digital
Software Product Description

PRODUCT NAME: VAX/VMS Operating System, Version 1.6 **SPD 25.1.4**

DESCRIPTION:

VAX/VMS is the general purpose operating system for the VAX-11/780 series systems. It provides a reliable, high-performance environment for the concurrent execution of multiuser timesharing, batch, and real-time applications written in BASIC, COBOL, FORTRAN, and assembly language.

System features:

- Virtual memory management for the execution of large programs
- Event-driven priority scheduling
- Shared memory, file, and interprocess communication data protection based on ownership and application groups
- User privilege and resource allocation control
- Easy-to-use, easily extended command language
- Multijob batch processing
- Tools for developing native and compatibility mode programs
- Extensive file and record management services
- Programmed system services for process and subprocess control and interprocess communication
- Common Run-Time Procedure Library
- System maintenance utilities

VAX/VMS provides a base for building real-time applications such as sensor-based systems, transaction applications, or computation applications. It minimizes operating system overhead because it:

- Uses the hardware context-switching instructions and queue instructions to schedule processes
- Uses the hardware software interrupt (AST) delivery mechanism to minimize the amount of CPU time to return from system services
- Uses the hardware AST delivery mechanism and queue instructions to minimize the amount of CPU time required for I/O request processing
- Uses the multiple hardware priority levels to improve I/O response time

VAX/VMS allows real-time applications to control their virtual memory paging and execution priority. Real-time applications can eliminate services not needed to reduce system overhead. For example, a program can bypass directory lookup to open a file, and bypass the file manager when accessing opened files. Processes granted the privilege to execute at real-time scheduling levels, however, do not necessarily have the privilege or accessing protected memory and/or data structures.

VAX/VMS schedules CPU time and memory residency on a preemptive priority basis. Thus real-time processes do not have to compete with lower priority processes for scheduling services. Scheduling rotates among processes of the same priority. The scheduler adjusts the priorities of processes assigned one of the low 16 priorities to overlap I/O and computation. Real-time processes can be placed in one of the top 16 scheduling priorities, in which case the scheduler does not alter their priority. Their priorities can be altered by the system manager or an appropriately privileged user.

VAX/VMS uses the VAX-11/780 memory management features to provide swapping, paging, and protection and sharing of both code and data. Memory is allocated dynamically. Applications can control the amount of physical memory allocated to executing processes, the protection of pages, and swapping. These controls can be added after the application is implemented.

Protection and Privilege:

Applications designers can use the VAX/VMS protection and privilege mechanisms to implement system security and privacy. VAX/VMS provides memory access protection both between and within processes. Each process has its own independent virtual address space which can be mapped to private pages or shared pages. A process cannot access any other process' private pages. VAX/VMS uses the 4 processor access modes to read- and/or write-protect individual pages within a process.

Protection of shared pages of memory, files, and interprocess communication facilities such as mailboxes and event flags is based on User Identification Codes individually assigned to users and data. The User Identification Codes establish the user's relationship to the data structure as Owner, the owner's Group, the System, or the World (all others). Depending on the relationship, the user may or may not have read or write access to a particular data structure. If the data structure is a file, the user may or may not have read, write, execute, or delete access.

VAX/VMS controls the use of certain system services by privileges and resource quotas assigned to a user by the system manager. Program execution control,

interprocess control, access to the system, and access to files and devices are each controlled by several distinct privileges. Resource quotas include limits on the number of simultaneously open files and the number of created subprocesses.

The system manager can also designate certain programs as having amplified privileges. These programs can exercise specific privileges beyond those of the user invoking the program.

System Reliability and Maintenance:

VAX/VMS automatically performs machine checks and internal software consistency checks. If the checks fail, VAX/VMS displays critical system status. If the system is set for auto-restart after a system failure, VAX/VMS reboots the system.

If the hardware detects power failure, VAX/VMS shuts the system down automatically. When the hardware detects power restoration, VAX/VMS begins the automatic restart procedure. If the contents of memory are still valid, VAX/VMS resumes processes at the point of interruption and restarts devices and communications lines. Optionally, processes can be notified of a power restore by means of an asynchronous system trap (AST).

Disk file backup operations can be performed on-line. Disk volume backup operations require exclusive access to the volume. Files can be restored selectively from a backup tape on-line.

VAX/VMS supports user mode on-line diagnostics for the supported peripherals. VAX/VMS includes on-line error logging for CPU errors, memory errors, peripheral errors, and software failures. The error log can be printed and analyzed on-line.

Command Language:

The user's default command interpreter is established by LOGIN based on the user's entry in the authorization file. Two command interpreters are supplied with VAX/VMS. MCR commands are those of the RSX-11M system. DCL commands are composed of English words that can be abbreviated to their shortest unique form. The DCL command interpreter assumes standard defaults for many fields. The same command language can be used for interactive and batch processing. When used interactively, the command interpreter prompts for any necessary missing parameters. The language includes a HELP facility that gives guidance on the use of commands and the meaning of system messages.

User commands provide:

- Program development and execution control: invoke the compilers, the assembler, the editor, the linker, and user-written programs; stop and continue program execution
- Resource allocation: allocate and deallocate devices, mount and dismount volumes
- Environmental control: assign and deassign logical names, set and show parameters such as terminal type and default directory
- File maintenance: create, copy, type, print, rename and delete files; list directories, initialize volumes
- Operational control: log in and log out, submit batch jobs, send messages to the operator
- Command language extension: assign logical names to file specifications, assign symbolic names to character strings, create and execute command procedures

Logical names can be used to make file specifications brief and make applications device-independent. A logical name can be assigned to a file specification, a portion of a file specification, or another logical name. The logical names used for defining separate portions of a file specification can be assigned their values independently by operators, system and group managers, and by the application programmers and users.

Command procedures can be used to create new commands. A command procedure is a file containing a collection of commands that are executed when the command procedure is invoked. Command parameters can be defined symbolically in the procedure file, and assigned meanings when the procedure is invoked.

A command line can be labeled, continued on subsequent lines, and commented. A command exists that prompts for input from the user. Symbols can be defined and tested for conditionally transferring control to labeled lines. Control can also be transferred on errors or unconditionally. User-specific defaults for a command environment can be set up automatically at every log-in because a command procedure is invoked during the log-in sequence.

The operator has access to the user commands and has special commands to manipulate batch and spool queues, control the system-wide user environment, control jobs, authorize users, show system activity, and respond to mount requests. Commands can be included in a command procedure that is executed automatically at system startup.

Batch Processing:

Batch jobs can be submitted by a user at a terminal, by another batch job, by a program, or as card decks. Submitted jobs are queued. The operator controls the number of batch jobs that can run concurrently.

The VAX/VMS system supports transparent line printer output spooling. Line printer spooling includes page accounting. A print job can be one or more print files. A print job can be submitted to a selected print queue by a terminal user, a batch job, or a program. There can be multiple print queues: one for any printer, and several for designated printers. Jobs within queues are priority ordered.

The operator can control batch and print jobs by altering their queue priority, by holding jobs for a specific time or indefinitely, and by starting, stopping, restarting, and aborting jobs or portions of jobs. The operator can initialize, delete, merge, and list queues, and control forms mounting.

Program Development Tools:

VAX/VMS provides the tools for developing both VAX-11 native mode programs and PDP-11 compatibility mode programs. Native programming languages include MACRO assembly language and the optional FORTRAN IV-PLUS, COBOL-74 and BLISS-32 languages. Compatibility mode programming languages include the optional BASIC-PLUS-2 and FORTRAN-IV languages.

VAX/VMS includes an interactive editor and a batch editor. Lines can be identified by number, by relative position, or by contents. Editing can be accomplished by replacing, deleting, transposing, or copying a line or group of adjacent lines; by substituting strings, or by interactively modifying lines a character at a time. Editing can be done to the file in any order. User-selected editing environment parameters can be set automatically at editor startup.

VAX/VMS provides a symbolic debugger for native mode programs that can be used in both interactive and batch mode. The debugging language is similar to the operating system's command language. Expressions and data formats are similar to those of the language being debugged.

VAX/VMS provides a file differences utility that contrasts two files by automatically aligning matching text, and optionally ignoring comments, empty records, trailing blanks, or multiple blanks. The output can be a file-by-file list of differences, interleaved list of differences, or list with change bars, or it can be a batch editor command input file.

Record and File Management Services:

VAX/VMS includes a record management input/output system that provides device-independent access to disks, tapes, unit record equipment, terminals, networks (via the DECnet-VAX product) and mailboxes. It provides sequential record access to sequential file organizations, and sequential, random, or combined record access to relative file organizations. In addition, programs can process multikey indexed files sequentially, randomly, or in combination using index keys. Multikey indexed file processing includes incremental reorganization.

The VAX/VMS on-disk structure supports volume sets containing up to 255 volumes. A volume set is defined as a logical storage entity made up of a collection of related volumes. A volume is a single physical unit of storages, such as, a disk spindle. Files may span any number of volumes within a volume set, and can be explicity placed and allocated on a particular volume or volumes. Volume sets may contain a mix of disk device types and can be extended by adding more volumes after initial definition.

The system provides multiple levels of named directories and subdirectories whose contents are alphabetically ordered. Files are identified by name, type, and version number (to distinguish separate generations). Users are not required to preallocate space, although they can do so. Users can control automatic allocation. For example, when a file is automatically extended, it can be extended by a given number of contiguous blocks. The disk structure has duplicates of its critical volume information. Volumes are mounted to identify them to the system. The system detects bad disk blocks dynamically and prevents re-use once the files to which they are allocated are deleted.

Multiple processes can read any given disk file concurrently. Multiple processes can read and/or write a sequentially organized disk file concurrently, but they are responsible for any record locking required to handle multiple readers and writers properly. Relative and multikey indexed file organization can be shared for writing with the system providing an automatic single record lock. The user can also explicity control record locks which will allow multiple records to be locked simultaneously.

VAX/VMS also includes an RSX/IAS compatible on-disk file structure for easy cross-migration of programs and data. Both file structures are readily accessible from programs running in either compatibility or native mode.

VAX/VMS supports multivolume magnetic tape files with transparent volume switching. Tape access positioning is either by name or by relative file position. The tape block size (blocking factor) is under program control. VAX/VMS also supports unlabeled tapes. Error recovery is automatic but can be overridden under program control using the Queue I/O Request system service call.

File Sort Utility:

VAX/VMS includes a file sort utility that accepts input files in binary or ASCII format. The file organization can be sequential, relative, or indexed. The information can be reordered in ascending or descending sequence. There are four possible sorting methods: Record Sort, Tag Sort, Address Routing Sort, and Index Sort. The sort utility also includes a set of procedures which are callable from any native mode language programs. The sort utility provides no file merge capability.

Programmed System Services:

VAX/VMS includes system services to control processes and process execution, real-time response, scheduling, and to obtain information. Process control services allow the creation of subprocesses and independent detached processes. Processes can communicate and synchronize using mailboxes, shared areas of memory, or shared files. A group of processes can also communicate and synchronize using multiple common event flag clusters.

Response control system services include the ability to lock the process or pages in memory, to lock shared areas in memory via an application-specific program, to cluster pages to minimize paging overhead, and to adjust priority. Scheduling services include setting a timer and scheduling wakeup.

A process can also be coded to handle most exception conditions, such as arithmetic trap, input/output error, or system resource wait.

Common Run-Time Procedure Library:

The run-time library is a set of general purpose and language-specific libraries of procedures for native programs. The run-time library includes a mathemati-

cal library, resource allocation library, general utility library, condition handling library, language-independent support library, and a FORTRAN-specific support library. New libraries can be installed without requiring the user to relink existing programs. The run-time library is shared as a global section.

RSX-11M Application Migration Executive:

The RSX-11M Application Migration Executive (AME) allows the migration of many existing applications from RSX-11M systems to VAX/VMS. It also allows the development on a host VAX/VMS system of tasks and system images for a target RSX-11M (Version 3.1) or RSX-11S (Version 2.1) system.

In many cases, the VAX/RSX-11 AME makes application migration to VAX/VMS possible by allowing:

- Recompilation and rebuilding of tasks originally developed under the RSX-11 or IAS systems
- Subsequent execution of these tasks under VAX/VMS
- Direct execution of tasks built originally under RSX-11M, Version 3 or 3.1

In many cases, the RSX-11M AME makes cross-system development to an RSX-11M/S system from a VAX/VMS system possible by allowing:

- Compilation of programs written in MACRO-11
- Building of these programs into RSX-11M tasks
- Partial debugging of these tasks
- Building of RSX-11M (Version 3 or 3.1) or RSX-11S (Version 2) system images if the customer has an RSX-11M or RSX-11S kit
- Ability to create and maintain RSX-11 libraries
- Development of applications that are to run on both RSX-11 and VAX/VMS systems

These tasks must:

- Not depend on the PDP-11 F.I.S. instructions
- Not require RSX-11 privileges
- Not access the PDP-11 I/O "page"
- Not issue DECnet system service directives
- Not issue PLAS memory management directives
- Not depend on the sense switches
- Not depend on devices that are not supported on the VAX/VMS system
- Not depend on the ability to share write access to relative or indexed files through RMS-11

Applications requiring the cooperation of a number of tasks can or can not operate depending on the system environmental assumptions that they make.

Installation, Bootstrap, and Configuration:

The VAX/VMS installation and bootstrap programs automatically configure the system to fit the hardware I/O configuration. At boot time, the operator can override the standard settings of many system parameters. During startup or on-line operations, devices, input/output drivers, etc., can be added to the configuration and be configured into the running system. All device names, allocations, addresses, and configuration parameters can be specified by the operator. Hardware and software configurations can be built into files that are processed automatically at bootstrap time.

User Environment Test Package:

VAX/VMS includes a User Environment Test Package that verifies that the major hardware and software system components are complete, properly installed, and ready to be used. This package is normally executed as part of system installation but can be rerun at any time to increase confidence in the system's integrity. This constitutes a significant but not exhaustive test of the system.

Components Summary:

The VAX/VMS product includes the following facilities:

- System installation package
- User Environment Test Package (UETP)
- Operating system nucleus, including virtual memory manager, swapper, system services, and input/output device drivers
- User authorization control program
- Job initiator and symbiont manager
- Card reader input symbiont
- Line printer output symbiont
- Accounting manager
- Operator Communications Manager
- Error logging and print utility
- DCL command interpreter
- MCR command interpreter
- Interactive and batch editors
- MACRO assembler
- Linker with cross-reference
- Library maintenance utility
- Common Run-Time Procedure Library
- Symbolic debugger for native programs
- Record Management Services for sequential, relative, and multikey indexed, file organizations
- FILES-11 disk file manager
- Multivolume disk file support
- ANS Level 3 magnetic tape file manager
- Sort utility
- File Management utilities
- File Differences utility
- File Dump utility
- Disk Backup/Restore utilities
- Disk Structure Verification utilities
- Disk Bad Block Locator utility
- Software Maintenance Release Update utility

Sources:

The availability of a source kit of the VAX/VMS operating system is aimed primarily at customers who wish to retrieve and modify isolated source modules. In addition, source modules may be used as templates for writing similar components to those provided; for example, device drivers, file ACPs (ancillary control programs), or CLIs (command language interpreters). The source kit is not intended for a complete rebuilding of the VAX/VMS operating system. Al-

though every attempt was made to provide an accurate source tape including the source modules and supporting command procedures, DIGITAL does not warrant the ability to build binaries of the complete VAX/VMS system. No supporting documentation is provided and sources for intermediate updates of VAX/VMS are not available (i.e., source kits are available only on major releases, V1.0, V2.0, etc.). Depending upon how much of the source kit a customer wishes to manipulate, as much as 2 dedicated RP06's may be required for processing following retrieval of the sources modules from tape.

The following components of VAX/VMS are NOT included in the Version 1.0 source kit:

1. Compatibility mode components including:
   - components derived from RSX-11M kit including PIP, FLX, etc.
   - Disk support utilities including VFY2, DSC2, etc.
   - SORT-11
   - RMS-11, RMS-11K and its utilities
   - SOS editor
2. Assemblers bundled with VAX/VMS
   - MACRO-11
   - VAX-11 MACRO
3. Some native mode components
   - UETP
   - VAX-11 SORT
   - ISAM modules of VAX-11 RMS
4. Unsupported bundled components

Standards:

VAX/VMS is based on the following American National Standards Institute (ANSI), U.S. Federal Information Processing Publications, and International Standards Organization standards:

- X3.4-1977 American Standard Code for Information Interchange
- X3.6-1973 Perforated tape code for information exchange
- X3.18-1974 One-inch perforated paper tape for information exchange
- X3.41-1974 Code Extension Techniques for use with 7-bit ASCII
- X3.42-1975 Representation of Numeric Values in Character Strings
- X3.27-1977 Magnetic Tape Labels and File Structure, Level 3
- X3.39-1973 Recorded Magnetic Tape (1600 cpi, PE)
- X3.22-1973 Recorded Magnetic Tape (800 cpi, NRZI)
- X3.26-1970 Hollerith Punched Card Code
- FIPS PUB 1, 2, 3-1, 7, 13, 14, 15, 16, 21, 22, 25, 26, 35, and 37 but not FIPS PUB 17 or 46; other FIPS PUBs are not applicable
- ISO 646-1973 7-bit Coded Character Set for Information Interchange
- ISO 1113-1973 Representation of 6- and 7-bit coded character sets on punched tape
- ISO 1154-1975 Punched paper tape — Dimensions and location of feed holes and code holes
- ISO 2022-1973 Code Extension Techniques for Use with ISO 646
- ISO 3307-1975 Representations of Time of the Day

MINIMUM HARDWARE REQUIRED:

Any VAX-11/780 system with at least one of the following:

- Two RK07 disk drives and at least 256K bytes of memory
- One RM03/RP05/RP06 disk drive and one TE16/TU45/TU77 magnetic tape and at least 256K bytes of memory

Additional memory may be required if additional devices are included in the configuration.

OPTIONAL HARDWARE:

CPU options:

- Additional memory
- H7112 memory battery backup
- FP780 floating point accelerator
- Up to 3 DW780 UNIBUS adaptors for a system total of 4 including the integral UNIBUS adaptor
- KU780 User Writeable Control Store

Disk Systems:

- Up to a system total of 8 RK06 and/or RK07 disk drives (UNIBUS devices)
- Up to a system total of 32 RM03 and/or RP05 and/or RP06 disk drives, less one drive for each magnetic tape controller included in the configuration (MASSBUS devices)

Magnetic Tape Systems:

- Up to a system total of 32 TE16, TU45 and/or TU77 magnetic tape transports, less eight transports for each RM03, RP05, or RP06 disk drive included in the configuration beyond 28 disk drives (MASSBUS devices)

NOTE:

MASSBUS disk drives and magnetic tape transports can be attached to the same MASSBUS.

Card Readers:

- Up to a system total of 2 CR11 card readers

Line Printers:

- Up to a system total of 16 LA11, LP11-C, -D, -R, -S, -V, -W, -Y, -Z line printers

Terminals and Terminal Line Interfaces:

- Up to a system total of 12 DZ11 8-line multiplexers or 6 DZ11 16-line multiplexers (or a combination of 8-line and 16-line DZ11s not to exceed 96 asynchronous lines) connected to at most 96 VT52, VT100, LA34, LA36, LA38 and/or LA120 terminals. The characteristics of the software application and system loading may impose constraints on aggregate throughput. The aggregate terminal throughput is up to 8K characters per second on output to the terminals and 1K characters per second on input from the terminals.

These rates assume that the CPU is only being utilized for terminal handling from a user program. To prevent buffer overruns on input, the terminals must use the ASCII control characters DC1 and DC3 for synchronizations as defined in DIGITAL's DECSTD 111, revision A.

Communications Devices:

- Up to a system total of 16 DMC11 interprocessor communications links operating at a maximum of 9.6 kilobits per second, or 4 DMC11 links operating at a maximum of 56 kilobits per second, or 2 DMC11 links operating (half-duplex only) at a maximum of 1 megabit per second, or 1 DMC11 link operating (full-duplex) at a maximum of 1 megabit per second. These line speeds are hardware specifications. The characteristics of the software application (including DECnet) may impose additional constraints on effective throughput.
- Up to a system total of 4 DUP11 synchronous interfaces (running VAX-11 2780/3780 Protocol Emulator optional software only) each operating at maximum of 9.6 kilobits per second.

Real-time Devices:

- Up to a system total of 2 LPA11-K microprocessor controllers for laboratory data acquisition I/O devices. Each LPA11-K can accommodate up to 2 AD11-Ks, 1 AA11-K, 1 KW11-K, 5 DR11-Ks and 2 AM11-Ks.

PREREQUISITE SOFTWARE:

None

OPTIONAL SOFTWARE:

VAX-11 FORTRAN IV-PLUS
VAX-11 COBOL-74
VAX-11 BLISS-32
PDP-11 BASIC-PLUS-2/VAX
PDP-11 DATATRIEVE/VAX
PDP-11 CORAL-66/VAX
FORTRAN IV/VAX to RSX
DECnet-VAX
VAX-11 2780/3780 Protocol Emulator

TRAINING CREDITS:

FIVE (5) — Applies only to options that include support services. Consult the latest Educational Services Catalog at your local office for the available courses, course requirements, and guidelines.

SUPPORT CATEGORY:

VAX/VMS is a DIGITAL Supported Software Product.

SOFTWARE INSTALLATION

DIGITAL installation is required for Software Product Support. There is no charge for installation if performed at the time of system installation. DIGITAL installed software products, except for operating systems, are subject to an add-on installation fee when purchased subsequent to system installation.

SOFTWARE PRODUCT SUPPORT

With the exception of the Newsletter, VAX/VMS includes Standard Services as defined in the Software Support Categories Addendum of this SPD.

Growth Constraints:

An update is the primary way in which DIGITAL provides corrected versions of a software product to users of that product. A VAX/VMS Version 1 Update is functionally the same product as VAX/VMS Version 1, but it includes corrections to deficiencies discovered in this product, and it may include enhancements. An enhancement is a capability not explicitly provided by this product or it is an improvement in stability or efficiency. The following items describe the growth constraints of a VAX/VMS Version 1 Update.

1. The minimum hardware requirements for executing a VAX/VMS Version 1 Update may be greater than the VAX/VMS Version 1 minimum hardware requirements for the same device configurations supported by VAX/VMS Version 1.
2. If a VAX/VMS Version 1 Update includes enhancements, the minimum memory or disk (hardware) requirements for such Update may be greater than the minimum memory or disk (hardware) requirements for VAX/VMS Version 1.

ORDERING INFORMATION:

Options with no support services are only available after the purchase of one supported license.

A single-use license only option is a license to copy the software previously obtained under license.

Source and/or listing options are only available after the purchase of at least one supported license and after a source license agreement is in effect.

The following key (M, R, V, Z) represents the distribution media for the product and must be specified at the end of the order number, e.g., QE001-AM = binaries on 9-track 1600 BPI Magtape (PE).

M = 9-Track 1600 BPI magtape (PE)
R = Microfiche
V = RK07 Disk cartridge
Z = No hardware dependency

QE001 -A— Single-use license, binaries, documentation, listings of selected modules on microfiche, support services (media: M, V)

QE001 -C— Single-use license, binaries, documentation, listings of selected modules on microfiche, no support services (media: M, V)

QE001 -D— Single-use license only, no binaries, no documentation, no support services (media: Z)

Update Options:

Users of VAX/VMS whose specified Support Category warranty has expired may order under license the following software update at the then current charge for such update. The update is distributed in binary form on the appropriate medium and includes no installation or other services unless specifically stated.

QE001 -H— Binaries, documentation (media: Y)

QE001 -H— Right to copy for single use (under existing license), no binaries, no documentation, no support services (media: Z)

Users of VAX/VMS whose specified Support Category warranty has not expired may order under license the following software update for the then current media charge. The update is distributed in binary form on the appropriate medium and includes no installation or other services unless specifically stated.

QE001 -W— Binaries, documentation (media: Y)

Source/Listing Options

QE001 -M— Sources (media: M) plus listing on Microfiche (Note: sources are written partially in VAX-11 BLISS-32; recompilation of those modules requires the optional VAX-11/BLISS-32 compiler)

QE001 -F— Listings (media: R)

Miscellaneous Options:

QE001 -G— Documentation only kit (media: Z)

ADDITIONAL SERVICES:

None