX C installed supports the essential set of interfaces necessary in an open system.

The inclusion of XPG3 BASE support in the VMS environment gives application developers a broader set of standards-based portability features to incorporate into their applications. Most applications that strictly conform to the POSIX and XPG3 specifications can be developed on a VMS system with VMS POSIX and the VAX C compiler, and then ported without modification to any other platform that also supports the same POSIX standards, draft standards, and XPG3 specifications.

User Environment

Users can access VMS by using the English-like Digital Command Language (DCL), the command language for VMS that is supplied with the system. DCL commands take the form of a command name followed by parameters and qualifiers. DCL commands provide information about the system, initiate system utilities, and initiate user programs. VMS prompts users to enter required DCL parameters, making it easy for novice users to use.

Users can enter DCL commands at a terminal or include them in command procedures and can run command procedures interactively or submit them to a batch queue for deferred execution.

Information on DCL and VMS Utilities is available through online Help. Online Help includes summary operational information on all aspects of system operation.

A number of tools and utilities are integrated into the VMS Operating System. This section briefly describes some of these tools and utilities.

Text processing — The Extensible VAX Editor (EVE), one of several text editors supplied by Digital, allows users to insert, change, and delete text quickly. Written in the VAX Text Processing Utility Language (VAXTPU), EVE is a full-screen editor that allows users to scroll through text on a terminal screen. EVE provides an EDT-style keypad, allowing users of EDT to transition to EVE easily.

Mail facility — The Mail facility allows users to send messages to any other user on the system. Multinode operation is available if DECnet-VAX is installed and licensed on each participating node.

Command-level programming — Command-level programming allows users to create special files called command procedures that contain a series of DCL commands. When users execute a command procedure, the system processes the commands in the command procedure. Users can also use special DCL commands to assign symbolic names, evaluate numerical and logical expressions, accept parameters, communicate interactively with the user invoking the command procedure, perform conditional (IF-THEN-ELSE) and branching (GOTO) logic, and handle error conditions.

User Environment Tailoring — Users can customize the computing environment with user login command procedures, shorthand commands, binding of commands to function keys, and command recall and editing.

Program Development Environment

VMS provides a comprehensive set of tools for developing programs including editors (for editing source programs), a linker, a librarian, and a symbolic debugger. The assembly-level VAX MACRO language is supplied with VMS.

The VMS Run-Time Library provides string manipulation, I/O routines, I/O conversion, terminal independent screen handling, date and time formatting routines, common mathematical functions, signaling and condition handling, and other general purpose functions. These routines can be called from programs written in VAX MACRO or from VAX Ada, VAX BASIC, VAX BLISS-32 Implementation Language, VAX C, VAX COBOL, VAX DIBOL, VAX FORTRAN, VAX Pascal, VAX PL/I, and VAX SCAN.

Major VMS languages (including those listed above) adhere to the VAX common calling standard, meaning that routines written in any of these languages can directly call routines written in any other language. Development of applications using multiple languages is simple and straightforward.

All routines in the Run-Time Library follow the VMS calling standard and condition handling conventions and most are contained within a shareable image.

At a lower level, programs can call system services directly for security, event flag, asynchronous system trap, logical name, record and file I/O, process control, timer, time conversion, condition handling, lock management, and memory management services. Again, system services use the VMS calling standard and condition handling conventions.

VMS supports execution of non-privileged images created on earlier versions of VMS. Recompiling and re-linking are typically not required.

Some tools available to the VMS programmer are:

Librarian utility — The Librarian utility permits efficient storage of object modules, macros, Help text, or any general record-oriented information in central, easily accessible files. Object module libraries are searched by the linker when the linker finds a reference it cannot resolve in one of its input files. Macro libraries are searched by the assembler when the assembler finds a macro that is not defined in the input file.

Debugger — The debugger allows users to trace program execution as well as display and modify register contents using the same symbols that are in the source code.

RMS file utilities — RMS file utilities allow users to analyze the internal structure of an RMS file and to determine the most appropriate set of parameters for an RMS file. They can also be used to create, efficiently load, and reclaim space in an RMS file. Refer to the *Operating System Environment* section of this Software Product Description (SPD) for more information on RMS.

File Differences utility — This utility compares the contents of two files and lists those records that do not match.

Terminal Fallback Facility (TFF) — This facility allows Digital 7-bit terminals, such as the VT100, to input and output the DEC Multinational Character Set (MCS). Specific tables allow conversion for a number of different 7-bit National Replacement Character sets, such as French, German, Spanish, and Swedish, to MCS. TFF also allows character composition on terminals that do not have the compose key.

National Character Set (NCS) utility — This utility allows users to define non-ASCII string collating sequences and to define conversion functions. Conversion functions use conversion algorithms to change an input string, for example, to change lower case characters to upper case. NCS also allows RMS indexed files to be collated using user-specified collating sequences.

System Management Environment

VMS provides a variety of tools to aid the system manager in configuring and maintaining an optimal system. Some tools available for the system manager are:

Backup utility — This utility provides full volume and incremental file backup for file-structured, mounted volumes and volume sets. Individual files, selected directory structures, or all files on a volume set can be backed up and restored. Files can be selected by various dates (creation, modification, etc.). Files can be backed up to magnetic tape, magnetic disk, or WORM (Write Once Read Many) optical disk. With standalone backup, system managers can back up and restore system disks. Standalone backup can also be used during the installation of the VMS Operating System. The Backup utility can be used to restore a saveset or list the contents of a saveset.

Analyze disk structure utility — This utility compares the structure information on a disk volume with the contents of the disk, prints the structure information, and permits changes to that information. It also can be used to repair errors that are detected in the file structure of disks.

Monitor utility — This utility permits the system manager to monitor different classes of system-wide performance data including process activity, I/O activity, memory management activity, vector processing activity, and

two-phase commit transaction activity at specified intervals. The data may be displayed as it is gathered or saved in a file for later use.

License Management Facility (LMF) — This facility allows the system manager to easily determine which software products are licensed on a standalone VAX and on each of the VAX systems in a VAXcluster System. It allows the system manager to select which subset of systems or users in a VAXcluster may use the software products. LMF also provides an audit trail that allows the system manager to track license changes that occur within a VAXcluster system. Refer to the *VAXcluster Support* section for more information on VAXcluster Systems.

VMS System Management (SYSMAN) utility — This utility allows the system manager to define a system management environment so that operations performed from the local VAX system can be executed on all other VAX systems in the defined environment. The environment may include VAX systems in a DECnet-VAX network or in a VAXcluster System.

Operations — VMS enables varying levels of privilege to be assigned to different operators. In addition, system generated messages can be routed to different terminals based on their interest to the console operators, tape librarians, security administrators, and system managers. Operators can use the VMS Help facility to get an online description of VMS Error Messages.

Security and Control — VMS provides privilege, protection, and quota mechanisms to control user access to system-controlled structures in physical memory, to system-structured files and volumes, and to certain devices.

User account information is maintained by the system manager in the User Authorization File (UAF). When creating user accounts with the Authorize utility, the system manager assigns the privileges and quotas associated with each user account. The system manager also assigns a unique user name, password, and user identification code (UIC) to each account. Optionally, additional identifiers can be assigned to each account, permitting users to belong to multiple overlapping groups or projects. Account use may be limited by time of day, day of week, and type of access, such as local, remote, or batch.

To log in and gain access to the system, the user must supply the user name and password. The password is encoded and does not appear on terminal displays. Users can change their password voluntarily, or the system manager can selectively enforce how frequently passwords change, password length, and generation of random alphabetic passwords.

Additionally, VMS provides several password filters that screen all user password changes against a dictionary of common passwords. This prevents users from reusing passwords that they have used within the last year. In addition to these built-in filters, a site can install their own filter to screen passwords against a site-specific password policy.

The system password hash algorithm can also be replaced with a private algorithm for those sites that have contractual agreements to use specific password encryption algorithms. This feature can be enabled on a per-user, per-password basis.

Login security includes break-in detection, which allows terminals to be disabled when password guessing is detected. When a user logs in, the system displays a message stating when the last login for the account occurred and if there have been failed attempts to log in since the last successful login.

A UIC consists of two fields, the unique user field and a group field. Every file, device, queue, or other system object is labeled with the UIC of its owner (normally the user who created the object).

Files, devices, queues, and other system objects are assigned a protection mask that allows read, execute, write, and delete access to be selectively granted to the object's owner, group, to privileged system users, or to all other users. In addition, files, devices, queues, and some other system objects can be protected with access control lists to allow access to be selectively granted or denied to a list of individual users, groups, or identifiers.

Scavenge protection can be enabled selectively in the form of file high-water marking, erase on allocate, and erase on delete, to ensure that file contents cannot be read after a file has been deleted.

Security alarms are provided to allow selective auditing of security related events, including:

- Login and logout
- Login failures and break-in attempts
- Authorization changes
- File access, selectable by use of privilege, type of access, and by individual file

Note: No system can provide complete security and Digital cannot guarantee system security. However, Digital continually strives to enhance the security capabilities of its products. Customers are strongly advised to follow industry-recognized security practices.

INSTALLATION

VMS is distributed as binary kits on tape and compact disc. Procedures for setting up the system disk from a kit and for preparing the system for day-to-day operations are easy and straightforward. The procedures are described in the *VMS Upgrade and Installation Manual* and in the *VMS Update Procedures*. Computer-specific information is contained in the upgrade and installation supplements for each family of VAX computers.

VMSINSTAL

VMS includes a facility to automate operating system software updates, as well as to handle the installation of optional Digital-supplied software products.

Tailoring Facility

Tailoring lets the system manager remove groups of VMS files from the system disk or add groups of VMS files that were formerly removed. The VMSTAILOR program supplies step-by-step instructions. The DECW\$TAILOR program is used to add or remove groups of DECwindows files from the system disk.

Due to space constraints, there is no guarantee that layered products can be installed if user files reside on the system disk.

Application programs will execute as long as the layered products or optional software products do not depend on optional software run-time components that are not supported in the tailored environment. Refer to the product's System Support Addendum (SSA) for the optional products supported in the tailored environment.

Batch/Print Facility

VMS provides an extensive batch/print facility that allows the creation of queues and the setup of spooled devices in order to process non-interactive workloads in parallel with timesharing or real-time jobs.

In the VMS Operating System, batch and print operations support two types of queues: generic queues and execution queues. A generic queue is an intermediate queue that holds a job until an appropriate execution queue becomes available to initiate the job. An execution queue is a queue through which the job (either print or batch) is actually processed or executed.

The system queues batch jobs for execution. The system manager can regulate the number of queues and the number of streams per queue (that is, the number of batch jobs in the queue that can execute concurrently).

Both generic and execution batch queues can have different attributes, such as the maximum CPU time permitted, working set size, and priority. Facilities are provided for starting and stopping queues, and for starting and stopping jobs in a queue. Because multiple execution queues can be associated with a generic queue, VMS enables load balancing across available CPUs in a VAXcluster system, increasing overall system throughput.

Print queues, both generic and execution, together with queue management facilities, provide versatile print capabilities, including support of ANSI and PostScript® file printing.

Sites requiring sophisticated batch job dependency checking and job restart capabilities should refer to the DECscheduler for VMS Software Product Description (SPD 32.19.xx).

Accounting

For accounting purposes, VMS keeps records of the use of system resources. These statistics include processor and memory utilization, I/O counts, print symbiont line counts, image activation counts, and process termination records. VMS Accounting allows various reports to be generated using this data.

Autoconfigure/Autogen

VMS provides utilities to automatically configure the available devices into the system tables and to set system operational parameters based on the detected peripheral and memory configuration. There is no need for a traditional "system generation" process when the hardware configuration is expanded or otherwise modified.

Operating System Environment

Process and Scheduling

The basic unit of execution in VMS is the process. A process consists of individual address space and registers known as "context," and code called an "executable image." The context identifies the process and describes its current state. Executable images consist of system programs and user programs that have been compiled and linked.

The maximum number of concurrent processes is 8,192 per VAX system.

Processes receive processor time to execute their images based on the priority of the process. Thirty-two priorities are recognized: priorities 0 to 15 are for time-sharing processes and applications that are not time critical (four is the typical default for time-sharing processes), and priorities 16 to 31 are for real-time processes.

Each time an event such as an I/O interrupt occurs, the system first services the event and then passes control to the highest priority process ready to execute. The system automatically adjusts priorities of processes whose base priority is in the range of 0 to 15 to favor I/O-bound and interactive processes, but the system will not adjust the priority of a process in the range of 16 to 31.

Real-time processes can be assigned higher priorities to ensure that they receive processor time whenever they are ready to execute. Real-time processes are scheduled pre-emptively; that is, if a real-time process is ready to execute, it is given the processor immediately, unless a real-time process with a higher priority is ready to execute.

VMS uses paging and swapping mechanisms to provide sufficient virtual memory for multiple concurrently executing processes. Also, paging and swapping is provided for processes whose memory requirements exceed available physical memory. The maximum working set size is 200,000 pages of memory.

Programmers can exercise control over memory management from within an image. An image executing in a real-time process, for example, can inhibit paging or swapping of critical code and data.

Peripheral devices can be managed by the system or allocated by individual processes. At least one disk must be a system disk. Other disks can be designated as data disks for the general use of all users logging into the system or for a specific group of users. The system controls interactive terminals and one or more printers.

Vector Processing

A single data item, having one value, is known as a scalar value. A group of related scalar values, or elements, all of the same data type, is known as a vector.

An extension to the VAX architecture defines an optional design for integrated vector processing that has been adopted by several VAX systems. The VAX vector architecture includes 16 64-bit vector registers (V0 through V15), each containing 64 elements; vector control registers; vector function units; and a set of vector instructions. VAX vector instructions transfer data between the vector registers and memory, perform integer and floating-point arithmetic, and execute processor control functions.

A more detailed description of the VAX vector architecture, vector registers, and vector instructions appears in the *VAX MACRO and Instruction Set Reference Manual*.

The VMS Operating System provides fully-shared, multi-programming support for VAX vector processing systems. By default, VMS loads vector support code when initializing vector-present systems, but does not load it when initializing vector-absent systems. A system manager can control this behavior by using the SYSGEN parameter VECTOR_PROC, as described in the VMS documentation.

The presence of vector support code in a system has little affect on processes running in a scalar-only system, or scalar processes running in a vector-present system. If many processes must compete simultaneously for vector processor resources in a system, the system manager can maintain good performance by adjusting system resources and process quotas as indicated in the VMS documentation.

The VMS Operating System makes the services of the vector processor available to system users by means of a software abstract known as a capability. A system manager can restrict the use of the vector processor to users holding a particular identifier by associating an access control list (ACL) entry with the CAPABILITY object VECTOR.

The VAX Vector Instruction Emulation Facility (VVIEF) is a standard feature of the VMS Operating System that allows vectorized applications to be written and debugged in a VAX system in which vector processors are not available. VVIEF emulates the VAX vector processing environment, including the non-privileged VAX vector instructions and the VMS vector system services, as described in the VMS documentation. Use of VVIEF is restricted to user mode code.

DECdtm Services

The DECdtm services embedded in the VMS Operating System support fully distributed databases using a "two phase commit" protocol. The DECdtm services provide the technology and features for distributed processing, ensuring both transaction and database integrity across multiple resource managers. Updates to distributed databases occur as a single "all or nothing" unit of work, regardless of where the data physically resides. This ensures consistency of distributed data.

DECdtm services allow applications to define "global transactions" that may include calls to any of a number of Digital data management products. Regardless of the mix of data management products used, the global transaction will either commit or abort. VMS is unique in providing transaction processing functionality as base operating system services.

DECdtm Features

- Embedded VMS system services support the DECtp architecture, providing features and the technology for distributed transaction processing.

- DECdtm allows multiple disjoint resources to be updated atomically. These resources can be either physically-disjointed (for example, on different CPUs) or logically-disjointed (for example, in different databases on the same CPU).
- DECdtm encourages robust application development. Applications can be written to ensure that data is never in an inconsistent state, even in the event of system failures.
- As a VMS service, DECdtm can be called using any Digital TP monitor (ACMS or DECintact) or database product (DBMS, RDB, RMS). This is useful for applications using several database products.

Interprocess Communication

VMS provides a number of facilities for applications that consist of multiple cooperating processes:

- Mailboxes are virtual devices that allow processes to communicate with queued messages.
- Shared memory sections on a single processor or a symmetrical multiprocessing (SMP) system permit multiple processes to access shared address space concurrently.
- Common event flags provide simple synchronization.
- The lock manager provides a more comprehensive enqueue/dequeue facility with multi-level locks, values, and ASTs (Asynchronous System Traps).

Symmetric Multiprocessing

VMS provides symmetric multiprocessing (SMP) support for multiprocessing VAX systems. SMP is a form of tightly coupled multiprocessing in which all processors perform operations simultaneously. The processors can perform operations in all VAX access modes (user, supervisor, executive, and kernel).

VMS SMP configurations consist of multiple central processing units executing code from a single shared memory address space. Users and processes share a single copy of VMS. SMP also provides simultaneous shared access to common data in global sections to all processors. VMS SMP dynamically balances the execution of all processes across all available processors based on process priority.

SMP support is an integral part of VMS and is provided transparently to the user. Because an SMP system is a single system entity, it is configured into a network and VAXcluster systems as a single node.

VAXcluster Support

VAXcluster Software is a VMS System Integrated Product (SIP) that is separately licensed. It provides a highly integrated VMS computing environment distributed over multiple VAX, VAX Workstation, and MicroVAX CPUs. This environment is called a VAXcluster system and may contain up to 96 VAX CPUs.

VAXcluster CPUs communicate using any combination of four interconnects; CI, DSSI, Ethernet, and FDDI. VAXcluster systems that include a CI may optionally be configured with HSC-series intelligent storage controllers.

Applications running on one or more CPUs in a VAXcluster system access shared resources in a coordinated manner. VAXcluster Software components synchronize access to shared resources, preventing multiple processes on any CPU in the VAXcluster from interfering with each other when updating data. This coordination ensures data integrity during multiple concurrent update transactions. Application programs can specify the level of VAXcluster-wide file sharing that is required; access is then coordinated by the VMS Extended QIO Processor (XQP) and Record Management Services (RMS).

The VMS queue manager controls VAXcluster-wide batch and print queues, which can be accessed by any VAXcluster CPU. Batch jobs submitted to VAXcluster-wide queues are routed to any available CPU so that the batch load is shared.

Two or more VAX computers connected to the same Computer Interconnect (CI) or Digital Storage Systems Interconnect (DSSI) must run VAXcluster software and be part of the same VAXcluster system.

Refer to the VAXcluster Software Software Product Description (SPD 29.78.xx) for more information.

Networking Facilities

VMS provides device drivers for all Digital Ethernet adapters listed in the *Ethernet Options* section of this SPD. Application programmers can use the QIO system service to communicate with other systems connected via the Ethernet using either Ethernet or IEEE 802.3 packet format. Simultaneous use of Digital Ethernet and IEEE 802.3 protocols are supported on any Digital Ethernet adapter.

VMS also provides device drivers for Digital asynchronous adapters that are supported by DECnet-VAX. Customers must order the VAX Wide Area Network Device Drivers kit (refer to SPD 29.64.xx) to obtain synchronous device drivers for Digital synchronous adapters. Not all devices are supported, and certain restrictions apply relative to line speed and line utilization. Refer to the *Hardware Charts* and *Appendix B* of

this SPD, as well as the DECnet-VAX SPD (25.03.xx), for more information.

DECnet-VAX offers task-to-task communications, file management, downline system and task loading, network command terminals, and network resource sharing capabilities using the Digital Network Architecture (DNA) protocols.

DECnet-VAX Software is a System Integrated Product (SIP) that is separately licensed from the VMS Operating System. Refer to the DECnet-VAX SPD (SPD 25.03.xx) for further information on supported communications devices and software features.

Internet networking is available through the VMS/ULTRIX Connection layered product. This product provides TCP/IP networking (useful with DECwindows), Network File System (NFS), File Transfer Protocol (FTP), Remote Terminal Services (TELNET), and other features. Refer to the VMS/ULTRIX Connection SPD (SPD 25.A4.xx).

Multi-Threading Capability

VMS includes a user-mode multi-threading capability referred to as DECthreads. DECthreads provides an implementation of draft 4 of the proposed POSIX 1003.4a standard and is Digital's implementation of the Distributed Computing Environment (DCE) Threads as defined by the Open Software Foundation. DECthreads is a library of run-time routines that allows the user to create multiple threads of execution within a single address space. Multi-threading capability allows computation activity to be overlapped with I/O activity. Synchronization elements, such as mutexes and condition variables, are provided to help ensure that shared resources are accessed correctly. DECthreads also provides multiple scheduling policies for scheduling and prioritizing threads.

Terminal Server Products

Digital's terminal server products can be used for terminal server access to VMS. When used in a VAXcluster system environment, terminal servers automatically distribute users at login time across the available VAX systems.

VMS can also establish a connection to other devices (such as printers) attached to such terminal servers.

Reliability

The system handles hardware errors as transparently as possible while maintaining data integrity and providing sufficient information to diagnose the cause of the error. The system limits the effects of an error by first determining if the error is fatal. If the error is fatal then the process that encountered the error is aborted. If the error occurs in system context then the current VMS

session is shut down. If the error is not fatal then recovery actions pertinent to the error are executed and current operation is continued.

In all cases, information relevant to the error is collected and put in the error log file for later analysis. Hardware errors include the following categories:

- Processor errors (these include processor soft errors, processor hard errors, processor machine checks, adapter errors).
- Memory errors are hardware errors that are handled in a slightly different manner. The system examines memory at startup time and does not use any pages found to be bad. During system operation, the hardware transparently corrects all single-bit memory errors for those systems with ECC memory. An unrecoverable error causes the memory page on which the error occurred to be added to the bad page list. If the page has not been modified, system operation continues with a new copy of the page.

Other failures include:

- Operating system errors (system-detected inconsistencies or architectural errors in system context)
 - User errors
 - I/O errors
- The system logs all processor errors, all operating system errors detected through internal consistency checks, all double-bit memory errors (and a summary of corrected single-bit errors), and all I/O errors. (Double-bit errors are detected only on those VAX and MicroVAX systems with ECC memory.)

If the system is shut down because of an unrecoverable hardware or software error, a dump of physical memory is written. The dump includes the contents of the processor registers. The VMS System Dump Analyzer utility is provided for analyzing memory dumps.

Power Failures

If power fails, the system shuts down automatically. When power is restored, the system restarts automatically and resumes processing at the point of interruption if the system has a time-of-day clock and a memory battery backup unit, if the contents of memory are still valid, and if the system is set to permit automatic rebooting.

The system restarts devices and communications lines. All I/O operations in progress, including magnetic tape I/O operations, are restarted. On request, programs can be notified of power restoration. An optional battery-operated hardware clock resets the date and time of day when the system restarts. If the system does not have a battery backup unit, or if the memory contents are not valid on power restoration, the system will reboot

automatically if the system is set to permit automatic rebooting.

If, for any reason, the system disk does not come back on line after a power failure within a specific time after the CPU regains power, the system shuts down.

Test Package and Diagnostics

VMS includes a User Environment Test Package (UETP) that verifies that the VMS Operating System is properly installed and ready for use on the customer's systems.

Diagnostics can be run on individual devices during normal system operation. Certain critical components can operate in degraded mode. For example, the memory cache can be disabled. The system places a component in degraded mode when errors pass a threshold level.

Input/Output

The QIO system service provides a direct interface to the operating system's I/O routines. These services are available from within most VAX programming languages and can be used to perform low-level I/O operations efficiently with a minimal amount of system overhead for time-critical applications.

Device drivers execute I/O instructions to transfer data to and from the device and to communicate directly with an I/O device. Each type of I/O device requires its own driver. Digital supplies drivers for all devices supported by the VMS Operating System and provides QIO system service routines to access the special device dependent features available in many of these devices. Users with special needs or non-VMS supported devices can write their own device drivers. The *VMS Device Support Manual* and the *VMS Device Support Reference Manual* in the VMS Extended Documentation set describe how to write device drivers.

The VMS Operating System supports a variety of disk and tape peripheral devices, as well as terminals, networks, mailboxes (virtual devices for interprocess communication), and more general I/O devices. These I/O devices include line printers, card readers, and general purpose data acquisition devices such as the DRB32.

VMS Record Management Services (VMS RMS)

VMS RMS is a set of I/O services that help application programs to process and manage files and records. Although it is primarily intended to provide a comprehensive software interface to mass storage devices, VMS RMS also supports device-independent access to unit-record devices.

VMS RMS supports sequential, relative, and indexed file organizations in fixed-length and variable-length record formats. VMS RMS also supports byte stream formats for sequential file organization. VMS RMS record access modes provide access to records in four ways: sequentially, directly by key value, directly by relative record number, and directly by record file address. VMS RMS also supports block I/O operations for various performance-critical applications that may require user-defined file organizations and record formats.

VMS RMS promotes safe and efficient file sharing by providing multiple file access modes, automatic record locking where applicable, and optional buffer sharing by multiple processes.

VMS RMS utilities aid file creation and record maintenance. These utilities convert files from one organization and format to another, restructure indexed files for storage and access efficiency, and reclaim data structures within indexed files. The utilities also generate appropriate reports.

For systems that have DECnet installed, VMS RMS provides a subset of file and record management services to remote network nodes. Network remote file operations are generally transparent to user programs.

DCL commands such as EDIT, CREATE, COPY, TYPE, and PRINT allow manipulation of RMS files and records within RMS files at the DCL command level.

RMS Journaling for OpenVMS

RMS Journaling for OpenVMS is a VMS System Integrated Product (SIP) that enables a system manager, user, or application to maintain the data integrity of RMS files in the face of a number of failure scenarios. It protects RMS file data from becoming lost, corrupted, or inconsistent. RMS Journaling for OpenVMS is separately licensed.

RMS Journaling provides the ability to maintain three types of journaling that maintain modification information for journaled RMS files.

- **Before Image Journaling.** Provides the ability to "undo" modifications that have been made to a file. This type of journaling provides the ability to return a file to a previous known state. This is useful in the event that a file is updated with erroneous or bad data. No application modifications are necessary in order to use Before Image journaling.
- **After Image Journaling.** Provides the ability to "redo" modifications that have been made to a file. This type of journaling allows you to recover files that are inadvertently deleted, lost or corrupted. RMS Journaling recovers the file by applying the journaled modifications to a backup copy, thereby restoring its final

state. No application modifications are necessary in order to use After Image journaling.

- **Recovery Unit Journaling.** Provides the ability to maintain transaction integrity. A transaction may be defined as a series of many file updates, on one or more files. In the event of any failure during the transaction, Recovery Unit journaling will roll-back the partially completed transaction to its starting point. This allows complex transactions to be completed as an atomic event - partially completed transactions can be avoided. Recovery Unit journaling requires application modification.

Refer to SPD 27.58.xx for more information.

Disk and Tape Volumes

Disk volumes can be organized into volume sets. Volume sets can contain a mix of disk device types and can be extended by adding volumes. Within a volume set, files of any organization type can span multiple volumes. Files can be allocated to the set as a whole (the default) or to specific volumes within the set. Optionally, portions of indexed files can be allocated to specific areas of a single disk volume or to specific volumes in a volume set.

Disk quotas can be placed to control the amount of space individual users can allocate. Quota assignment is made by User Identification Code and can be controlled for each volume set in the system (or for each individual volume if the volume is not part of a set).

Disk structure information can be cached in memory to reduce the I/O overhead required for file management services. Although not required to do so, users can preallocate space and control automatic allocation. For example, a file can be extended by a given number of blocks, contiguously or noncontiguously, for optimal file system performance in specific cases.

The system applies software validity checks and checksums to critical disk structure information. If a volume is improperly dismounted because of user error or system failure, the system automatically rebuilds the volume's structure information the next time the volume is mounted. The system detects bad blocks dynamically and prevents their reuse once the files to which the blocks were allocated are deleted. On Digital Storage Architecture (DSA) disks, the disk controller dynamically detects and replaces bad blocks automatically.

The system provides eight levels of named directories and subdirectories whose contents are alphabetically ordered. Device and file specifications follow Digital conventions. Logical names can be used to abbreviate the specifications and to make application programs device and file-name independent. A logical name can be assigned to an entire specification, to a portion of a specification, or to another logical name.

VMS supports multivolume magnetic tape files with transparent volume switching. Access positioning is done either by filename or by relative file position.

Volume Shadowing for OpenVMS

Digital provides the Volume Shadowing for OpenVMS product for performing disk shadowing operations, using a RAID 1 implementation.

Volume Shadowing for OpenVMS is a VMS System Integrated Product (SIP) that is separately licensed. Volume Shadowing for OpenVMS provides high data availability for disk storage devices by ensuring against data loss resulting from media deterioration or through controller or device failure. This prevents storage subsystem component failures from interrupting system or application operation.

The system disk and Files-11 On-Disk Structure 2 (ODS2) data disks can be volume shadowed.

The Volume Shadowing for OpenVMS product supports shadowing of all MSCP-compliant DSA disks and all Digital SCSI disks. All disks in a single shadow set must have the same physical geometry and can be located on a single system or anywhere in a VAXcluster system. Disks can be configured on any MSCP or Digital SCSI compliant controller; this includes HSC-series controllers, local controllers, DSSI Integrated Storage Elements, and VMS MSCP Served DSA devices. Nonlocal disks can be accessed using any of the supported VAX-cluster interconnects (CI, DSSI, Ethernet, FDDI, and mixed).

Volume Shadowing for OpenVMS provides fault tolerance resulting from disk media errors or controller errors across the full range of VAX processors and configurations. Shadow set member units can be located on different controllers and VMS MSCP servers, providing configuration flexibility and a high degree of data availability.

Refer to SPD 27.29.xx for more information.

VMS DECwindows Motif™

Digital offers a separately orderable layered product called VMS DECwindows Motif™. VMS DECwindows Motif provides support for both OSF/Motif™, an open standard that is the new default user interface, and the X User Interface in a single run-time and development environment. Because both Motif and XUI are based on MIT's X Window System, applications written to either toolkit continue to run regardless of which environment the user selects. Refer to the VMS DECwindows Motif SPD (SPD 36.09.xx) for more information.

VMS DECwindows Environment

Integral to VMS is support for the VMS DECwindows desktop environment. VMS DECwindows is based on MIT's specification for the X Window System, Version 11, Release 3, and is delivered as a component of the VMS Operating System. X Window System standards supported as part of DECwindows include the X11 network protocol, a base set of workstation fonts, the C language binding for the Xlib programming library, and the C language binding for the Xtoolkit library. Also featured within DECwindows for workstation users is support for Adobe's Display PostScript integrated into X11.

Support of the X11 network protocol in the client library, and display server components provides VMS with the ability to interoperate with other X11-compliant systems in a distributed fashion.

DECwindows supports the client-server distribution inherent in the X Window System, with three VMS-provided transport interfaces — local shared memory, DECnet, and TCP/IP (using Digital's VMS/ULTRIX Connection (UCX) layered product). Users can also provide their own transport subsystems and transport interfaces.

To determine whether a separately orderable DECwindows or X application runs on or can communicate with a VMS DECwindows system, consult the application's Software Product Description.

The DECwindows desktop environment provides a graphical user interface to VMS. This user interface defines a powerful model for interacting with the VMS Operating System using a point and click metaphor. It includes a set of integrated desktop applications that demonstrate the power of this new metaphor and that provide VMS users with a base set of desktop tools.

The user environment consists of four basic components:

1. The Session Manager provides the top-level user interface to a DECwindows workstation. It performs application activation, session-wide customization, screen printing, security management, and session control. The session manager also allows users to specify the language in which DECwindows should run, provided that a VMS DECwindows language variant kit has been ordered and installed.
2. The Window Manager provides user control for managing windows.
3. FileView is a graphical interface to VMS file management that allows users to navigate through the VMS file system and perform operations on files.

4. The DECterm terminal emulator provides workstation users with a traditional character cell interface for existing VMS features and applications. It is a ReGIS and sixel compatible VT320 terminal emulator. Programs written for VT52, VT100, VT220, or VT320-class terminals and using VMS terminal driver features operate without modification in this workstation window. DECterm also provides workstation-oriented features such as mouse-based cursor positioning, variable screen sizes, and cutting and pasting of text between terminal emulators and other DECwindows applications.

Applications

A set of integrated desktop applications is provided as a base component of the DECwindows environment. These applications establish and demonstrate the consistent DECwindows user model. They also provide significant end user capabilities.

- Bookreader — A tool for viewing the contents of books that are distributed and stored on-line
- Calculator — A basic scientific calculator
- Calendar — A personal time management system
- Cardfiler — A hierarchical information storage application similar to an online address and/or phone book
- Clock — An analog and/or digital date and time display with notification by alarm
- Compound Document viewer — Tools for reading documents containing compound text, graphics, and image data on terminals and DECwindows workstations
- DEBUG — A DECwindows user interface to the VMS DEBUGGER
- Mail — A DECwindows user interface to the VMS mail facility
- Notepad — A simple text editor
- Paint — A simple bitmap graphics editor
- Puzzle game — A game that challenges users to sort mixed up puzzle tiles
- TPU/EVE — A DECwindows user interface to the VMS TPU/EVE editor

DECwindows workstation users can display PostScript files featuring WYSIWYG (what you see is what you get) compatibility between the display and any of Digital's PostScript printers. Display PostScript ability is available within the Compound Document viewer and DECwindows Mail.

Programming Support

The VMS DECwindows environment includes an extensive set of programming libraries and tools for use by developers of new applications. These components support the development of portable applications by focusing on three broad areas:

- X Window System (X) support
- X User Interface (XUI) support
- Compound Document Architecture (CDA) support

Components from each of these areas can be used in any combination to address the needs of applications. They can also use the tools from a variety of different programming languages. All programming libraries have been provided with procedural language bindings in both the style of the VAX calling standard and the style of the MIT C language programming conventions.

Support is provided for the following languages:

VAX Ada	VAX FORTRAN
VAX BASIC	VAX MACRO
VAX BLISS-32 Implementation Language	VAX Pascal
VAX C (VAX calling standard or MIT convention)	VAX PL/I

X Window System (X) Programming Support

The X Window System compatible X programming library (Xlib) provided by the VMS DECwindows environment provides basic resource management (windows, color maps, input devices) and bitmap graphics services. It defines a mapping of the X network protocol to a procedure library.

The X toolkit programming library is also supported by the VMS DECwindows environment. It is described further under XUI Programming Support.

X User Interface (XUI) Programming Support

XUI determines the application model for Digital and third-party software tailored for the DECwindows environment. It establishes the conventions and styles that are encouraged for applications that share a DECwindows workstation. Applications use XUI components to build user interfaces that make them look and feel like integrated members of the Digital computing environment.

The XUI Style Guide, available in the VMS DECwindows Programming Kit, describes the principles, philosophy, and components used to build consistent and well-integrated DECwindows applications.

Its concepts are implemented by the XUI Toolkit. The XUI Toolkit is a superset of the X Window System Xtoolkit and contains four components:

- Xtoolkit components (known as intrinsics) for managing, modifying, and creating user interface objects (known as widgets and gadgets)
- DECwindows widgets and gadgets for implementing common user interface objects such as scroll bars, menus, and push buttons
- Utility routines that provide applications with functions for performing common tasks such as cut and paste
- Resource manager routines for loading user interface definition files and creating widgets and gadgets based on the contents of the definition files

The XUI Toolkit is used in conjunction with the DECwindows User Interface Language (UIL) compiler. The user interface definition files produced by this compiler contain the data to separate form and function in DECwindows applications and allow DECwindows toolkit widget and gadget details, such as menu item labels, to be stored separately from the toolkit and application runtime code. This capability allows application developers to prototype and modify user interface designs, separate form and function in applications, and support international products.

Enhanced X Windows Display PostScript (XDPS)

The Display PostScript system provided with VMS DECwindows extends the native X graphical programming environment for Digital DECwindows workstation users.

X Display PostScript adds the following capabilities to the basic X11 environment:

- All DECwindows fonts can be displayed at any size and rotation angle
- XDPS graphics specified in a user-defined coordinate systems are independent of monitor density
- Color or gray-scale rendition are automatically modified to take advantage of the monitor type through either direct display, color dithering, or half-toning
- DPS Display routines can be downloaded to the server and executed on command
- Sophisticated graphics primitives such as precisely-controlled Bezier curves can be displayed
- Any display can be scaled and rotated arbitrarily

Programming access to XDPS is through the Adobe Client Library. In addition, a converter called pswrap allows users to convert PostScript code into C programs that can be called from other languages.

Compound Document Architecture (CDA) Programming Support

The CDA Toolkit provides access routines that applications can use to create, read, and write files containing compound text, graphics, and imaging data. These files provide a vehicle for recording this information on disk, a medium for interchange of this data between applications, and an intermediate form from which high-resolution printable graphics data can be generated.

In addition to providing support for developing new applications to access compound documents, VMS also provides fallback support, allowing many existing utilities to read and operate on these new kinds of files.

Transport Mechanisms

VMS DECwindows supports three different user-selectable mechanisms for transport of X network protocol packets between applications and display servers.

A VMS DECwindows-specific shared memory-based transport is used when the DECwindows application and display server are located on the same workstation. This optimization provides significantly greater performance. It is the default transport under these circumstances.

DECnet is used when the DECwindows application and display server are distributed across two different machines in the network. It is the default transport under these circumstances.

TCP/IP is used when the DECwindows application and display server are distributed across two different machines in the network and the Digital-supplied VMS /ULTRIX Connection (UCX) layered product is being used to make the connection. See the *SOFTWARE LICENSING* section of this SPD for licensing details.

Workstation Device Support

The VMS DECwindows environment provides several software components to support displaying graphics and windowing output on and receiving keyboard and pointer driver input from VAX workstations.

Device drivers are provided to support output to monochrome and color displays and to receive input from keyboard, mouse, and tablet devices.

A display server compatible with the X Window System receives output requests from applications and translates those requests into driver commands. They also relay driver-generated input events back to the applications.

Over 400 video fonts are provided in a variety of styles and point sizes for use on 75 and 100 dot per inch (dpi) monitors. These video fonts have been designed to correspond directly to the fonts used by Digital's PostScript printers. In addition, a font compiler is provided so that customers can make their own private fonts available on their DECwindows workstations and terminals.

Multi-headed Workstation Support

A multi-headed workstation consists of one system box, one keyboard and one mouse, but more than one monitor and graphics controller. It is a single-user workstation. Multi-headed workstations provide more screen area for complex applications.

The screens on the multiple monitors are controlled by a single server. The mouse cursor can be moved freely between screens, and the keyboard can be used to generate input to windows on any screen. The server implementation handles each monitor as a separate X11 screen. This means that a single window cannot cross screen boundaries; for example, users cannot drag a window from one monitor to another. However, users can cut and paste between windows on different screens, and windows can be opened on either screen, or both, by user applications.

The Dual Monitor Option is a cable and adapter module that allows two monitors to be connected at the same time to a single VAXstation 3100 system box (models 30, 38, 40, and 48). The Quad Monitor Option is a cable and adapter module that allows four monitors to be connected at the same time to a single VAXstation 4000 model 60. The system must include one of the 8-plane graphics options, either the GPX graphics or SPX graphics accelerator.

The system must include at least one monochrome monitor, VR150 or VR262, driven by the single-plane frame buffer that is standard on all VAXstations 3100s. VAXstation 4000 model 60s do not require a monochrome monitor.

The second monitor, connected to the 8-plane graphics option, can be color, or it can be monochrome for gray scale operations. Supported color monitors for the VAXstation 3100s are the VR160, VR290, VR297, VR299, and VRT19. Supported color monitors for the VAXstation 4000 model 60 are VRT16, VRT19, and VR320.

Standards

The VMS Operating System is based on the public, national, and international standards listed below. These standards are developed by the American National Standards Institute (ANSI), U.S. Federal Government (responsible for FIPS), Institute of Electrical and

Electronic Engineers (IEEE), and the International Organization for Standardization (ISO). The following information may be useful in determining responsiveness to stated conformance requirements as enabled in particular commercial and/or government procurement solicitation documents.

- ANSI X3.4-1986: American Standard Code for Information Interchange
- ANSI X3.22-1973: Recorded Magnetic Tape (800 BPI, NRZI)
- ANSI X3.26-1980: Hollerith Punched Card Code
- ANSI X3.27-1987: File Structure and Labeling of Magnetic Tapes for Information Interchange
- ANSI X3.39-1986: Recorded Magnetic Tape (1600 BPI, PE)
- ANSI X3.40-1983: Unrecorded Magnetic Tape
- ANSI X3.41-1974: Code Extension Techniques for Use with 7-bit ASCII
- ANSI X3.42-1975: Representation of Numeric Values in Character Strings
- ANSI X3.54-1986: Recorded Magnetic Tape (6250 BPI, GCR)
- ANSI X3.131-1986 (SCSI I): Small Computer System Interface
- ANSI X3T9.2/89-042 (SCSI II): Small Computer System Interface as described in REV 10C
- ANSI/IEEE 802.2-1985: Logical Link Control
- ANSI/IEEE 802.3-1985: Carrier Sense Multiple Access with Collision Detection
- FIPS 1-2: Code for Information Interchange, its Representations, Subsets, and Extensions
Note: 1-2 includes ANSI X3.4-1977(86)/FIPS 15; ANSI X3.32-1973/FIPS 36; ANSI X3.41-1974/FIPS 35; and FIPS 7
- FIPS 2-1/ANSI 3.6-1965: Perforated Tape Code for Information Interchange
- FIPS 3-1/ANSI X3.22-1973: Recorded Magnetic Tape Information Interchange (800 CPI, NRZI)
- FIPS 13/ANSI X3.21-1967: Rectangular Holes in Twelve-row Punched Cards
- FIPS 14/ANSI X3.26-1980: Hollerith Punched Card Code
- FIPS 16-1/ANSI X3.15-1976: Bit Sequencing of the Code for Information Interchange in Serial-by-bit Data Transmission

Note: FED STD 1010 adopts FIPS 16-1

- FIPS 22-1/ANSI X3.1-1976: Synchronous Signaling Rates Between Data Terminal and Data Communication Equipment

Note: FED STD 1013 adopts FIPS 22-1

- FIPS 25/ANSI X3.39-1986: Recorded Magnetic Tape for Information Interchange (1600 CPI, Phase Encoded)
- FIPS 26/ANSI X3.18-1967: One Inch Perforated Paper Tape for Information Interchange
- FIPS 37/ANSI X3.36-1975: Synchronous High Speed Data Signaling Rates Between Data Terminal Equipment and Data Communication Equipment

Note: FED STD 1001 adopts FIPS 37

- FIPS 50/ANSI X3.54-1986: Recorded Magnetic Tape for Information Interchange, 6250 CPI (246 CPMM), Group Coded Recording
- FIPS 79/ANSI X3.27-1987: Magnetic Tape Labels and File Structure for Information Interchange
- FIPS 86/ANSI X3.64-1979: Additional Controls for Use with American National Standard Code for Information Interchange
- FIPS 151-1: Portable Operating System Interface (POSIX 1003.1)
- Other FIPS not applicable
- POSIX 1003.1, 1988: System application programming interface
- POSIX 1003.2, draft 10: Shell and utilities
- POSIX 1003.4, draft 9: Real-time programming

Note: Information regarding interchangeability of ANSI and FED standards with FIPS is contained in "ADP Telecommunications Standards Index," July 1988, published and maintained by the General Services Administration.

- ISO 646: ISO 7-bit Coded Character Set for Information Exchange
- ISO 1001: File Structure and Labeling of Magnetic Tapes For Information Interchange
- ISO 1863: Information Processing — 9-track, 12, 7 mm (0.5 in) wide magnetic tape for information interchange recorded at 32 rpmm (800 rpi)
- ISO 1864: Information Processing — Unrecorded 12, 7 mm (0.5 in) wide magnetic tape for information interchange — 35 ftpmm (800 ftpi) NRZI, 126 ftpmm (3 200 ftpi) phase encoded and 356 ftmm (9 042 ftpi), NRZI
- ISO 2022: Code Extension Techniques for Use with ISO 646
- ISO 3307: Representations of Time of the Day

- ISO 3788: Information Processing — 9-track, 12, 7 mm (0.5 in) wide magnetic tape for information interchange recorded at 63 rpmm (1 600 rpt), phase encoded
- ISO 4873: 8-bit Code for Information Interchange — Structure and Rules for Implementation
- ISO 5652: Recorded Magtape (6250)
- ISO 6429: Control Functions for Coded Character Sets

VMS Disk Block Requirements

Disk Space Requirements (Block Cluster Size = 2):

The disk block size for the VMS Operating System, Version 5.5-2 after installation is approximately 107,600 blocks. This figure includes 5,600 blocks for page and swap files. Most systems will require larger page and swap files. This figure also includes Help library files that are in data-compressed format. Most system managers choose to expand these files (for faster access). The expansion requires approximately 8,500 additional blocks.

At least 67,000 free blocks are required in order to update VMS V5.5 to VMS V5.5-2. Alternative installation options are available for small operating system disk configurations. Please refer to the *VMS Versions 5.5-2 Update Procedures* for information concerning these installation options.

To support full VMS, a system disk of greater than 100 MB is recommended. When a smaller disk is used, additional tailoring is required prior to installing some VMS options. This does not include the dump file space. Refer to *VMS Upgrade and Installation Procedures* for information on tailoring.

VMS DECwindows Disk Block Requirements

The disk block size for the complete VMS DECwindows XUI environment after installation is approximately 68,000 blocks. This is in addition to the 107,600 blocks required for the other components of the VMS Operating System environment. A subset of the DECwindows environment can be installed. For example, programming support need not be installed in a user environment.

The following list describes how many blocks are needed for each section:

- User environment and applications — 14,000 blocks. This section provides support for running VMS DECwindows applications on VAX compute servers.

- Workstation device support — 19,000 blocks. This number includes 2,800 blocks for the 75 dpi fonts and 3,900 blocks for the 100 dpi fonts. On 75 dpi systems, the 100 dpi fonts do not have to be installed. On 100 dpi systems, both sets of fonts must be installed.
- Programming support — 32,000 blocks (approximately 3,500 per language). This number includes support for all the programming languages. If only a subset of languages is installed, the amount of disk space will be less.
- Example files — approximately 3,000 blocks.

Note that the individual sizes add up to more than the total because some components are shared by multiple portions of the environment.

To support full VMS and full VMS DECwindows, a system disk of greater than 115 MB is recommended. When a smaller disk is used, additional tailoring is required prior to installing some VMS and VMS DECwindows options. Refer to the *VMS Upgrade and Installation Procedures* for information on tailoring.

The VMS DECwindows software installation is an optional step in the VMS installation or upgrade procedure. It has been designed this way to allow users who do not need the VMS DECwindows software to conserve disk space and to allow systems with less than minimum configuration requirements to continue to run VMS. Please refer to the *VMS Installation and Upgrade Manual* for details concerning the partial installation of the VMS DECwindows software.

Memory Requirements

The following tables describe the minimum amount of memory required for a system user to install, boot, and login to a VMS system. To ensure satisfactory performance of applications, additional memory will be required.

The minimum amount of memory supported for a stand-alone VMS system is 2 MB. This first table contains the minimum amount of additional memory required for the following components to be installed on a VMS system.

Component	Necessary Memory
DECnet	.5 MB
VAXcluster	1.5 MB
DECwindows with remote execution of applications	1.5 MB
DECwindows with local execution of applications	2.0 MB

Two example configurations based on the previous table are:

System	Minimum Supported Memory
DECwindows with applications executing remotely, and DECnet	4.0 MB
DECwindows with applications executing locally, VAXcluster and DECnet	6.0 MB

Note: These are the minimum memory requirements. More memory will be required for satisfactory performance of the operating system and DECwindows applications. The performance and memory usage of VMS DECwindows systems is particularly sensitive to system configuration and window and application usage. Remote execution of an application requires an additional system that runs the application while the display of the application occurs on the local workstation.

Please refer to specific layered product Software Product Descriptions for their memory requirements.

Please refer to the VMS documentation for more information on performance.

GROWTH CONSIDERATIONS

The minimum hardware/software requirements for any future version of this product may be different from the requirements for the current version.

DISTRIBUTION MEDIA

Compact Disc

9-track 1600 BPI Magnetic tape, TK50 Streaming Tape

The VMS Operating System is also available as part of the VMS Consolidated Software Distribution on CDROM.

The VMS Documentation is also available as part of the VMS Online Documentation Library on CDROM.

DOCUMENTATION

Extensive documentation is available for VMS. The documentation is organized into functional subkits, based on usage. For example, all system management manuals are in one subkit. An easy-to-use desk-top set of manuals is also available for users who do not require extensive documentation.

Documentation for VMS DECwindows is available in two different sets. The VMS DECwindows User Kit is for the end user and the VMS DECwindows Programming Kit is for the DECwindows software developer.

In addition, the VMS Online Documentation Library compact disc contains the following VMS documentation, which can be read using the DECwindows Bookreader application:

- VMS Base Documentation Set
- VMS Extended Documentation Set
- VMS DECwindows User Kit and Programmer Kit¹
- Selected VMS Layered Product Documentation

ORDERING INFORMATION

This section contains order numbers for VMS media, licenses, documentation, and services.

ORDERING INFORMATION This section contains order numbers for OpenVMS media, licenses, documentation, and services.

Software Licenses

QL-001A*-** VAX VMS Operating System License for OpenVMS

QL-005A*-** OpenVMS O/S Base License

QL-XULA*-** OpenVMS Interactive User License

Media and Documentation

With Base Documentation Set: QA-09SA*-H*

With Extended Documentation Set: QA-001A*-H*

Additional Media

VMS Consolidated Software Distribution on CDROM: QA-VWJ8A-A8

Additional Documentation Sets

Base Documentation Set: QA-09SAA-GZ

Extended Documentation Set: QA-001AA-GZ

DECwindows User Kit Documentation:¹

QA-09SAB-GZ

DECwindows Programmers Kit Documentation:

QA-001AM-GZ

VMS Online Documentation Library on Compact Disc: QA-VYR8A-G8

¹Included in both VMS Base Documentation and Extended Documentation Sets.

¹ With the exception of the Adobe PostScript Documentation, which is not available online

Software Product Services

Software Support Service:²

QT-001A*-** VAX VMS Operating System Software Support Service for OpenVMS

QT-005A*-** OpenVMS O/S Base Software Support Service

QT-XULA*-** OpenVMS Interactive User Software Support Service

²A variety of integrated and a la carte Hardware and Software Products are available. For additional information, please contact your local office.

Media and Documentation Update Service

With Base Documentation Set: QT-09SA*-E*

With Extended Documentation Set: QT-001A*-E*

Additional Media Update Service

VMS Consolidated Software Distribution on CDROM: QT-VWJ8A-C8

Documentation Only Update Service

Base Documentation Set: QT-09SAA-KZ

Extended Documentation Set: QT-001AA-KZ

VMS Online Documentation Library on Compact Disc: QT-VYR8A-C8

The Software Media and Extended Documentation Set (QA-001A*-H*) is recommended for users managing high-end VAX systems, e.g., VAX 6000 610, VAXcluster systems, or DECnet-VAX networks. The Software Media and Base Documentation Set (QA-09SA*-H*) is recommended for managers of small standalone systems and for general end-users.

* Denotes variant fields. For additional information on available licenses, services, and media, refer to the appropriate price book.

SOFTWARE LICENSING

The VMS software is furnished under the licensing provisions of Digital's Standard Terms and Conditions.

Digital offers a separately orderable layered product called VMS DECwindows Motif. Refer to the VMS DECwindows Motif SPD (SPD 36.09.xx) for more information.

Integral to VMS is support for the VMS DECwindows desktop environment, which is delivered as a component of the VMS Operating System, requiring no separate license.

Customers who wish to run DECwindows over TCP/IP need only purchase the VMS/ULTRIX Connection product media and documentation kit. A separate license is not required. Customers who want to utilize the full VMS/ULTRIX Connection functionality (FTP, NFS, TELNET) do need to purchase a separate license. Refer to the VMS/ULTRIX Connection System Support Addendum (SSA 25.A4.xx-x) for required versions.

Please see the *Third Party Licensing* section in *Appendix C* for information regarding the Adobe licensing.

The System Integrated Products (SIPs), VAXcluster Software (SPD 29.78.xx), DECnet-VAX (SPD 25.03.xx), VAX Volume Shadowing (SPD 27.29.xx), and VAX RMS Journaling (SPD 27.58.xx) are separately licensed products. Please refer to the appropriate product's SPD for more information.

Software License Information

The VMS Operating System uses one of two different categories of licenses depending on the hardware and software configurations used and currently supported. This information is also provided in the applicable country's Price List.

These are the two categories of Operating System licenses for OpenVMS:

- 1. VAX VMS Licensing
- 2. OpenVMS Licensing

Digital provides the proper license type with the purchase of the system. Not all VMS license types are available for all system models.

VAX VMS License Information

The VAX VMS licenses include the rights for the VAX Rdb/VMS Run-Time Option. This allows the running of an application developed using VAX Rdb/VMS. However, VAX Rdb/VMS has separate media and documentation. In addition, should a user want to perform Rdb development, a separate license must be purchased. Refer to SPD 25.59.xx for further information.

There are four types of VAX VMS licenses:

- 1. Traditional License (QL-001A*-**)

This type of license provides unlimited use to the users on a defined system. VAX VMS traditional licenses are sized to capacity according to system type.

- 2. Multi-user License (QL-001A*-**)

This type of license provides use according to a specified number of concurrent users. This is an activity-based license. The Multi-user License provides the customer with the right to use the operating system up to the limit of users specified in the license. An operating system "User" is a person who is logged onto the system and/or is using the system interactively. Interactive use of the operating system includes the display of information upon any video or hardcopy display product whether in a DECwindows/X Windows environment or otherwise. This license is only available on limited system models, primarily MicroVAX and VAX 4000 systems.

- 3. VAX VMS Workstation License (QL-001A*-**)

This type of license provides use for a single user on a VAX Workstation.

- 4. File and Application Server License (QL-001A*-**)

This type of license provides for the non-interactive use of OpenVMS.

OpenVMS-based VAXservers are sold with a File and Application Server License. The intent of an OpenVMS-based VAXserver is to provide file, print, application, and compute "services" to "clients" who have remotely submitted their requests (for example via network/remote submit/batch jobs, etc.).

The software licensing stipulates that no direct operating system log-ons by users are permitted on the OpenVMS-based VAXserver. One direct log-on is allowed for system management purposes only.

While remote submission of OpenVMS-based applications for execution on a OpenVMS-based VAXserver is allowed, interactive use (direct log-on and execution) of OpenVMS-based layered products is prohibited.

All VAX VMS licenses provide the right to use only the OpenVMS features, functionality, and facilities provided by the current version license. Any features, functionality, and facilities not specifically licensed in the purchased version of OpenVMS may not be used if a prior version kit containing such unlicensed features is installed.

Not all VAX VMS license types are available for all versions of VMS, OpenVMS or all VAX models.

OpenVMS License Information

There are two types of OpenVMS licenses:

- 1. OpenVMS O/S Base License (QL-005A*-**)

OpenVMS O/S Base License grants the right to unrestricted, non-interactive use of the OpenVMS Operating System for the execution of remotely submitted requests for batch, print, application, and computing services, on a designated, single processor.

No direct OpenVMS operating system log-ons by users are permitted on the system. One direct log-on is allowed for system management purposes only.

The OpenVMS Base License does not include the license right for the VAX Rdb/VMS Run-Time Option. The Rdb/VMS Run-Time License is available separately.

Interactive use of systems licensed with an OpenVMS O/S Base License requires the addition of an OpenVMS Interactive User License (for one or more users).

The OpenVMS O/S Base License provides the right to use only the OpenVMS features, functionality, and facilities provided by the current version. Any features, functionality, and facilities not specifically licensed in the purchased version of OpenVMS may not be used if a prior version kit containing such unlicensed features is installed.

2. OpenVMS Interactive User License (QL-XULA*-**)

The OpenVMS Interactive User License provides the right to interactively use the operating system by the specified, or unlimited, number of concurrent users, on a designated, single processor. A user is an individual who is logged on to a processor and/or is interactively using the operating system software by means other than login. An OpenVMS O/S Base License is a prerequisite to the OpenVMS Interactive User License.

This license grants the right to use the same version of the operating system that is permitted under the corresponding O/S Base License at the time of the initial installation of the Interactive User License.

In-cabinet upgrades are supported with OpenVMS licensing. When upgrading a processor, the customer is required to upgrade the operating system licenses. For OpenVMS, this is accomplished with a BASE upgrade license that upgrades the O/S BASE license and permits the use of all "specified quantity" (e.g., 4 user) interactive licenses on the processor. For unlimited user licenses, an additional upgrade license for Unlimited Interactive User is required.

The OpenVMS O/S Base and Interactive Use licenses are not supported by VMS or OpenVMS operating system releases prior to OpenVMS Version 5.5.

Digital provides the proper license type with the purchase of the system. Not all OpenVMS license types are available for all system models.

License Management Facility Support

The VMS Operating System supports the License Management Facility.

If no VMS license is registered and activated using the License Management Facility, then a single login is permitted for system management purposes through the system console (OPA0:).

Several of the VAX VMS and OpenVMS license types are based on the number of concurrent users, called an activity license. Every product has the option to define an activity as related to the License Management Facility. OpenVMS defines activities, sometimes referred to as an OpenVMS "user," as follows:

- Each remote terminal connection is considered an activity. This is true even if you set host to your local node (SET HOST 0).
- Each connection from a terminal server is considered an activity.
- A multiple-window session on a workstation is considered one activity, regardless of the number of windows.
- A batch job is not considered an activity.
- A remote network connection that is a connection other than a remote terminal connection, is not considered an activity.

For more information about Digital's licensing terms and policies, contact your local Digital office.

SOFTWARE PRODUCT SERVICES

A variety of service options are available from Digital. For more information, contact your local Digital office.

SOFTWARE WARRANTY

Warranty for this software product is provided by Digital with the purchase of a license for the product as defined in the Software Warranty Addendum of this SPD and the applicable Digital Standard Terms and Conditions.

SUPPORTED HARDWARE FOR VMS, VMS DECwindows, VAXcluster, and DECnet-VAX

This section of the SPD contains four parts: Hardware Charts, *Appendix A*, *Appendix B*, and *Appendix C*.

The charts list the hardware that VMS, VMS DECwindows, DECnet-VAX, and VAXcluster Software supports. Combinations of hardware options are subject to limitations such as bandwidth, physical configuration constraints, and electrical load and power supply.

Appendix A describes system-specific restrictions for the configurations listed.

Appendix B describes Digital terminals, disks, tapes, controllers, communications options, and VAXcluster options. Some restrictions for specific devices are listed if applicable.

The content of this hardware configuration appendix is intended to specify the device limitations and provide a general guide. It does not describe all possible hardware configurations or circumstances. Any particular configuration should be discussed with Digital. Contact Digital for the most up-to-date information on possible hardware configurations.

Digital reserves the right to change the number and type of devices supported by VMS, VMS DECwindows, DECnet-VAX, and VAXcluster Software. The minimum hardware requirements for future versions and updates of VMS, VMS DECwindows, DECnet-VAX, and VAXcluster Software may be different from current hardware requirements. For configuration details about VAX hardware, refer to the *VAX System and Options Catalog* and the *Networks and Communications Buyers Guide*.

Refer to the individual SPDs for DECnet-VAX (SPD 25.03.xx) and VAXcluster Software (SPD 29.78.xx) for detailed product information.

How to Read the Charts

The first column lists the VAX system, the media (tape, disk, or compact disc) from which the VMS Operating System can be loaded onto the system disk, and the maximum number of busses supported on the system.

The second column lists the disk controllers and drives that can be used on the system. A disk controller can be used with any disk drive listed next to it: for example, on a MicroVAX II or VAXstation II system the RQDX3 disk controller can be used with an RD52, RD53, RD54, RX50, or RX33 disk drive.

The third column lists the tape controllers and drives that can be used on the system. The tape controller can be used with any tape drive listed next to it: for example, on a MicroVAX II or VAXstation II system, the TQK50 controller can be used with the TK50 tape drive.

The fourth and fifth columns list the communications and VAXcluster options available for the systems. The listed Ethernet devices can also be used for network connections.

The sixth column lists other hardware that can be used and the maximum amount of memory allowed on the systems in each category.

System	Disks		Tapes		Communication (WAN)	Options (LAN/CI)	Miscellaneous	
	CTRL	DRIVE	CTRL	DRIVE				
MicroVAX II, VAXstation II	KDA50 RQDX2	RA-series* RD51 RD52 RD53 RX50	TQK50 TQK70 TSV05 KLESI	TK50 TK70 TS05 TU81-Plus* RV20*	Asynch-	CXA16*+ CXB16*+ CXY08* DZV11 DZV11* DZV11 DZQ11	DEQNA DELQA DESQ#	DRV11-WA* LPV11 VCB01-KP (VsII) VCB02-B (VsII/GPX) VCB02-D (VsII/GPX) RQDXE
(Load Media) TK50 Magtape RX33## CDROM	RQDX3	RD52 RD53 RD54 RX50			Synch-	DMV11 DSV11		
(BUSSES) 1 Q-bus 2 DSSI**	KRQ50	RRD50 RRD40						16 MB Max Mem
	KLESI KFQSA	RC25 (DSSI) RF30 RF71						

* Can be used on a MicroVAX II system only.
 ** Only available via the KFQSA.
 + DECnet-VAX does not support these options.
 # Only available with BA200-series enclosures.
 ## VMS distribution on this media has been retired.
 Supports Display PostScript.

MicroVAX 2000 VAXstation 2000	Integral	RD32 RD53 RD54 RX33	TZK50	TK50	Asynch-	DST32*+ DSH32	Integral	VS40X (Vs2000)
(Load Media) TK50 RX33#					Synch-	DST32*+ DSH32*		14 MB Max Mem
(BUSSES) N/A								

* Can be used on a MicroVAX 2000 system only.
 # VMS distribution on this media has been retired.
 + Concurrent use of the DST32 and the DHT32 is not supported.
 Supports Display PostScript.

System	Disks		Tapes		Communication (WAN)	Options (LAN/CI)	Miscellaneous
	CTRL	DRIVE	CTRL	DRIVE			
MicroVAX 3100 VAXserver 3100 Models 10/10e 20/20e (Load Me- dia*) TK50 CDROM (BUSSES) Integral SCSI	Integral	RX23 RZ23 RZ24 RZ25 RZ55 RZ56 RZ57 RRD40 RRD42 RX26 RZ23L	TKZ50	TK50Z TZ30 TLZ04 TZK10	DSH32 (1 sync. & 8 async. lines)	Integral	32 MB Max Mem

* Factory-loaded software on all configurations that include RZ23L, RZ24, and RZ25 internal disks.

System	Disks		Tapes		Communication (WAN)	Options (LAN/CI)	Miscellaneous
	CTRL	DRIVE	CTRL	DRIVE			
MicroVAX 3100 Models 30/40/80/90 (Load Media) TK50 CDROM TZ85 (BUSSES) Integral SCSI	Integral	RX33+ RZ24 RZ25 RZ55+ RZ56+ RZ57+ RZ58+ RRD42 RZ26 RX26 RZ23L RZ24L		TK50Z+ TZ30 TLZ04+ TZK10 TZ85+		DHW41-AA DHW41-BA DHW42-AA DHW42-BA DHW42-UP DHW42-CA DSW41-AA DSW42-AA	Integral Model 80 72 MB Max Mem Model 90 128 MB Max Mem

*Factory-loaded software on all configurations that include RZ24L, RZ25 and RZ26 internal disks
+External device only

VAXstation 3100 Series (Load Media) TK50 CDROM (BUS) SCSI	Integral	RZ22 RZ23 RZ24 RZ55 RZ56 RRD40 RX23	Integral	TK50Z TZ30			Integral	WS01X VCB02 Graphics VS40X-PA Graphics Coprocessor 32 MB Max Mem
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Supports Display PostScript.

VAXstation 3200 (Load Media) TK50 CDROM (BUS) 1 Q-bus	RQDX3 KRQ50	RD53 RD54 RRD40 RRD50	TQK50 TSV05	TK50 TS05	Asynch- Synch-	DHV11 DZQ11 DSV11	DELQA	Graphics Sub- system for the Vs3200 32MB Max Mem
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Supports Display PostScript.

System	Disks		Tapes		Communication (WAN)		Options (LAN/CI)	Miscellaneous
	CTRL	DRIVE	CTRL	DRIVE				
MicroVAX 3300/3400	Integral	RF30	TQK70	TK70	Asynch-	CXA16+		52 MB Max Mem
VAXserver 3300/3400		RF31	TQK50	TK50		CXB16+		
		RF31F	KFQSA	TF85		CXY08		
	KFQSA	RF71		TF857				
(Load Media)		RF72	TSV05	TS05	Synch-	DSV11		
TK50	KRQ50	RRD40	KLES1	TU81-Plus				
CDROM		RRD50						
Magtape	KZQSA	RRD42						
		TLZ04						
	KDA50	RA-series						
(BUSSES)								
1 DSSI*								
1 Q-bus								

* Second DSSI available only via the KFQSA.

+ DECnet-VAX does not support these options.

Note: Refer to the Systems and Options Catalog for listing of supported Q-bus options.

MicroVAX 3500	RQDX3	RD53*	TQK70	TK70	Asynch-	CXA16+	DELQA	Graphics Subsystem for the Vs3500
VAXserver 3500		RD54*	TQK50	TK50		CXB16+	DESQA	
	KDA50	RA-series	TSV05	TS05		CXY08		
VAXstation 3500	KRQ50	RRD40		TF85				
		RRD50		TF857	Synch-	DSV11		64MB Max Mem
	KZQSA	RRD42	KFQSA	TU81-Plus				
(Load Media)		TLZ04	KLES1					
TK50	KFQSA	RF30	RV20					
Magtape		RF31						
CDROM		FR31F						
		RF71						
		RF72						
(BUSSES)								
1 Q-bus								
1 DSSI **								

* Available on MicroVAX 3500 system only.

+ DECnet-VAX does not support these options.

** Only available via the KFQSA.

Supports Display PostScript.

Note: Refer to the Systems and Options Catalog for listing of supported Q-bus options.

VAXstation 3520	I/O Adapter	RZ55	TQK70	TK70	Asynch-	CXA16+	Integral	Graphic Subsystem for the Vs3520/3540 VCB03 optional graphics
VAXstation 3540		RZ56				CXB16+		
		RRD40				CXY08		
(Load Media)					Synch-	DSV11		
TK50								64MB Max Mem
CDROM								
(BUSSES)								
1 SCSI								
1 Q-bus								

Supports Display PostScript.

+ DECnet-VAX does not support these options.

Note: Refer to the Systems and Options Catalog for listing of supported Q-bus options.

System	Disks		Tapes		Communication (WAN)	Options (LAN/CI)	Miscellaneous
	CTRL	DRIVE	CTRL	DRIVE			
MicroVAX 3600	KDA50 KRQ50	RA-series RRD40	TQK70 TQK50	TK70 TK50	Asynch-	CXA16+ CXB16+ CXY08	64 MB Max Mem
VAXserver 3600	KZQSA	RRD50 RRD42	TSV05 KLESI	TS05 TU81-Plus			
VAXserver 3602	KFQSA	TLZ04 RF30 RF31 RF31F	KFQSA	RV20 TF85 TF857	Synch-	DSV11	
(Load Media) TK50 Magtape CDROM		RF71 RF72					
(BUSSES) 1 Q-bus 1 DSSI**							

+ DECnet-VAX does not support these options.

** Only available via the KFQSA.

Note: Refer to the Systems and Options Catalog for listing of supported Q-bus options.

MicroVAX 3800	KFQSA	RF30 RF31	TQK70 TQK50	TK70 TK50	Asynch-	CXA16+ CXB16+ CXY08	DESQA DELQA	64 MB Max Mem
VAXserver 3800		RF31F RF71 RF72	TSV05 KLESI KFQSA	TS05 TU81-Plus TF85 TF857				
(Load Media) TK50 CDROM	KRQ50 KZQSA	RRD40 RRD50 RRD42 TLZ04						
(BUSSES) 1 Q-bus 1 DSSI*	KDA50	RA-series						

* Only available via the KFQSA.

+ DECnet-VAX does not support these options.

Note: Refer to the Systems and Options Catalog for listing of supported Q-bus options.

MicroVAX 3900	KDA50 KRQ50	RA-series RRD40	TQK70 TQK50	TK70 TK50	Asynch-	CXA16+ CXB16+ CXY08	DESQA DELQA	64 MB Max Mem
VAXserver 3900	KZQSA	RRD50 RRD42	KLESI TSV05	TU81-Plus TS05				
(Load Media) TK50 CDROM Magtape	KFQSA	TLZ04 RF30 RF31 RF31F RF71 RF72	KFQSA	TF85 TF857	Synch-	DSV11		
(BUS) 1 Q-bus 1 DSSI*								

* Only available via the KFQSA.

+ DECnet-VAX does not support these options.

Note: Refer to the Systems and Options Catalog for listing of supported Q-bus options.

System	Disks		Tapes		Communication (WAN)	Options (LAN/CI)	Miscellaneous	
	CTRL	DRIVE	CTRL	DRIVE				
VAX-11/730	UDA50	RA-series	TS11	TS11	Asynch-	DMF32	DEUNA+	CR11
	RK711	RK07	TUK50	TU80		DZ11	DELUA+	DR11-W
(Load Media)	RL211	RL02	KLESI	TU81		DZ32		DMF32-LP
RL02*	RX211	RX02		TU81-Plus	DMZ32		LP11	
Magtape	RUX50	RX50			DHU11		LPA11	
	(Integral)						FP730	
(BUS)	IDC	RL02			Synch-	DMF32		
1 UNIBUS		R80				DMR11		5 MB Max Mem

* VMS distribution on this media has been retired.
 + VAX-11/730 systems are not supported in VAXcluster systems.

System	Disks		Tapes		Communication (WAN)	Options (LAN/CI)	Miscellaneous	
	CTRL	DRIVE	CTRL	DRIVE				
VAX-11/750	UDA50	RA-series	TS11	TS11	Asynch-	DMF32	DEUNA	DMF32-LP
	RK711	RK07	KLESI	TU80		DZ11	DELUA	DR11-W
(Load Media)	RL211	RL02		TU81		DZ32	(CI)	DR750
RL02*	RX211	RX02		TU81-Plus	DMZ32	CI750	DW750	
RK07*	KLESI	RC25		RV20	DHU11		FP750	
RA60*	RUX50	RX50	TUK50	TK50	Synch-	DMF32 DMR11	H7112	
Magtape		RM03		TA-series			KU750	
		RM05	(CI)				LPA11	
(BUSSES)		RM80	HSC			RH750		
2 UNIBUS		RP06	TM03	TE16		LP11		
3 MASSBUS		RP07	TM78	TU77				
	(CI)			TU78			14 MB Max Mem	
	HSC	ESE-20						
		RA-series						

* VMS is not distributed on this media type.

System	Disks		Tapes		Communication (WAN)	Options (LAN/CI)	Miscellaneous	
	CTRL	DRIVE	CTRL	DRIVE				
VAX-11/780	UDA50	RA-series	TS11	TS11	Asynch-	DMF32	DEUNA	DM32-FP
VAX-11/785	RK711	RK06	KLESI	TU80		DZ11	DELUA	DR11-W
	RL211	RK07		TU81		DMZ32	(CI)	DR780
(Load Media)	RX211	RL02		TU81-Plus		DHU11	CI780	DW780
RK07*	KLESI	RX02		RV20				H7112
RA60*	RUX50	RC25	TUK50	TK50	Synch-	DMF32		FP780**
Magtape		RX50		TA-series		DMR11		
		RM03	(CI)					KE780**
(BUSES)		RM05	HCS					KU780**
4 UNIBUS		RM80	TM03	TE16				RH780
4 MASSBUS		RP05	TM78	TU45				LP11
		RP06		TU77				
		RP07		TU78				
	(CI)							64 MB Max Mem
	HCS	ESE-20						
		RA-series						

* VMS is not distributed on this media.

** These options are used on the VAX-11/780 only.

*** Used on the VAX-11/785.

VAXft Models 110 /310	KFE52	RF31 RF72	KFE52	TF70	Synch-	DSF32	Integral	128 MB Max Mem
(Load Media)								
TK50								
CDROM via InfoServer								
(Busses)								
2 DSSI								
VAXft Models 410 /610/ 612	KFE52	RF31 RF72 RF73	KFE52 (Model 610/612 only) KFQSA	TF70 TF85 TF857	Synch-	DSF32	Integral	256 MB Max Mem
(Load Media)								
TK50								
CDROM via InfoServer								
(Busses)								
2 DSSI								

System	Disks		Tapes		Communication (WAN)	Options (LAN/CI)	Miscellaneous	
	CTRL	DRIVE	CTRL	DRIVE				
VAX 4000 Model 100	Integral & KFQSA	RF30 RF31 RF31F RF31T	Integral KZQSA KFQSA TSV05	RSV20 TF85 TF857 TZK10	Asynch-	DHW42-AA DHW42-BA DHW42-UP DHW42-CA	Integral DELQA DESQA	128 MB Max Mem
(Load Media) TK50		RF35	KLESI	TZ30	Synch-	DSW42-AA		
CDROM		RF71 RF72		TLZ04 TLZ06				
(BUS) 1 Q-bus	KDA50	RF73		TS05				
2 DSSI	KRQ50 KZQSA	RA-series RRD40 RRD42 RWZ01 RX26		TSZ07 TU81-Plus				

Note: Factory loaded software on all configurations that contain a disk.

VAX 4000 Model 200	Integral & KFQSA	RF30 RF31 RF31F	TQK50 TQK70 TSV05	RSV20 TF85 TF857	Asynch-	CXA16+ CXB16+ CXY08	Integral DELQA DESQA	64 MB Max Mem
(Load Media) TK50		RF35	KLESI	TLZ04	Synch-	DPV11		
CDROM		RF71 RF72 RF73	KZQSA Integral & KFQSA	TS05 TSZ07 TK50 TK70		DSV11		
(BUS) 1 Q-bus	KDA50	RA-series		TU81-Plus				
4 DSSI	KRQ50 KZQSA	RRD40 RRD42						

Note: Factory loaded software on all configurations that contain a disk.

VAX 4000 Model 300	Integral & KFQSA	RF30 RF31 RF71	TQK70 TQK50 TSV05	TK70 TS05 TU81-Plus	Asynch-	CXA16+	Integral DESQA	256 MB Max Mem
(Load Media) TK50		RF31F	KLESI	TK50	Synch-	CXB16+ CXY08	DELQA	
CDROM		RF72 RF73 RF25	KZQSA Integral & KFQSA	RSV20 TLZ04 TSZ07 TF85		DSV11 DPV11		
(BUS) 1 Q-bus	KDA50	RA-series		TF857				
4 DSSI	KRQ50 KZQSA	RRD40 RRD42						

Note: Factory loaded software on all configurations that contain a disk.

System	Disks		Tapes		Communication (WAN)	Options (LAN/CI)	Miscellaneous
	CTRL	DRIVE	CTRL	DRIVE			
VAX 4000 Model 400	Integral & KFQSA	RF30 RF31 RF31F	TQK50 TQK70 TSV05	RSV20 TF85 TF857	Asynch- Synch-	CXA16+ CXB16+ CXY08	512 MB Max Mem
(Load Media) TK50 CDROM		RF31T RF35 RF71	KLESI KZQSA Integral	TLZ04 TS05 TSZ07		DPV11 DSV11	
(BUS) 1 Q-bus 4 DSSI	KDA50 KRQ50 KZQSA	RF72 RF73 RA-series RRD40 RRD42 RWZ01	& KFQSA	TK50 TK70 TU81-Plus TLZ06			

Note: Factory loaded software on all configurations that contain a disk.

VAX 4000 Model 500	Integral & KFQSA	RF30 RF31 RF31F	TQK50 TQK70 TSV05	RSV20 TF85 TF857	Asynch- Synch-	CXA16+ CXB16+ CXY08	512 MB Max Mem
(Load Media) TK50 CDROM		RF31T RF35 RF71	KLESI KZQSA Integral	TLZ04 TS05 TSZ07		DPV11 DSV11	
(BUS) 1 Q-bus 4 DSSI	KDA50 KRQ50 KZQSA	RF72 RF73 RA-series RRD40 RRD42 RWZ01	& KFQSA	TK50 TK70 TU81-Plus TLZ06			

Note: Factory loaded software on all configurations that contain a disk.

VAX 4000 Model 600	Integral & KFQSA	RF30 RF31 RF31F	TQK50 TQK70 TSV05	RSV20 TF85 TF857	Asynch- Synch-	CXA16+ CXB16+ CXY08	512 MB Max Mem
(Load Media) TK50 CDROM		RF31T RF35 RF71	KLESI KZQSA Integral	TLZ04 TS05 TSZ07		DPV11 DSV11	
(BUS) 1 Q-bus 4 DSSI	KDA50 KRQ50 KZQSA	RF72 RF73 RA-series RRD40 RRD42 RWZ01	& KFQSA	TK50 TK70 TU81-Plus TLZ06			

Note: Factory loaded software on all configurations that contain a disk.

System	Disks		Tapes		Communication (WAN)	Options (LAN/CI)	Miscellaneous
	CTRL	DRIVE	CTRL	DRIVE			
VAX 6000- 200 Series+	KDB50	RA-series	KLESI	TU81-Plus	Asynch-	DMB32	LP11*
VAXserver	KDM70		TBK50	RV20		DHB32	DMB32-LP
6000-210	TM32		TBK70	TK50		DEMNA	DR11-W*
VAXserver	(CI)		(CI)	TK70	Synch-	DEMFA	DWMUA*
6000-220	HSC	ESE-20	HSC	TA-series		DSB32	DRB32
		RA-series	KDM70			CIBCA-AA	
						CIBCA-BA	
						CIXCD-AB	512 MB Max Mem
(Load Media)							
TK50							
Magtape							
CDROM via							
InfoServer							
(BUSES)							
6 VAXBI							
1 UNIBUS							
2 VME							
(DWMVA)							
KFMSA							

+ Formerly named the VAX 6210, 6220, 6230, 6240.
 * Supported on the VAX 6000-210 and VAX 6000-220 systems only.

VAX 6000- 300 Series+	KDB50	RA-series	KLESI	TU81-Plus	Asynch-	DMB32	DEBNA	LP11*
VAXserver	KDM70		TBK50	TK50		DHB32	DEBNI	DMB32-M
6000-310	TM32		TBK70	TK70			DEMNA	DR11-W*
/320	(CI)		(CI)		Synch-	DMB32	DEMFA	DRB32
	HSC	ESE-20	HSC	TA-series		DSB32	(CI)	DWMUA*
		RA-series	KDM70				CIBCA-AA	
							CIBCA-BA	512 MB Max Mem
							CIXCD-AB	
(Load Media)								
TK50								
Magtape								
CDROM via								
InfoServer								
(BUSES)								
6 VAXBI								
1 UNIBUS*								
2 VME								
(DWMVA)								
KFMSA								

+ Formerly named the VAX 6310, 6320, 6330, 6340, 6360.
 * Supported on the VAX 6000-310 and VAX 6000-320 systems only.

System	Disks		Tapes		Communication (WAN)	Options (LAN/CI)	Miscellaneous	
	CTRL	DRIVE	CTRL	DRIVE				
VAX 6000-400 Series VAXserver 6000-410 /420	KDB50 KDM70 TM32	RA-series	KLESI TBK70 TBK50 (CI) HSC	TU80-Plus TK70 TK50 TA-series	Asynch- Synch-	DMB32 DHB32 DMB32 DSB32	DEBNA DEBNI DEMNA DEMFA (CI) CIBCA-BA CIXCD-AB	LPA11 DR11-W FV64A DMB32 DRB32 512 MB Max Mem
(Load Media) TK50 Magtape CDROM via InfoServer								
(BUSSES) 6 VAXBI 1 UNIBUS 2 VME (DWMVA) KFMSA								
VAX 6000-500 Series VAXserver 6000-510 /520	KDB50 KDM70 TM32	RA-series	KLESI TBK70 TBK50 (CI) HSC	TU80-Plus TK70 TK50 TA-series	Asynch- Synch-	DMB32 DHB32 DMB32 DSB32	DEBNA DEBNI DEMNA DEMFA (CI) CIBCA-BA CIXCD-AB	FV64A DMB32 DRB32 512 MB Max Mem
(Load Media) TK50 Magtape CDROM via InfoServer								
(BUSSES) 6 VAXBI 2 VME (DWMVA) KFMSA								
VAX 6000-600 Series	KDB50 KDM70 TM32	RA-series	KLESI TBK70 TBK50 (CI) HSC	TU80-Plus TK70 TK50 TA-series	Asynch- Synch-	DMB32 DHB32 DMB32 DSB32	DEBNA DEBNI DEMNA DEMFA (CI) CIBCA-BA CIXCD-AB	DMB32 DRB32 512 MB Max
(Load Media) TK50 Magtape CDROM via InfoServer								
(BUSSES) 6 VAXBI 2 VME (DWMVA) KFMSA								

System	Disks		Tapes		Communication (WAN)	Options (LAN/CI)	Miscellaneous	
	CTRL	DRIVE	CTRL	DRIVE				
VAX 8200	KDB50	RA-series	KLESI	TU81-Plus	Asynch-	DHB32	DEBNA	DMB32-LP
VAX 8250	(CI)		TM32	RV20		DMB32	DEBNI	DR11-W
(Load Media)	HSC	ESE-20	TS11	RV64		DHU11	DELUA	DWBUA
Magtape		RA-series	TUK50	TU80		DMF32	(CI)	DRB32
RA60*			TBK50	TU81		DMZ32	CIBCA-AA	LP11
TK50			(CI)	TU81-Plus	Synch-	DMB32	CIBCA-BA	128 MB Max Mem
(BUSSES)			HSC	TK50		DSB32	CIBCI	
1 VAXBI				TA-series				
1 UNIBUS								

* VMS Operating System is not distributed on RA60 media.

VAX 8300	KDB50	RA-series	KLESI	TU81-Plus	Asynch-	DHB32	DEBNA	DMB32-LP
VAX 8350	(CI)		TM32	RV20		DMB32	DEBNI	DR11-W
(Load Media)	HSC	ESE-20	TS11	RV64		DHU11	DELUA	DWBUA
Magtape		RA-series	TUK50	TU80		DMF32	(CI)	DRB32
RA60*			TBK50	TU81-Plus		DMZ32	CIBCA-AA	LP11
TK50			(CI)	TU81-Plus	Synch-	DMB32	CIBCA-BA	128 MB Max Mem
(BUSSES)			HSC	TK50		DSB32	CIBCI	
1 VAXBI				TA-series				
1 UNIBUS								

* VMS Operating System is not distributed on RA60 media.

VAX 85xx	KDB50	RA-series	KLESI	TU81-Plus	Asynch-	DHB32	DEBNA	DMB32-LP
(Load Media)	(CI)			RV20		DMB32	DEBNI	DR11-W
Magtape	HSC	ESE-20		RV64		DHU11	DELUA	DWBUA
(BUSSES)		RA-series	(CI)			DMF32	(CI)	DRB32
2 VAXBI			HSC	TA-series	Synch-	DMZ32	CIBCA-AA	LP11
1 UNIBUS						DMB32	CIBCA-BA	256 MB Max Mem
					DSB32	CIBCI		

System	Disks		Tapes		Communication (WAN)	Options (LAN/CI)	Miscellaneous	
	CTRL	DRIVE	CTRL	DRIVE				
VAX 8600	UDA50	RA-series	TS11	TS11	Asynch-	DMF32	DEUNA	DMF32-LP
VAX 8650	RL211	RL02	KLESI	TU80		DZ11	DELUA	DR11-W
	RX211	RX02	TUK50	TU81		DZ32	(CI)	DR780
(Load Media)	RUX50	RX50		TU81-Plus		DMZ32	CI780	DW780
Magtape	KLESI	RC25	(CI)			DHU11		FP86-AA
		RM03	HSC	RV20				RH780
(BUSSES)		RM05		TK50	Synch-	DMF32		
7 UNIBUS		RM80		TA-series		DMR11		260 MB Max
6 MASSBUS		RP05	TM03	TE16			Mem	
2 SBI		RP06	RM78	TU77				
		RP07		TU78				
	(Integral)		IDTC	TU81				
	IDTC	RA60						
	(CI)	RA80						
	HSC	RA81						
		RA82						
		ESE-20						
		RA-series						
VAX 8700	KD850	RA-series	KLESI	TU81-Plus	Asynch-	DHB32	DEBNA	DMB32-LP
VAX 8800	(CI)			RV20		DMB32	DEBNI	DR11-W
	HSC	ESE-20		RV64		DMF32	DELUA	DRB32
(Load Media)		RA-series	(CI)			DMZ32	(CI)	DWBUA
Magtape			HSC	TA-series			CIBCA-AA	LP11
					Synch-	DMB32	CIBCA-BA	
(BUSSES)						DSB32	CIBCI	512 MB Max
4 VAXBI							Mem	
2 UNIBUS								
VAX 8810*	KD850	RA-series	KLESI	TU81-Plus	Asynch-	DMB32	DEBNA	DMB32-LP
VAX 8820	(CI)			RV20		DHB32	DEBNI	DR11-W
VAX 8830	HSC	ESE-20		RV64			(CI)	DWBUA
VAX 8840		RA-series			Synch-	DMB32	CIBCA-AA	DRB32
						DSB32	CIBCA-BA	LP11
(Load Media)							CIBCI**	
Magtape								512 MB Max
								Mem
(BUSSES)								
6 VAXBI								
1 UNIBUS								

* The VAX 8810 can support a maximum of 4 VAXBIs.

** Supported only on the VAX 8810.

System	Disks		Tapes		Communication (WAN)		Options (LAN/CI)	Miscellaneous
	CTRL	DRIVE	CTRL	DRIVE				
VAX 9000-110/210	KDM70 (6 max)	RA-series ESE-20	KLESI (2 max)	RV20 RV64	Asynch-	DMB32 (2 max)	DEMNA (4 max)	DRB32-M/-E/-W /-C
VAX 9000-310/410	(CI) HSC	ESE-20 RA-series	KDM70 KFMSA (2 max)	TA-series RF-series TF-series	FDDI-	DHB32 (2 max) DEMFA (4 max)	(CI) CIXCD (4 max) DEBNI (3 max)	(2 max) DWMBB-HA/ CA/-JA (VAXBI EXP) KDB50 (2 max) DSB32-M (2 max)
(Load Media) Magtape CDROM via InfoServer					Synch-	DMB32 DSB32		
(BUSSES) 1 XMI 4 VAXBI								512 MB Max Mem

NOTE: The VMS software that runs on the MicroVAX console subsystem is licensed for use only with standard console activities. No other use is intended or implied.

Appendix A

This appendix describes some restrictions to the system configurations listed in the charts. See the *VAX System and Options Catalog* and the *Network and Communications Buyers Guide* for details of VAX hardware configurations.

MicroVAX I/VAXstation I Systems

The final version of VMS that supports these systems is VMS V5.1-1.

MicroVAX II System

The CX-series boards and DESQA controller can be used in a BA213 cabinet only.

MicroVAX 2000 and VAXstation 2000 Systems

DECnet-VAX supports only one asynchronous data/modem RS-232C serial line up to 9600 baud on the integral 4 line asynchronous controller.

VAXserver 3602 System

The VAXserver 3602 is two VAXserver 3600 systems.

VAX-11/725

VMS V5.1 was the final version to support the VAX-11/725.

VAX-11/730 System

The VAX-11/730 system supports additional memory to a maximum of 5 MB for systems configured with R80/RL02 or dual RL02 disks. Other VAX-11/730 system configurations support a maximum of 3 MB of memory for the VAX-11/730 only.

A maximum of two RL02 disk drives can be added to the dual RL02 and the R80/RL02 configuration for VAX-11/730 only.

The VAX-11/730 system supports one UNIBUS magnetic tape subsystem.

Refer to the *Hardware System and Options Catalog* for the different hardware options supported on these systems.

The VMS DECwindows environment is not supported on these systems.

Appendix B

This appendix describes Digital Equipment Corporation terminals, disks, tapes, controllers, communications options, and VAXcluster options.

Terminals and Terminal Line Interfaces

To prevent input from overflowing a buffer, terminals use the ASCII control characters DC1 and DC3 for synchronization as defined by Digital's DEC STD 111, Revision A.

The following table lists the terminals that are supported by VMS:

VT52	VT100-series	LA-series
VT300-series	VT1000-series	LQP02
	VT200-series	

Terminals on Professional 350, Rainbow 100, and DECmate II systems emulate VT100 terminals.

Only limited support is available for the VT52. The VT131, when running an application, operates in block mode. When interacting with VMS and its associated utilities, the VT131 only operates in VT100 (or interactive) mode and not in block mode.

Note: The VT1000 is a monochrome windowing terminal that supports standard ANSI applications and "X" windows. The transport protocols supported are LAT for VMS. The product supports 15 inch and 19 inch monitors.

Disks

To support full VMS, a system disk of greater than 100 MB is recommended. To support full VMS and full VMS DECwindows, a system disk of greater than 115 MB is recommended. When a smaller disk is used, additional tailoring is required prior to installing some VMS and VMS DECwindows options. This does not include the dump file space. Refer to the *Upgrade and Installation Procedures Manual* for information on tailoring. For the disks that have been introduced since the last edition of the VMS Operating System SPD, the minimum required version of VMS for these disks is listed.

ESE-20	120 MB solid state disk drive.	(MSCP)
ESE-52	120 MB solid state disk drive.	(MSCP) (V5.5-2)
ESE-56	600 MB solid state disk drive.	(MSCP) (V5.5-2)
ESE-58	960 MB solid state disk drive.	(MSCP) (V5.5-2)

RA60	205 MB removable disk drive.	(MSCP)	RRD40*	600 MB read-only optical disk drive.	(Q-bus and SCSI)
RA70	280 MB fixed disk drive.	(MSCP)	RRD42	600 MB read-only optical disk drive.	(SCSI) (V5.4-2)
RA71	700 MB fixed disk drive.	(MSCP) (V5.4-2)	RRD50*	600 MB read-only optical disk drive.	(Q-bus)
RA72	1 GB fixed disk drive.	(MSCP) (V5.4-2)	RP05**	88 MB removable disk drive.	(MASSBUS)
RA80	128 MB fixed disk drive.	(MSCP)	RP06	176 MB removable disk drive.	(MASSBUS)
RA81	456 MB fixed disk drive.	(MSCP)	RP07	516 MB fixed disk drive. (2.2 MB/sec transfer rate is supported if the RH780 is at REV B1 or greater for the VAX-11/780, VAX-11/785, VAX 8600 and VAX 8650.)	(MASSBUS)
RA82	622 MB fixed disk drive.	(MSCP)			
RA90	1.2 GB fixed disk drive.	(MSCP)			
RA92	1.5 GB fixed disk drive.	(MSCP)			
RC25*	2 disks each 26 MB (1 fixed and 1 removable) disk drive with shared spindle.	(Q-bus, UNIBUS)			
RD32*	VAX 42 MB fixed disk drive for MicroVAX 2000 and VAXstation 2000.		RX02*	512 KB diskette drive. The RX02 drive also writes using single-density RX01 diskettes.	(UNIBUS)
RD51*	10 MB fixed disk drive.	(Q-bus)			
RD52*	31 MB fixed disk drive.	(Q-bus)	RX23	1.47 MB diskette drive.	(SCSI)
RD53*	71 MB fixed disk drive.	(Q-bus, or Integral Controller on MicroVAX 2000)	RX26	2.8 MB diskette drive.	(SCSI) (V5.5)
			RX33*	1.2 MB diskette drive. Requires minimum RQDX3 microcode of V3.0.	(Q-bus, or Integral Controller on MicroVAX 2000)
RD54	159 MB fixed disk drive.	(Q-bus, or Integral Controller on MicroVAX 2000)	RX50*	400 KB diskette drive.	(Q-bus, or Integral Controller on MicroVAX 2000)
RF30	150 MB fixed disk drive.	(DSSI)	RV20*	2 GB Write Once Read Many optical disk drive.	(Q-bus, UNIBUS, VAXBI)
RF31F	200 MB fixed disk drive.	(DSSI) (V5.4-2)	RV64*	2 GB Write Once Read Many optical disk sub-system.	(Q-bus, UNIBUS, VAXBI)
RF31-JA	381 MB shockmounted removable disk drive.	(DSSI)			
RF31-KA	381 MB fixed disk drive.	(DSSI)	RZ22*	52 MB fixed disk drive.	(SCSI)
RF35	800 MB fixed disk drive.	(DSSI) (V5.5)	RZ23**	104 MB fixed disk drive.	(SCSI)
RF71	400 MB fixed disk drive.	(DSSI)	RZ23L	121 MB fixed disk drive.	(SCSI) (V5.4-1)
RF73	2 GB fixed disk drive.	(DSSI) (V5.5)	RZ24	209 MB fixed disk drive.	(SCSI)
RK06*	14 MB removable disk drive.	(UNIBUS)	RZ24L	240 MB fixed disk drive.	(SCSI) (V5.4-3)
RK07*	28 MB removable disk drive.	(UNIBUS)	RZ25	425 MB fixed disk drive.	(SCSI) (V5.4-3)
RL02*	10 MB removable disk drive.	(UNIBUS)	RZ26	1.0 GB fixed disk drive.	(SCSI) (V5.5-2)
RM03+	67 MB removable disk drive.	(MASSBUS)	RZ35	852 MB fixed disk drive.	(SCSI) (V5.4-3)
RM05	256 MB removable disk drive.	(MASSBUS)	RZ55	332 MB fixed disk drive.	(SCSI)
RM80	124 MB fixed disk drive.	(MASSBUS)	RZ56	665 MB fixed disk drive.	(SCSI)
R80**	124 MB fixed disk drive for VAX-11/725 and VAX-11/730.		RZ57	1 GB fixed disk drive.	(SCSI) (V5.4-3)
			RZ58	1.35 GB fixed disk drive.	(SCSI) (V5.5)

- * Device cannot be used as a VMS system disk.
- ** Device cannot be used as a VMS system disk with VMS DECwindows environment.

Disk Options Supported by Digital's Services Enterprise Integration Center (SEIC)

RF30-RA	150 MB removable disk drive.	(DSSI)
RF31-RA	381 MB removable disk drive.	(DSSI)
RF71-RA	400 MB removable disk drive.	(DSSI)
RF71-RA	1 GB removable disk drive.	(DSSI)
RWZ01	594 MB optical removable disk drive.	(SCSI) (V5.4-3)

Tapes

TA78	STI TU78.	(MSCP)
TA79	STI TU79.	(MSCP)
TA81	STI TU81.	(MSCP)
TA90	1.2 GB, tape cartridge subsystem. (5 inch 200 MB cartridge)	(MSCP)
TA90E	1.2 GB tape cartridge subsystem. Compacts data records automatically.	(MSCP)
TA91	High performance tape drive.	(MSCP) (V5.4-2)
TE16	9-track magnetic tape drive.	(MASSBUS)
TF70	290 MB TK70 tape cartridge drive.	(DSSI) (V5.4-2)
TF85	2.6 GB streaming tape cartridge drive.	(DSSI) (V5.4-2)
TF857	18.2 GB tape cartridge loader.	(DSSI) (V5.4-2)
TK50	95 MB, 5 1/4 inch streaming tape cartridge drive.	(Q-bus and SCSI)
TK70	296 MB, 5 1/4 inch streaming tape cartridge drive.	(Q-bus)
TLZ04	4 GB, 3.5 inch, 4 mm tape drive.	(SCSI)
TLZ06	4 GB, 3.5 inch, 4 mm DAT tape drive.	(SCSI) (V5.5-1)
TS11	9-track magnetic tape drive.	(UNIBUS)
TU77	9-track magnetic tape drive.	(MASSBUS)

TU78	9-track magnetic tape drive.	(MASSBUS)
TU80	9-track magnetic tape drive.	(UNIBUS)
TU81	9-track magnetic tape drive.	(UNIBUS)
TU81-Plus	Streaming 9-track magnetic tape drive.	(Q-bus, UNIBUS, VAXBI)
TZ30	95 MB, 5 1/4 inch, half-height, tape drive.	(SCSI)
TZ85	2.6 GB, 5 1/4 inch tape drive.	(SCSI) (V5.4-3)
TZ86	6 GB, 5 1/4 inch, tape drive.	(SCSI) (V5.5-2)
TZK10	320/525 MB QIC (quarter inch cartridge) tape drive.	(SCSI) (V5.4-2)

Tape Options Supported by Digital's Services Enterprise Integration Center (SEIC)

TLZ08	5.25 inch, 2 GB, 8 mm tape drive.	(SCSI)
TS05	9-track magnetic tape drive.	(Q-bus)
TSZ05	1600 BPI, 9 track tape drive.	(SCSI)
TSZ07	1600/6250 BPI, tape drive.	(SCSI) (V5.4-1)

Controllers

DMB32-LP	VAXBI DMA parallel high speed line printer controller.
DRB32	High speed general purpose parallel interface for VAXBI (systems).
DMF32-LP	Synchronous/Asynchronous communication option with printer port for use on UNIBUS based systems.
HSC40	Hierarchical Storage Controller for MSCP disks and TMSCP tapes. (HSC Software must be a minimum Version of 6.5)
HSC50	Hierarchical Storage Controller for MSCP disks and TMSCP tapes. (HSC Software must be a minimum Version of 4.1)
HSC60	Hierarchical Storage Controller for MSCP disks and TMSCP tapes. (HSC Software must be a minimum Version of 6.5)
HSC65	Hierarchical Storage Controller for MSCP disks and TMSCP tapes. (HSC Software must be a minimum Version of 7.0)
HSC70	Hierarchical Storage Controller for MSCP disks and TMSCP tapes. (HSC Software must be a minimum Version of 6.5)

HSC90	Hierarchical Storage Controller for MSCP disks and TMSCP tapes. (HSC Software must be a minimum Version of 6.5)	RQDXx	Q-bus disk controller for MicroVAX and VAX-station systems. There is an RQDX1, RQDX2, and an RQDX3 controller. The RQDXx disk controller supports as many as four disk units, with each RX50 diskette drive counting as two units. Due to controller limitations, the system supports a maximum of 4 devices; the number of RD/RX devices the system supports depends on the enclosure. The RQDX3 disk controller is required for the RD54 and the RX33 drives.
HSC95	Hierarchical Storage Controller for MSCP disks and TMSCP tapes. (HSC Software must be a minimum Version of 7.0)		
IDC	Integrated Disk Controller for VAX-11/725 and VAX-11/730 systems.		
IDTC	Integral Disk and Tape Controller for VAX 8600 and VAX 8650 systems.	RX211	UNIBUS diskette controller for two RX02 drives. One RX211 diskette controller is supported per system.
LPA11-K	Microprocessor controller for laboratory acquisition I/O devices, accommodating up to two AD11-Ks, one AA11-K, one KW11-K, two AM11-Ks, and five DR11-Ks. One LPA11-K controller is supported per UNIBUS and a maximum of two are supported per system.	RUX50	UNIBUS diskette controller for RX50 drives. One RUX50 diskette controller is supported per system.
KDA50	Q-bus MSCP disk controller. The KDA50 disk controller supports up to four of the following drives: RA60, RA70, RA80, RA81, and RA82.	TM03	MASSBUS tape controller for the TE16 and TU77 magnetic tape drives.
KDB50	VAXBI MSCP disk controller. The KDB50 disk controller supports up to four of the following drives: RA60, RA80, RA81, and RA82.	TM32	BI-bus 9 track tape controller only with large record support.
KDM70	The KDM70 is an intelligent MSCP/TMSCP mass-storage controller that supports RA Series Disks and Storage Arrays, TA Series Tape, and ESE20.	TM78	MASSBUS tape controller for the TU78 magnetic tape drive.
KFQSA	Q-bus DSSI bus storage adapter. This adapter allows up to seven DSSI storage devices to attach to the DSSI bus. (Six DSSI storage devices are allowed in a Dual-Host Configuration.)	TQK50	Q-bus tape controller for the TK50 cartridge tape drive.
KLESI	Q-bus, UNIBUS, and VAXBI tape controller for the TU81-Plus, RV20, or RC25.	TQK70	Q-bus tape controller for the TK70 cartridge tape drive.
KRQ50	Q-bus controller for the RRD40/RRD50 compact disk reader.	TS11	UNIBUS tape controller for the TS11 magnetic tape drive.
KZQSA	Q-bus to SCSI bus adapter. This adapter allows up to 7 SCSI storage devices to attach to the SCSI bus.	TBK50	BI-bus tape controller for the TK50 cartridge tape drive.
LP11	UNIBUS parallel high-speed line printer controller for the LPxx printers.	TBK70	BI-bus tape controller for the TK70 cartridge tape drive.
LPV11	Q-bus parallel high-speed line printer controller.	TUK50	UNIBUS tape controller for the TK50 cartridge tape drive. One TUK50 tape controller is supported per system.
RK711	UNIBUS disk controller for RK07 disk drives.	UDA50	UNIBUS MSCP disk controller. The UDA50 controller must have a minimum microcode version of REV 3. The UDA50 controller supports up to 4 of the following disk drives: RA60, RA80, RA81, and RA82.
RL211	UNIBUS disk controller for the RL02 disk drive.		
			<i>Controller Options Supported by Digital's Services Enterprise Integration Center (SEIC)</i>
		TSV05	Q-bus tape controller for the TS05 magnetic tape drive.
		TSU05	Unibus tape controller for the TS05 magnetic tape drive.
			<i>MASSBUS Adapter/Tape Subsystems</i>
			These include a MASSBUS adapter, a tape formatter, and a transport (a TU77 for the TxU77 subsystems, a TE16 transport for TxE16 subsystem, or a TU78 for the TEU78 subsystem).

A maximum of three additional TU77 magnetic tape transports can be added to a TxU77 subsystem and a maximum of seven additional TE16 magnetic tape transports can be added to a TxE16 subsystem. Different magnetic tape transports cannot be mixed on the same tape subsystem.

With disks and magnetic tape transports mixed on the same MASSBUS, the following rules apply:

- Disks can be added to a magnetic tape subsystem to a maximum of seven additional disks per tape subsystem.
- Tapes cannot be added to a disk subsystem.

Asynchronous Terminal Controllers

CXA16	16 line serial terminal multiplexer (DEC-423), maximum baud rate supported: 38400. (No modem control) (Q-bus)
CXB16	16 line serial terminal multiplexer (RS422), maximum baud rate supported: 38400. (No modem control) (Q-bus)
CXY08	8 line serial terminal multiplexer (RS232), maximum baud rate supported: 19200. (Full modem control) (Q-bus)
DHB32	16 line asynchronous terminal controller for VAXBI, maximum baud rate supported: 19200. (VAXBI)
DHF11	32 line asynchronous terminal controller (DEC 423), maximum baud rate supported: 19200. (No modem control) (Q-bus)
DHT32	8 line asynchronous terminal controller (DEC 423). (No modem control) (MicroVAX 2000)
DHQ11	8 line asynchronous terminal controller (EIA RS-232-C or RS-423-A), maximum baud rate supported: 19200. (Full modem control) (Q-bus)
DHU11	16 line asynchronous terminal controller (RS-232-C), maximum baud rates supported: VMS 19200, DECnet-VAX 9600. (Full modem control) (UNIBUS)
DHV11	8 line asynchronous terminal controller (EIA RS-232-C or RS-423-A), maximum baud rates supported: VMS 19200, DECnet-VAX 9600. (Full modem control) (Q-bus)
DMB32	8 line asynchronous terminal controller, maximum baud rates supported: VMS 19200, DECnet-VAX 9600. (Full modem control) (VAXBI)
DMF32	8 line asynchronous terminal controller, maximum baud rates supported: VMS supports 19200, DECnet-VAX supports 9600. (Full modem control on first 2 lines) (UNIBUS)

DMZ32	24 line asynchronous terminal controller (EIA RS-232-C or RS-423-A), maximum baud rates supported: VMS 19200, DECnet-VAX 9600. (Modem support dependent on configuration) (UNIBUS)
DSH32	1 line synchronous (full modem control) and 8 line asynchronous (no modem control) communications controller for the MicroVAX 2000. DEC423 devices are supported. Maximum baud rates supported: VMS 19.2 KBPS (kilobits/second).
DZ11	8 line asynchronous terminal controller (EIA RS-232-C or RS-423-A), maximum baud rate supported: 9600. (Partial modem control) (UNIBUS)
DZ32	8 line asynchronous terminal controller (EIA RS-232-C or RS-423-A), maximum baud rate supported: 9600. (Partial modem control) (UNIBUS)
DZQ11	4 line asynchronous terminal controller (EIA RS-232-C or RS-423-A), maximum baud rate supported: VMS supports 19200, DECnet-VAX supports 9600. (Partial modem control) (Q-bus)
DZV11	4 line asynchronous terminal controller (EIA RS-232-C or RS-423-A), maximum baud rate supported: VMS supports 19200, DECnet-VAX supports 9600. (Partial modem control) (Q-bus)

Integral asynchronous serial lines for the MicroVAX 2000 and the VAXstation 2000.

On the MicroVAX 2000, one line is the modem/data line and three are data-only lines. On the VAXstation 2000, the lines support keyboard, mouse, modem connection, and printer or plotter. DECnet-VAX supports all four asynchronous data/modem RS-232C serial lines up to 9.6 KBPS on the integral 4 line asynchronous controller for MicroVAX 2000.

Synchronous Controllers

The VAX Wide Area Network Device Drivers software product contains the synchronous device drivers and is required when using synchronous communication options. Refer to SPD 29.64.xx for more information.

DMB32	Point-to-point synchronous interface. (VAXBI)
DMC11	High-speed local point-to-point synchronous interface; retired device, no longer offered as an option. (UNIBUS)
DMF32	Point-to-point or multipoint synchronous interface. (UNIBUS)
DMP11	Point-to-point or multipoint synchronous interface; (UNIBUS) retired device, no longer offered as an option.

DMR11	Remote point-to-point synchronous interface; (UNIBUS) replaces DMC11.	DELQA	Ethernet controller to Q-bus. This is the replacement for DEQNA. The minimum revision level required is C3.
DMV11	Point-to-point or multipoint synchronous interface. (Q-bus)	DESQA	Ethernet controller to Q-bus for S-BOX configurations.
DPV11	Synchronous, 1 line, half or full-duplex point-to-point communication interface supporting DDCMP, HDLC, SDLC, or BISYNC protocols.	KFE52	DSSI/Ethernet Adapter for the VAXft 3000. Minimum of two adapters per system providing redundant connection to the Ethernet and the DSSI buses.
DSB32	Two line, multiple protocol, synchronous adapter. (VAXBI)		
DSH32	1 line synchronous (full modem control) and 8 line asynchronous (no modem control) communications controller for the MicroVAX 2000. DEC423 devices are supported. Maximum baud rates supported: VMS 19.2 KBPS (kilobits/second). 9.6 KBPS for MicroVAX 2000, etc.		
DST32	Synchronous single line support for DDCMP up to 9.6 KBPS, full duplex for MicroVAX 2000 systems. Concurrent use with the DHT32 is not supported.		
DSV11	Synchronous, 2 line, half or full-duplex point-to-point communication interface supporting DDCMP (1 or 2 lines up to 64 KBPS).		
DSF32	DEC WANcontroller 620 — Two line synchronous communications controller designed specifically for the VAXft 3000 processors, supporting DDCMP. DDCMP is supported at speeds up to 64 KBPS per line for a two-line operation.		
<i>LAN Options</i>			
DEUNA	Ethernet to UNIBUS controller.		
DELUA	Ethernet to UNIBUS controller. The minimum revision level required is F1.		
DEBNA	Ethernet to VAXBI communication controller.		
DEBNI	Ethernet to VAXBI communication controller.		
DEMFA	The DEMFA is a high performance network adapter that connects XMI systems to both Ethernet and IEEE FDDI (Fiber Distributed Data Interconnect) local area networks.		
DEMNA	The DEMNA is a high performance network adapter that connects XMI systems to both the Ethernet and IEEE 802.3 local area networks.		
DESVa	Ethernet controller interface.		
DEQNA	Ethernet controller to Q-bus. The minimum revision level required is K3. All systems utilizing a DEQNA must operate with software data checking enabled. Since AUTOGEN will automatically set the correct parameter, no system management intervention is required. Not supported by VAXcluster software. Not supported for any interfaces except for access using QIO or ALTSTART interfaces.		
			<i>CI Options</i>
			VAXcluster Software may support multiple CI adapters per system. Refer to the VAXcluster Software Product Description (SPD 29.78.xx) for the supported configurations.
		CI750	CI Adapter for VAX-11/750 systems. (Minimum microcode version REV 8.7 is required.)
		CI780	CI Adapter for VAX-11/780, VAX-11/785, VAX 8600, and VAX 8650 systems. (Minimum microcode version REV 8.7 is required.)
		CIBCI	CI Adapter for VAXBI systems. (Minimum microcode version REV 8.7 is required.)
		CIBCA-AA	Native CI Adapter for VAXBI systems. (Minimum microcode version REV 7.5 is required.)
		CIBCA-BA	Native CI Adapter for VAXBI systems. (Minimum microcode version REV 5.2 is required.)
		CIXCD-AA	Native CI Adapter for VAX 9xxx XMI systems. (Minimum microcode version REV 1.0 is required.)
		CIXCD-AB	Native CI Adapter for VAX 6xxx XMI systems. (Minimum microcode version REV 1.0 is required.)
			<i>Miscellaneous</i>
		CR11	Card reader. One CR11 card reader is supported per system. (UNIBUS)
		DRV11-WA	General purpose DMA interface. (Q-bus)
		DR11-W	General purpose high-speed DMA interface — one DR11-W interface supported per UNIBUS.
		DR750	High performance general purpose interface for the VAX-11/750. One DR750 interface is supported per system. This device may not be used in conjunction with the CI750.
		DR780	High performance general purpose interface for the VAX-11/780 and VAX-11/785. One DR780 interface is supported per system. On the VAX 8600 and VAX 8650 as many as four per system are permitted provided that the M8297-YA is used.
		DSSI	Digital Storage Systems Interconnect.
		DWBUA	XMI to UNIBUS adapter.

DWMBA	XMI to BI adapter; also the adapter used to connect the XMI to VAX expander cabinet.	®	PostScript is a registered trademark of Adobe Systems, Inc.
DWMVA	XMI to VME adapter.	™	Motif and OSF/Motif are trademarks of Open Software Foundation, Inc.
DW750	UNIBUS Adapter for second UNIBUS for the VAX-11/750 system.	™	The DIGITAL Logo, ACMS, BI, CI, CX, DBMS, DD-CMP, DECdtm, DECintact, DECmate, DECnet, DECscheduler, DECtp, DECterm, DECwindows, DELUA, DEUNA, DEQNA, Digital, DRB32, EDT, HSC, HSC40, HSC50, HSC70, KDA, KDM, KLESI, KRQ50, LAT, LQP02, MASSBUS, MicroVAX, OpenVMS, RA, RC, Rdb/VMS, RF, RK, RL, RM, RQDX2, RQDX3, RRD50, RUX50, RX, TA, TE, TEU78, TK, TM, TS, TQK50, TS05, TU, UDA, ULTRIX, UNIBUS, VAX, VAX Ada, VAX BASIC, VAX C, VAX COBOL, VAX DIBOL, VAX FORTRAN, VAX MACRO, VAX Pascal, VAX SCAN, VAXBI, VAXcluster, VAXft, VAXstation, VAXserver, VMS, VR150, VR160, VT, VT100 and VT1000 are trademarks of Digital Equipment Corporation.
DW780	UNIBUS Adapter for VAX-11/780, VAX 8600 and VAX 8650.		
FP730	Floating Point Accelerator for the VAX-11/730 system.		
FP750	Floating Point Accelerator for the VAX-11/750 system.		
FP780	Floating Point Accelerator for the VAX-11/780 system.		
FP785	Floating Point Accelerator for the VAX-11/785 system.		
FP86-AA	Floating Point Accelerator for the VAX 8600 and VAX 8650 systems.		
FV64A	Vector Processing option for the VAX 6000-400.		
H7112	Memory battery back-up for VAX-11/750, VAX-11/780, VAX-11/785, VAX 8600, and VAX 8650 systems. This is required for power-fail/recovery.		
KE780	G and H floating point microcode for the VAX-11/780 system.		
KU780	User-writeable control store for the VAX-11/780 system.		
MA780	Multiport shared memory. A multiple version VMS 4.7 and VMS 5.x-n VAXcluster system is not supported if the system is configured with MA780 memory.		
RH750	MASSBUS adapter for the VAX-11/750 system.		
RH780	MASSBUS controller for the VAX-11/780, VAX-11/785, VAX 8600, and VAX 8650 systems.		
SBI	System Backplane Interconnect for the VAX-11/780, VAX-11/785, and I/O BUS for the VAX 8600 and VAX 8650 systems.		
SCSI	Small Computer System Interconnect.		
VS40X	4-plane graphics coprocessor.		
WS01X	VAXstation 3100 SPX Graphics option.		
InfoServer 100	InfoServer 100 is a stand-alone Ethernet-based virtual disk server. The server has locally attached SCSI removable CDRoms and SCSI disk storage. VMS V5.5 supports virtual disk reads. For other features, please refer to the InfoServer 100/150 Software Product Descriptions.		

Appendix C

Third Party Licensing Section

Adobe Systems Incorporated, License Terms and Agreement

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