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Part 2: Posix® Realtime Application Support (AEP)

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Partie 2: Support d'application en temps réel POSIX® (AEP)

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Abstract: This standard is part of the POSIX® series of standardized profiles for open systems. It defines environment profiles for portable realtime applications.

Keywords: AEP, application portability, data processing, environment, open systems, operating system, portable application, POSIX profiles, realtime application environments, realtime environment

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— *Part 1: PSE 10-HIP — Posix Supercomputing Application Environment Profile*

— *Part 2: Posix® Realtime Application Support (AEP)*

Annexes A and B form a normative part of this part of ISO/IEC ISP 15287. Annex C is for information only.

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Introduction

The purpose of this standard is to define realtime application environments based on the ISO/IEC 9945 series of standards. It is intended for realtime systems implementors and realtime applications software developers.

This standard is designed to support building systems where not all the interconnected boxes use the same profile, for example, a hierarchical system where the bottom-level device controllers use the "minimal" profile, the next level up follows the larger "control" profile, and so on. There are interfaces called out for the smaller profiles that make no sense in an isolated box; those interfaces are there solely to support the construction of heterogeneous systems, and systems of communicating peers. Such systems are very common in practice.

To summarize, this standard is embedded in a much larger and widely supported set of standards, which yields benefits during code development, as much development and testing is done on the larger and more comfortable systems. It also may be used in the construction of large and heterogenous systems.

Four profiles have been defined to reflect the wide range of system requirements presented by realtime designs. The intent is to provide a meaningful and coherent set of interfaces that will provide software vendors and consumers with a uniform framework for describing and specifying operating system capabilities. This allows an application writer to construct an application that may be easily moved to a different system that supports the same profile. Similarly, it allows a vendor to claim conformance with an established standard, even if that vendor's implementation does not support the full POSIX feature set.

Initially, the focus of this standard is to provide standardized environments supporting the C language. Options are provided for bindings to the Ada programming language as well as for the C language. Bindings for other languages to these services may be developed and this standard will be updated as appropriate.

Within this document, the term "POSIX/RT-AEP" refers to this standard.

Organization of This Part of IEEE Std 1003.13-1998 (POSIX.13)

This standard is divided into eight elements:

(1) General (Section 1)

(2) Normative references (Section 2)

(3) Definitions (Section 3)

(4) Conventions and abbreviations (Section 4)

(5) Conformance (Section 5)

(6) The various realtime profiles (Sections 6 through 9)

(7) ISPICS requirements (C) (Annex A)

(8) ISPICS requirements (Ada) (Annex B)

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References are used to direct the reader to other related sections.

Informative annexes are not part of the standard and are provided for information only. They are provided for guidance and to facilitate understanding.

In publishing this standard, the developers simply intend to provide a yardstick against which various realtime application environments can be measured for conformance. It is not the intent of the developers to measure or rate any products, to reward or sanction any vendors of products for conformance or lack of conformance to this standard, or to attempt to enforce this standard by these or any other means. The responsibility for determining the degree of conformance or lack thereof with this standard rests solely with the individual who is evaluating the product claiming to be in conformance with this standard.

Base Documents

The various realtime application environments described herein are based on the ISO/IEC 9945 and IEEE 1003 family of documents as well as ISO 9899, 1539, 8652, and 8859.

Scenario

This standard is based directly on existing small and/or realtime (typically non-UNIX™) kernel practice as well as the growing body of practice with POSIX conformant kernels having realtime features. The general approach taken in this standard is to specify interfaces, taken from POSIX, sufficient to deliver the functionality typical of current realtime systems, (see Table 1-19 through Table 1-27).

Each profile is specified with full features, to give users clear direction. Vendors may provide means to configure out those parts that are not needed by specific applications. Vendors wishing to expand on the specified profiles are strongly encouraged to take the added interfaces from other POSIX.13 profiles or from the base standards, rather than invent new interfaces.

For each profile, the minimum hardware typically required is specified. This is the hardware assumed to be present; implementations may, of course, have more, but nothing in the profile requires—either directly or indirectly—more than the specified minimum hardware model.

Audience

The intended audience for this class of profiles is all persons concerned with an industry-wide standard realtime application environment based on the POSIX suite of standards. This includes at least four groups of people:

(1) Persons buying hardware and software systems.

(2) Persons managing companies that are deciding on future corporate computing directions.

(3) Persons implementing realtime operating systems.

(4) Persons developing realtime applications where portability is a primary objective.

Background

The developers of POSIX/RT-AEP represent a cross section of hardware

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manufacturers, vendors of operating systems and other software development tools, software designers, consultants, academics, authors, applications programmers, and others. In the course of their deliberations, the developers reviewed related U.S. and international standards, both published and in progress.

Conceptually, POSIX/RT-AEP describes a set of application environment profiles needed for the construction and execution of portable realtime application programs.

The developers of this standard have tried to capture the functionality of existing realtime systems in a reasonable number of profiles that specify predominate application environments. It is felt that these profiles, although not optimum, are a best fit to existing classes of applications and systems.

Features of several commercial realtime kernels were considered. These included **pSOS**™[1], **VRTX32**™[2], and **VxWorks**™[3]. Since these products were commercially successful, they must have addressed a significant market segment. In addition, the uniprocessor subset of VITA's **ORKID** specification, NGCR's "***Tiny Real Time***" (TRT), and the **uITRON** specification were examined. These were proposed standard interfaces for small realtime embedded systems.

The following is a list of features that are representative of current realtime systems and highlights the range of system requirements. While some concepts are common to virtually all implementations (e.g., preemptive, priority-based scheduling), some only apply to smaller systems (e.g., a single address space), and some only to more full-featured systems (e.g., network support, self-hosting).

Basic Realtime Multitasking and Synchronization

— Multiple flows of control

— Preemptive priority scheduling of flows of control

— One address space for all flows of control

— Direct control of location of memory areas

— Inter-thread communications mechanism via message passing (queues)

— Binary and counting semaphores, without priority inheritance

— Mutual exclusion, with optional priority inheritance

— Local or global event flags (one thread awaits multiple things)

— Multiple memory areas, with both fixed- and variable-sized blocks allocation policies

— System time in units of clock ticks

— Timeouts on all blocking services in units of clock ticks

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2) **VRTX32** *is a registered trademark of Micro Research, Inc.*

3) **VxWorks** *is a registered trademark of Wind River Systems, Inc.*

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— Hardware interrupt control and support for user interrupt handlers

— Signals

— Exception handling

— Minimal synchronous I/O interface: *open*(), *close*(), *read*(), *write*(), *ioctl*()

— Debugger interface

— No memory protection

— Application runs in privileged (supervisor) mode, if applicable

— Direct I/O, rather than via kernel

— System executable size and memory requirements are major constraints

I/O

Realtime systems supporting I/O generally provide the following features:

— Named I/O devices

— Support for serial I/O lines

— Pipes

— Installable user device drivers

— Memory mapped I/O

Local File System

Realtime systems supporting a file system generally provide the following features:

— Named files

— Hierarchical filesystem (directories)

— Contiguous preallocation of disk space

— May provide media compatibility with another filesystem (e.g. **MS-DOS**™[4] or **RT-11**™[5])

— No user IDs or file protection

Historically, filesystems for embedded realtime systems typically have had a one-level name space, contiguous allocation of disk space, and relatively short filenames. They have not supported an arbitrary hierarchy of named directories, non-contiguous allocation of disk space, or long filenames. They may have had numbered directories (e.g. **RSX-11M**™[6]), or only contiguous allocation of disk space (e.g. **RT-11**™).

However, recent commercial offerings have supported multilevel named directories and both contiguous and non-contiguous disk space allocation. In these implementations, the support of these features with potentially non-

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4) **MS-DOS** *is a registered trademark of Microsoft Corporation.*

5) **RT-11** *is a registered trademark of Digital Equipment Corporation.*

6) **RSX-11M** *is a registered trademark of Digital Equipment Corporation.*

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deterministic performance does not preclude an application from restricting itself to features with deterministic performance. For example, it is still possible to use contiguous files exclusively. Because it is relatively easy to implement both, and need not interfere with deterministic performance, the working group did not make a distinction between realtime and time-sharing filesystems in this AEP.

Traditional implementations of POSIX.1 filesystems employ a disk buffer cache to improve performance by reducing the number of physical media accesses, and by reordering the accesses to take advantage of the characteristics of rotating media. These implementations have not made a distinction between the buffering of data transfers [*read*() and *write*()], and directory operations [*creat*(), *link*(), *unlink*(), *mkdir*(), *rmdir*(), *rename*()]. A result of this is that a system crash at an unexpected moment can leave the filesystem in a corrupted state. This situation is usually corrected at the next system reboot by a filesystem checker and recovery program, such as *fsck*(). The checking and correcting of a corrupted filesystem may take a long and variable amount of time to perform, and may require a human operator to monitor its progress. Either of these characteristics would make a filesystem check unacceptable for some embedded realtime applications. It was suggested therefore, that such applications limit their use of directory operations to *safe* times, and that implementations maintain the filesystem in such a way that a filesystem check during reboot is avoided. This was considered, but rejected on the grounds that not all applications would require the capability, and that it was neither specifiable nor testable.

Network Communication

Realtime systems supporting networking generally provide the following features:

— Compatibility with a protocol stack (e.g. TCP/IP)

— May support applications such as FTP, TELNET, TFTP, rcp

Distributed File System

Realtime systems supporting a distributed (non-local) file system generally provide the following features:

— Remote access to a filesystem

— Performance not realtime

Memory Protection

Realtime systems supporting memory protection (typically requiring a memory management unit) generally provide the following features:

— Memory mapping and protection

— Ability to map to special areas of memory (I/O page, frame buffer)

— Typically do not have demand paging for realtime parts

Multiprocessor Support

Realtime systems supporting multiprocessing generally provide one of the following methods:

— **network**
Non-transparent access to remote objects, RPC

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— **distributed**
Transparent access to objects, no load-balancing

— **symmetric**
Presence of a global task scheduling queue (may also have local scheduling queues)

Self-Hosting
Realtime systems supporting the capability for program development, text editing, compilation, etc. generally provide the following features:

— Shell

— Text editor

— Compiler, assembler, linker, debugger

— May have user ID protection

Related Standards Activities

Activities to extend this family of POSIX standards to address additional requirements are in progress and similar efforts can be anticipated in the future.

The following areas are under active consideration at this time, or are expected to become active in the near future:[7)]

(1) Language-independent service descriptions of ISO/IEC 9945-1:1996.

(2) C, Ada, and FORTRAN Language bindings to (1).

(3) Shell and Utility facilities.

(4) Verification testing methods.

(5) Additional realtime facilities.

(6) Secure/Trusted System considerations.

(7) Network interface facilities.

(8) System Administration.

(9) Graphical User Interfaces.

(10) Profiles describing application- or user-specific combinations of open systems standards for supercomputing, multiprocessor, and batch extensions; and multiuser systems based on historical models.

(11) An overall guide to POSIX-based or related open systems standards and profiles.

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7) A Standards Status Report that lists all current IEEE Computer Society standards projects is available from the IEEE Computer Society, 1730 Massachusetts Avenue NW, Washington, DC 20036-1903; Telephone: +1 202 371-0101; FAX: +1 202 728-9614. Working drafts of POSIX standards under development are available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331 (http://www.standards.ieee.org/).

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Approved amendments are published separately until the full document is reprinted and such amendments are incorporated in their proper positions.

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IEEE Information Technology — Standardized Application Environment Profile — POSIX® Realtime Application Support (AEP)

Section 1: General

1.1 Overview

This standard establishes a set of Realtime Environment Profiles based on ISO/IEC 9945-1:1990 {3} as amended by IEEE Std 1003.1b-1993 {5}, IEEE Std 1003.5b-1996 {9}, and ISO/IEC 9945-2:1993 {4} (POSIX) work and related standards specifying foundations for realtime applications.

The Application Environment Profiles specified herein are appropriate for the development and execution of realtime applications using the services and utilities provided by standards called out in this document.

1.2 Taxonomy Position

Editor's Note: The following taxonomy is consistent with the 8-25-1993 draft of TR10000-3.

P — OSE Profiles

AEP — Application Environment Profiles

PS — System Profiles

PSE — Generic Environment Profiles

PSE5 — Realtime Environments

PSE51 — Minimal Realtime System Profile

PSE52 — Realtime Controller System Profile

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PSE53 — Dedicated Realtime System Profile

PSE54 — Multi-Purpose Realtime System Profile

1.2.1 Rationale for Positioning (informative)

(This subclause is not a part of ISO/IEC ISP 15287-2: 2000)

This document contains requirements for Application Program Interfaces and Units of Functionality necessary to support four instances of the Generic Realtime Environment class of applications. It specifies the behavior to be observed at the interfaces of the Application Platform on which the class of applications can run. This subset of an OSE profile is complete and coherent within the context of the class of applications supported. As such, it is a System Profile class of Application Environment Profile (AEP).

1.3 Realtime System Profiles

This document describes four realtime profiles and their minimum hardware requirements.

1.3.1 Minimal Realtime System Profile

These systems are typically embedded in systems dedicated to unattended control of one or more special I/O devices. Neither user interaction nor a file system (mass storage) is required. The programming model is that of a single POSIX process (corresponding to the processor's hardware address space) containing one or more threads of control (POSIX.1c threads or Ada tasks). Although there is only one process, a Message Passing interface is provided for communications among threads of control and between PSE5X instantiations. Special devices are operated and controlled either by memory-mapped I/O or by the basic I/O interface, which provides a standard way to access the intrinsically nonstandard I/O hardware and its nonportable control code.

The hardware model for this profile assumes a single processor with its memory, but no memory management unit (MMU) or common I/O devices are required. (If there are in fact multiple processors, typically there are multiple instantiations of the operating system, perhaps communicating via shared memory or a backplane channel, perhaps isolated).

1.3.2 Realtime Controller System Profile

These systems are an extension of the Minimal Realtime System Profile. Support for a file system interface and asynchronous (non-blocking) I/O interfaces has been added.

The hardware model for this profile assumes a single processor and memory (MMU is not required). Mass storage devices are not required; the file system may, for instance, be implemented in memory (RAM disk).

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1.3.3 Dedicated Realtime System Profile

These systems are an extension of the Minimal Realtime System Profile. Support for multiple processes has been added. There is a common interface for device drivers and files but no hierarchical file system. Since memory management hardware may be provided, the functionality of memory locking is provided.

The hardware model for this profile assumes one or more processors with or without MMUs in the same system.

1.3.4 Multi-Purpose Realtime System Profile

These systems include all the functionality of the other three profiles. They provide comprehensive functionality and run a mix of differing realtime and non-realtime tasks. This functionality includes all of POSIX.1, POSIX.1b, and POSIX.1c and/or POSIX.5b. Since users may conduct interactive sessions on those systems, all of POSIX.2 and POSIX.2a are also included. Support for additional functionality is provided by options for programming languages. Support for multi-threaded processes is required so that multi-tasking may be done by threads (POSIX.1c threads or Ada tasks), processes, or both.

The hardware model for this profile assumes one or more processors with memory management units, high-speed storage devices, special interfaces, network support, and display devices. The system supports a mix of realtime and non-realtime tasks, some being interactive user tasks.

1.4 Units of Functionality

Some of the profiles specified in this standard do not require support for all the functionality specified in a referenced standard. In this case, if that referenced standard does not contain options for specifying just the required functionality, only those Units of Functionality referenced by the profile may be used by a strictly conforming application. Table 1-1 shows the Units of Functionality defined for POSIX.1; each of these units is a set of functions that represents a separately implementable element of POSIX.1. Table 1-2 defines the functions from the C Standard required to support the POSIX Units of Functionality. Table 1-3 represents the Units of Functionality defined for POSIX.1c. No Units of Functionality are necessary for POSIX.1b. Table 1-5 through Table 1-18 show the Units of Functionality defined for POSIX.5b.

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Table 1-1 – POSIX.1 Units of Functionality

Unit of Functionality	Included Functions
POSIX_SINGLE_PROCESS	*sysconf*(), *time*(), *uname*()
POSIX_MULTI_PROCESS	*execl*(), *execle*(), *execlp*(), *execv*(), *execve*(), *execvp*(), *fork*(), *getenv*(), *getpid*(), *getppid*(), *sleep*(), *times*(), *wait*(), *waitpid*(), *_exit*()
POSIX_JOB_CONTROL	*setpgid*(), *tcgetpgrp*(), *tcsetpgrp*()
POSIX_SIGNALS	*alarm*(), *kill*(), *pause*(), *sigaction*(), *sigaddset*(), *sigdelset*(), *sigemptyset*(), *sigfillset*(), *sigismember*(), *sigpending*(), *sigprocmask*(), *sigsupend*()
POSIX_USER_GROUPS	*geteuid*(), *getegid*(), *getgid*(), *getgroups*(), *getlogin*(), *getpgrp*(), *getuid*(), *setgid*(), *setsid*(), *setuid*()
POSIX_FILE_SYSTEM	*access*(), *chdir*(), *closedir*(), *creat*(), *fpathconf*(), *fstat*(), *getcwd*(), *link*(), *mkdir*(), *opendir*(), *pathconf*(), *readdir*(), *rename*(), *rewinddir*(), *rmdir*(), *stat*(), *unlink*(), *utime*()
POSIX_FILE_ATTRIBUTES	*chmod*(), *chown*(), *umask*()
POSIX_FD_MGMT	*dup*(), *dup2*(), *fcntl*(), *lseek*()
POSIX_DEVICE_IO	*open*(), *close*(), *read*(), *write*()
POSIX_DEVICE_SPECIFIC	*cfgetispeed*(), *cfgetospeed*(), *cfsetispeed*(), *cfsetospeed*(), *ctermid*(), *isatty*(), *tcgetattr*(), *tcsetattr*(), *tcsendbreak*(), *tcdrain*(), *tcflush*(), *tcflow*(), *ttyname*()
POSIX_SYSTEM_DATABASE	*getgrgid*(), *getgrnam*(), *getpwnam*(), *getpwuid*()
POSIX_PIPE	*pipe*()
POSIX_FIFO	*mkfifo*()
POSIX_C_LANG_SUPPORT	See Table 1-4

Table 1-2 – C Language Support for POSIX.1 Units of Functionality

Unit of Functionality	Included Functions
POSIX_DEVICE_IO	*clearerr*(), *getc*(), *getchar*(), *gets*(), *fclose*(), *fdopen*(), *feof*(), *ferror*(), *fflush*(), *fgetc*(), *fgets*(), *fileno*(), *fopen*(), *fprintf*(), *fputc*(), *fputs*(), *fread*(), *freopen*(), *fscanf*(), *fwrite*(), *perror*(), *printf*(), *putc*(), *putchar*(), *puts*(), *sprintf*(), *scanf*(), *sscanf*(), *setbuf*(), *ungetc*()
POSIX_FILE_SYSTEM	*remove*(), *rename*(), *tmpfile*(), *tmpnam*()
POSIX_FD_MGMT	*fseek*(), *ftell*(), *rewind*()
POSIX_MULTI_PROCESS	*assert*(), *exit*(), *setlocale*()
POSIX_SIGNALS	*abort*(), *sigsetjmp*(), *siglongjmp*()

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Table 1-3 – POSIX.1c Units of Functionality

Unit of Functionality	Included Functions
POSIX_USER_GROUPS_R	*getlogin_r*()
POSIX_DEVICE_SPECIFIC	*ttyname_r*()
POSIX_FILE_LOCKING	*flockfile*(), *ftrylockfile*(), *funlockfile*(), *getc_unlocked*(), *getchar_unlocked*(), *putc_unlocked*(), *putchar_unlocked*()
POSIX_C_LANG_SUPPORT_R	*strtok_r*(), *asctime_r*(), *ctime_r*(), *gmtime_r*(), *localtime_r*(), *readdir_r*(), *rand_r*()
POSIX_SYSTEM_DATABASE_R	*getgrgid_r*(), *getgrnam_r*(), *getpwuid_r*(), *getpwnam_r*()

Table 1-4 – POSIX_C_LANG_SUPPORT Units of Functionality

Support Group	Included Functions
Character Handling	*isalnum*(), *isalpha*(), *iscntrl*(), *isdigit*(), *isgraph*(), *islower*(), *isprint*(), *ispunct*(), *isspace*(), *isupper*(), *isxdigit*(), *tolower*(), *toupper*()
Mathematics	*acos*(), *asin*(), *atan*(), *atan2*(), *ceil*(), *cos*(), *cosh*(), *exp*(), *fabs*(), *floor*(), *fmod*(), *frexp*(), *idexp*(), *log*(), *log10*(), *modf*(), *pow*(), *sin*(), *sinh*(), *sqrt*(), *tan*(), *tanh*()
Non-Local Jumps	*longjmp*(), *setjmp*()
General Utilities	*abs*(), *atof*(), *atoi*(), *atol*(), *bsearch*(), *calloc*(), *free*(), *malloc*(), *qsort*(), *rand*(), *realloc*(), *srand*()
String Handling	*strcat*(), *strchr*(), *strcmp*(), *strcpy*(), *strcspn*(), *strlen*(), *strncpy*(), *strncat*(), *strncmp*(), *strpbkr*(), *strrchr*(), *strspn*(), *strstr*(), *strtok*()
Date and Time	*asctime*(), *ctime*(), *gmtime*(), *localtime*(), *mktime*(), *strftime*(), *time*(), *tzset*()

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Table 1-5 – POSIX.5 Units of Functionality (Single Process)

POSIX_SINGLE_PROCESS	
Package	**Subprograms**
POSIX	All
POSIX_Limits	All
POSIX_Options	All
POSIX_Profiles	All*
POSIX_Configurable_System_Limits	All
POSIX_Calendar	All
POSIX_Process_Environment	Argument_List
	Copy_From_Current_Environment
	Copy_To_Current_Environment
	Copy_Environment
	Clear_Environment
	Set_Environment_Variable
	Delete_Environment_Variable
	Length
	For_Every_Environment_Variable
	For_Every_Current_Environment_Variable
	Environment_Value_Of
	Is_Environment_Variable

NOTE:

* — The package POSIX_Profiles is defined in Annex B of this document.

Table 1-6 – POSIX.5 Units of Functionality (Multi-Process)

POSIX_MULTI_PROCESS	
Package	**Subprograms**
POSIX_Process_Primitives	All
POSIX_Unsafe_Process_Primitives	All
POSIX_Process_Times	All
POSIX_Process_Identification	Get_Process_ID
	Get_Parent_Process_ID

Table 1-7 – POSIX.5 Units of Functionality (Job Control)

POSIX_JOB_CONTROL	
Package	**Subprograms**
POSIX_Process_Identification	Set_Process_Group_ID
	Create_Process_Group
POSIX_Terminal_Functions	Get_Process_Group_ID
	Set_Process_Group_ID
POSIX_Signals	Set_Stopped_Child_Signal
	Stopped_Child_Signal_Enabled

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Table 1-8 – POSIX.5 Units of Functionality (Signals)

POSIX_SIGNALS	
Package	**Subprograms**
POSIX_Signals	Add_Signal Add_All_Signals Delete_Signal Delete_All_Signals Is_Member Send_Signal Set_Blocked_Signals Block_Signals Unblock_Signals Blocked_Signals Ignore_Signal Unignore_Signal Is_Ignored Pending_Signals Await_Signal* Await_Signal_Or_Timeout* Interrupt_Task Get_Signal** Set_Signal** Get_Notification Set_Notification Get_Data** Set_Data**

NOTE:

All — indicates all subprograms in a package are required to be supported. Where overloaded versions of a subprogram exist, each instance is required, except as noted. All Image and Value functions must be supported for all packages provided by the implementation.

* — (Return type Signal)

** — (Operation on type Signal_Event)

Table 1-9 – POSIX.5 Units of Functionality (User Groups)

POSIX_USER_GROUPS	
Package	**Subprograms**
POSIX_Process_Identification	Get_Real_User_ID Get_Effective_User_ID Get_Real_Group_ID Get_Effective_Group_ID Set_User_ID Create_Session Set_Group_ID Get_Groups Get_Login_Name Get_Process_Group_ID

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Table 1-10 – POSIX.5 Units of Functionality (File System)

POSIX_FILE_SYSTEM	
Package	**Subprograms**
POSIX_Configurable_File_Limits	All
POSIX_File_Status	All
POSIX_Files	For_Every_Directory_Entry
	Create_Directory
	Unlink
	Remove_Directory
	Rename
	Accessibility
	Is_Accessible
	Existence
	Is_File_Present
	Set_File_Times
	Link
	Filename_Of
	Is_File
	Is_Directory
	Is_FIFO
	Is_Character_Special_File
	Is_Block_Special_File
POSIX_Process_Environment	Change_Working_Directory
	Get_Working_Directory
POSIX_IO	Open_Or_Create

Table 1-11 – POSIX.5 Units of Functionality (File Attributes)

POSIX_FILE_ATTRIBUTES	
Package	**Subprograms**
POSIX_Permissions	Set_Allowed_Process_Permissions
	Get_Allowed_Process_Permissions
POSIX_Files	Change_Owner_And_Group
	Change_Permissions

Table 1-12 – POSIX.5 Units of Functionality (FD Management)

POSIX_FD_MGMT	
Package	**Subprograms**
POSIX_File_Locking	All
POSIX_IO	Duplicate
	Duplicate_And_Close
	Get_File_Control
	Set_File_Control
	Get_Close_On_Exec
	Set_Close_On_Exec
	Seek
	File_Size
	File_Position

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Table 1-13 – POSIX.5 Units of Functionality (Device IO)

POSIX_DEVICE_IO	
Package	**Subprograms**
POSIX_IO	Open Close Read Write Generic_Read Generic_Write Is_Open

Table 1-14 – POSIX.5 Units of Functionality (Device Specific)

POSIX_DEVICE_SPECIFIC	
Package	**Subprograms**
POSIX_Terminal_Functions:	Get_Terminal_Characteristics Get_Controlling_Terminal_Name Set_Terminal_Characteristics Terminal_Modes_Of Define_Terminal_Modes Bits_Per_Character_Of Define_Bits_Per_Character Special_Control_Character_Of Define_Special_Control_Character Disable_Control_Character Input_Time_Of Define_Input_Time Minimum_Input_Count_Of Define_Minimum_Input_Count Input_Baud_Rate_Of Output_Baud_Rate_Of Define_Input_Baud_Rate Define_Output_Baud_Rate Send_Break Drain Discard_Data Flow
POSIX_IO	Is_A_Terminal Get_Terminal_Name

Table 1-15 – POSIX.5 Units of Functionality (System Database)

POSIX_SYSTEM_DATABASE	
Package	**Subprograms**
POSIX_Group_Database	All
POSIX_User_Database	All

Table 1-16 – POSIX.5 Units of Functionality (Pipes)

POSIX_PIPE	
Package	**Subprograms**
POSIX_IO	Create_Pipe

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Table 1-17 – POSIX.5 Units of Functionality (FIFO)

POSIX_FIFO	
Package	**Subprograms**
`POSIX_Files`	`Create_FIFO`

Table 1-18 – POSIX.5 Units of Functionality (Ada Language Support)

POSIX_ADA_LANG_SUPPORT	
Package	**Subprograms**
`System`	Extra Requirements specified in POSIX.5b, Section 2.8
`System_Storage_Elements`	All
`POSIX_Page_Alignment`	All
`POSIX_Supplement_To_Ada_IO`	All
`Ada_Task_Identification`	All
`Ada_Streams`	All

1.5 Development Environment

Although POSIX.2/2a is not required for the execution environment of PSE51, PSE52, or PSE53, {POSIX2_SW_DEV} is required in development environments for all four profiles. The options {POSIX2_C_BIND} and {POSIX2_C_DEV} are required for C-Language development environments.

1.6 Summary of Profile Features

The following tables summarize the requirements of the four profiles. Since POSIX.1, POSIX.1c, and/or POSIX.5 do not provide sufficient options to remove features unnecessary for some profiles, Units of Functionality have been developed and are described in Table 1-1 through Table 1-18, and defined by Annex A and Annex B.

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Table 1-19 – POSIX.1 and POSIX.5b Units of Functionality Requirements

Unit of Functionality	PSE51	PSE52	PSE53	PSE54
POSIX_SINGLE_PROCESS	X	X	X	X
POSIX_MULTI_PROCESS	-	-	X	X
POSIX_SIGNALS	X	X	X	X
POSIX_USER_GROUPS	-	-	-	X
POSIX_FILE_SYSTEM	-	X	-	X
POSIX_FILE_ATTRIBUTES	-	-	-	X
POSIX_FIFO	-	-	-	X
POSIX_DEVICE_IO	X	X	X	X
POSIX_FD_MGMT	-	X	X	X
POSIX_PIPE	-	-	X	X
POSIX_DEVICE_SPECIFIC	-	-	-	X
POSIX_SYSTEM_DATABASE	-	-	-	X
POSIX_C_LANG_SUPPORT*	X	X	X	X
POSIX_ADA_LANG_SUPPORT**	X	X	X	X

NOTE:

* — Required only for C-Language option.

** — Required only for Ada-Language option.

Table 1-20 – POSIX.1 Option Requirements

Option	PSE51	PSE52	PSE53	PSE54
_POSIX_JOB_CONTROL	-	-	-	X
_POSIX_SAVED_IDS	-	-	-	X
_POSIX_CHOWN_RESTRICTED	-	-	-	X
_POSIX_NO_TRUNC	X	X	X	X
_POSIX_VDISABLE	-	-	-	X
NGROUPS_MAX	-	-	-	>=8

Table 1-21 – POSIX.5b Option Requirements

Option	PSE51	PSE52	PSE53	PSE54
Job_Control_Support	-	-	-	X
Saved_IDs_Support	-	-	-	X
Change_Owner_Restriction	-	-	-	X
Filename_Truncation	-	-	-	-

In all profiles that do not support the POSIX_JOB_CONTROL Unit of Functionality, the subprogram `POSIX_Signals.Set_Stopped_Child_Signal` shall fail silently.

In all profiles that do not support the POSIX_JOB_CONTROL Unit of Functionality, the subprogram `POSIX_Signals.Stopped_Child_Signal_Enabled` shall return `False`.

`POSIX_Limits.Groups_Maxima'First` shall be zero for PSE51, PSE52, and PSE53. For PSE54 it shall be greater than or equal to eight.

`POSIX_Terminal_Functions.Disable_Control_Character` (which corresponds to {_POSIX_VDISABLE}) is not supported in PSE51, PSE52, and PSE53. For PSE54,

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`POSIX_Terminal_Functions.Disable_Control_Character` shall not raise `POSIX_Error` with an error code of `Operation_Not_Implemented`.

For PSE51 and PSE52, the blocking behavior of all relevant operations defined by POSIX.5b shall be `Tasks` (see POSIX.5b, clause 2.4.1.5).

Table 1-22 – POSIX.1b Option Requirements

Option	PSE51	PSE52	PSE53	PSE54
_POSIX_FSYNC	X	X	X	X
_POSIX_MAPPED_FILES	-	X	-	X
_POSIX_MEMLOCK	X	X	X	X
_POSIX_MEMLOCK_RANGE	X	X	X	X
_POSIX_MEMORY_PROTECTION	-	-	X	X
_POSIX_PRIORITY_SCHEDULING	-	-	X	X
_POSIX_SEMAPHORES	X	X	X	X
_POSIX_SHARED_MEMORY_OBJECTS	X	X	X	X
_POSIX_REALTIME_SIGNALS	X	X	X	X
_POSIX_TIMERS	X	X	X	X
_POSIX_MESSAGE_PASSING	X	X	X	X
_POSIX_SYNCHRONIZED_IO	X	X	X	X
_POSIX_ASYNCHRONOUS_IO	-	X	X	X
_POSIX_PRIORITIZED_IO	-	-	X	X

The correspondence between the options listed in Table 1-22 and the options described in POSIX.5b, clause 2.5, are as follows:

Table 1-23 – POSIX.1b Options vs POSIX.5b Options

POSIX.1b Options	POSIX.5b options
_POSIX_ASYNCHRONOUS_IO	Asynchronous I/O
_POSIX_MAPPED_FILES	Memory Mapped Files
_POSIX_MEMLOCK	Memory Locking
_POSIX_MEMLOCK_RANGE	Memory Range Locking
_POSIX_MEMORY_PROTECTION	Memory Protection
_POSIX_MESSAGE_PASSING	Message Queues
_POSIX_PRIORITIZED_IO	Prioritized I/O
_POSIX_PRIORITY_SCHEDULING	Priority Process Scheduling
_POSIX_REALTIME_SIGNALS	Realtime Signals
_POSIX_SEMAPHORES	Semaphores
_POSIX_SHARED_MEMORY_OBJECTS	Shared Memory Objects
_POSIX_SYNCHRONIZED_IO	Synchronized I/O
_POSIX_TIMERS	Timers
_POSIX_FSYNC	File Synchronization

Table 1-24 – POSIX.1c Option Requirements

Option	PSE51	PSE52	PSE53	PSE54
_POSIX_THREADS	X	X	X	X
_POSIX_THREAD_ATTR_STACKSIZE	X	X	X	X
_POSIX_THREAD_PRIO_INHERIT	X	X	X	X
_POSIX_THREAD_PRIORITY_SCHEDULING	X	X	X	X
_POSIX_THREAD_PRIO_PROTECT	X	X	X	X
_POSIX_THREAD_PROCESS_SHARED	-	-	X	X
_POSIX_THREAD_ATTR_STACKADDR	X	X	X	X

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The correspondence between the options listed in Table 1-24 and the options described in POSIX.5b, clause 2.5, are as follows:

Table 1-25 – POSIX.1c Options vs POSIX.5b Options

POSIX.1c Option	POSIX.5b Option
_POSIX_THREAD_PRIO_INHERIT	Mutex Priority Inheritance
_POSIX_THREAD_PRIO_PROTECT	Mutex Priority Ceiling
_POSIX_THREAD_PROCESS_SHARED	Process Shared

NOTE: The other options in Table 1-24 are not visible in the Ada binding. The POSIX.5b analog to the POSIX.1c _POSIX_THREAD_PRIORITY_SCHEDULING option is support for the priority model defined in [Ada RM {1}, clause D.1], the pragmas and package interfaces defined in [Ada RM {1}, clauses D.2-D.5], and the requirements of POSIX.5b, clause 13.2.1.

In addition, the Mutexes Option (specified in POSIX.5b, clause 2.5) must be supported by all profiles.

Table 1-26 – POSIX.1c Unit of Functionality Requirements

Option	PSE51	PSE52	PSE53	PSE54
POSIX_USER_GROUPS_R	-	-	-	X
POSIX_DEVICE_SPECIFIC_R	-	-	-	X
POSIX_FILE_LOCKING	X	X	X	X
POSIX_C_LANG_SUPPORT_R	X	X	X	X
POSIX_SYSTEM_DATABASE_R	-	-	-	X

NOTE: There is no Ada equivalent to Table 1-26, since all POSIX Ada calls are tasking safe.

Table 1-27 – POSIX.2/2a Option Requirements

Option	PSE51**	PSE52**	PSE53**	PSE54
POSIX2_C_BIND*	X	X	X	X
POSIX2_C_DEV*	X	X	X	X
POSIX2_CHAR_TERM	-	-	-	X
POSIX2_FORT_DEV	-	-	-	-
POSIX2_FORT_RUN	-	-	-	X
POSIX2_LOCALEDEF	-	-	-	-
POSIX2_SW_DEV	X	X	X	X
POSIX2_UPE	-	-	-	X

NOTE:

* — Required only for C-Language option.

** — Required only for the development platform.

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Section 2: Normative References

2.1 Normative References

The following standards contain provisions which, through references in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this profile of IEEE and ISO are encouraged to investigate the possibility of applying the most recent editions of the standards listed below. Members of IEC and ISO maintain registers of currently valid International Standards.

{1} ISO/IEC 8652: 1995[1)], *Information Technology— Programming languages—Ada [Revision of the first edition (ISO 8652:1987)].*

{2} ISO/IEC 9899: 1990, *Information processing systems—Programming languages—C.*

{3} ISO/IEC 9945-1: 1990 (IEEE Std 1003.1-1990), *Information Technology—Portable Operating System Interface (POSIX)—Part 1: System Application Program Interface (API) [C Language].*

{4} ISO/IEC 9945-2: 1993 (IEEE Std 1003.2-1992) (includes IEEE Std 1003.2a-1992 User Portability Extension), *Information Technology—Portable Operating System Interface (POSIX)—Part 2: Shell and Utilities.*

{5} IEEE Std 1003.1b-1993, *IEEE Standard for Information Technology—Portable Operating System Interface (POSIX)—Part 1: System Application Program Interface (API)—Amendment 1: Realtime Extension [C Language].*

{6} IEEE Std 1003.1i-1995, *IEEE Standard for Information Technology—Portable Operating System Interface (POSIX)—Part 1: System Application Program Interface (API)—Amendment: Technical Corrigenda to Realtime Extension [C Language].*

{7} IEEE Std 1003.5-1992, *IEEE Standard for Information Technology—POSIX Ada Language Interfaces—Part 1: Binding for System Application Program Interface (API).*

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1) ISO/IEC documents can be obtained from the ISO office, 1 rue de Varembé, Case Postale 56, CH-1211, Genève 20, Switzerland/Suisse (http://www.iso.ch/) and from the IEC office, 3 rue de Varembé, Case Postale 131, CH-1211, Genève 20, Switzerland/Suisse (http://www.iec.ch/). ISO/IEC publications are also available in the United States from the Sales Department, American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036, USA (http://www.ansi.org/).

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{8} IEEE Std 1003.1c-1995, *IEEE Standard for Information Technology—Portable Operating System Interface (POSIX)—Part 1: System Application Program Interface (API)—Amendment 2: Threads Extension [C Language].*

{9} IEEE Std 1003.5b-1996, *IEEE Standard for Information Technology—POSIX Ada Language Interfaces— Part 1: Binding for System Application Program Interface (API)—Amendment 1: Realtime Extensions.*

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Section 3: Definitions

3.1 Terms

3.1.1 Terminology

For the purposes of this standard, the following terms apply:

3.1.1.1 may: An indication of an optional feature.

With respect to implementations, the word *may* defines optional behavior that any implementation can use and that a strictly conforming application must tolerate. With respect to Strictly Conforming POSIX.13 Applications, the word *may* means that the optional feature shall not be used.

3.1.1.2 shall: An indication of a requirement on the implementation or on Strictly Conforming POSIX.13 Applications, where appropriate.

3.1.1.3 should:

(1) With respect to implementations, an indication of an implementation recommendation, but not a requirement.

(2) With respect to applications, an indication of a recommended programming practice for applications and a requirement for Strictly Conforming POSIX.13 Applications.

3.1.1.4 system documentation: All documentation provided with an implementation, except the conformance document.

Electronically distributed documents for an implementation are considered part of the system documentation.

3.2 Definitions

3.2.1 Terminology

For the purposes of this standard, the following definitions apply:

3.2.1.1 Application Environment Profile (AEP): An OSE profile which specifies a complete and coherent subset of the Open System Environment. [ISO/IEC TR 10000-3:1998 {B3}]

3.2.1.2 Application Platform: A set of resources on which an application will run.

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3.2.1.3 Base Standard: An approved IEEE, National, Regional, or International Standard which defines and describes basic functionality and capability. [ISO/IEC TR 10000-1:1998 {B1}]

3.2.1.4 Component Profile: An Application Environment Profile that specifies a unit of functionality in terms of the interfaces that it supports and the interfaces that it uses, and the relationships between these interfaces. [ISO/IEC TR 10000-3:1998 {B3}]

3.2.1.5 Conformance Document: A document provided by an implementor that contains implementation details as described in 5.1.1.2.

3.2.1.6 Development Platform: A system used to prepare an application for execution. Such a system is possibly distinct from the system on which the application will execute.

3.2.1.7 Generic Application Environment Profile: An Application Environment Profile which is not specific to a particular community of use. [ISO/IEC TR 10000-3:1998 {B3}]

3.2.1.8 Generic Interface Profile: An Interface Profile which is not specific to a particular community of use. [ISO/IEC TR 10000-3:1998 {B3}]

3.2.1.9 Industry Specific Application Environment Profile: An Application Environment Profile which deals with specific industry requirements. [ISO/IEC TR 10000-3:1998 {B3}]

3.2.1.10 Industry Specific Interface Profile: An Interface Profile which deals with specific industry requirements. [ISO/IEC TR 10000-3:1998 {B3}]

3.2.1.11 Interface Profile (IP): An OSE Profile defining one interface of the Open System Environment. [ISO/IEC TR 10000-3:1998 {B3}]

3.2.1.12 International Standardized Profile (ISP): An internationally agreed-to, harmonized document which identifies a standard or group of standards, together with options and parameters, necessary to accomplish a function or set of functions. [ISO/IEC TR 10000-1:1998 {B1}]

3.2.1.13 Open System Environment (OSE): The comprehensive set of interfaces, services, and supporting formats for interoperability and/or for portability of applications, data or people, as specified by information technology standards and profiles. [ISO/IEC TR 10000-3:1998 {B3}]

3.2.1.14 Profile (for ISO standardization): A set of one or more base standards (and where applicable) chosen classes, subsets, options, and parameters of those base standards to accomplish a function. [ISO/IEC TR 10000-1:1998 {B1}]

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3.2.1.15 Realtime Environment Profile: A profile designed to support applications requiring bounded response.

3.2.1.16 System Profile: An Application Environment Profile that specifies a set of functions necessary to support a class of applications. It specifies the behavior to be observed at the interfaces of the application platform on which the class of applications can run. [ISO/IEC TR 10000-3:1998 {B3}]

NOTE: A system profile is defined in terms of component profiles that specify units of functionality that can be combined to realize the application platform.

3.2.1.17 Unit of Functionality: A separately implementable element of an OSE system. [ISO/IEC TR 10000-3:1998 {B3}]

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Section 4: Conventions and Abbreviations

4.1 Conventions

This standard uses the following typographic conventions:

(1) The *italic* font is used for:

— Cross references to defined terms within 5.1, and 3.2.1.

— Symbolic parameters that are generally substituted with real values by the application.

— C-language data types and function names (except in function Synopsis subclauses).

— Global external variable names.

(2) The `constant-width` (Courier) font is used:

— For references to utility names and C language headers.

— For references to Ada identifiers.

(3) Symbolic constants or limits defined in certain headers are represented as:

{_POSIX_AEP_REALTIME_}.

In some cases tabular information is presented "inline"; in others it is presented in a separately labeled table. This arrangement was employed purely for ease of typesetting and there is no normative difference between these two cases.

The conventions listed previously are for ease of reading only. Editorial inconsistencies in the use of typography are unintentional and have no normative meaning in this standard.

Notes provided as parts of labeled tables and figures are integral parts of this standard (normative). Footnotes and notes within the body of the text are for information only (informative).

Numerical quantities are presented in international style: comma is used as a decimal sign and units are from the International System (SI).

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4.2 Abbreviations

For the purposes of this document the following abbreviations apply:

4.2.1 C Standard: ISO/IEC 9899:1990 {2}, *Information processing systems—Programming languages—C.*

4.2.2 POSIX.1: ISO/IEC 9945-1: 1990 {3}, (IEEE Std 1003.1-1990), *Information Technology—Portable Operating System Interface (POSIX)—Part 1: System Application Program Interface (API) [C Language].*

4.2.3 POSIX.2 ISO/IEC 9945-2: 1993 {4}, (IEEE Std 1003.2-1992), *Information Technology— Portable Operating System Interface (POSIX)—Part 2: Shell and Utilities.*

4.2.4 POSIX.1b: IEEE Std 1003.1b-1993 {5}, *IEEE Standard for Information Technology—Portable Operating System Interface (POSIX)—Part 1: System Application Program Interface (API)—Amendment 1: Realtime Extension [C Language],* as amended by IEEE Std 1003.1i-1995 {6}, *IEEE Standard for Information Technology—Portable Operating System Interface (POSIX)—Part 1: System Application Program Interface (API)—Amendment: Technical Corrigenda to Realtime Extension [C Language].*

4.2.5 POSIX.1c: IEEE Std 1003.1c-1995 {8}, *IEEE Standard for Information Technology—Portable Operating System Interface (POSIX)—Part 1: System Application Program Interface (API)—Amendment 2: Threads Extension [C Language].*

4.2.6 POSIX.5b: IEEE Std 1003.5-1992 {7}, *IEEE Standard for Information Technology—POSIX Ada Language Interfaces—Part 1: Binding for System Application Program Interface (API) as amended by IEEE Std 1003.5b-1996* {9}, *IEEE Standard for Information Technology—POSIX Ada Language Interfaces—Part 1: Binding for System Application Interface (API)—Amendment 1: Realtime Extensions.*

4.2.7 Ada RM: ISO/IEC 8652: 1995(E) {1}, *Information Technology—Programming Languages—Ada [Revision of the first edition (ISO 8652:1987)].*

4.2.8 AEP: *Application Environment Profile.*

4.2.9 ISP: *International Standardized Profile.*

4.2.10 OSE: *Open System Environment.*

4.2.11 PSE: *Generic Environment Profile.*

4.2.12 PSE51: *The Minimal Realtime System Profile defined herein.*

4.2.13 PSE52: *The Realtime Controller System Profile defined herein.*

4.2.14 PSE53: *The Dedicated Realtime System Profile defined herein.*

4.2.15 PSE54: *The Multi-Purpose Realtime System Profile defined herein.*

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Section 5: Conformance

5.1 Conformance

5.1.1 Implementation Conformance

5.1.1.1 Requirements

An implementation may claim conformance to one or more of the profiles defined by this standard. For any given profile a *conforming implementation* shall meet all of the following criteria:

(1) The system shall support all required interfaces referenced in the appropriate standardized profile. These interfaces shall support the functional behavior described in the appropriate base standard, and any additional constraints or options described herein.

(2) The system may provide additional functions or facilities not required by this standard. Nonstandard extensions should be identified as such in the system documentation. Nonstandard extensions, when used, may change the behavior of functions or facilities defined in the appropriate base standard. The conformance document shall define an environment in which an application can be run with predictable behavior specified by the referenced standards. In no case shall such an environment require modification of the appropriate Strictly Conforming POSIX.13 Application.

5.1.1.2 Documentation

An implementation may document conformance to one or more of these profiles in one of two specific manners:

(1) If the implementation is fully conformant to the referenced base standard(s), then that implementation may cite the separate conformance documents that document the base standard conformance. This will primarily apply to implementations that support the PSE53 or PSE54 Profiles.

(2) If the implementation does not fully conform to one or more of the referenced base standards, or if separate base standard conformance documents are not cited, the implementation shall document the specific extent of conformance to each such base standard. This specification shall include:

— A complete list of interfaces from the base standard that are present in the implementation.

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— Limit values whose specification is normally required in a conformance document for the base standard (e.g. the limit values found in the <limits.h> and <unistd.h> headers), stating values, the conditions under which those values may change, and the limits of such variations, if any.

— A description of the behavior of the implementation for all implementation-defined features specified by those portions of the base standard that the implementation provides. This requirement shall be met by listing these features and providing either a specific reference to the system documentation or providing full syntax and semantics of these features. The conformance document may specify the behavior of the implementation for those features where the referenced standards state that the implementations may vary or where features are identified as undefined or unspecified.

Regardless of whether separate base standard conformance documents are cited, the conformance document for these profile(s) shall contain a statement that indicates the full name, number, and date of the standard (i.e. the profile standard) that applies. The conformance document may also list international standards that are available for use by a Conforming POSIX.13 Application. Applicable characteristics where documentation is required by one of these standards or by standards of government bodies, may also be included.

5.1.2 Application Conformance

An application claiming conformance to one or more of these profiles shall use only the facilities described in that profile and included referenced standard elements, and shall fall within one of the categories in 5.1.2.1, 5.1.2.2, or 5.1.2.3.

5.1.2.1 Strictly Conforming Application

An application is said to be strictly conforming to a given POSIX.13 profile if the application requires only the facilities required in that profile. Such an application shall accept any behavior described in the profile as *unspecified* or *implementation-defined*, and for symbolic constants, shall accept any value in the range permitted by the profile. Such applications are permitted to adapt to the availability of facilities whose availability is indicated by the constants in 6.1.3, 7.1.3, 8.1.3, and 9.1.3.

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5.1.2.2 Conformant Application

5.1.2.2.1 ISO/IEC Conformant Application

An application is said to be ISO/IEC Conformant to a given POSIX.13 profile if the application requires only the facilities required in that profile and approved Conformant Language bindings for any ISO or IEC standard. Such an application shall include a statement of conformance that documents all options and limit dependencies, and all other ISO or IEC standards used.

5.1.2.2.2 <National Body> Conformant POSIX.13 Application

An application is said to be <National Body> Conformant to a given POSIX.13 profile if the application requires only the facilities required in that profile. Such an application shall include a statement of conformance to document all options and limit dependencies, and all other <National Body> standards used.

5.1.2.3 Conformant Application Using Extensions

An application is said to be conformant using extensions if it only uses nonstandard facilities consistent with this standard. Such an application shall fully document its requirements for these extended facilities, in addition to the documentation required of a Conformant Application. A Conformant Application Using Extensions shall be either an ISO/IEC Conformant Application Using Extensions or a <National Body> Conformant Application Using Extensions. (See 5.1.2.2.1 and 5.1.2.2.2.)

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