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Software Product Description

PRODUCT NAME: ULTRIX MLS+ Trusted Worksystem Software, Version 2.1 **SPD 34.10.03**

DESCRIPTION

ULTRIX MLS+ Trusted Worksystem Software Version 2.1 is a security-enhanced version of the ULTRIX Operating System Version 4.3 and the ULTRIX Worksystem Software Version 4.2. ULTRIX MLS+ Trusted Worksystem Software provides both client and server support. For licensing purposes, the ULTRIX MLS+ system is considered an extension of the ULTRIX Worksystem Software.

The trusted implementation of the X Window System™ is based on the industry standard OSF/Motif® V1.1.3 window manager and X11 R4 window server.

ULTRIX MLS+ Version 2.1 has completed an evaluation against the Department of Defense Trusted Computer System Evaluation Criteria. The governmental evaluation team determined that ULTRIX MLS+ Version 2.1 satisfies all of the specified requirements of the Criteria at the B1 level. For a complete description of the evaluated hardware and how MLS+ satisfies each requirement of the Criteria, refer to the Final Evaluation Report, ULTRIX MLS+ Version 2.1.

The ULTRIX MLS+ system is also designed according to standards for the Compartmented Mode Workstation (CMW) class of products as defined by the Defense Intelligence Agency and specified in *Security Requirements for System High and Compartmented Mode Workstations* by John P. L. Woodward. ULTRIX MLS+ successfully completed Initial Product Assessment for both B1 and CMW requirements.

The ULTRIX MLS+ system is an interactive, demand-paged, virtual memory, timesharing operating system that provides:

- A hierarchical file system with dismountable volumes
- Compatible device and interprocess I/O
- Asynchronous processes
- System command language selectable on a per-user basis
- Disk quotas and job quotas
- Over 200 subsystems

The ULTRIX MLS+ system is binary compatible with the ULTRIX V4.3 system unless restricted by the security policies. The ULTRIX MLS+ system can support many commercial applications without modifications.

Security Enhancements

The ULTRIX MLS+ system provides protected processing of sensitive information. The heart of the system is the Trusted Computing Base (TCB), a set of protection mechanisms that enforce the system's security policies. Security features are transparent to applications, with the exception of security policy violations.

Console Password

The ULTRIX MLS+ system includes password protection at the boot-ROM level. When the console password feature is enabled, a user must correctly enter a password before executing privileged console commands. For example, a user must know this password to boot an image other than that specified by the default bootpath..

A trusted user can change the password either at the console prompt or from a running system with the cpasswd command.

Access Policies

The ULTRIX MLS+ system security policies are:

- Discretionary Access Control (DAC) - provides both the traditional UNIX mechanism of "owner, group, and other" access permissions and a more granular access control list (ACL) mechanism, controlled by the object's owner.
- Mandatory Access Control (MAC) - provides a mechanism for the security officer to define sensitivity labels that apply to processes and security-related objects (such as files, sockets, and windows) in the system.
- Information Labels (ILs) - provides a mechanism for the user to more finely define the sensitivity of the actual contents of information in a system object, and to associate special access-related markings for printed material (e.g., "for your eyes only" or "restricted distribution"). When information is added to a file (object) or process (subject), the system automatically adjusts the information label as necessary.
- Privileges - provides a least privilege mechanism in which the kernel prohibits processes from performing security-related operations unless they have the distinct privilege associated with that operation, instead of the traditional omnipotent "uid 0" definition of privilege.

The ULTRIX MLS+ system security policies extend to both the window system and the network file system, providing a consistent implementation policy across the entire system.

Trusted Printer Subsystem

The trusted printer subsystem provides correctly marked header and trailer pages, and top and bottom page labeling for PostScript® printers. The printers may be connected directly, either through a LAT or through a TCP/IP network. The subsystem allows print jobs to be sent to and received from other systems using the BSD™ printer protocol. The trusted network software ensures that these print jobs will be correctly labeled.

Trusted X Window System

The MLS+ trusted implementation of the X Window System has the following features: discretionary access control (DAC), mandatory access control (MAC), information labels, auditing, object reuse and trusted path. All windows and icons are properly labeled by a trusted implementation of Motif® Window Manager. Interwindow data moves (cut and paste) are monitored by the Trusted Selection Handler. The trusted path region is controlled by the Trusted Path Handler. All trusted clients are monitored for proper operation by a Trusted Client Handler.

The MLS+ Security Policies, implemented at the protocol level of X11, allows well-behaved, ICCCM-compliant X clients to run off-the-shelf on an MLS+ system. The Trusted X Window System is based on Version 11 Release 4 of X Windows and OSF/Motif Version 1.1.3.

Trusted Networking

MLS+ has a number of trusted network facilities. DEC MultiSIX is the name of the comprehensive trusted network strategy implemented by MLS+. Trusted networking facilities include: TNET, FTP, remote commands, NFS, TELNET, NIS, and DNSIX V3.0 (SAMP).

- Trusted Network (TNET) - Supports the BSD 4.3 socket mechanism and the Internet Protocol Suite. TNET lets an ULTRIX MLS+ host establish TCP/IP connections to both MLS+ and non-MLS+ hosts, using extensions to the socket mechanism to pass security attributes (such as sensitivity labels) between MLS+ hosts. When communicating with non-MLS+ hosts, security attributes are removed from exported messages and added to imported messages.
- Trusted File Transfer Program (FTP) - Provides most of the standard FTP server capabilities while preserving the ULTRIX MLS+ mandatory and discretionary access policies. An FTP connection is established by using the MLS+ client's sensitivity label as the connection sensitivity label. Files that are transferred during this session contain the sensitivity label. The file information label is propagated to the file using the normal information label float rules.
- Trusted rlogin, rsh, rcp Commands - Enforces MLS+ security policies. Unprivileged users can use these commands to connect to remote MLS+ systems on a network.
- Trusted NFS - Provides the ability to mount both labeled (trusted) and unlabeled (standard) file systems. For a labeled file system mounted between MLS+ hosts, Trusted NFS maintains the correct security attributes for each remote-mounted file. For an unlabeled file system, an administrator assigns security attributes to the mount point; these attributes are applied on all files in the mounted file system.
- Trusted TELNET - Supports a trusted TELNET server, which provides the ULTRIX TELNET server capabilities while preserving the ULTRIX MLS+ mandatory and discretionary access policies. A TELNET connection is established using the MLS+ client sensitivity label as the connection sensitivity label.
- Trusted Network Information Services (NIS) - Provides a distributed data lookup service for sharing information between systems on a network. Trusted NIS supports sharing the following MLS+ administrative files in addition to the usual NIS maps:

/tcb/files/auth/<letter>/<user>	Protected password database
/etc/auth/system/defaults	Default settings for protected password database
/tcb/files/TNETRHDB	Remote hosts database
/etc/auth/system/authorize	Command authorization database
/etc/auth/subsystems/users	User authorization database

Trusted NIS also allows users to update their NIS passwords from an NIS client.

- DNSIX 3.0 Session Attribute Modulation Protocol (SAMP) - Transports security attributes between endpoints of a network connection. For more information, refer to the Standards section in this SPD.

Trusted Interprocess Communications (IPC)

The ULTRIX MLS+ system provides socket modifications that support the passing of security attributes across AF_UNIX and AF_INET connections. AF_UNIX sockets are local and have access to the full set of security attributes available to the local system. AF_INET sockets pass the security attributes associated with the process at either end, but must rely on the TNET databases for information about the amount of trust vested in a remote host.

Sockets support the following security attributes: sensitivity labels, information labels, privilege set, login user ID (LUID), effective user ID (EUID), effective group ID (EGID), supplementary groups, and process ID.

Unlabeled Hosts

For MLS+ systems to interoperate with systems that do not have MultiSIX support (unmodified hosts), MLS+ provides the ability to define security attributes for non-MLS+ systems. MLS+ can interoperate with any system that supports the standard TCP/IP and TCP/UDP protocol family. The unmodified host is treated as a single-level host. Unmodified host support also allows an MLS+ host to act as the gateway between a single-level LAN and a multilevel LAN.

Trusted Multilevel Mail (MLS+ Mail)

ULTRIX MLS+ Mail is an easy-to-use Motif windows interface to multilevel secure messaging. Messages can also be exchanged with standard ULTRIX systems in a single-level mode.

This new trusted dxmail program:

- Allows each user ONE multilevel mailbox that can accept messages at any security level, up to the user's clearance.
- Allows users to read all of their messages from trusted dxmail, even if every message has a different security level.
- Allows users to send mail with any specified security label (up to their clearance level).
- Makes replies and forwarded messages default to the same sensitivity label (SL) as the original message.
- Handles information labels (ILs) in exactly the same way as the MLS+ operating system.
- Displays messages with the same color coded label bars as the MLS+ operating system.
- Allows such things as fonts, colors, new mail notification, and button definition, to be customized.

Multilevel Security Directories

Multilevel Security (MLS) directories provide a solution to the problem of managing files and directories at different sensitivity labels. For application portability, standard ULTRIX directories are supported.

Hidden Directories

For compatibility purposes, the ULTRIX MLS+ system supports the "hidden" directories used by some vendors of compartmented mode workstations.

Separate Administrative Accounts

The system provides for three separate administrative accounts as an alternative to the traditional "root" account. MLS+ provides a simple to use interface for these three functions:

- Information System Security Officer (ISSO) - Responsible for security aspects of system management:
  - — Assigns privileges and authorizations to users, programs, and processes, thus controlling the ability of any user to perform a specific action.
  - — Maintains and assigns proper information and sensitivity labels.
  - — Collects and reviews audit data.
  - — Assures that system objects are properly protected.
- System Administrator - Responsible for general system management and account creation. The system administrator is also responsible for granting authorizations to the ISSO.
- Operator - Responsible for day-to-day operations.

User Environment

The user environment includes the following facilities:

User Interfaces - Shells
Commands
Posix nawk(1)

User Interfaces - Shells

Digital provides the following shells with the ULTRIX MLS+ system:

- C Shell
- BSD Bourne Shell
- System V Bourne Shell
- Korn Shell

All shells are programmable and allow for a customizable user environment.

Commands

The ULTRIX MLS+ commands are based on the BSD 4.3 specification.

The following ULTRIX MLS+ commands meet specifications for Posix 1003.2, Draft 8:

diff	**id**	**ln**
tr	**env**	**find**
getopts	**date**	**mkdir**
mkfifo	**mktemp**	**bc**
chgrp	**chmod**	**chown**
tee	**cp**	**join**
ar	**nawk**	**cmp**
make	**basename**	**dirname**
fold	**sort**	**uniq**

Internationalization support for awk is not available in the ULTRIX MLS+ system.

Posix nawk(1)

Because of the migration towards full compliance with Posix 1003.2, both the awk and nawk utilities are included in the ULTRIX MLS+ system.

The nawk utility introduces a number of new features:

- New keywords: delete, do, function, return
- New built-in functions: atan2, cos, sin, rand, srand, gsub, sub, match, close, system
- New predefined variables: FNR, ARGC, ARGV, RSTART, RLENGTH, SUBSEP
- New expression operators: ? : , ^
- The FS variable and the third argument to split are now treated as extended regular expressions.
- The operator precedence has changed to more closely match C.
- The escape characters have been added to the extended regular expression.

Note that nawk does not support internationalized capabilities.

Command Differences Between VAX and RISC ULTRIX MLS+ Systems

The following table lists the command differences between VAX and RISC systems.

VAX Only	Different	RISC Only
-arff	**-config**	**-btou/utob**
-radisk	**-csh**	**-cord**
-rxformat	**-sh5**	**-uid**
-symorder	**-prof**	**-dis**
-2780/3780	**-ranlib**	**-odump**
-adb	**-lint**	**-pixie**
-makespt	**-make**	**-ppu**
-/usr/mdec	**-ps**	**-showsnf**
-vcc	**-disktab**	**-stdump**
-lk	**-makedev**	**-uac**
-libg	**-brk**	

Program Development Environment

The ULTRIX MLS+ programming environment provides many of the development tools that are available with the ULTRIX operating system, such as vi, cc, adb, dbx, sccs, and lint. To facilitate the development of trusted applications, the ULTRIX MLS+ system includes several libraries containing security-related routines.

Note: The DECstation uses the Common Object File Format (COFF) in its object files and load modules.

Digital offers CASE tools and languages (such as FORTRAN, Pascal, and ADA) as layered products for the ULTRIX operating system.

C Compiler

ULTRIX MLS+ is packaged with C compilers for different programming needs: The R4000 MIPS C 3.0 and VAX C/ULTRIX MIPS C 3.0 compilers are available only on ULTRIX RISC systems; VAX C is available only on ULTRIX VAX systems. Pascal for RISC, FORTRAN for RISC, and DEC C for ULTRIX are all available as optional ULTRIX layered products.

- MIPS C 3.0 Compiler (packaged with ULTRIX MLS+) - Includes the MIPS C 3.0 compiler and related development tools and libraries. This compiler is not available on ULTRIX VAX systems.

The MIPS C 3.0 compiler supports: a -std0 K&R[1] mode with ANSI® extensions, a -std1 mode that provides strict ANSI adherence, and a -std (default) mode that is ANSI C with popular extensions.

The compiler also supports a -mips1 mode that generates code executable on any supported MIPS RISC processor (R2000, R3000 or R4000 series), and a -mips3 mode that generates code specific to and optimized for the MIPS R4000 series processors.

- VAX C/ULTRIX Compiler (of interest only to VAX users) - Is a K&R implementation of the C programming language for all ULTRIX VAX systems. VAX C/ULTRIX is not supported or available on ULTRIX RISC systems.

  VAX C/ULTRIX includes extensions as defined by the proposed ANSI Standard for C. Many compute-bound C applications compiled with VAX C/ULTRIX will run significantly faster than when compiled with Portable C Compiler (pcc) on ULTRIX. VAX C /ULTRIX cannot be used for system-level programs requiring the ASM pseudo function, or where undocumented or nonstandard C features of pcc are used. If necessary, an application can be linked using some object modules compiled with both VAX C/ULTRIX and pcc. VAX C/ULTRIX uses the native runtime and system libraries on ULTRIX. It also uses the native header files. It supports the pcc command line with the exception of the following options: -go, -p, -t, -R, -S, and -B. VAX C/ULTRIX is compatible with VAX C, Version 2.3 for VMS systems, except for VMS-specific options.

- DEC C for ULTRIX, Version 1.0 (optional layered product) - Is a Digital ANSI-compliant C compiler currently available for the RISC architecture running the ULTRIX Operating System V4.1 or later.

  DEC C provides support for the ANSI definition of the C programming language-ANSI X3J11/88-159. DEC C has passed the Plum Hall test suite.

  Using the command-line options, DEC C is compatible with older dialects of C, including common K&R C and VAX C.

  The compiler provides support for function inlining to eliminate call overhead. The compiler also provides source-code checking such as those found in the lint(1) utility for assistance in identifying nonportable or unintended coding practices.

  In addition to the language, the ANSI C standard also defines the contents of the C library and defining header files.

  The documentation for DEC C is available in hardcopy form with the media kit and in online (Bookreader) form with the ULTRIX Online Documentation (OLD) disc. The online man(1) command provides access to the c89 and cpp89 manpages for the compiler and preprocessor, respectively.

  ULTRIX and ULTRIX Worksystem Software (UWS) include a license for DEC C. The binaries and documentation are not included in the operating system media and must be ordered as a separate DEC C Media and Documentation package. Refer to the ORDERING INFORMATION section for specific ordering information.

xreflect

The xreflect utility is an X protocol analyzer with additional features designed for ULTRIX MLS+. It has the ability to change what an X client perceives as its default visual. This is useful for running X clients that require a particular default visual. It can also print the security attributes of the protocol stream to aid in debugging security-aware X clients.

CDA Toolkit

The CDA Toolkit is an object library that provides the data structures and routines used to create, store, and interchange the modifiable file formats supported by Compound Document Architecture (CDA). The CDA Toolkit is used to create CDA-compliant applications or to write converters that will interchange existing file formats using CDA data structures as the intermediate format.

Migration to and from the CDA environment includes portability across the RISC ULTRIX, VAX ULTRIX, and VMS operating systems. Electronic mailing and copying of revisable CDA documents provide support for hardware-independent and system-independent display and printing.

CDA data structures are predefined aggregate types that store in memory all the items needed to encode Digital Data Interchange Format (DDIF) and Digital Table Interchange Format (DTIF) documents. DDIF aggregates are used to create CDA-compliant compound documents, graphics and image documents, or converters. DTIF aggregates are used to create CDA-compliant table data documents or converters for use by spreadsheet and database applications.

CDA data structures are used by supplying the appropriate information for all the items stored in each aggregate. The way in which the data structures are linked using the CDA routines determines the structure of the documents created by supporting applications.

CDA routines perform multiple operations including file, stream, and aggregate management; item storage and access; and reading, writing, and conversion of CDA

[1] Kerrigan, Brian W., Ritchie, Dennis M., *The C Programming Language*, Copyright 1988, Prentice-Hall.

data structures. Calls to the CDA routines are encoded within an application source file.

The CDA Toolkit includes the DDIF, DTIF, and Text input and output converters; a PostScript output converter; and an Analysis output converter, which is a debugging tool that produces text output of CDA in-memory data structures.

Digital encourages independent software vendors to use the CDA Toolkit and its converter architecture to write new converters. The CDA Converter Architecture provides the advantage of a standard hub of interchange so all CDA-compliant converters, whether developed by Digital or independent software vendors, can participate in data exchange.

The CDA Viewer, also packaged with the CDA Toolkit, displays the contents of all CDA-supported documents on a UWS workstation or character-cell terminal.

Callable DECwindows and character-cell viewer routines are used to write portable viewer widgets.

Data Encryption/Decryption Facilities

The object code distribution for the ULTRIX MLS+ Operating System includes no forms of encryption or decryption other than the one way password encryption algorithm.

Compatibility with Other UNIX Offerings

To the extent consistent with the ULTRIX MLS+ security policies, the ULTRIX MLS+ Trusted Worksystem Software is compatible with other software system implementations that are specified in the ULTRIX Operating System Software Product Description. These include:

- 4BSD - The ULTRIX operating system is based on the 4BSD (4th Berkeley Software Distribution), Version 4.2 and Version 4.3.
- SVID - The ULTRIX operating system provides SVID (System V Interface Definition) support based on SVID Issue 2, Volume 1.

  Note: ULTRIX source programs that conform to the SVID, Issue 1, may require recompilation.
- Posix nawk(1) - In anticipation of Posix 1003.2 final acceptance, a Posix convergent awk utility, now called nawk(1), is available. The nawk utility includes a change in the order of operator precedence. This may affect some existing awk programs that do not explicitly define precedence with the use of parentheses.

System Management Environment

System administration facilities include:

- Role program support for the Information System Security Officer (ISSO) and the system administrator
- Printer labeling top, bottom, header page, and trailing page PostScript
- Printer setup enhancements
- Site-definable security encodings file
- Integral bad-block replacement for SCSI disks
- System diagnostics
- Error logging
- Streaming tape
- Network installation for Digital worksystems via Ethernet from another ULTRIX MLS+ or ULTRIX server with the UWS server kit installed
- Online System Exerciser Suite for communication devices, disk drives, magnetic tape drives, memory system, line printers, file system, and TCP/IP networks
- Magnetic tape facilities for interchange with ULTRIX MLS+, ULTRIX, and other UNIX systems
- Network Information Services (NIS), which provide centralized system management of files over an Ethernet network

Trusted Client/Server Computing

The trusted client/server computing environment includes the following facilities:

- Network Remote Installation (RIS) - Performs a remote installation through a local area network. The RIS is structured to remotely install both VAX and RISC workstations from a VAX or RISC server. To manage a large number of workstation installations, the RIS is capable of installing through a database file.
- PrintServer Software - The ULTRIX MLS+ system incorporates client software providing support for the PrintServer line of printers. The software includes ANSI-to-PostScript, ReGIS-to-PostScript, and TEX-to-PostScript filters. The latter two filters are available only on VAX systems.

Operating System Environment

The operating system environment supports:

- Multiple file systems
- Multilevel security (MLS) directories
- Prestoserve file system accelerator
- OPEN SCSI CAM architecture
- Multiple communication facilities

File System Features

The ULTRIX MLS+ operating system provides a file system hierarchy of named directories and subdirectories. The operating system provides the ability to mount multiple local and remote file systems. The system supports the following file systems with security labeling:

- ULTRIX File System (UFS) - The traditional ULTRIX file system does not support MLS+ security labels on individual files. The mount point is labeled; files descending from that mount point are considered to have the labels assigned the mount point.
- Network File System V2.0 (NFS) - The traditional NFS file system does not support MLS+ security labels on individual files. The mount point is labeled; files descending from that mount point are considered to have the labels assigned the mount point.
- Trusted UFS - The local MLS+ file system supports labeling each file with MLS+ security attributes (such as sensitivity labels, information labels, access control lists, and privileges).
- Trusted Network File System - Trusted NFS is an extension of the Network File System based on specifications being developed by the Trusted Systems Interoperability Group (TSIG) and the Internet Engineering Task Force (IETF). Trusted NFS supports the ULTRIX MLS+ security features when communicating with similar trusted systems, and supports backwards compatibility with traditional implementations of NFS on non-trusted systems.

  Trusted NFS allows transparent file access over an Ethernet network. ULTRIX MLS+ systems with trusted NFS may interoperate with systems running either unmodified NFS or trusted NFS. Posix-compatible file and record locking is supported by the NFS lock manager. Trusted NFS provides users the ability to use B1 and CMW features with other systems implementing the Trusted NFS server protocol. Trusted NFS also allows remote access to file systems at a single level using unmodified NFS.
- Synchronous File System - The ULTRIX MLS+ system supports synchronous file system writes on a per-file basis. In addition, an option to the mount command permits an entire file system to be designated as synchronous, in which case, all writes issued to files in that file system are performed synchronously. This synchronous option provides for more deterministic file system operations and is useful in database applications. The file system buffer cache size is configurable.

Multilevel Security (MLS) Directories

The MLS directories are the default directories (the ones made by mkdir). MLS directories provide the following:

- Both files and filenames have sensitivity labels (SLs) and information labels (ILs). A directory has a sensitivity label but no discrete information label. The information label of a process that is reading directory entries floats to the high-water mark of the directory entries being read.
- A directory can contain files at different sensitivity levels. Each directory has a minimum SL. The sensitivity of both the filename and the file must dominate the sensitivity level of the directory. A directory can contain filenames whose SLs range from the directory's minimum SL up to System High.
- Processes with different sensitivity labels can create temporary files the same way they would in a nonsecure UNIX implementation, as a unique name with a common pathname prefix (/tmp or /usr/tmp). An unprivileged process sees only filenames that are dominated by the sensitivity level of the process.

Prestoserve File System Accelerator

The ULTRIX MLS+ system provides software support for the Prestoserve file system accelerator, a hardware and software package that can improve I/O response and throughput, and thus can improve NFS server performance. Specifics on supported processors are in the HARDWARE REQUIREMENTS section.

OPEN SCSI CAM Architecture

ULTRIX MLS+ for RISC includes the OPEN SCSI CAM architecture, an enhanced software architecture for the SCSI hardware subsystems. This architecture uses Common Access Method (CAM), a standard defined software interface between device drives and the host bus adapter by which SCSI peripherals are attached to a host processor. With this well architected interface, system manufacturers and other suppliers of intelligent peripherals are able to more easily write the necessary drivers and support code for other third-party devices.

OPEN SCSI CAM is not supported with the ULTRIX MLS+ system on VAX ULTRIX processors.

Communication Facilities

The ULTRIX MLS+ system supports:

- Asynchronous Lines - Dynamic reassignment of asynchronous lines allows use of the same modems for dialing in and out of a system without user intervention. Terminal drivers support 7-bit and 8-bit characters. Asynchronous lines are not supported in a trusted fashion for ULTRIX MLS+ Trusted Worksystem Software Version 2.1.
- Ethernet - The ULTRIX MLS+ system includes Ethernet support, which allows for Ethernet communication using the TCP/IP network protocols over ThinWire and Thickwire Ethernet.
- FDDI - The ULTRIX MLS+ system provides fiber optic support for the DECsystem 5000 series.

Although the Network Time Protocol (NTP) is not supported, the ULTRIX MLS+ system can utilize NTP, which provides the ability to synchronize and distribute time for all machines in a network environment. The University of Maryland developed the NTP daemon. The University of California at Berkeley time synchronization daemon, timed, is used to distribute time to all machines in a network.

Trusted OSF/Motif X11 Window System

The Trusted X Window System is based on the industry standard OSF/Motif window manager and X11 R4 window server.

The following graphics subsystems are supported:

- Single-plane mono (MX)
- 8-plane color bit mapped (CX)
- 8-plane 2D accelerated (PX)
- 8-plane color Smart Frame Buffer (HX)
- 8-plane 3D (PXG)
- 24-plane true color (TX)
- 24-plane 3D (PXG+)
- 96-plane 3D (PXG Turbo+)

The X Window System is a network-based window system. The protocol is implemented in the servers on the display end and in the libraries on the client end. Digital fully supports the X11 protocol in the clients, libraries, and servers with TCP/IP as the underlying communications protocol.

Users can open multiple window sessions at different security levels with a single login. The look and feel of the ULTRIX MLS+ window system is based on the Motif window standard but is enhanced to include user-customizable, color-coded, and patterned label bars to reflect the sensitivity label of the window. Users can access only the information for which they are appropriately cleared.

The Trusted X Window System is aware of the sensitivity of the data displayed and updates the information in the label bar accordingly. When data with a new information label is displayed on the screen, the new information label is combined with the current window information label. The information label in the label bar changes as the label of the data displayed in the window changes.

The system has an additional login prompt for the default sensitivity label of a session. A user can set the default sensitivity label to any level within the accreditation range up to the clearance defined in the user's authentication profile. If users specify a level above their clearance, then the system denies access.

The Trusted X Window System provides capabilities to manipulate windows and display graphical and textual output through a window. The capabilities provided by the Trusted X Window System include:

- Creating connections to the server at any valid sensitivity label within the user's clearance
- Creating and destroying windows
- Displaying graphics output such as lines, polygons, filled polygons
- Displaying text output to a window
- Manipulating window functions such as map, unmap, resize, restack, iconify, de-iconify
- Manipulating cursor functions
- Handling font management routines
- Selecting and controlling input events
- Controlling error handling
- Handling color-management routines
- Displaying window security banner
- Invoking trusted path (including user-defined trusted path)
- Managing trusted cut and paste
- Managing the screen high-water mark
- Changing file sensitivity and information labels
- Managing the trusted mechanism for starting an application
- Pausing and logging out

X Library (Xlib)

The Xlib programming library contains routines that handle window management, perform graphics output, and manage input from devices for the client applications. Xlib provides routines based on the X11 R4 specification.

The MLS+ system provides a library, /usr/lib/libSecXext.a, which contains the Security Extension.

X Toolkit (Xt) Intrinsics Library

The MIT X Version 11 X toolkit intrinsics library is a set of "C language routines designed to facilitate the design of user interfaces, with reusable components called 'widgets'."[2]

The X11 intrinsics perform such operations as:

- Creating and realizing widgets
- Querying and setting widget configuration and state
- Managing input from the user of the application

The X11 intrinsics were voted as a nonexclusive standard by the X Consortium in June 1988. The intrinsics library may change in future versions to remain compatible with X Consortium standards.

X User Interface (XUI)

The XUI widget set, developed by Digital, is based on the X Toolkit (Xt) intrinsics library. It provides the base functionality necessary to build a wide variety of applications.

The XUI Application Programming Interface, accepted by the Open Software Foundation, includes:

- An XUI Style Guide which enforces a coherent user interface
- MIT X Version 11 Intrinsics
- A set of widgets
- A functionally enhanced resource manager (DRM)
- A User Interface Language (UIL) compiler
- Aids for internationalization
- Mechanisms for interactions between and within components

XUI supports the following widgets:

Attached Dialog Box, Caution Box, Command Window, Dialog Box, File Selection, Help, Label, List Box, Main Window, Menu, Menu Bar, Message Box, Option Menu, Pop-Up Attached Dialog Box, Pop-Up Dialog Box, Pop-up Menu, Pulldown Menu Entry, Push Button, Radio Box, Scale, Scroll Bar, Scroll Window, Selection Box, Separator, Text Edit, Toggle Button, Window, and Work In Progress Box.

XUI also supports "gadgets" which are more functionally limited than widgets, but give applications better performance by using less memory. Gadgets are included for creating labels, push buttons, toggle buttons, and separators.

DECwindows Motif

The DECwindows Motif widget set is based on the X Toolkit (Xt) intrinsics library. This set provides rich functionality for building a wide variety of applications.

DECwindows Motif V1.1.3 supports program development in the C language only. The development environment comprises components from Open Software Foundation with some additions from Digital.

The Motif Application Programming Interface includes the Motif User Interface Toolkit and the Presentation Description Language. The Motif Toolkit is a superset of the X Window System toolkit and contains the following components:

- X Toolkit components (known as intrinsics) for managing, modifying, and creating user interface objects (known as widgets and gadgets). The intrinsics may change in future versions of Motif.
- Motif widgets and gadgets for implementing objects such as scroll bars, menus, and push buttons.
- Utility routines that provide functions for common tasks such as cut and paste.
- Resource manager routines for loading user interface definition files and creating widgets and gadgets based on their contents.

The Motif Style Guide (Part # AA-PC7B-TE) describes how to build consistent, well-integrated Motif applications.

X Applications

The windowing system provides an end-user environment. The bundled set of components include user interface applications, desktop applications, software development tools, and additional applications.

- User Interface Applications include the following:
  - — Trusted Window Manager (mwm) - Allows the user to manipulate windows through the use of functions such as move, resize, restack, iconify,

[2] *X Toolkit Intrinsics Programming Manual for X Version 11*, O'Reilly & Associates, Inc.

refresh, and de-iconify windows. There are mechanisms to set up default parameters when activating applications.

— Trusted Path Handler (dxtp) - Maintains the trusted path region, an area at the bottom of the screen where the user is guaranteed communication with the Trusted Computing Base.

— Trusted Selection Handler (dxhandler) - Mediates inter-window data moves. It presents a dialog box that lets a user specify the true sensitivity label and information label of the data being transferred.

— Trusted Session Manager (dxsession) - Implements a modified host-access control mechanism that allows the specification of host /user pairs, thus restricting access to the X server on a user-by-user basis.

— Trusted Terminal Emulator (dxterm) - Emulates VT300, VT220, VT100, VT52, and ReGIS-type terminals. The information label displayed by a dxterm window label bar correctly reflects the high-water mark of information labels associated with the text displayed in the text window.

— Trusted File Label Utility (dxchlevel) - Allows a user to change the MAC, IL and DAC attributes of of a file-system object.

— Trusted dxhostmanager - Is an X window tool for setting up your network and handling the Trusted Network (TNET) databases.

— Trusted Client Handler (dxwatchdog) - Starts the trusted clients, mwm, dxtp and dxhandler. If any of these trusted clients is terminated, then dxwatchdog sends a request to X server to force termination of the session.

— ULTRIX User Executive (dxue) - Provides for application invocation, directory navigation, file manipulation, and simple file view.

- Desktop Applications include the following:
  — Integrated multilevel mail (MLS+ Mail)
  — Calendar
  — Clock
  — Calculator
  — Bookreader
  — Cardfiler
  — DECpaint graphics editor
  — Mail
  — Puzzle
- Software Development Tools include the following:
  — Graphical debugger based on dbx
  — Visual file comparator
  — xreflect
- Additional applications include the following:
  — DDIF Utilities (command-line functions to manipulate DDIF files)
  — DDIF Libraries

Standards

The ULTRIX MLS+ system supports the following standards:

- Posix
- SVID
- X/Open™
- Motif
- ISO 9660
- DNSIX 3.0 Session Attribute Modulation Protocol (SAMP)
- RFC 1108
- Internet RFC protocols
- Internet non-RFC standards

Posix

The ULTRIX MLS+ system provides all the Posix interfaces required by the IEEE 1003.1-1988 standards, except where prohibited by security requirements. Source programs written in the C language that follow the programming guidelines contained in these standards are highly compatible. This product also meets the NIST (National Institute of Standards and Technology) and FIPS (Federal Information Processing Standards) 151-1 standards, except where prohibited by security requirements.

SVID

SVID support is based on SVID Issue 2, Volume 1 except where prohibited by security requirements.

X/Open

The ULTRIX MLS+ system provides the X/Open interfaces required by the X/Open Portability Guide Issue 3 Base Level, except where prohibited by security requirements.

Motif

ULTRIX DECwindows for OSF/Motif V1.1.3 supports the OSF/Motif Application Environment for Motif V1.1.3. In addition, the ULTRIX DECwin-dows for OSF/Motif V1.1.3 is XPG3 branded.

ISO 9660

ISO 9660 is an ISO standard for a volume and file structure for the interchange of information using CD–ROM. ULTRIX is based on the following levels of ISO 9660:

- Level 2 of Interchange
- Level 1 of Implementation - Enables the user to:
  - — Mount single volume ISO 9660 formatted CD–ROMs as a local file system
  - — List and examine files using standard UNIX utilities and programs
  - — Read files and directories using the standard Posix system interface
- NFS export mounted ISO 9660 file systems
- Execute local and remote non-interleaved files
- Execute interleaved files remotely through NFS

DNSIX 3.0 Session Attribute Modulation Protocol (SAMP)

The ULTRIX MLS+ system offers secure networking based on the security protocols from the Trusted System Interoperability Group (TSIG), which has published its version of the DNSIX 3.0 specifications. ULTRIX MLS+ utilizes the DNSIX Security Attribute Modulation Protocol to transport security attributes between endpoints of a network connection. The Security Attribute Token Mapping Protocol is used to translate security attributes to a network representation common between two or more hosts.

RFC 1108

ULTRIX MLS+ has the ability to generate IP Security Options according to Internet RFC 1108. This allows mandatory access controls to be used at the network level.

Internet RFC Protocols

The ULTRIX MLS+ Operating System implements the following internet RFC (Request for Comment) protocols in a trusted mode:

Protocol	Name	RFC
IP	Internet Protocol as amended by:	791
	-IP Subnet Extension	950
	-IP Broadcast Datagrams	919
	-IP Broadcast Datagrams with subnets	922
	-Security Options for the Internet Protocol	1108
ICMP	Internet Control Message Protocol	792
UDP	User Datagram Protocol	768
TCP	Transmission Control Protocol	793
TELNET	Telnet Protocol	854
FTP	File Transfer Protocol	959
SUN-NFS	Network File System Protocol	1094
SMTP	Simple Mail Transfer Protocol	821
MAIL	Format of Electronic Mail Messages	822
ARP	Address Resolution Protocol	826
IP-E	Internet Protocol on Ethernet Networks	894
IP-FDDI	Transmission of IP over FDDI	1188
TIME	Time Protocol	868
FINGER	Finger_Protocol	1196

Additional RFC protocols are provided with ULTRIX MLS+ for use in a nontrusted manner.

Internet Non-RFC Standards

ULTRIX MLS+ also supports the following Internet non-RFC standards:

4.3BSD Socket Interface
4.2BSD inetd
4.3BSD lpd
4.3BSD netstat
4.3BSD ping
4.3BSD rcp
4.3BSD rexecd
4.3BSD rlogin
4.3BSD rsh
4.3BSD uucp
Athena: Kerberos Version 4
Network Computing System (NCS) V1.5
Sun Network Information Service (Yellow Pages)
Sun NFS Lock Manager and Status Monitor

Internationalization

The ULTRIX MLS+ system includes a comprehensive set of library routines, commands, and utilities to support the development of internationalized application software. Refer to the ULTRIX Operating System Software Product Description (SPD 26.40.xx) for details.

ULTRIX MLS+ SUBSET SUPPORT

The ULTRIX MLS+ distribution kits contain supported software subsets, unsupported software subsets, and ULTRIX DECwindows for OSF/Motif V1.1.3 subsets.

Supported Software Subsets

The supported software subsets are divided into mandatory and optional. A list of mandatory and optional subsets can be found in the *ULTRIX MLS+ Installation Guide*.

While most subsets on the supported-subset media are supported, some subsets are unsupported and others are supported with limitations.

In general, VAX subsets whose names begin with MLS or UWS are supported, as are RISC subsets whose names begin with MDS or UDW. The following is a list of exceptions to this convention: they are subsets whose names begin with MLS, MDS, UWS or UDW that are either unsupported or are supported with limitations.

- MLSBScxxx - Bisynchronous Communications Unsupported.
- MDSDLxxx/MLSDLxxx - Diskless Support Environment Unsupported.
- MDSKERBxxx/MLSKERBxxx - Kerberos Network Authentication-Supported but not integrated with the system. This subset is nontrusted.
- MDSMOPxxx/MLSMOPxxx - Maintenance Operations Protocol-Supported for nontrusted network booting.
- MDSRPCRTxxx/MLSRPCRTxxx - RPC Runtime Environment-Supported but not integrated with the system. This subset is nontrusted.
- MDSUUCPxxx/MLSUUCPxxx - UNIX-to-UNIX Copy Facility-Supported but not integrated with the system. This subset is nontrusted.
- UWS3DFONTxxx - VS35XX X11/DECwindows Fonts Unsupported.
- UDWFONTSTRxxx - X11/DECwindows PEX Fonts Unsupported.

Unsupported Software Subsets

In addition to the subsets supported by the MLS+ system, Digital provides other software components on an "as is" basis. This software is not warranted by Digital and no software performance reports will be acknowledged or answered on any of these components. Support services cannot be purchased for this software.

The unsupported subsets have names beginning with ULX (VAX) or UDX (RISC). Unsupported software components are delivered on a separate distribution media, with the exception of CD–ROM, in which case the unsupported subset is contained in a separate partition on the disk.

ULTRIX DECwindows for OSF/Motif V1.1.3 Subsets

The ULTRIX DECwindows for OSF/Motif installation includes files and commands with names that begin with DXV (for VAX) or DXM (for RISC). Of these subsets, DXVUNDEM0113 or DXMUNDEMO113 are unsupported.

ULTRIX MLS+ WINDOW SYSTEM - NONTRUSTED/TRUSTED COMPONENTS

Supported Window System components are either nontrusted or trusted.

Nontrusted Components

The ULTRIX MLS+ system supports the following Window System components as nontrusted:

/usr/bin/dxfc-DECwindows Font Compiler
/usr/bin/dxdb-Graphical Debugger
/usr/bin/dxnotepad-DECwindows text editor
/usr/bin/dxdiff-DECwindows visual differences program
/usr/bin/dxcardfiler-DECwindows interface to the Cardfiler
/usr/bin/dxvdoc-DECwindows compound document viewer
/usr/bin/dxpaint-DECwindows bitmap editor
/usr/bin/dxuil-DECwindows User Interface Compiler
/usr/bin/dxue-DECwindows User Executive
/usr/bin/dxterm-DECwindows Terminal Emulator
/usr/bin/dxcalc-DECwindows Calculator
/usr/bin/dxpuzzle-DECwindows interface to a puzzle game
/usr/bin/dxclock-DECwindows clock program
/usr/bin/dxcalendar-DECwindows calendar
/usr/bin/dxmkfontdir-Creates table on fonts in a directory
/usr/lib/libdwt.a
/usr/lib/libXt.a
/usr/lib/libXaw.a
/usr/lib/libX11.a
/usr/lib/libXext.a
/usr/lib/libfp.a

Note: Support of /usr/lib/libXaw.a and /usr/lib/libXt.a is limited to the functionality provided in X11R4 from the Massachusetts Institute of Technology (MIT). Digital warrants these libraries to have the same functionality as the libraries of MIT, except as restricted by security considerations.

Trusted Components

The ULTRIX MLS+ system supports the following Window System components as trusted:

/usr/tcb/tpath/dxchlevel-Trusted File Label Tool
/usr/tcb/tpath/dxchpwd-Trusted Change Password Program
/usr/tcb/bin/dxhandler-Trusted Selection Handler
/usr/tcb/bin/dxhostmanager-Trusted Network Management Tool
/usr/tcb/bin/dxhostuser-Trusted Host-Access Control Program
/usr/tcb/bin/mwm-Trusted Motif Window Manager
/usr/tcb/bin/dxsession-Trusted DECwindows Session Manager
/usr/tcb/bin/dxtp-Trusted Path Handler
/usr/tcb/bin/dxterm-Trusted Terminal Emulator
/usr/tcb/bin/dxwatchdog-Trusted Client Handler
/usr/tcb/bin/Xprompter-Trusted Login Window Display
/usr/bin/Xqvsm-Trusted VAXstation Monochrome X Server
/usr/bin/Xqdsg-Trusted VAXstation Color X Server
/usr/bin/Xws-Trusted DECstation MX/CX/PX/HX X Server
/usr/bin/Xtx-Trusted DECstation TX X Server
/usr/bin/Xwstsd-Trusted DECstation PXG, PXG+, PXGT, PXGT+ X Server
/usr/lib/libSecXext.a-Security Extension Client Library

HARDWARE REQUIREMENTS

The ULTRIX MLS+ Trusted Worksystem Software can execute on valid VAX and RISC based systems that include the minimum system configuration. Performance depends on the application programs, the processor type, processor memory, and secondary storage.

- Minimum memory requirements are 16 MB. It is recommended that systems have at least 24 MB of memory. If using 3D applications, 32 MB of memory is recommended.
- To utilize all of physical memory, users should have at least as much swap space as they have physical memory.
- Minimum disk space required for a basic installation is approximately 200 MB. Minimum disk space required for an advanced installation is approximately 400 MB.

ULTRIX MLS+ is not available as Factory Installed Software (FIS). Therefore, systems must be ordered with a load device.

Standalone Workstation - Minimum Hardware Configuration

The minimum hardware configuration for a standalone workstation is as follows:

- Supported ULTRIX MLS+ processor at appropriate hardware revision level
- Minimum amount of main memory (refer to the OPTIONAL HARDWARE section)
- Supported ULTRIX MLS+ system device capable of holding the supported subsets (refer to the OPTIONAL HARDWARE section)
- Supported ULTRIX MLS+ software load and backup device for local (non-network) installation
- A valid load device for diagnostics
- One Digital graphics display console
- Support for graphics (CX, HX, MX, PX, PXG+, PXG Turbo+)

Server - Minimum Hardware Configuration

The minimum hardware configuration for a server is as follows:

- Supported ULTRIX MLS+ processor at appropriate hardware revision level
- Minimum amount of main memory (refer to the OPTIONAL HARDWARE section)
- Supported ULTRIX MLS+ system device capable of holding the supported subsets (refer to the OPTIONAL HARDWARE section)
- Supported ULTRIX MLS+ software load and backup device for local (non-network) installation
- A valid load device for diagnostics
- One console terminal with ASCII capability.

OPTIONAL HARDWARE

Additional memory and/or secondary storage may be required depending upon the need for ULTRIX MLS+ software or optional software products and usage of ULTRIX MLS+ Trusted Worksystem Software.

Note: Combinations of hardware options are subject to limitations such as bandwidth, physical configuration restraints, thermal dissipation, and electrical loads/power.

System configuration details are described in the Systems and Options Catalog.

Devices listed in each processor table are those that are supported in a trusted mode. Additional peripherals supported by ULTRIX V4.3A may work with ULTRIX MLS+, but trust cannot be guaranteed for those devices not specifically called out in the processor tables.

The following sections list hardware options supported by the ULTRIX MLS+ Trusted Worksystem Software. All device drivers for these hardware units contained in the ULTRIX MLS+ system are warranted by Digital.

HARDWARE CONFIGURATION NOTES

Disks

To have a standalone system, the user needs at least an RZ25 or RZ55 disk drive. If the system has only one RZ25 or RZ55 drive, the user should load only the mandatory subsets.

Beyond the system requirements, a minimum of 64 MB of swap space is recommended. More swap space may be required to run specific applications. Users should have at least as much swap space as they have physical memory in the machine in order to use all of the physical memory.

To use a system as a server, the system needs at least one RZ55 drive in addition to the system disk.

SCSI

Disk and tape devices are connected to the DECstation and DECsystem via SCSI (Small Computer System Interface) controllers. There is one integral SCSI controller and, optionally, up to three more SCSI controllers, depending on the processor type. Each SCSI controller will support up to seven devices in any combination. Each controller has an identifier that can be set via the Console Interface. Each added device must have its own unique identifier which must not conflict with any other device including the SCSI controller. The SCSI controller should always have the highest ID.

The SCSI cable length is limited to six meters, thereby limiting the number of external devices (tapes and disks) that can actually be attached to the system per bus.

Computer Interconnect

ULTRIX MLS+ does not support configurations that utilize the Computer Interconnect (CI) hardware.

Prestoserve

The addition of the Prestoserve option uses one memory slot, thus reducing the maximum amount of configurable memory by the amount of memory that is contained on one memory module.

Tapes

The TZ85 and TZ30 tape drives accept TK50 distribution media.

Automatic stack loader tape devices are not supported.

DECstation 3100

Although the DECstation 3100 has four ports, ports 1 and 2 are not available; port 3 is a system console; port 4 is available for a printer or modem.

DECstation, DECsystem 5000 Series

The 5000 Series can support up to 28 disks only if no tape drives are configured. The actual number of tape and disk drives cannot exceed 28 (seven per SCSI controller). If four SCSI controllers are configured, then the system cannot support a workstation monitor.

DECstation, DECsystem 5000 Models 120/125/133

The RZ23L device is supported via the TURBOchannel Extender (TcE).

DECstation, DECsystem 5000 Models 200/240

The RZ23, RZ23L, RZ24 and RZ24L devices are supported via the TURBOchannel Extender (TcE).

A maximum of two tape devices can be configured per SCSI bus.

DECstation, DECsystem 5000 Models 20/25/33

The RX26 device may either be FDI-based, in which case it is integral in the system; or SCSI-based, in which case it is a separate device.

The RZ23L device is supported via the TURBOchannel Extender (TcE).

DECsystem 5100

The DECsystem 5100 can support up to seven SCSI disks. The actual number of tapes and disks cannot exceed seven.

DECsystem 5500

Two KZQSAs are supported. The DECsystem 5500 supports all SCSI disks and tapes on the KZQSA. The KZQSA supports data devices only and not boot devices.

DECsystem 5900

CITCA is not supported.

The RZ23, RZ23L, RZ24 and RZ24L devices are supported via the TURBOchannel Extender (TcE).

Networking Devices

The total number of optional I/O devices depends on the number of available I/O slots. For example, a DECstation 5000 Model 200 with an HX graphics card can support only two additional I/O devices.

Communication Devices

The number of devices listed for each DECstation or DECsystem does not include those reserved for devices such as the monitor, keyboard, and mouse.

- The DECsystem 5000 Model 25/33/50 has one general purpose asynchronous/synchronous serial interface on the system module. A TURBOchannel-based serial connector would be needed if more serial lines are required.
- The DECstation 2100/3100 and VAXstation 3100 reserves the first two lines. Lines 3 and 4 are available to the user for modem port and printer port or console.
- The DECsystem, DECstation 5000 Models 200/240 use the first two lines (keyboard and mouse). The additional two lines are available to the user for ASCII terminals, modems, or printers. These ports are supported up to 19200 baud.

Modems

Modems must be configured such that the "Forced DSR" attribute is not set. If the "Forced DSR" attribute is set, the modem will be unable to recognize loss of connection, and might incorrectly assume that a connection has been established. Consult the modem's corresponding Owner's Manual for specific information on clearing the "Forced DSR" option.

Printers

DEClaser support is equivalent to that which is available for the LN03, LN03R, and LN03S printers.

DECstation 2100 and DECstation 3100

Memory

Minimum-16 MB
Maximum-24 MB

Disks-Five Maximum

RRD40-valid load device
RX23-data device only; only one device can be connected
RZ23-data device only
RZ23L-data device only
RZ24-data device only
RZ55
RZ56
RZ57
RZ58
RRD42
RZ24L
RX33
RZ25
RZ26

Tapes-Two Maximum

TK50Z-valid load device
TLZ04-data device only
TSZ05
TKZ08
TLZ06
TSZ07
TZ30
TZK10
TZ85

Graphics Subsystem

Single-plane mono
8-plane color bitmapped graphics

Workstation Monitor

VR150
VR160
VR260
VR290
VR299

I/O Adapters

N/A

Networking Devices

One internal LANCE controller

Communication Devices-As UNTRUSTED

Two-line asynchronous

Modem/Pad Devices-As UNTRUSTED

DF224
DF03
DF112
DF212
DF242

Line Printers-One Maximum

LN03R	DEClaser 1150
LN05R	DEClaser 2150
LN06R	DEClaser 2250
LPS20/40	DEClaser 3250

Asynchronous Terminals-As UNTRUSTED

VT100
VT200
VT300
VT400

All terminals and serial printers are supported in 7-bit and 8-bit ASCII.

Keyboard Support

LK201

VAXstation 3100

Memory

Minimum-16 MB
Maximum-32 MB

Disks - Eight Maximum

RRD40 - valid load device
RX23 - data device only; only one device can be connected
RZ22 - data device only
RZ23 - data device only
RZ23L - data device only
RZ24 - data device only
RZ55
RZ56
RZ57
RZ58
RRD42
RRD43
RRD44
RX22
RX33

Tapes - One Maximum

Controller - N/A
TK50Z - valid load device
TLZ04 - data device only
TZ30 - valid load device
TSZ07

Graphics Subsystem

One VS40X-MA
One VS40X-PA

Workstation Monitor

VR150
VR160
VR260
VR290

I/O Adapters

N/A

Networking Devices

One internal LANCE controller

Communication Devices-As UNTRUSTED

Two-line asynchronous

Modem/Pad Devices-As UNTRUSTED

DF224
DF03
DF112
DF212
DF242

Line Printers-One Maximum

LN03R	DEClaser 1150
LN05R	DEClaser 2150
LN06R	DEClaser 2250
LPS20/40	DEClaser 3250

Asynchronous Terminals-As UNTRUSTED

VT100
VT200
VT300
VT400

All terminals and serial printers are supported in 7-bit and 8-bit ASCII.

Keyboard Support

LK201

Note: Disk and tape devices (except the RX23 on a VAXstation 3100 Model 30) are connected to the VAXstation 3100 via the SCSI. The number of devices supported is less than the maximum number allowed by the ANSI SCSI specification. This is necessary to provide greater SCSI bus data integrity and operating system performance.

The maximum number of devices supported for the VAXstation 3100 Model 30 and VAXstation Model 38 are:

One TZ30 tape drive (internal)
One TK50Z tape drive (expander box)
Two RRD40 optical disk drives
Two RZ23 disks (internal)
Two RZ5X disks (expander box)
One RX23 SCSI Floppy Disk Drive (for Model 38 only)

There is a maximum of four externally mounted devices; the total number of devices is not to exceed six for the Model 30 and seven for the Model 38.

The maximum number of devices supported for the VAXstation 3100 Model 40 and VAXstation Model 48 are:

One TZ30 tape drive (internal)
One TK50Z tape drive (expander box)
Two RRD40 optical disk drives
Three RZ23 disks (internal)
Three RZ5X disks (expander box)

The Model 40 needs an RZ55 to be used as a server in addition to the system disks.

There is a maximum of four externally mounted devices; the total number of devices is not to exceed eight.

DECstation, DECsystem 5000 Models 120, 125, 133

Memory

Minimum-16 MB
Maximum-128 MB
One Prestoserve (Optional for DECsystem 133)

Disks-28 Maximum

RRD40-valid load device
RX23-data device only
RX26-data device only
RZ23-data device only
RZ23L-data device only
RZ24-data device only
RZ25
RZ55
RZ56
RZ57
RZ58
RRD42
RRD43
RRD44
RZ24L
RX33
RZ26

Tapes-Two Maximum

TK50Z - valid load device
TLZ04 - data device only
TSZ05
TKZ08
TLZ06
TSZ07
TZ30
TZK10
TZ85
TKZ09

DECstation Graphics Subsystem

Single-plane mono (MX)
8-plane color bitmapped graphics (CX)
2-plane 2D accelerated graphics (PX)
8-plane Smart Frame Buffer (HX)
8-plane 3D, entry level (PXG)
8-plane 3D, low- to mid-range (PXG+)
24-plane 3D, mid-range (PXG+)
24-plane true color frame buffer (TX)
96-plane 3D, high performance (PXG Turbo+)

Workstation Monitor

VR262
VR297
VR299
VR319
VRT16
VRT19
VR320
VRC16
VRM17

I/O Adapters

One VME
Three SCSI
One TURBOchannel Extender

Networking Devices

Up to four LANCE controllers
Three FDDI/DEFZA or DEFTA
Three Ethernet/PMAD

Communication Devices-As UNTRUSTED

Two-line asynchronous

Modem/Pad Devices-As UNTRUSTED

DF224
DF03
DF112
DF212
DF242

Line Printers-Two Maximum

LN03R
LN05R
LN06R
LPS20/40
DEClaser 1150
DEClaser 2150
DEClaser 2250
DEClaser 3250

Asynchronous Terminals-As UNTRUSTED

VT100 Series
VT200 Series
VT300 Series
VT420

Keyboard Support

LK401

DECstation, DECsystem 5000 Models 200 and 240

Memory

Minimum-16 MB
Maximum-480 MB
One Prestoserve (optional for the DECsystem 240)

Disks-28 Maximum

RRD40-valid load device
RX23-data device only
RZ23-data device only
RZ23L-data device only
RZ24-data device only
RZ25-data device only
RZ55
RZ56
RZ57
RZ58
RRD42
RRD43
RRD44
RZ24L
RX33
RZ26

Tapes-Two Maximum

TK50Z - valid load device
TLZ04 - data device only
TSZ05
TKZ08
TLZ06
TSZ07
TZ30
TZK10
TZ85
TKZ09

DECstation 5000/200 Graphics Subsystem

Single-plane mono (MX)
2-plane 2D accelerated graphics (PX)
8-plane Smart Frame Buffer (HX)
8-plane color bitmapped graphics (CX)
8-plane 3D, entry level (PXG)
8-plane 3D, low- to mid-range (PXG+)
24-plane 3D, mid-range (PXG+)
24-plane true color frame buffer (TX)
24-plane 3D (PXG TURBO)
96-plane 3D, high performance (PXG Turbo+)

DECstation 5000/240 Graphics Subsystem

Single-plane mono (MX)
8-plane Smart Frame Buffer (HX)
8-plane 3D, low- to mid-range (PXG+)
24-plane 3D, mid-range (PXG+)
24-plane true color frame buffer (TX)
96-plane 3D, high performance (PXGTurbo+)

Workstation Monitor

VR262
VR297
VR299
VR319
VRT16
VRT19
VR320
VRC16
VRM17

I/O Adapters

One VME
One TURBOchannel Extender
Three SCSI (PMAZ)

Networking Devices

Up to four LANCE controllers
Three FDDI/DEFZA or DEFTA
Three Ethernet/PMAD
Three FDDI/DEFTA (240)

Communication Devices-As UNTRUSTED

Two-line asynchronous

Modem/Pad Devices-As UNTRUSTED

DF224
DF03
DF112
DF212
DF242

Line Printers-Two Maximum

LN03R
LN05R
LN06R
LPS20/40
DEClaser 1150
DEClaser 2150
DEClaser 2250
DEClaser 3250

Asynchronous Terminals-As UNTRUSTED

VT100 Series
VT200 Series
VT300 Series
VT420

Keyboard Support

LK201
LK401

DECsystem 5100

Memory

Minimum-16 MB
Maximum-128 MB
One Prestoserve

Disks-Seven Maximum

RRD40-valid load device
RX23-data device only
RZ23-data device only
RZ23L-data device only
RZ24-data device only
RZ25-data device only
RZ55
RZ56
RZ57
RZ58
RRD42
RRD43
RRD44
RZ24L
RX33
RZ26

Tapes-Four Maximum

Controller - TQK70
Controller - SCSI
TK50Z - valid load device
TLZ04 - data device only
TSZ05
TKZ08
TLZ06
TSZ07
TZ30
TZK10
TZ85
TKZ09

Graphics Subsystem

N/A

Workstation Monitor

N/A

I/O Adapters

None

Network Devices

None

Communication Devices-As UNTRUSTED

One-line asynchronous

Modem/Pad Devices-As UNTRUSTED

Two full modems maximum
DF224
DF03
DF112
DF212
DF242

Line Printers-One Maximum

LN03R
LN05R
LN06R
LPS20/40
DEClaser 1150
DEClaser 2150
DEClaser 2250
DEClaser 3250

Asynchronous Terminals-As UNTRUSTED

VT100 Series
VT200 Series
VT300 Series
VT420

Keyboard Support

N/A

DECsystem 5500

Memory

Minimum-16 MB
Maximum-256 MB
One Prestoserve

Disks - 32 Maximum

Controller
SCSI
KDA50
DSSI
KFQSA
KZQSA

RA70
RA90
RRD40 - valid load device
RX23 - data device only
RZ23 - data device only
RZ23L - data device only
RZ24 - data device only
RZ25 - data device only
RZ55
RZ56
RZ57
RZ58
ESE20
RA60
RA71
RA72
RA73
RA81
RA82
RA92
RF30
RF31
RF71
RF72
RRD42
RZ24L
RX33
RZ25
RZ26

Tapes-Four Maximum

Controller
TQK70
SCSI
KLESI-SA
TSV05
TK50Z - valid load device
TLZ04 - data device only
TK70
TKZ08
TLZ06
TS05
TSZ05
TSZ07
TU81E
TZ30
TZK10
TZ85
TKZ09

Graphics Subsystem

N/A

Workstation Monitor

N/A

I/O Adapters

None

Network Devices

None

Communication Devices-As UNTRUSTED

CXA16 CXB16 CXY08 DELQA/DESQA DESTA

Modem/Pad Devices-As UNTRUSTED

DF224
DFA01
DF02
DF03
DF112
DF212
DF224
DF242

Line Printers-One Maximum

LN03R
LN05R
LN06R
LPS20/40
DEClaser 1150
DEClaser 2150
DEClaser 2250
DEClaser 3250

Asynchronous Terminals-As UNTRUSTED

VT100 Series
VT200 Series
VT300 Series
VT420

Keyboard Support

N/A

DECsystem 5900 (Uniprocessor Model only)

Memory

Minimum-64 MB
Maximum-448 MB
One Prestoserve

Disks-28 Maximum

RRD40
RRD42
RRD43
RRD44
RX23
RX26
RX33
RZ23
RZ23L
RZ24
RZ24L
RZ25
RZ26
RZ55
RZ56
RZ57
RZ58

Tapes-Two Maximum

TK50Z TKZ08 TKZ04 TLZ06 TSZ05 TSZ07 TZ30 TZK10 TZ85 TKZ09

Graphics Subsystem

N/A

Workstation Monitor

N/A

I/O Adapters

One VME One TURBOchannel Extender Three SCSI (PMAZ) CI not supported

Network Devices

Three DEFZA or DEFTA
Three Ethernet (Thickwire) (PMAD)

Communication Devices-As UNTRUSTED

One-line asynchronous

Modem/Pad Devices-As UNTRUSTED

DF03
DF112
DF212
DF224
DF242

Line Printers-Two Maximum

LN03R
LN05R
LN06R
LPS20/40
DEClaser 1150
DEClaser 2150
DEClaser 2250
DEClaser 3250

Asynchronous Terminals-As UNTRUSTED

VT100
VT200
VT300
VT420

DECstation, DECsystem 5000 Models 20, 25, 33

Memory

Minimum-16 MB
Maximum-40 MB

Load device is required

Disks-21 Maximum

RRD40
RRD42
RX23
RX26
RX33
RZ23
RZ23L
RZ24
RZ24L
RZ25
RZ26
RZ55
RZ56
RZ57
RZ58

Tapes-One Maximum

TK50Z
TKZ08
TLZ04
TLZ06
TSZ05
TSZ07
TZ30
TZK10
TZ85

DECstation Graphics Subsystem

Single-plane mono (MX)
8-plane color Smart Frame Buffer (HX)
24-plane true color graphics (TX)
8-plane 3D accelerated graphics (PXG+)
24-plane 3D accelerated graphics (PXG Turbo+)

Workstation Monitor

VR262
VR290
VR297
VR299
VR319
VR320
VRC16
VRM17
VRT16
VRT19

I/O Adapters

One VME
One TURBOchannel Extender
Three SCSI (PMAZ)

Network Devices

Up to three LANCE controllers
Two FDDI/DEFZA or DEFTA
Two Ethernet PMAD

Communication Devices-As UNTRUSTED

One-line asynchronous

Modem/Pad Devices-As UNTRUSTED

DF03
DF112
DF212
DF224
DF242
DF296

Line Printers-One Maximum

LN03R
LN05R
LN06R
LPS20/40
DEClaser 1150
DEClaser 2150
DEClaser 2250
DEClaser 3250

Asynchronous Terminals-As UNTRUSTED

VT100
VT200
VT300
VT420

Keyboard Support

LK501

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Sources:

- ULTRIX MLS+ V1.0A sources for both RISC and VAX platforms: QB-GNAAA-E*

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- Motif V1.1.3 Documentation Kit, QA-YMBAA-GZ-contains books of interest to Motif application programmers.

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