COMPAQ

Software Product Description

PRODUCT NAME: DIGITAL MLS+ Operating System, Version 4.0D SPD 46.21.04

DESCRIPTION

DIGITAL MLS+ Version 4.0D is Compaq Corporation's security enhanced implementation of DIGITAL UNIX® Version 4.0D software for Alpha systems.

The DIGITAL MLS+ operating system is designed to meet the B1/CMW level of security specified in the following documents:

- Department of Defense, National Computer Security Center. Trusted Computer System Evaluation Criteria (TCSEC), DoD 5200.28-STD. December 1985.
- Security Requirements for System High and Compartmented Mode Workstations, DDS-2600-5502-87.
- Information Technology Security Evaluation Criteria (ITSEC). June 1991.

The DIGITAL MLS+ Operating System is a trusted version of a 64-bit advanced kernel architecture based Carnegie-Mellon University's Mach V2.5 kernel design with components from Berkeley Software Distribution (BSD) 4.3 and 4.4, UNIX® System V, and other sources. DIGITAL MLS+ is Digital Equipment Corporation's security-enhanced implementation of the Open Software Foundation™ (OSF®) OSF/1R1.0, R1.1, and R1.2 technology, and the Motif® graphical user interface and programming environment.

DIGITAL MLS+ provides symmetric multiprocessing (SMP) and numerous features to assist application programmers in developing applications that use shared libraries, multithread support, and memory mapped files.

The DIGITAL MLS+ trusted implementation of the X Window System™ is based on Version 11, Release 6 (X11R6) from the X Consortium Inc.

To ensure a high level of compatibility with DIGITAL's ULTRIX Operating System, the DIGITAL MLS+ Operating System is compatible with Berkeley 4.3 and System V programming interfaces.

The DIGITAL MLS+ system is binary compatible with the Digital UNIX software unless restricted by the security policy. Well-behaved commercial applications should run without modifications on DIGITAL MLS+.

DIGITAL MLS+ V4.0D is on based DIGITAL UNIX V4.0D and includes many extensions and security enhancements. For licensing purposes, the DIGITAL MLS+ system is treated as though it were a Layered Product for DIGITAL UNIX.

SECURITY ENHANCEMENTS SUMMARY

The DIGITAL 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 policy. Security features are transparent to applications, with the exception of security policy violations.

Console Password

The DIGITAL MLS+ system provides a command line interface (cpasswd(8)) to set, clear or query the console password used by the firmware Password Security Feature on the DEC 2000 and DEC 3000 platforms.

This allows the System Administrator to change the console password on these platforms without shutting down the Operating System.

Access Policies

The DIGITAL MLS+ system security policy includes the following access policies:

- 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 (POSIX 1006.3 Draft 11 ACLs).
- Mandatory Access Control (MAC) - provides a mechanism for the security officer to define sensitivity that can be applied to all 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 reflect the sensitivity of the actual contents of information in a system object. When information is added to a file (object) or process (subject), the system automatically adjusts the information label as necessary.

Auditing

A tool is provided to monitor normal, as well as unauthorized usage of a system with a choice of a GUI or command line interface.

Identification and Authentication

DIGITAL MLS+ provides an enhanced Identification and Authentication subsystem which provides extensive login controls.

The System Administrator can assign extended attributes on a per-user basis, including:

- Command authorizations, privileges, and clearance
- Audit mask
- Maximum unsuccessful login tries allowed
- Account expiration time
- Minimum time between password changes
- Minimum and maximum length of password
- Password expiration time
- Password lifetime
- Password history limit
- Automatic password generation controls
- Password trivialty checks
- Site password policy checks

Other extended attributes are tracked by the system on a per user-basis including:

- Time of last successful and unsuccessful password change
- Last user to change user's password
- Time of last successful and unsuccessful login
- Terminal associated with last successful and unsuccessful login
- Number of consecutive unsuccessful logins
- Password usage history

The System Administrator can also assign extended attributes on a per-terminal basis, including:

- Maximum unsuccessful login attempts allowed
- Delay between login tries

Other extended attributes are tracked by the system on a per-terminal basis including:

- User id and time of last successful/unsuccessful login
- User id and time of last logout
- Number of consecutive unsuccessful logins

Trusted Printer Subsystem

The trusted printer subsystem provides correctly marked header and trailer pages, and top and bottom page labeling for directly connected and networked printers. Printers may be connected through a local serial port, a LAT server or through a TCP/IP network. The subsystem also allows print jobs to be sent to remote systems using the BSD printer protocol. In that case, the remote system is responsible for providing correctly marked header and trailer pages.

Trusted X Window System

The MLS+ trusted implementation of the X Window System has the following features: traditional UNIX discretionary access control, mandatory access control (MAC), information labels (ILs), 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 Trusted Client Handler.

The MLS+ Security Policy, 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 6 (X11R6) of X Windows and OSF/Motif version 1.2.5.

The X server's default visual is dynamic (PseudoColor).

Trusted MultiSIX Networking

DIGITAL MLS+ has a number of trusted network facilities. DIGITAL MultiSIX is the name of the comprehensive trusted network strategy implemented by MLS+.

The Trusted Network (TNET) architecture supports the BSD 4.3 and 4.4 socket mechanism and the Internet Protocol Suite. TNET lets an MLS+ host establish TCP/IP connections to both labeled and unlabeled hosts, using extensions to the socket mechanism to pass security attributes (such as sensitivity labels) between MLS+ hosts.

The TSIX1.1 (RE) Security Attribute Modulation Protocol (SAMP) transports security attributes between endpoints of a network connection. More information on this is given below.

Trusted networking facilities include:

- Trusted File Transfer Program (FTP) - Provides most of the standard FTP server capabilities while preserving the MLS+ mandatory and discretionary access policies. An FTP connection is established 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 - Enforce MLS+ security policies. Unprivileged users can use these commands to connect to remote MLS+ systems on a network.
- Trusted Network File System (TNFS) - Provides the ability to mount labeled (trusted) file systems. For a labeled file system mounted between MLS+ hosts, Trusted NFS maintains the correct security attributes for each remote-mounted file.
- Trusted TELNET - Supports a trusted TELNET server, which provides the TELNET server capabilities while preserving the 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) - NIS can be used to distribute MLS+ security databases including :
  - Protected passwords – Security-related information contained in users' protected password database entries (last successful login, number of unsuccessful logins, etc.) are kept up to date with each login attempt. Users can also update their NIS passwords from a DIGITAL MLS+ NIS client.
  - System defaults
  - Command authorization definitions
  - User command authorizations
  - Trusted network remote hosts
- Interoperability - 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 Sockets - The DIGITAL 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 security attributes of 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.

DIGITAL MLS+ implements the following security-specific networking standards:

- TSIX(RE) 1.1 Trusted Networking

The DIGITAL MLS+ system offers secure networking based on the security protocols from the Trusted System Interoperability Group (TSIG). DIGITAL MLS+ conforms to TSIX(RE) 1.1, supports TSIX(RE) 1.0 and supports the TSIG TSIX API, a vendor-neutral, TSIG-approved set of application programming interfaces for setting, sending, receiving, and retrieving security attributes across a network. Security attributes are passed as tokens between hosts using the TSIG protocols Security Attribute Modulation Protocol (SAMP) and the Security Attribute Token Mapping Protocol (SATMP). MLS+ also supports the Common IP Security Options (CIPSO) as specified by the IETF CIPSO working Group of TSIG.

- RFC 1108

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.

Trusted Multilevel Mail (MLS+ Mail)

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

Trusted Multilevel Mail provides each user with a multilevel mailbox that can accept messages at any security level, up to the user's clearance and allows users to read all of their messages from trusted dxmail, even if every message has a different security level. Users can send mail with any specified security label (up to their clearance level).

Multilevel Security Directories

Multilevel Security (MLS) directories provide a solution to the problem of managing files and directories at different sensitivity labels. This allows unprivileged users to place files at different sensitivity levels in the same directory.

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 information labels for 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 label 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 whose sensitivity labels are dominated by the sensitivity label of the process.

Hidden Directories

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

Separate Administrative Roles

The system provides for three separate administrative roles as an alternative to the traditional "root" account. DIGITAL 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.
  - Sets up the audit subsystem.
  - 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.
- Network Information System Security Officer (Net ISSO) - Responsible for adding and removing hosts and maintaining their security attributes.

COMPATIBILITY WITH ULTRIX MLS+

The majority of the Application Programming Interface (API) is identical to previous versions of MLS+ that ran under ULTRIX on VAX and MIPS hardware. Specifics are contained in the DIGITAL MLS+ Programming Guide, which is packaged with the DIGITAL MLS+ Administrator/Programmer Kit as well as with the DIGITAL MLS+ Full Documentation Kit.

STANDARDS

DIGITAL MLS+ is based on the DIGITAL UNIX operating system. DIGITAL UNIX, in turn, complies with numerous standards and industry specifications, which are listed below. DIGITAL MLS+ conforms with these standards and specifications to the extent that they are consistent with the DIGITAL MLS+ security policies. Where there is direct conflict between an industry standard or specification and security policies, DIGITAL MLS+ remains consistent with the security policies. For more information on the following standards and specifications, please refer to the DIGITAL UNIX Software Product Description (SPD 41.61.xx).

- XPG4 UNIX (also known as the Single UNIX Specification, previously known as Spec1170)
- Motif (DIGITAL MLS+ supports the same version as DIGITAL UNIX but it is NOT based on CDE 1.0)
- POSIX.1 and FIPS151-2
- IEEE Std 1003.1b-1993 (Realtime Extension)
  - DIGITAL MLS+ does NOT support the optionally enabled fully pre-emptive kernel.
- IEEE Std 1003.1c-1995 (Threads Extension)
- IEEE Std 1003.2-1992 (Shells and Utilities)
- System V Release 3.2 (SVR3) - SVID Issue 2
- System V Release 4.0 (SVR4) - SVID Issue 3

SHARED LIBRARIES

DIGITAL MLS+ provides a full complement of dynamic shared libraries, based on System V semantics, which increase system performance, reduce minimum hardware requirements, and ease system management.

INSTALLATION

Systems with graphic adapters are presented a Motif compliant graphical interface for installation. Other system configurations are presented with a simple text based interface.

DIGITAL MLS+ is customer-installable. Installation Services are available for those customers who would like an experienced DIGITAL Software Specialist to install the software.

Installation

An installation procedure installs DIGITAL MLS+ onto the system. Installations may repartition the system drives removing all existing information. Two options are available with a full installation:

- The default installation process configures the disk with the UFS file system, and loads the mandatory DIGITAL MLS+ software subsets.
- The custom installation provides the ability to customize file system layout and select optional software for installation. Mandatory and dependent subsets are automatically loaded.

License Management Facility (LMF)

DIGITAL's License Management Facility (LMF) provides on-line checking of software licenses and enables easier software management. LMF incorporates support for two types of licenses, availability and activity. LMF is limited to single node capability.

USER INTERFACES

Internet Interface

DIGITAL UNIX includes the Netscape Navigator Gold Version 3.4® World-Wide-Web browser. The software license for this bundled version of the Netscape Navigator Internet client is included with the DIGITAL UNIX base license.

User Environment

The user interface environment for DIGITAL MLS+ is DECwindows Motif, which is based on the X Window System, Version 11, Release 6 (X11R6), and Motif R1.2.5.

This environment consists of:

Window manager:	The Trusted Motif Window Manager (mwm) provides user control for managing windows.
Login manager:	The Trusted XDM login manager manages logins on the X server.
Session manager:	The session manager provides for application launching and customization of the X session.
Terminal emulation:	XTerm and Trusted DXTerm provide users with traditional character cell interfaces.
Additional applications:	Calculator, Calendar, Cardfiler, Clock, Mail.

Mail User Agents

In addition to the Trusted Multilevel Mail support described previously, MLS+ includes the standard DIGITAL UNIX mail agents including binmail, and MH.

DIGITAL MLS+ also supplies mail and mailx for character cell systems. The mailx/Mail system is compatible with SVID 2, XPG4, and the Berkeley Enhanced mailer (/usr/bin/ucbmail).

Motif

DIGITAL MLS+ includes the Trusted DECwindows Motif graphical user interface as previously described.

The Motif programming environment provides an extensive set of Window System libraries and tools for use by developers of new applications. Provided in both shareable and static versions, these libraries include:

- Motif Toolkit (Xm)
- Motif Resource Manager (Mrm)
- DIGITAL extensions to the OSF/Motif Toolkit (DXm)
- User Interface Language (UIL)
- User Interface Language Compiler (UIL)
- Widget Meta-Language Compiler (wml) and description files
- X Toolkit Intrinsics Library (Xt)
- X Library (Xlib)

In addition, DIGITAL MLS+ provides the OSF/Motif and X11 programming examples, which are intended as illustrations of various Motif and X11 programming techniques. Note that many of the examples are not fully implemented by the Open Software Foundation but do provide valuable programming information. A README file is included with each example and outlines the features and limitations of the particular application.

X Window System

X11R6

The X Window System, Version 11, Release 6 (X11R6) is supported in DIGITAL MLS+.

The following are new X Consortium standards in Release 6. DIGITAL MLS+ provides support for all of these to the extent that they are consistent with the DIGITAL MLS+ security policies:

- X Image Extensions (V5) - This is a complete implementation of full XIE 5.0 protocol, except for the following techniques that are excluded from the SI: ColorAlloc: Match, Requantize Convolve: Replicate Decode: JPEG lossless Encode: JPEG lossless Geometry:AntialiasByArea, AntialiasByLowpass.
- Inter-Client Communications Conventions Manual Update: - DIGITAL MLS+ supports version 2.0 of the ICCCM.
- Inter-Client Exchange Protocol and Library
- X Session Management Protocol and Library
- Input Method Protocol
- X Logical Font Descriptions (update)
- SYNC extension
- XTEST extension
- BIG-REQUESTS extension
- XC-MISC extension

X 11R6.1

In addition, DIGITAL MLS+ supports selected Release 6.1 (X11R6.1) features, including the X Keyboard extension (XKB) (version 0.65) and the double buffering extension (DBE).

Adobe Display Postscript System

In addition, DIGITAL MLS+ supports the Adobe Display PostScript System X server extension and client library.

- Display PostScript X server extension
- Display PostScript client library

The license to use the Adobe Display PostScript X server extension and client library is included with DIGITAL UNIX.

The Licensee agrees to only execute Display PostScript on those DIGITAL computer systems listed in the hardware support tables in this Software Product Description (SPD), licensee agrees not to make use of the Display PostScript software, directly or indirectly, to print bitmap images with print resolutions greater than 150 dots/per/inch (DPI), or to generate fonts or typefaces for use other than with the DIGITAL computer systems identified in this SPD. However, the foregoing limitation shall not be deemed to prohibit the printing of images of greater than 150 DPI resolution when such images are used solely for incidental or illustrative purposes.

FILE SYSTEMS

The DIGITAL MLS+ file system architecture is based on OSF/1 Virtual File System (VFS) which is based on the Berkeley 4.3 Reno Virtual File System. VFS provides an interface into files regardless of the file system in which the file resides.

DIGITAL MLS+ supports the following file system types as multi-level file systems:

- UNIX file System (UFS) – based on the Berkeley Fast File System
- Network File System (NFS) – using Trusted NFS protocol
- Memory File System (MFS)
- File-on-File Mounting File System (FFM)

DIGITAL MLS+ supports the following file system types as single-level file systems:

- UNIX File System (UFS) – based on the Berkeley Fast File System
- POLYCENTER Advanced File System (AdvFS)
- Network File System (NFS) – using NFS V2 or NFS V3 protocols
- ISO 9660 Compact Disk File System (CDFS)

DIGITAL MLS+ supports the following file system types as labeled file systems with all access protected by privilege:

- /proc File System

File system limits are documented in the DIGITAL UNIX Release Notes.

POLYCENTER Advanced File system

The POLYCENTER Advanced File System (AdvFS) is a journaled, local file system that provides higher availability and greater flexibility than traditional UNIX file systems. Using transaction journaling AdvFS recovers file domains in seconds rather than hours after an unexpected restart such as a power failure. AdvFS journaling also provides increased file system integrity. AdvFS provides greater flexibility by allowing filesets (file systems) to share a single storage pool, and enabling hard and soft fileset quotas in addition to user and group quotas.

The right to use the POLYCENTER Advanced File System is granted by the DIGITAL UNIX Operating System license. In addition, a separately licensed, optional layered product, the POLYCENTER Advanced File System Utilities, can be ordered. Refer to the OPTIONAL SOFTWARE section of this SPD for more information.

UNIX File System (UFS)

UFS is compatible with the Berkeley 4.3 Tahoe release.

Network File System (NFS)

DIGITAL MLS+ provides a Trusted NFS server and client protocol which is based on NFS V2 (described below). The Trusted NFS protocol allows transparent file access over TCP/IP networks to labeled (multi-level) file systems.

DIGITAL MLS+ NFS V2 allows transparent file access over TCP/IP networks to unlabeled file systems. In addition, the Network Information System (NIS), formerly Yellow Pages (YP), is provided for centralized system management of files. The automounter service automatically mounts and unmounts NFS file systems. The NFS locking service allows advisory and record locks to be used with remotely mounted files. All mounts done using DIGITAL MLS+ NFS V2 must be single-level mounts.

An NFS V3 server and client protocol implementation is provided in addition to V2. NFS V3 can only be used to provide access to unlabeled file systems. NFS V3 includes 64-bit support for file access, exclusive create semantics, negotiable transfer sizes, safe asynchronous writes, added support for access checking and other changes designed to increase efficiency and performance. All mounts done using DIGITAL MLS+ NFS V3 must be single-level mounts.

NFS file systems can use either the UDP or TCP transport protocols.

Network Lock Manager (NLM) V4 includes support for files larger than 2 GB. Support for additional over-the-wire error code is also provided. NLM V3 is supported for NFS V2 compatibility.

Memory File System (MFS)

The DIGITAL MLS+ MFS is a memory-based UFS. The MFS has the same file system structure as the UFS, but resides in virtual memory. No permanent file structures or data are written to disk, so the contents of an MFS file system are lost on reboot, unmount, or power failure. An MFS is useful for temporary files or for read-only files that are loaded into it after it is created.

ISO 9660 Compact Disk File System (CDFS)

The DIGITAL MLS+ implementation of CDFS is based on ISO 9660, a standard for a volume and file structure for the interchange of information using CD-ROM. DIGITAL MLS+ CDFS is based on the following levels of ISO 9660:

- Level 2 of Interchange
- Level 1 of Implementation, which enables the user to:
  - Mount single volume CD-ROMs which are formatted in compliance with ISO 9660, 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
  - Support the High Sierra Group extensions which provide compatibility with older format CD-ROMs

CDFS also supports CD-ROMs recorded using the Rock Ridge Interchange Protocol, Revision 1.09, August 1991. Rock Ridge specifies the use of the extension fields that are defined by ISO 9660:1988, and it uses those extensions to provide the following information:

- File owner, file group, file permissions
- Additional file types (symbolic links, device special files, named pipes)
- setuid, setgid, and sticky bits
- Hard link counts

- POSIX file names (mixed case names, unstructured names, and longer names than ISO-9660:1988 allows)
- Deep directory hierarchies (greater than 8 levels)
- File time stamps

XCDR extensions - X/Open Preliminary Specification (1991) CD-ROM Support Component (XCDR)

XCDR extensions allow users to examine selected ISO 9660 attributes through defined utilities and shared libraries. In addition, functionality is provided to allow a system administrator to substitute different file protections, owners, and file names for CD-ROM files.

File-on-File Mounting File System (FFM)

The File-on-File Mounting File System (FFM) allows regular, character, or block-special files to be mounted over regular files, and is primarily used by the SVR4-compatible system calls fattach and fdetach of a STREAMS-based pipe (or FIFO).

File-Based Pipes

A file-based pipe implementation replaces the socket-based pipes implementation for improved performance.

/proc File System

The SVR4-compatible /proc file system for DIGITAL MLS+ allows running processes to be accessed and manipulated as files by ordinary system calls, open, close, read, write, seek and ioctl.

Logical Storage Manager (LSM)

DIGITAL MLS+ Logical Storage Manager (LSM) is an integrated host-based solution to data storage management. Basic LSM functionality, including disk spanning and concatenation, is provided with the base operating system. Additional features, including disk striping, mirroring, and a graphical user interface, are available with a separate license. LSM is RAID Advisory Board (RAB) certified for RAID Levels 0 and 1. Refer to the OPTIONAL SOFTWARE section of this SPD and the LSM SPD for more information.

A migration utility allows LVM users to migrate their LVM volumes to LSM. This utility will be retired in the next major release of the operating system.

NETWORKING

TCP/IP

DIGITAL MLS+ allows for TCP/IP network communications over supported network devices. The TCP/IP protocol suite is implemented in the socket framework.

Sockets

DIGITAL MLS+ provides sockets that are based on the Berkeley UNIX Operating System structure, which provides a framework for I/O over a network.

STREAMS

DIGITAL MLS+ provides SVR4-compatible STREAMS. Like sockets, STREAMS provides a framework for character I/O to and from user space to kernel networking protocols.

X/Open Transport Interface (XTI)

X/Open Transport Interface (XTI) is an extension to the System V STREAMS user space interface called Transport Level Interface (TLI). This interface is thread-safe.

Data Link Bridge (DLB)

Digital MLS+ provides a DLPI-compatible interface into the non-STREAMS (BSD) driver environment. This interface does not support complete DLPI semantics. The DLB interface is the preferred interface for STREAMS modules to access the BSD-based datalink services.

screend

When the system is operating as an IP router, screend provides flexible per-packet access controls for forwarded packets. This can be used as part of a comprehensive network security plan. DIGITAL MLS+ also provides interface access filtering to reinforce the system security against IP spoofing attacks.

Packetfilter

The Packetfilter is a software interface that allows an application to send and receive packets directly to or from a LAN (Ethernet or FDDI). The Packetfilter provides flexible demultiplexing (filtering) of incoming packets, so that many such applications can run simultaneously.

The DIGITAL MLS+ Packetfilter supports two filtering models: the CMU/Stanford model, as supported in ULTRIX, and the BSD Packet Filter (BPF), which provides more flexible and efficient filtering. BPF was

developed by the University of California, Lawrence Berkeley Laboratory.

Several public domain applications that use the Packetfilter are integrated in Digital MLS+ including rarpd, tcpdump, tcpslice, nfswatch, and nfslogsum.

Data Link Interface (DLI)

DIGITAL MLS+ provides a Data Link Interface to allow applications to directly use the data link layer services in order to interact directly with the network device drivers.

Simple Network Management Protocol (SNMP)

The SNMP agent allows management of the Internet, FDDI, system resources, and network resources using the SNMP. The agent is extensible, allowing software developers to add Management Information Bases (MIBs) to the agent and to participate in the SNMP.

The SNMP agent contains the following base system functionality:

- Full SNMP V1.0 agent capabilities
- MIB implementations for managing Internet MIB-2 objects, FDDI objects, and Token Ring objects

Point-to-Point Connections

The DIGITAL MLS+ system supports point-to-point connections using Serial Line Internet Protocol (SLIP) and Point-to-Point Protocol (PPP). These interfaces are only supported with single-level endpoint host entries. The PPP subsystem is asynchronous and supports only IP. It provides authentification with Password Authentification Protocol (PAP) and Cryptographic Authentification Protocol (CHAP).

Open Network Computing (ONC)

DIGITAL MLS+ supports Open Network Computing (ONC) V4.2 including: Network File System V2 and V3, PCNFSd, Lock Manager, Status Monitor, NFSportmon, Network Information Service (NIS), automount, and user level RPC.

Asynchronous Transfer Mode (ATM)

The Digital MLS+ Asynchronous Transfer Mode (ATM) subsystem supports the ATM Forum's User-Network Interface (UNI) V3.0 and V3.1 specifications, including the Interim Local Management Interface (ILMI) protocol for registration of up to 32 addresses per interface, UNI signaling for point-to-point connections, and best effort and CBR VCs for AAL5 PDUs. Also, per-VC cell pacing (to limit the rate at which an end-system transmits) is supported.

In addition, the ATM subsystem supports Classical IP (RFC 1577) including support for multiple IP subnets, per-VC MTU negotiation, and Packetfilter access (for filtering incoming packets only (RPC 1577). Lastly, DIGITAL MLS+ supports the ATM Forum's Emulation specification (for IP unicast/broadcast packets only).

DIGITAL MLS+ does not support the UNI V3.0 and V3.1 specifications for full ATM Simple Network Management Protocol (SNMP) Management Information Bases (MIBs), point-to-multipoint connections, Operations and Maintenance (OAM**)** flows, VBR VCs, AAL1, AAL3/4, or raw AAL

Fast Ethernet

DIGITAL MLS+ supports Fast Ethernet (IEEE 802.3 100Base-TX. Hardware options supported by DIGITAL MLS+ are listed in the Hardware Tables at the back of this SPD.

Fiber Distributed Data Interface (FDDI)

DIGITAL MLS+ provides FDDI fiber optic support is based on all relevant ANSI and IEEE standards. Hardware options supported by DIGITAL MLS+ are listed in the Hardware Tables at the back of this SPD.

Token Ring

DIGITAL MLS+ supports Token Ring (IEEE 802.5) with source routing support for multi-ring networks. Hardware options supported by DIGITAL MLS+ are listed in the Hardware Tables at the back of this SPD.

IP Multicast

DIGITAL MLS+ supports the Level 2 end-system IP Multicast functionality, specified in RFC 1112, on Ethernet and FDDI. The implementation provides integrated multicast address management for multi-protocol environments.

The DIGITAL MLS+ implementation also provides kernel routines for encapsulating IP tunnels to enable wide area IP Multicast routing.

These routines include kernel code from public domain Multicast support Version 3.5 and mrouted (Version 3 Copyright 1989 by the Board of Trustees of Leland Stanford University), which provides the Distance Vector Multicast Routing Protocol (DVMRP).

Name Services

DIGITAL MLS+ supports the Domain Name System as described in RFC 1034 and RFC 1035, providing a host name and address lookup service for the Internet network.

The DIGITAL MLS+ implementation of the Domain Name System is based on BIND Version 4.9.3. The user can use BIND to supplement the host's database.

DIGITAL MLS+ also supports the Sun® Network Information Service (NIS), formerly known as Yellow Pages (YP). NIS can be used to replace or supplement hosts, aliases, group, networks, password, protocols, rpc, and services databases.

Network Time Protocol (NTP)

DIGITAL MLS+ provides the Network Time Protocol (NTP) V3 to synchronize and distribute the time for all machines in a network environment. The time synchronization daemon, xntpd, is used to distribute time to all machines in a network.

Time Synchronization Protocol (TSP)

DIGITAL MLS+ provides Berkeley's Time Synchronization Protocol (TSP) to synchronize the time of all machines in a network without ensuring the accuracy of the time that is provided.

Local Area Transport (LAT)

DIGITAL MLS+ provides a STREAMS-based implementation of the Local Area Transport (LAT) that serves terminals to one or more service nodes on a local area network (LAN). LAT allows a host to function as both a service node and a server node. It also enables host applications to initiate connections to server ports (designated as application ports) to access remote devices such as printers.

RFC Standards

Except where there is conflict with CMW and/or "Orange Book" security policies, The DIGITAL MLS+ Operating System implements the following Internet RFC (Request for Comment) and Non-RFC standards:

RFC	Protocol	Name
678	_____	Standard File Formats
768	UDP	User Datagram Protocol
791	IP	Internet Protocol as amended by RFCs 922 and 950
792	ICMP	Internet Control Message Protocol
793	TCP	Transmission Control Protocol
821	SMTP	Simple Mail Transfer Protocol
822	MAIL	Format of Electronic Mail Messages
826	ARP	Address Resolution Protocol
854	TELNET	Telnet Protocol
855	_____	Telnet option specifications
856	_____	Telnet binary transmission
857	_____	Telnet echo option
858	_____	Telnet Suppress Go Ahead option
859	_____	Telnet status option
868	TIME	Time Protocol
893	_____	Trailer Encapsulations
894	IP-E	Internet Protocol on Ethernet Networks
903	RARP	Reverse Address Resolution Protocol
904	EGP	Exterior Gateway Protocol
919	_____	Broadcast Datagram over IP
922	_____	IP Broadcast Datagrams with Subnets
950	_____	IP Subnet Extension
951	BOOTP	The Bootstrap Protocol
954	RPC	NICNAME/WHOIS (Obsoletes RFC 812)
959	FTP	File Transfer Protocol
1014	XDR	External Data Representation
1034, 1035	DOMAIN	Domain Name System
1042	IP-IEEE	Internet Protocol on IEEE 802
1049	_____	Content-Type Field for Internet Messages
1050	RPC	Sun Remote Procedure Calls
1055	SLIP	Serial Line Internet Protocol
1057	_____	Portmapper
1058	RIP	Routing Information Protocol
1094	NFS	Network File System Protocol
1112	_____	Host Extensions for IP Multicast
1116	_____	Telnet Line Mode Option
1119	NTP	Network Time Protocol minus authentication
1122	_____	Requirements for Internet Hosts Communication Layers (Must Level)
1123	_____	Requirements for Internet Hosts Applications and Support (Must Level)
1144	CSLIP	Compressing TCP/IP Headers for Low-Speed Serial Links
1155	SMI	Structure of Management Information
1156	MIB	Management Information Base
1157	SNMP	Simple Network Management Protocol
1188	IP-FDDI	Transmission of IP over FDDI (Obsoletes RFC 1103)
1191	_____	Path MTU Discovery (router specification, host specification (TCP only))

1212	_____	Concise MIB definitions
1213	MIB-II	Management Information Base II (supersedes RFC 1158 and 1156)
1225	POP3	Post Office Protocol, Rev. 3
1231	_____	IEEE 802.5 Token Ring MIB (set operations are not supported)
1253	_____	OSPF Version 2 Management Information Base
1256	_____	Router Discovery Messages
1282	_____	BSD rlogin
1285	_____	FDDI Management Information Base (set operations are not supported)
1288	FINGER	Finger Protocol (obsoletes RFC 1196)
1305	NTP	Network Time Protocol V3.0
1321	MD5	The MD5 Message Digest Algorithm
1323	TCP-HIPER	TCP Extensions for High Performance (Window Scale option only)
1332	IPCP	The PPP Internet Protocol Control Protocol (obsoletes RFC 1172)
1334	PAP/ CHAP	PPP Authentication Protocols
1350	TFTP	Trivial File Transfer Protocol (obsoletes RFC 783)
1483	_____	Multiprotocol Encapsulation over ATM AAL5 (routed protocol encapsulation only)
1497	BOOTP	BOOTP Vendor Information Extensions (obsoletes RFC 1048, 1084, 1395; updates RFC 951)
1514	_____	Host Resources MIB (set operations are not supported)
1518	_____	An architecture for IP Address Allocation with CIDR
1521	_____	MIME support as stated in Appendix A of this RFC
1533	_____	DHCP options and BOOTP vendor extensions
1534	_____	Interoperation between DHCP and BOOTP
1541	_____	Dynamic Host Configuration Protocol
1542	_____	Clarifications and Extensions for the Bootstrap Protocol (obsoletes RFC 1532; updates RFC 951)
1547	IS-PPP	Requirements for an Internet Standard Point-to-Point Protocol
1571	_____	Telnet Environment Option Interoperability Issues
1572	_____	Telnet Environment Option
1577	_____	Classical IP over ATM
1583	OSPF	OSPF V2 (obsoletes RFC 1247)
1589	_____	A Kernel Model for Precision Time-keeping (the support to discipline the system clock to an external precision timing source is not supported)
1626	_____	Default MTU for IP over ATM
1661	PPP	The Point-to-Point Protocol (obsoletes RFCs 1548,1331, and 1171) (asynchronous IP only)
1700	_____	Assigned Numbers (obsoletes RFC 1340, and so forth)
1755	_____	Signaling for IP of ATM
1813	NFS	Network File System Version 3 Protocol
1953	_____	Ipsilon Flow Management Protocol Specification for IPv4
1954	_____	Transmission of Flow Labeled IPv4 on ATM Data Links

Non-RFC Standards

- 4.3BSD and 4.4BSD Socket Interface
- 4.3BSD inetd
- 4.3BSD lpd
- 4.3BSD netstat
- 4.3BSD ping
- 4.3BSD rcp
- 4.3BSD rexecd
- 4.3BSD rlogin
- 4.3BSD rmt
- 4.3BSD rsh
- 4.3BSD Sendmail V5.65 with IDA enhancements
- 4.3BSD syslog
- uucp Basic Networking Utilities (HoneyDanBer)
- X/Open Transport Interface (XTI)
- Sun Open Network Computing (ONC) 4.2
- New rdist command packaged as optional nrdisk
- BSD Packet Data Compression (for PPP)

DEVELOPMENT ENVIRONMENT

DEC Fortran Run-Time Libraries

The DEC Fortran run-time support libraries (libfor, libfutil, libUfor) enable users to run previously compiled programs that require the DIGITAL Fortran libraries at run-time. These libraries support Fortran program function areas including input and output, intrinsic functions, data formatting, data conversion, miscellaneous math functions, Fortran bindings to common operating system services, and more.

DEC C++ Run-Time Libraries

The DEC C++ run-time support libraries (libcxx, libcomplex, libtask) are provided to enable users to run previously compiled applications containing DEC C++ code, without requiring DEC C++ installed on the target system. These libraries support DEC C++ program functions in areas including input and output, complex arithmetic, multitasking, and more.

DEC COBOL

The DEC COBOL run-time support libraries (libcob, libots2, libisamstub) are provided to enable users to run previously compiled programs which require the DEC COBOL libraries at run-time. These libraries support COBOL program functions in areas including file input and output, decimal arithmetic, COBOL ACCEPT/DISPLAY statements, STRING/UNSTRING operations, CALL and CANCEL, and more.

DEC Pascal Run-Time Libraries

The DEC Pascal run-time support libraries (libpas.a, libpas.so, and libpas_msg.cat) are provided to enable users to run previously compiled programs which require the DEC Pascal libraries at run time. These libraries support DEC Pascal program functions in areas including input and output, miscellaneous math functions, time and date services, miscellaneous file services, and more.

DIGITAL Portable Math Library

The DIGITAL Portable Math Library (DPML) is a common math library for FORTRAN, C, and Pascal. It provides IEEE single and double floating-point support.

Memory-Mapped File Support

DIGITAL MLS+ supports the Berkeley mmap function and, therefore, allows an application to access data files with memory operations rather than file input and output operations.

Shells

DIGITAL MLS+ provides the following shells:

- POSIX shell
- C shell
- Bourne shell from System V
- Korn shell

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

Dynamic Loader

DIGITAL MLS+ uses an SVR4-compatible loader to dynamically load shared libraries. This loader provides SVR4 symbol resolution semantics, including symbol preemption.

The COFF object file format is supported for all forms of object files.

Loadable Subsystems Framework

DIGITAL MLS+ includes configuration manager framework, which allows dynamic loading (and configuring) of kernel subsystems. The framework, composed of a configuration manager daemon (cfgmgr), a kernel loader daemon (kloadsrv), a system configuration database (sysconfigtab), and its management utility (sysconfigdb), allows kernel modules (such as device drivers) to be loaded after the system is booted.

Foreign Device Boot Support

DIGITAL MLS+ provides the ability for device driver developers to build and deliver single binary drivers that work at installation time. This allows the device to be used during the installation process. This ability is currently only supported for graphics device drivers.

Loadable Drivers Framework

Device driver suppliers may now dynamically load their drivers into the kernel using the configuration manager framework. Functions provided to facilitate integration of third-party device support include:

- Autoconfiguration support
- Interrupt registration support
- Installation support
- Loadable driver support for the following buses:
- TURBOchannel
- EISA
- ISA
- PCI
- SCSI peripheral devices
- VMEbus

Common Access Method (CAM)

Common Access Method (CAM) is an ANSI standard for the software drivers that provide the interface between an operating system and a SCSI device. The DIGITAL MLS+ CAM implementation is highly compatible with ANSI X3.131-1986, Level 2 and supports SCSI-2 based CAM.

HARDWARE REQUIREMENTS

The DIGITAL MLS+ Operating System can execute on valid Alpha systems and must include the minimum system configuration outlined below**.** The actual amount of work supported at one time, with good performance, depends on the types of processing performed as well as on the physical memory and secondary storage available.

- DIGITAL MLS+ requires the minimum component of main memory to be 64 MB.
- Based on testing, system configurations are limited to 256 physical volumes (disks). The maximum logical volume size supported is 512 GB.
- DIGITAL MLS+ requires a system disk capable of holding the supported software subsets. For a Default Installation (mandatory subsets only), a minimum of 425MB disk (such as RZ25) is required. For a Custom Installation selecting all BASE software subsets, a 680MB disk (such as RZ56) is required.
- Systems which have more subsets installed than the Default Installation, but fewer subsets than the Custom Installation selecting all BASE software subsets will require varying minimum disk space for an installation. Refer to the Installation Guide for a list of subset sizes to help determine the disk space requirements for an installation on such systems.
- DIGITAL MLS+ supports the backup devices listed in the OPTIONAL HARDWARE section of this SPD.
- The supported load devices include CD-ROM readers (such as RRD44) or a variety of network interfaces.
- Installation of service updates will require either a 4mm tape device or the capability to download from an external network.
- DIGITAL MLS+ System Administration requires a DIGITAL graphics display console (minimum 800 x 600) for Alpha systems. On a networked DIGITAL MLS+ system, the graphics display may be on a remote system but, in this case, one console terminal with ASCII capability must be locally attached.

OPTIONAL HARDWARE

Additional memory and/or secondary storage may be required depending upon the usage of the DIGITAL MLS+ Operating System software and/or optional software products.

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

System configuration details are described in the DIGITAL *Systems and Options Catalog*. This is located at: http://www.digital.com/info/SOC/

Hardware options supported by DIGITAL MLS+ are listed in the Hardware Tables at the back of this SPD. All device drivers contained in DIGITAL MLS+ for these hardware units are warranted by DIGITAL.

SUPPORTED HARDWARE

The hardware tables in this Software Product Description list supported hardware for DIGITAL MLS+. The content of this section is intended to provide a general guide. It does not describe all possible hardware configurations or circumstances. Any particular configuration should be discussed with Compaq. Contact Compaq for the most up-to-date information on possible hardware configurations.

Compaq reserves the right to change the number and type of devices supported by DIGITAL MLS+. For configuration details about Alpha systems, refer to the DIGITAL *Systems and Options Catalog* located at: http://www.digital.com/info/SOC/

Embedded and Real-Time Boards

An embedded and real-time OEM is a hard goods/capital equipment manufacturer that utilizes Compaq's products embedded in the OEM's own products. The Compaq products act as specialized controllers of specific functions in the OEM's product, not as a general-purpose computer.

Compaq products may be physically embedded within the OEM's product (for example, a CPU board and software inside a telephone switch) or may be functionally integrated into the solution (for example, a system box and software controlling a flight simulator). The Compaq product is perceived by the end customer to be an integral and dedicated component of the Embedded and Real-time OEM's product, NOT a general-purpose computer.

Symmetric Multiprocessing (SMP)

Symmetric multiprocessing (SMP) enables systems with two or more processors to execute the same copy of the operating system, access common memory, and execute instructions simultaneously. The SMP functionality fully exploits the additional compute capabilities of multiple processors. Capabilities include:

- Multiple threads from the same or different tasks can run concurrently on different processors.
- Process Affinity - Allows binding a process to a specific processor.

- Unattended Reboot - On a hard failure of a non-boot processor, the operating system tags the failing CPU and reboots the system, without enabling the defective CPU.
- Stop/Start CPU - Ability to stop and start a specified non-boot processor.
- Processor Sets - Ability to dedicate a process, or set of processes, to a specific processor or set of processors. Can also be used to partition the available processors among a set of users.

PC Card Support

DIGITAL MLS+ provides PCMCIA (PC Card) support for the following platforms:

- AlphaStation 200, 255, 400, 600
- AlphaServer 1000
- Personal Workstation au models

The support is limited to the following capabilities:

- Support of supplied ISA to PCMCIA adapters
- Support of fax/modem PC cards:
- The Megahertz XJ2288 is the only modem card fully qualified on DIGITAL UNIX. Other modem cards of similar type may work.
  - MEGAHERTZ XJ2288
  - MEGAHERTZ XJ1144
  - AT&T Paradyne KeepinTouch Card
  - DIGITAL PCMCIA V3.2bis 14,400 Fax
- Hot swap capability of PC cards

OPTIONAL SOFTWARE

DIGITAL UNIX Developers' Toolkit

The DIGITAL UNIX Developers' Toolkit includes the DEC C compiler and provides developers with a number of development tools that speed and simplify application development. The Developers' Toolkit includes tools for debugging, memory leak detection and analysis, linking and link management, profiling and performance monitoring, source code control, and other development tools traditionally associated with DIGITAL MLS+. This product is licensed separately from the DIGITAL MLS+ operating system. (SPD 44.36.xx)

Logical Storage Manager (LSM)

The DIGITAL UNIX Logical Storage Manager is an integrated, host-based solution to data storage management, providing concatenation, striping, mirroring, and a graphical user interface that allows data storage management functions to be performed online, without disrupting users or applications. (SPD 51.24.xx)

POLYCENTER Advanced System Utilities

The POLYCENTER Advanced File System Utilities extend the high availability and flexibility of AdvFS. The AdvFS Utilities provide on-line utilities to dynamically resize file systems, defragment files, balance percentage of space utilized on volumes, undelete files using trashcans, stripe files, and clone files for hot backup.

Note that DIGITAL MLS+ does NOT support the AdvFS Utilities Graphical User interface (GUI).

Prestoserve for DIGITAL UNIX

Prestoserve for DIGITAL UNIX is a disk write accelerator for disk block device write operations. This product is available on most Alpha systems. (SPD 35.11.xx)

GROWTH CONSIDERATIONS

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

DISTRIBUTION MEDIA

DIGITAL MLS+ is distributed on CD-ROM

ORDERING INFORMATION

The Digital MLS+ Operating System license provides a licensed user the right to use the software as described within this Software Product Description. Separate licenses are available for the right to use the development tools and the C compiler. Refer to the SPD for the DIGITAL UNIX Developers' Extensions (SPD 44.36.xx) for details.

A license for DIGITAL UNIX, either as part of a packaged system or ordered separately, is a prerequisite for DIGTAL MLS+.

DIGITAL MLS+ Operating System

Licenses:

Prerequisites: DIGITAL UNIX Operating System:

DIGITAL UNIX 2-User Base Licenses: QL-MT4A*-**

DIGITAL UNIX Software User Licenses: QL-MT7A*-**

DIGITAL MLS+ Operating System:

DIGITAL MLS+ U/A 2 User License: QL-0UNAE-BC (workgroup tier)

DIGITAL MLS+ U/A 3 To Unlimited: QL-0UNAE-BR (workgroup tier)

DIGITAL MLS+ U/A 2 User License: QL-0UNAG-BC (departmental tier)

DIGITAL MLS+ U/A 3 To Unlimited: QL-0UNAG-BR (departmental tier)

DIGITAL MLS+ Unlimited License: QL-0UNAQ-AA (Enterprise tier)

Software Product Services:

Prerequisites: DIGITAL UNIX Operating System

Software Product Services: QT-MT4A*-**/QT-MT7A*-**

DIGITAL MLS+ Operating System

Software Product Services: QT-0UNA*-**

Software Media Kit:

DIGITAL MLS+ : QA-0UNAA-H8

The software media kit includes CD-ROMs containing the operating system binaries and complete on-line documentation. Hardcopy start-up documentation is also included in the Media kit, including the Installation Guide and Release Notes.

Software Documentation

Full Documentation Kit (excluding Reference Pages): QA-0UNAA-GZ

The full Documentation Kit is a complete hardcopy documentation set for DIGITAL MLS+, including all end user, programmer, and system documentation.

The Software Media Kit contains versions of the documentation found online via the CD-ROM, as well as additional documentation published by companies other than DIGITAL.

Most documentation provided with DIGITAL MLS+ that is published by companies other than Compaq is available in hard copy only.

SOFTWARE LICENSING

The DIGITAL MLS+ Operating System software is furnished under the licensing of Compaq Computer Corporation's Standard Terms and Conditions.

There are four types of DIGITAL UNIX Operating System licenses available on Alpha processors. For more information on these licenses, please refer to the DIGITAL UNIX Software Product Description (SPD 41.61.xx).

SOFTWARE PRODUCT SERVICES

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

YEAR 2000 READY

This product is Year 2000 Ready.

Year 2000 Ready is defined: "Year 2000 Ready" products are defined by Compaq as products capable of accurately processing, providing, and/or receiving date data from, into and between the twentieth and the twenty-first centuries, and the years 1999 and 2000, including leap year calculations, when used in accordance with the associated product documentation and provided that all hardware, firmware, and software used in combination with such products properly exchange accurate date data with the products.

For additional information visit the DIGITAL Brand area on Compaq's Year 2000 web site located at: http://www.compaq.com/year2000/

To ensure that this product is Year 2000 Ready, the following testing process/methods were utilized:

- Code Inspection – All source code modules used to build this product were inventoried and inspected to ensure correct date handling for date data eyond the year 2000.
- System Date Handling – This product was tested to ensure that the system properly handles future time including but not limited to the following dates: December 31, 1999 to January 1, 2000 rollover; February 28, 2000; February 29, 2000; March 1, 2000; and January 1, 2001.
- Regression Testing – This product was tested using a comprehensive suite of regression tests for functional, performance, and standards compliance with system time set to future dates including dates in and beyond the year 2000.

To ensure that this product inter-operates properly with other hardware and software, the following testing process/methods were utilized:

- Year 2000 readiness was tested using supported hardware and firmware.
- This product has been tested for Year 2000 readiness while operating within a computer network of other systems.

- The Associated Products (shipped with the DIGITAL UNIX media kit) have been tested in conjunction with the operating system for Year 2000 readiness.

SOFTWARE WARRANTY

This software is provided by Compaq with a 90-day conformance warranty in accordance with the Compaq warranty terms applicable to the license purchase.

HARDWARE SUPPORT TABLES

The hardware options supported by DIGITAL MLS+ are listed in the following tables. These hardware options include information on systems and peripherals.

Table 1[1]
Supported AlphaServer Systems

ALPHASERVERS	MODEL	MODEL	MODEL	MODEL	MODEL
DEC 2000	300	500			
DEC 3000	300 300L 300X 300LX	400 400S 500 500S	500X 600 600S	700 800 800S	900
DEC 4000	6XX	7XX			
DEC 7000	6XX	7XX			
AlphaServer l000	4/200	4/266	5/300		
AlphaServer l000A	4/233	4/266	5/300	5/333	5/400 5/500
AlphaServer 2000	4/200	4/233	4/275	5/250	5/300 5/375
AlphaServer 2l00	4/200	4/233	4/275	5/250	5/300 5/375
AlphaServer 2100A	4/275	5/250	5/300		
AlphaServer 4000	5/300	5/300E	5/400	5/466	
AlphaServer 4100	5/300	5/300E	5/400	5/466	
AlphaServer 8400	5/300	5/350	5/440	5/625	

[1] Refer to the appropriate platform Systems and Options Catalog for system specific restrictions. http://www.digital.com/info/SOC/

Table 1a[1]
Supported Alpha Workstation Systems

ALPHA WORKSTATIONS	MODEL	MODEL	MODEL	MODEL	MODEL
AlphaStation 200	4/100	4/166	4/233		
AlphaStation 250	4/266				
AlphaStation 400	4/233	4/266			
AlphaStation 255	4/233	4/300			
Personal Workstation	433au	500au	600au		
Ultimate Workstation	533au				
AlphaStation 500	5/266	5/333	5/400	5/500	
AlphaStation 600	5/266	5/300	5/333		
AlphaStation 600a	5/500				

Table 1b[1]
Supported Boards and Components

BOARDS & COMPONENTS	MODEL	MODEL	MODEL	MODEL	MODEL
Embedded & Real-time Boards/Systems	AXPpci 33	AXPpci 33S	AXPvme 64 AXPvme 100 AXPvme 160 AXPvme 224 AXPvme 230	Alpha VME 4/244 Alpha VME 4/288 Alpha VME 5/352 Alpha VME 5/480	AlphaVME 2100 (190, 275 MHz)
Modular Computing Components	EBM43-AZ	EBM44-AZ	EBM21-AZ	EBM23-AZ	
Single Board Computers	EB66+ EB64+	EB164	AlphaPC 64	AlphaPC 164	AlphaPC 164/LX AlphaPC 164/SX

[1] Refer to the appropriate platform Systems and Options Catalog for system specific restrictions. http://www.digital.com/info/SOC/

Table 2[1]
Storage Device Support Table

CD-ROM Drives:	RRD42 RRD43	RRD44 RRD45	RRD46
Disks:	RZ24L RZ25 RZ25F RZ25L RZ25M RZ26 RZ26F RZ26L	RZ26N RZ28 RZ28B RZ28D RZ28L RZ28M RZ29B RZ29L RZ40 RZ55 RZ56 RZ57 RZ58	RZ73 RZ74 RZ1BB RZ1BC RZ1CB RZ1CC RZ1DB
Solid State Disks:	EZ31 EZ32	EZ51 EZ54 EZ58	EZ64 EZ69
Floppy Drives:	RX23	RX26	RX33
FDI Floppy Drives:	RX23	RX23L	
Tapes:	TLZ04 TLZ06 TLZ07 TLZ09 TLZ10 TKZ08 TKZ09 TKZ60	TKZ63 TSZ07 TZ30 TZ85	TZ86 TZ87 TZ88 TZ89 TZK10 TZK11 TZK20 TZS20
RAID Controllers:	HSZ10 HSZ20	HSZ22 HSZ40	HSZ50 HSZ70

[1] Refer to the appropriate platform Systems and Options Catalog for system specific restrictions. http://www.digital.com/info/SOC/

Table 3[1]
Network Adapters

DE203 (ISA Ethernet)	DGLPB
DE204 (ISA Ethernet)	DGLTA (TC ATM)
DE205 (ISA Ethernet)	DEFPA (PCI FDDI)
DE422 ((EISA Lance Ethernet)	DEFTA (TC FDDI)
DE425 (EISA Tulip Ethernet)	DEFZA (TC FDDI)
DE434 (PCI Ethernet)	DW110 (ISA Token Ring)
DE450 (PCI Ethernet)	DW300 (EISA Token Ring)
DE500 (PCI Fast Ethernet)	
DE506	
DE520 (PMC Fast Ethernet	
DEFAA (FBUS + FDDI)	PBXNP (PCI Token Ring)
DEFEA (EISA FDDI)[1]	PBXNP
DEFPZ	PBXDI
DEMFA (XMI FDDI)	PMAD (Thickwire Ethernet)
DEMNA (XMI Ethernet)	
DETRA (TC Token Ring)	
DGLPD (PCI ATM)	

Table 4[1]
CI Storage Controllers

HSC40	HSC70
HSC50	HSC90
HSC65	HSC95

[1] Refer to the appropriate platform Systems and Options Catalog for system specific restrictions. http://www.digital.com/info/SOC/

Table 5[1]
Storage Adapters and Controllers

CIXCD-AC (XMI CI)	KZPSA (PCI FWD)
KDM70 (XMI CI)	KZPSC (PCI RAID)
	KZPSM (PCI, 1 SCSI, 1Ethernet)
KZESC (EISA RAID)	KZTSA (TC FWD SCSI)
KZMSA (XMI)	P2SE (PCI, 2 SCSI, 1 Ethernet)
KZPAA (PCI)	
	PMAZB (TC Dual Slow SCSI)
KZPBA (PCI)	PMAZC (TC Dual Fast SCSI)
KZPDA(PCI)	

Table 6[1]
Miscellaneous Adapters

KFE70-AA (EISA Bridge)	
KFTIA (ITIOP)	

Table 7[1]
ATAPI Devices

Toshiba XM-5602B	
Toshiba XM-5702B	
Toshiba XM-6102B	

Table 8[1]
Graphic Subsystems

PB2GA-AA	PBXWT-A (CALCOMP DB III)
PB2GA-FX (ATI Mach 64 CX)	PMAGC-XX
	PMAGB
PB2GA-JX (TRIO 64 PCI Card)	PMAGB-BX
PBXGA-AX/BX/CX	PMAGB-JX
PBXGB-XX	PMAGD-XX
PBXGC-XX	TGA8M
PBXGK-XX (ELSA/Comet PCI)	ZLX-M-L
	ZLXP-L
	ZLXP-M

Table 9[1]

[1] Refer to the appropriate platform Systems and Options Catalog for system specific restrictions. http://www.digital.com/info/SOC/

DSA Disk Drives

RA60	RA81
RA71	RA82
RA72	RA90
RA73	RA92

Table 10[1]
DSA Tape Drives

TA78	TA90
TA79	TA91

Table 11[1]
DIGITAL Printers

DEClaser 1100	LN03R ScriptPrinter	
DEClaser 1150	LN17 ps	
DEClaser 2100		
DEClaser 2150		
DEClaser 2200		
DEClaser 2250		
DEClaser 3200		
DEClaser 3250		
DEClaser 3500		
DEClaser 5100		

[1] Refer to the appropriate platform Systems and Options Catalog for system specific restrictions. http://www.digital.com/info/SOC/

Table 12[1]
Asynchronous Terminals

VT100	VT240	VT340
VT102	VT300	VT420
VT200	VT320	VT510
VT220		

Table 13
Monitors

PC7XV-DE	VRC16-H4	VRCX1-W3/W4/WA
PC7XV-DG	VRC16-HX	VRCX5-W3/W4/WA
PCXAV-F	VRC16-H4/HA	VRM17
PCXBV-DE/DF/PC	VRC16-PA/P4	VRM20
VRC14-PA/P4	VRC17-W	VRTX7-W3/W4/WA
VRC15	VRC17-WA/W3/W4	VRT16
VRC15-KA/K4	VRC19	VRT17
VRC15-KX/WX	VRC21	VRT17-PA/P4
VRC15-PA/P4	VRC21-LA/L4	VRT17-PX/WX
VRC15-W	VRC21-LX/WX	VRT17-WA/W3/W4
VRC15-WA/W3/W4	VRC21-PA/P4	VRT17-WA/W3/W4
VRC16	VRC21-W	VRTX7-W3
VRC16-HA	VRC21-WA/W3/W4	VR319
		VR320

[1] Refer to the appropriate platform Systems and Options Catalog for system specific restrictions. http://www.digital.com/info/SOC/

Table 14[1]
Keyboards

PCXAL	LK47W
PCXAL-XX	LK450
LK401	LK461
LK411	LK46W
LK411-XX	LK471
LK421	LK471-XX
LK443	LK47W
LK444	LK97W
LK46W	

Table 15[1]
Mouse/Tablet

PBXAS-AA/AB (3 button)	
PBXWS-AA (3 button)	PCXLN-AD
PBXWS-WA (3 button)	VSXXX-AA
PBXWT-A (CalComp DB III)	VSXXX-AB
PC7XS-AA (2 button)	VSXXX-FA
PC7XS-CA (3 button)	VSXXX-GA

Table 16[1]
Modems

PCXBF-AA (2400/9600)	PCXDF-AA/BA (FAX/Modem)
PCXCF-AA (9600/9600)	DF02
PCXDF-AA (14400/9600)	DF03
PCXDF-BA	DF296

[1] Refer to the appropriate platform Systems and Options Catalog for system specific restrictions. http://www.digital.com/info/SOC/