

IEEE Std 1003.13™-2003

(Revision of
IEEE Std 1003.13-1998)

1003.13™

IEEE Standard for Information Technology— Standardized Application Environment Profile (AEP)—POSIX® Realtime and Embedded Application Support

IEEE Computer Society

Sponsored by the
Portable Applications Standards Committee



3 Park Avenue, New York, NY 10016-5997, USA

10 September 2004

Print: SH95191
PDF: SS95191

*Recognized as an
American National Standard (ANSI)*

IEEE Std 1003.13™-2003
(Revision of
IEEE Std 1003.13-1998)

IEEE Standard for Information Technology— Standardized Application Environment Profile (AEP)—POSIX® Realtime and Embedded Application Support

Sponsor

**Portable Applications Standards Committee
of the
IEEE Computer Society**

Approved 12 May 2004

American National Standards Institute

Approved 10 December 2003

IEEE-SA Standards Board

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

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

MS-DOS is a registered trademark of Microsoft Corporation.

QNX is a registered trademark of QNX Software Systems, Ltd.

POSIX is a registered trademark of the Institute of Electrical and Electronics Engineers, Incorporated.

pSOS is a registered trademark of Wind River Systems, Inc.

RTLinux is a product of FSMLabs, Inc.

RT-11 is a trademark of Mentec Inc.

RSX-11M is a trademark of Mentec Inc.

RTEMS is free software developed by OAR Corporation for the U.S. Army Missile Command.

UNIX is a registered trademark of The Open Group.

VRTX32 is a registered trademark of Mentor Graphics Corporation.

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

The Institute of Electrical and Electronics Engineers, Inc.
3 Park Avenue, New York, NY 10016-5997, USA

Copyright © 2004 by the Institute of Electrical and Electronics Engineers, Inc.
All rights reserved. Published 10 September 2004. Printed in the United States of America.

IEEE is a registered trademark in the U.S. Patent & Trademark Office, owned by the Institute of Electrical and Electronics Engineers, Incorporated.

Print: ISBN 0-7381-3885-1 SH95191
PDF: ISBN 0-7381-3886-X SS95191

No part of this publication may be reproduced in any form, in an electronic retrieval system or otherwise, without the prior written permission of the publisher.

IEEE Standards documents are developed within the IEEE Societies and the Standards Coordinating Committees of the IEEE Standards Association (IEEE-SA) Standards Board. The IEEE develops its standards through a consensus development process, approved by the American National Standards Institute, which brings together volunteers representing varied viewpoints and interests to achieve the final product. Volunteers are not necessarily members of the Institute and serve without compensation. While the IEEE administers the process and establishes rules to promote fairness in the consensus development process, the IEEE does not independently evaluate, test, or verify the accuracy of any of the information contained in its standards.

Use of an IEEE Standard is wholly voluntary. The IEEE disclaims liability for any personal injury, property or other damage, of any nature whatsoever, whether special, indirect, consequential, or compensatory, directly or indirectly resulting from the publication, use of, or reliance upon this, or any other IEEE Standard document.

The IEEE does not warrant or represent the accuracy or content of the material contained herein, and expressly disclaims any express or implied warranty, including any implied warranty of merchantability or fitness for a specific purpose, or that the use of the material contained herein is free from patent infringement. IEEE Standards documents are supplied **“AS IS.”**

The existence of an IEEE Standard does not imply that there are no other ways to produce, test, measure, purchase, market, or provide other goods and services related to the scope of the IEEE Standard. Furthermore, the viewpoint expressed at the time a standard is approved and issued is subject to change brought about through developments in the state of the art and comments received from users of the standard. Every IEEE Standard is subjected to review at least every five years for revision or reaffirmation. When a document is more than five years old and has not been reaffirmed, it is reasonable to conclude that its contents, although still of some value, do not wholly reflect the present state of the art. Users are cautioned to check to determine that they have the latest edition of any IEEE Standard.

In publishing and making this document available, the IEEE is not suggesting or rendering professional or other services for, or on behalf of, any person or entity. Nor is the IEEE undertaking to perform any duty owed by any other person or entity to another. Any person utilizing this, and any other IEEE Standards document, should rely upon the advice of a competent professional in determining the exercise of reasonable care in any given circumstances.

Interpretations: Occasionally questions may arise regarding the meaning of portions of standards as they relate to specific applications. When the need for interpretations is brought to the attention of IEEE, the Institute will initiate action to prepare appropriate responses. Since IEEE Standards represent a consensus of concerned interests, it is important to ensure that any interpretation has also received the concurrence of a balance of interests. For this reason, IEEE and the members of its societies and Standards Coordinating Committees are not able to provide an instant response to interpretation requests except in those cases where the matter has previously received formal consideration. At lectures, symposia, seminars, or educational courses, an individual presenting information on IEEE standards shall make it clear that his or her views should be considered the personal views of that individual rather than the formal position, explanation, or interpretation of the IEEE.

Comments for revision of IEEE Standards are welcome from any interested party, regardless of membership affiliation with IEEE. Suggestions for changes in documents should be in the form of a proposed change of text, together with appropriate supporting comments. Comments on standards and requests for interpretations should be addressed to:

Secretary, IEEE-SA Standards Board
445 Hoes Lane
Piscataway, NJ 08854 USA

NOTE—Attention is called to the possibility that implementation of this standard may require use of subject matter covered by patent rights. By publication of this standard, no position is taken with respect to the existence or validity of any patent rights in connection therewith. The IEEE shall not be responsible for identifying patents for which a license may be required by an IEEE standard or for conducting inquiries into the legal validity or scope of those patents that are brought to its attention.

Authorization to photocopy portions of any individual standard for internal or personal use is granted by the Institute of Electrical and Electronics Engineers, Inc., provided that the appropriate fee is paid to Copyright Clearance Center. To arrange for payment of licensing fee, please contact Copyright Clearance Center, Customer Service, 222 Rosewood Drive, Danvers, MA 01923 USA; +1 978 750 8400. Permission to photocopy portions of any individual standard for educational classroom use can also be obtained through the Copyright Clearance Center.

Contents

	PAGE
List of Figures	vii
List of Tables	viii
Introduction	x
Section 1: Overview.....	1
1.1 Scope	1
1.2 Taxonomy Position	2
1.2.1 Rationale for Positioning (informative)	2
1.3 Realtime System Profiles	2
1.3.1 Minimal Realtime System Profile (PSE51)	2
1.3.2 Realtime Controller System Profile (PSE52)	3
1.3.3 Dedicated Realtime System Profile (PSE53).....	3
1.3.4 Multi-Purpose Realtime System Profile (PSE54)	3
1.4 Units of Functionality.....	4
1.5 Development Environment	4
1.6 Summary of Profile Features.....	17
Section 2: Normative References	23
2.1 Normative References.....	23
Section 3: Terms and Definitions.....	25
3.1 Terminology	25
3.2 Definitions.....	26
3.3 Rationale for Definitions (informative)	28
Section 4: Conventions and Abbreviations	31
4.1 Conventions.....	31
4.2 Abbreviations	32
Section 5: Conformance	33
5.1 Conformance	33
5.1.1 Implementation Conformance	33
5.1.2 Application Conformance	34
Section 6: Minimal Realtime System Profile (PSE51)	37
6.1 Introduction.....	37
6.1.1 Identification.....	37
6.1.2 Conformance	37
6.1.3 Options	38
6.1.4 The Compilation Environment (C language option).....	38

COPYRIGHT © 2004 IEEE. ALL RIGHTS RESERVED.

6.2	Operating System Interface Requirements	39
6.2.1	POSIX.1 Interfaces (C Language Option)	39
6.2.2	POSIX.26 Interfaces (C Language Option)	40
6.2.3	POSIX.5c Interfaces (Ada Language Option)	40
6.3	Application Constraints	42
6.3.1	Constraints related to POSIX.1 Interfaces (C Language Option) . .	42
6.3.2	Constraints related to POSIX.5c Interfaces (Ada Language Option).	43
6.4	Shell and Utility Requirements	45
6.5	Development Platform Requirements	45
6.5.1	C Language Development Option	45
6.5.2	Ada Language Development Option	45
6.6	Rationale for Operating System Requirements (informative)	46
6.6.1	Operating System Interface Requirements	46
6.6.2	Shell and Utility Requirements	54
6.6.3	Development Platform Requirements	54
Section 7:	Realtime Controller System Profile (PSE52)	55
7.1	Introduction.	55
7.1.1	Identification	55
7.1.2	Conformance	55
7.1.3	Options	56
7.1.4	The Compilation Environment (C language option)	56
7.2	Operating System Interface Requirements	57
7.2.1	POSIX.1 Interfaces (C language Option).	57
7.2.2	POSIX.26 Interfaces (C Language Option)	58
7.2.3	POSIX.5c Interfaces (Ada Language Option)	59
7.3	Application Constraints	60
7.3.1	Constraints Related to POSIX.1 Interfaces (C Language Option) . .	61
7.3.2	Constraints related to POSIX.5c Interfaces (Ada Language Option).	61
7.4	Shell and Utility Requirements	62
7.5	Development Platform Requirements	62
7.5.1	C Language Development Option	62
7.5.2	Ada Language Development Option	63
7.6	Rationale for Operating System Requirements (informative)	63
7.6.1	Operating System Interface Requirements	63
7.6.2	Shell and Utility Requirements	71
7.6.3	Development Platform Requirements	72
Section 8:	Dedicated Realtime System Profile (PSE53)	73
8.1	Introduction.	73
8.1.1	Identification	73
8.1.2	Conformance	73
8.1.3	Options	74
8.1.4	The Compilation Environment (C language option)	74
8.2	Operating System Interface Requirements	75
8.2.1	POSIX.1 Interfaces (C Language Option)	75
8.2.2	POSIX.26 Interfaces (C Language Option)	77

COPYRIGHT © 2004 IEEE. ALL RIGHTS RESERVED.

8.2.3 POSIX.5c Interfaces (Ada Language Option)	77
8.3 Application Constraints	79
8.3.1 Constraints related to POSIX.1 Interfaces (C Language Option) . .	79
8.3.2 Constraints related to POSIX.5c Interfaces (Ada Language Option).	79
8.4 Shell and Utility Requirements	80
8.5 Development Platform Requirements	80
8.5.1 C Language Development Option	80
8.5.2 Ada Language Development Option	81
8.6 Rationale for Operating System Requirements (informative)	81
8.6.1 Operating System Interface Requirements.	81
8.6.2 Shell and Utility Requirements	89
8.6.3 Development Platform Requirements	90
Section 9: Multi-Purpose Realtime System Profile (PSE54)	91
9.1 Introduction.	91
9.1.1 Identification.	91
9.1.2 Conformance	91
9.1.3 Options	92
9.1.4 The Compilation Environment (C language option).	92
9.2 Operating System Interface Requirements.	93
9.2.1 POSIX.1 Interfaces (C Language Option)	93
9.2.2 POSIX.26 Interfaces (C Language Option)	95
9.2.3 POSIX.5c Interfaces (Ada Language Option)	95
9.3 Application Constraints	97
9.3.1 Constraints Related to POSIX.1 Interfaces (C Language Option). .	97
9.3.2 Constraints Related to POSIX.5c Interfaces (Ada Language Option).	98
9.4 Shell and Utility Requirements	98
9.5 Development Platform Requirements	99
9.5.1 C Language Development Option	99
9.5.2 Ada Language Development Option	99
9.6 Rationale for Operating System Requirements (informative)	100
9.6.1 Operating System Interface Requirements.	100
9.6.2 Shell and Utility Requirements	108
9.6.3 Development Platform Requirements	108
Annex A: POSIX Profiles Package (Ada Language).	109
Annex B: Description of Optional Interfaces	111
B.1 POSIX.1 Options.	111
B.2 POSIX.5c Options	120
Annex C: Bibliography.	123
C.1 Related Open Systems Standards	123
C.2 Other Documents	123
Alphabetic Topical Index.	125

COPYRIGHT © 2004 IEEE. ALL RIGHTS RESERVED.

List of Figures

Figure I.1 — Main Building Blocks of the Profiles.	xvii
--	------

Copyright © 2004 IEEE. All rights reserved.

List of Tables

Table 1-1 — POSIX.1 Units of Functionality	5
Table 1-2 — POSIX.5 Units of Functionality (Ada Language Support) . .	10
Table 1-3 — POSIX.5 Units of Functionality (Device IO)	11
Table 1-4 — POSIX.5 Units of Functionality (Device Specific)	11
Table 1-5 — POSIX.5 Units of Functionality (Event Management)	12
Table 1-6 — POSIX.5 Units of Functionality (FD Management)	12
Table 1-7 — POSIX.5 Units of Functionality (FIFO)	12
Table 1-8 — POSIX.5 Units of Functionality (File Attributes)	12
Table 1-9 — POSIX.5 Units of Functionality (File System)	13
Table 1-10 — POSIX.5 Units of Functionality (Job Control)	13
Table 1-11 — POSIX.5 Units of Functionality (Multi-Process)	14
Table 1-12 — POSIX.5 Units of Functionality (Networking)	14
Table 1-13 — POSIX.5 Units of Functionality (Pipes)	14
Table 1-14 — POSIX.5 Units of Functionality (Signals)	15
Table 1-15 — POSIX.5 Units of Functionality (Single Process)	15
Table 1-16 — POSIX.5 Units of Functionality (System Database)	16
Table 1-17 — POSIX.5 Units of Functionality (User Groups)	16
Table 1-18 — Units of Functionality Requirements	17
Table 1-19 — POSIX.1 Option Requirements	18
Table 1-21 — POSIX.1 Options vs. POSIX.5c Options	20
Table 1-20 — Requirements for Other Standards	20
Table 6-1 — POSIX.1 Units of Functionality Requirements	39
Table 6-2 — POSIX.1 Option Requirements	39
Table 6-3 — POSIX.5c Units of Functionality Requirements	40
Table 6-4 — POSIX.5c Option Requirements	41
Table 6-5 — Functions required to be async-signal-safe	42
Table 7-1 — POSIX.1 Units of Functionality Requirements	57
Table 7-2 — POSIX.1 Option Requirements	57
Table 7-3 — POSIX.5c Units of Functionality Requirements	59
Table 7-4 — POSIX.5c Option Requirements	59
Table 7-5 — Functions required to be async-signal-safe	61
Table 8-1 — POSIX.1 Units of Functionality Requirements	75
Table 8-2 — POSIX.1 Option Requirements	75
Table 8-3 — POSIX.5c Units of Functionality Requirements	77
Table 8-4 — POSIX.5c Option Requirements	77
Table 9-1 — POSIX.1 Units of Functionality Requirements	93
Table 9-2 — POSIX.1 Option Requirements	94
Table 9-3 — POSIX.1 Units of Functionality Requirements	95

Copyright © 2004 IEEE. All rights reserved.

Table 9-4 — POSIX.5c Option Requirements	96
Table 9-5 — Shell and Utilities Option Requirements (C Language Option)	98
Table 9-6 — Shell and Utilities Option Requirements (Ada Language Option)	98
Table B-1 — Functions under each POSIX.1 System Interface Option	111
Table B-2 — Utilities under each POSIX.1 Shell and Utilities Option	119
Table B-3 — Packages and Subprograms under Each POSIX.5c Option	120

Copyright © 2004 IEEE. All rights reserved.

Introduction

(This introduction is not a normative part of IEEE Std 1003.13™-2003, IEEE Standard for Information Technology—Standardized Application Environment Profile (AEP)—POSIX® Realtime and Embedded Application Support.)

The purpose of this standard is to define realtime and embedded 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 a revision of IEEE Std 1003.13-1998, where four realtime application environment profiles (or POSIX subsets) are defined. The goal of this revision is to update each of the four profiles according to implementation experience and to add the services defined in the following, newly approved POSIX standards:

- ISO/IEC 9945:2003 {3} (identical to IEEE Std 1003.1™-2003)
- IEEE 1003.26™-2003 {4}
- ISO/IEC 14519:2001 {5}

The base standard, ISO/IEC 9945:2003 {3}, allows profiling standards supporting functional requirements less than those required in the full base standard to subset both mandatory and optional functionality required for POSIX Conformance (see the Base Definitions volume of POSIX.1 {3}, Section 2.1.5.1). POSIX.13 articulates these subprofiling options through Units of Functionality, defined herein, and by use of named options defined in the base standard.

This standard specifies realtime profiles both for the C language and for the Ada language options. Because Ada Bindings to ISO/IEC 9945:2003 {3} are currently under development, the C language option contains more services than the Ada language option in the current draft. If these Ada Bindings are completed before this proposed standard is sent to ballot, the draft will be amended to incorporate them. Otherwise, an amendment of IEEE Std 1003.13-2003 will be produced in the future, to incorporate the added Ada language services.

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

Copyright © 2004 IEEE. All rights reserved.

development and testing is done on the larger and more comfortable systems. It also may be used in the construction of large and heterogeneous 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 standard, the term "POSIX.13" refers to this standard, IEEE Std 1003.13-2003.

Organization of this Standard

This standard is divided into nine elements:

- (1) Overview (Section 1)
- (2) Normative references (Section 2)
- (3) Terms and definitions (Section 3)
- (4) Conventions and abbreviations (Section 4)
- (5) Conformance (Section 5)
- (6) The various realtime profiles (Section 6, Section 7, Section 8, and Section 9)
- (7) The POSIX Profiles package in Ada (Annex A)
- (8) A description of the optional interfaces of the base standards (Annex B)
- (9) Bibliography (Annex C)

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

Informative annexes are not normative parts of the standard and are provided for information only. They are provided for guidance and to help understanding.

Copyright © 2004 IEEE. All rights reserved.

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 (C99 Language) and 8652 (Ada95 Language).

Scenario

This standard is based directly on existing small and/or realtime [typically non-UNIX^{®1)}] 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 1-18 through Table 1-21).

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.

1) UNIX is a registered trademark of The Open Group.

Rationale on Background

This clause contains rationale common to all four realtime profiles.

The developers of POSIX.13 represent a cross section of hardware 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.13 describes a set of application environment profiles (AEPs) 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 during the development of the 1998 version of POSIX.13. These included **pSOS**^{™, 2)}, **VRTX32**^{®, 3)} and **VxWorks**^{®, 4)}. 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 all proposed standard interfaces for small realtime embedded systems.

Features of other commercial realtime kernels such as **RTLinux**⁵⁾ and **QNX**^{®, 6)} as well as free software products such as **RTEMS**⁷⁾ were considered during the development of the current revision of POSIX.13.

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

2) **pSOS** is a registered trademark of Wind River Systems, Inc.

3) **VRTX32** is a registered trademark of Mentor Graphics Corporation.

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

5) **RTLinux** is a product of FSMLabs, Inc.

6) **QNX** is a registered trademark of QNX Software Systems, Ltd.

7) **RTEMS** is free software developed by OAR Corporation for the U.S. Army Missile Command.

Copyright © 2004 IEEE. All rights reserved.

- 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 or priority ceiling protocols
- Local or global event flags (one thread awaits multiple things)
- Multiple memory areas, with both fixed- and variable-sized block allocation policies
- System time in units of clock ticks
- Timeouts on all blocking services in units of clock ticks
- Hardware interrupt control and support for user interrupt handlers
- Signals
- Exception handling
- Minimal synchronous I/O interface: *open()*, *close()*, *read()*, *write()*, *ioctl()*, *posix_devctl()*
- 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

Copyright © 2004 IEEE. All rights reserved.

Local File System

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

- Named files
- Hierarchical file system (directories)
- Contiguous preallocation of disk space
- May provide media compatibility with another file system [e.g., **MSDOS**^{®8)} or **RT-11**^{™9)}]
- No user IDs or file protection

Historically, file systems 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**^{™10)}], 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 nondeterministic 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 file systems in this AEP.

Although few embedded systems had a hard drive and a file system, present flash memory technology has enabled embedded systems, even those with strict vibration requirements, to have a file system resident on this kind of nonvolatile media. This has caused the POSIX.13 profile designed for large embedded systems, the Dedicated Realtime System Profile (PSE53), to incorporate a simplified file system in this new revision of the standard.

Traditional implementations of POSIX.1 file systems employ a disk buffer cache to improve average 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

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

9) **RT-11** is a trademark of Mentec Inc.

10) **RSX-11M** is a trademark of Mentec Inc.

Copyright © 2004 IEEE. All rights reserved.

the file system in a corrupted state. This situation is usually corrected at the next system reboot by a file system checker and recovery program, such as `fsck`. The checking and correcting of a corrupted file system may take a long and variable amount of time to perform, may require a human operator to monitor and control its progress, and may nonetheless fail to repair the file system. Any one of these characteristics would make a file system check unacceptable for some embedded realtime applications. It was therefore suggested that such applications limit their use of directory operations to *safe* times, and that implementations maintain the file system in such a way that a file system 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 file system
- 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, remote procedure calls
- **distributed**
Transparent access to objects, no load-balancing

Copyright © 2004 IEEE. All rights reserved.

- **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

Only the larger profiles (i.e., PSE54) are likely to be self-hosted.

Overview of the Profiles Structure (Rationale)

This clause contains rationale common to all four realtime profiles.

The four profiles defined in this standard are designed to make applications upwards compatible to higher profiles. Figure I.1 shows the main building blocks of each of the four profiles specified in this standard. Please note that the full differences between the different profiles are more complex than those appearing on this figure. See 1.6 for a full description of the differences between the profiles.

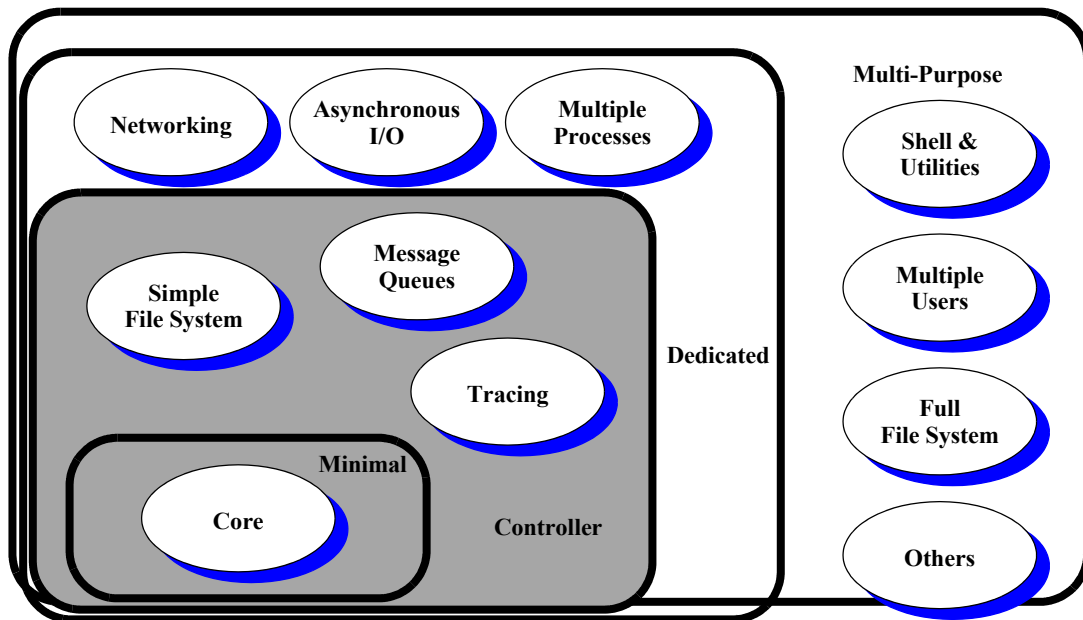


Figure I.1 — Main Building Blocks of the Profiles

Copyright © 2004 IEEE. All rights reserved.

The “core” building block in Figure I.1 refers to the Units of Functionality and options required in all four profiles. See 6.2 for a description of the core services. Profiles with only one implicit process (PSE51 and PSE52) are shaded in the figure, to highlight this major difference with the larger profiles, which require support for multiple processes (and thus require having an MMU).

Related Standards Activities

Activities to extend this standard 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 future¹¹⁾:

- (1) Additional system application program interfaces (APIs) in C language
- (2) Ada language bindings
- (3) Additional realtime facilities
- (4) Fault tolerance
- (5) Profiles describing application- or user-specific combinations of Open Systems standards

If you have interest in participating in the Portable Application Standards Committee (PASC) working groups addressing these issues, please send your name, address, and telephone number to

Secretary, IEEE Standards Board
Institute of Electrical and Electronics Engineers, Inc.
445 Hoes Lane
Piscataway, NJ 08854
USA

When writing, ask to have your letter forwarded to the chair of the appropriate PASC working group.

If you have interest in participating in this work at the international level, contact your ISO/IEC national body.

11) 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, Inc., 445 Hoes Lane, Piscataway, NJ 08854 (<http://www.standards.ieee.org/>).

Notice to Users

Errata

Errata, if any, for this and all other standards can be accessed at the following URL: <http://standards.ieee.org/reading/ieee/updates/errata/index.html>. Users are encouraged to check this URL for errata periodically.

Interpretations

Current interpretations can be accessed at the following URL: <http://standards.ieee.org/reading/ieee/interp/index.html>.

Patents

Attention is called to the possibility that implementation of this standard may require use of subject matter covered by patent rights. By publication of this standard, no position is taken with respect to the existence or validity of any patent rights in connection therewith. The IEEE shall not be responsible for identifying patents or patent applications for which a license may be required by to implement an IEEE standard or for conducting inquiries into the legal validity or scope of those patents that are brought to its attention.

Participants in the 2003 Version

IEEE Std 1003.13-2003 was prepared by the System Services Working Group—Realtime, sponsored by the Portable Application Standards Committee of the IEEE Computer Society. At the time this standard was approved, the membership of the System Services Working Group—Realtime was as follows:

Portable Application Standards Committee

Chair:	Lowell G. Johnson
Vice Chair:	Joseph M. Gwinn
Functional Vice Chairs:	Jay Ashford
	Andrew Josey
	Curtis Royster, Jr.
Secretary:	Nick Stoughton

Copyright © 2004 IEEE. All rights reserved.

IEEE System Services Working Group—Realtime

Chair:	Joseph M. Gwinn
Secretary:	Karen D. Gordon
Technical Editor:	Michael González
Ballot Coordinator:	James T. Oblinger
Technical Reviewer:	Michael González

Working Group

At the time this standard was completed, the IEEE System Services Working Group—Realtime had the following members:

Pierre-Jean Arcos	Dave Emery	François Riche
Ted Baker	Andrew Josey	Doug Robinson
Bob Barned	Jim Litchfield	Greg Shelton
Donald Cragun	Franklin C. Prindle	Peter van der Veen
	Ray Richards	

Balloting Committee

The following members of the individual balloting committee voted on this standard. Balloters may have voted for approval, disapproval, or abstention.

Alejandro Alonso	Scott Gudgel	François Riche
Pierre-Jean Arcos	Joseph M. Gwinn	John Riley
Mario Barbacci	Barry Hedquist	Curtis Royster, Jr.
Mitchell Bonnett	Charles Hammons	Diane Schleicher
Mark Brown	Karl Heubaum	Stephen Schwarm
Paul Buerger	Lowell G. Johnson	Yuriy Sheynin
Donald Cragun	Andrew Josey	Gil Shultz
John Davies	Joerg Kampmann	Keld Simonsen
Juan Antonio de la Puente	Bill LaPlant	Arun Subbarao
Sourav Dutta	Roger J. Martin	Mark-Rene Uchida
Yaacov Fenster	George Miao	Srinivasa Vemuru
Michel Gien	James T. Oblinger	Rina Walach
Michael González	Peter Petrov	Oren Yuen
Karen D. Gordon	Franklin C. Prindle	Janusz Zalewski
	Vikram Punj	

Copyright © 2004 IEEE. All rights reserved.

When the IEEE-SA Standards Board approved this standard on 10 December 2003, it had the following membership:

Don Wright, *Chair*
Howard M. Frazier, *Vice Chair*
Judith Gorman, *Secretary*

H. Stephen Berger	Donald N. Heirman	Daleep C. Mohla
Joseph A. Bruder	Laura Hitchcock	William J. Moylan
Bob Davis	Richard H. Hulett	Paul Nikolich
Richard DeBlasio	Anant Kumar Jain	Gary S. Robinson
Julian Forster*	Lowell G. Johnson	Malcolm V. Thaden
Toshio Fukuda	Joseph L. Koepfinger*	Geoffrey O. Thompson
Arnold M. Greenspan	Tom McGean	Doug Topping
Raymond Hapeman	Steve M. Mills	Howard L. Wolfman

*Member Emeritus

Also included are the following nonvoting IEEE-SA Standards Board liaisons:

Alan Cookson, *NIST Representative*
Satish K. Aggarwal, *NRC Representative*

Savoula Amanatidis
IEEE Standards Managing Editor

Participants in the 1998 Version

IEEE Std 1003.13-1998 was prepared by the System Services Working Group—Realtime, sponsored by the Portable Application Standards Committee of the IEEE Computer Society. At the time this standard was approved, the membership of the System Services Working Group—Realtime was as follows:

Portable Application Standards Committee

Chair:	Lowell G. Johnson
Vice Chair:	Joseph M. Gwinn
Functional Vice Chairs:	Jay Ashford
	Andrew Josey
	Curtis Royster, Jr.
Secretary:	Nick Stoughton

Copyright © 2004 IEEE. All rights reserved.

IEEE System Services Working Group—Realtime

Chair:	Joseph M. Gwinn Susan Corwin (to 1995)
Secretary:	Karen D. Gordon Franklin C. Prindle (1996) Lee Schermerhorn (to 1994)
Technical Editor:	Bob Luken
Ballot Coordinators:	Andrew E. Wheeler, Jr. James T. Oblinger
Technical Reviewers:	Andrew E. Wheeler, Jr. Joseph M. Gwinn Karen D. Gordon

Working Group

Ray Alderman	Michael Feustel	Dave Lunger
Larry Anderson	Bill Gallmeister	Bill Maes
Pierre-Jean Arcos	Michael González	James T. Oblinger
Charles R. Arnold	Karen D. Gordon	Offer Pazy
V. Raj Avula	Randy Greene	Carolyn Petersen
Theodore P. Baker	Rick Greer	Dave Plauger
Todd Bargorek	Joseph M. Gwinn	Arlan Pool
Robert Barned	Steven A. Haaser	Franklin C. Prindle
Richard M. Bergman	Barbara Haleen	François Riche
Nawaf Bitar	Geoffrey R. Hall	Robert Rose
Steve Brosky	Patrick Hebert	Gordon W. Ross
David Butenhof	Mary R. Hermann	Barry Ruzek
Hans Petter Christiansen	David Hughes	Webb Scales
Dave Cooper	Duane Hughes	Lee Schermerhorn
Susan Corwin	Michael B. Jones	Del Swanson
Bill Cox	Steven Kleiman	Barry Traylor
June R. Curtis	Robert Knighten	Stephen R. Walli
Peter Dibble	C. Douglass Locke	Andrew E. Wheeler, Jr.
Christoph Eck	Kent Long	David Wilner
Maryland R. Edwards	Robert D. Luken	John Zolnowsky

Balloting Group

The following persons were members of the 1003.13 Balloting Group that approved the standard for submission to the IEEE Standards Board:

Norman Aaronson	Andy R. Bihain	Lee Damico
Alejandro Alonso-Muñoz	Shirley Bockstahler-Brandt	Christoph Eck
Pierre-Jean Arcos	Steve Case	James A. Eiler
Charles R. Arnold	Hu Cheng	Philip H. Enslow
Theodore P. Baker	Hans Pietter Christiansen	Donna K. Fisher
Robert Barned	Susan Corwin	Michel Gien
Jason Behm	Donald Cragun	John Gilbert
Richard M. Bergman	June R. Curtis	Michael González

Copyright © 2004 IEEE. All rights reserved.

Karen D. Gordon
Mars J. Gralia
Randy Greene
Joseph M. Gwinn
Steven A. Haaser
Geoffrey R. Hall
Patrick Hebert
Hans H. Heilborn
Duane Hughes
Hal Jespersen
Michael B. Jones
Joe Kelsey
Judy Kerner
Lawrence J. Kilgallen

Martin J. Kirk
Thomas M. Kurihara
Kevin Lewis
C. Douglass Locke
Kent Long
James P. Lonjers
Lee W. Lucas
Robert D. Luken
Dave Lunger
Marshall McKusick
Craig B. Meyers
Diana Norwood
James T. Oblinger
Dave Plauger
Arlan Pool

Franklin C. Prindle
Paul Rabin
Wendy Rauch
Henry H. Robbins
Steven Schwarm
Del Swanson
Sandra Swearingen
James G. Tanner
Mark-Rene Uchida
Andrew E. Wheeler, Jr.
David Wilner
Oren Yuen
John J. Zenor
John Zolnowsky

When the IEEE-SA Standards Board approved IEEE 1003.13 on 19 March 1998, it had the following membership:

Richard J. Holleman *Chair*
Donald N. Heirman, *Vice Chair*
Judith Gorman, *Secretary*

Satish K. Aggarwal
Clyde R. Camp
James T. Carlo
Gary R. Engmann
Harold E. Epstein
Julian Forster*
Thomas F. Garritty
Ruben D. Garzon

James H. Gurney
Jim D. Isaak
Lowell G. Johnson
Robert Kennelly
E.G. "Al" Kiener
Joseph L. Koepfinger*
Stephen R. Lambert
Jim Logothetis
Donald C. Loughry

L. Bruce McClung
Louis-François Pau
Ronald C. Petersen
Gerald H. Peterson
John B. Posey
Gary S. Robinson
Hans E. Weinrich
Donald W. Zispe

*Member Emeritus

Noelle Humenick
IEEE Standards Project Editor

Copyright © 2004 IEEE. All rights reserved.

This page is left intentionally blank.

IEEE Standard for Information Technology— Standardized Application Environment Profile (AEP)—POSIX[®] Realtime and Embedded Application Support

Section 1: Overview

1.1 Scope

This standard establishes a set of Realtime and Embedded Environment Profiles based on ISO/IEC 9945:2003 {3}, IEEE Std 1003.26[™]-2003 {4}, ISO/IEC 14519:2001 {5}, and related standards specifying foundations for realtime applications. It is a revision of the previous IEEE Std 1003.13[™]-1998, which established Realtime Profiles based on ISO/IEC 9945-1:1990, as amended by IEEE Std 1003.1b[™]-1993, IEEE Std 1003.5b[™]-1996, and ISO/IEC 9945-2:1993. Both C {2} and Ada {1} language application program interfaces are addressed in this standard.

The Application Environment Profiles (AEPs) specified herein are appropriate for the development and execution of realtime or embedded applications using the services and utilities provided by standards called out in this standard.

Copyright © 2004 IEEE. All rights reserved.

1.2 Taxonomy Position

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

PSE53— Dedicated Realtime System Profile

PSE54— Multi-Purpose Realtime System Profile

1.2.1 Rationale for Positioning (informative)

(This subclause is not a normative part of IEEE Std 1003.13-2003.)

This standard 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 Open System Environment (OSE) profile is complete and coherent within the context of the class of applications supported. As such, it is a System Profile class of AEP.

1.3 Realtime System Profiles

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

1.3.1 Minimal Realtime System Profile (PSE51)

PSE51 systems are typically embedded in larger 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 (implicit)

Copyright © 2004 IEEE. All rights reserved.

POSIX process (corresponding to the processor's hardware address space), containing one or more threads of control (POSIX.1 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 (PSE52)

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

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

1.3.3 Dedicated Realtime System Profile (PSE53)

These systems are an extension of the Realtime Controller System Profile. Support for multiple processes has been added. Although these are usually embedded systems, flash memory technology enables presence of a simplified file system, even in those systems with mechanical or environmental requirements that preclude a rotating-media hard drive. 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, each with its own MMU, in the same system.

1.3.4 Multi-Purpose Realtime System Profile (PSE54)

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 most of POSIX.1 {3} and/or POSIX.5c {5}. Since

Copyright © 2004 IEEE. All rights reserved.

users may conduct interactive sessions on those systems, all the mandatory elements of the Shell and Utilities volume of POSIX.1 {3} are also included. Support for multiple multithreaded processes is required so that multitasking may be done by threads (POSIX.1 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 {3}; each of these units represents a Subprofiling Option Group (see the Base Definitions volume of POSIX.1 {3}, Section 2.1.5.1) and is a set of interfaces that represents a separately implementable element of POSIX.1 {3}. Table 1-2 through Table 1-17 show the Units of Functionality defined for POSIX.5c {5}.

1.5 Development Environment

Although the Shell and Utilities part of POSIX.1 {3} is not required for the execution environment of PSE51, PSE52, or PSE53, option POSIX2_SW_DEV is required in the development environments for all four profiles. The option POSIX2_C_DEV is required for C language development environments.

Copyright © 2004 IEEE. All rights reserved.

Table 1-1 — POSIX.1 Units of Functionality

Unit of Functionality	Included Interfaces
POSIX_C_LANG_JUMP	<i>longjmp()</i> , <i>setjmp()</i>
POSIX_C_LANG_MATH	<i>acos()</i> , <i>acosf()</i> , <i>acosh()</i> , <i>acoshf()</i> , <i>acoshl()</i> , <i>acosl()</i> , <i>asin()</i> , <i>asinf()</i> , <i>asinh()</i> , <i>asinhf()</i> , <i>asinhhl()</i> , <i>asinhl()</i> , <i>atan()</i> , <i>atan2()</i> , <i>atan2f()</i> , <i>atan2l()</i> , <i>atanf()</i> , <i>atanh()</i> , <i>atanhf()</i> , <i>atanhl()</i> , <i>atanl()</i> , <i>cabs()</i> , <i>cabsf()</i> , <i>cabsl()</i> , <i>cacos()</i> , <i>cacosf()</i> , <i>cacosh()</i> , <i>cacoshf()</i> , <i>cacoshl()</i> , <i>cacosl()</i> , <i>carg()</i> , <i>cargf()</i> , <i>cargl()</i> , <i>casin()</i> , <i>casinf()</i> , <i>casinh()</i> , <i>casinhf()</i> , <i>casinhhl()</i> , <i>casinhl()</i> , <i>catan()</i> , <i>catanf()</i> , <i>catanh()</i> , <i>catanhf()</i> , <i>catanhhl()</i> , <i>catanhl()</i> , <i>cbrt()</i> , <i>cbrtf()</i> , <i>cbrtl()</i> , <i>ccos()</i> , <i>ccosf()</i> , <i>ccosh()</i> , <i>ccoshf()</i> , <i>ccoshhl()</i> , <i>ccosl()</i> , <i>ceil()</i> , <i>ceilf()</i> , <i>ceilhl()</i> , <i>cexp()</i> , <i>cexpf()</i> , <i>cexpl()</i> , <i>cimag()</i> , <i>cimagf()</i> , <i>cimagl()</i> , <i>clog()</i> , <i>clogf()</i> , <i>clogl()</i> , <i>conj()</i> , <i>conjf()</i> , <i>conjl()</i> , <i>copysign()</i> , <i>copysignf()</i> , <i>copysignl()</i> , <i>cos()</i> , <i>cosf()</i> , <i>cosh()</i> , <i>coshf()</i> , <i>coshhl()</i> , <i>cosl()</i> , <i>cpow()</i> , <i>cpowf()</i> , <i>cpowl()</i> , <i>cproj()</i> , <i>cprojf()</i> , <i>cprojl()</i> , <i>creal()</i> , <i>crealf()</i> , <i>creall()</i> , <i>csin()</i> , <i>csinf()</i> , <i>csinh()</i> , <i>csinhf()</i> , <i>csinhhl()</i> , <i>csinhl()</i> , <i>csqrt()</i> , <i>csqrtf()</i> , <i>csqrtl()</i> , <i>ctan()</i> , <i>ctanf()</i> , <i>ctanh()</i> , <i>ctanhf()</i> , <i>ctanhhl()</i> , <i>ctanhl()</i> , <i>erf()</i> , <i>erfc()</i> , <i>erfcf()</i> , <i>erfcl()</i> , <i>erff()</i> , <i>erfl()</i> , <i>exp2()</i> , <i>exp2f()</i> , <i>exp2l()</i> , <i>expf()</i> , <i>expl()</i> , <i>expm1()</i> , <i>expm1f()</i> , <i>expm1l()</i> , <i>fabs()</i> , <i>fabsf()</i> , <i>fabsl()</i> , <i>fdim()</i> , <i>fdimf()</i> , <i>fdiml()</i> , <i>floor()</i> , <i>floorf()</i> , <i>floorl()</i> , <i>fma()</i> , <i>fmaf()</i> , <i>fmal()</i> , <i>fmax()</i> , <i>fmaxf()</i> , <i>fmaxl()</i> , <i>fmin()</i> , <i>fminf()</i> , <i>fminl()</i> , <i>fmod()</i> , <i>fmodf()</i> , <i>fmodl()</i> , <i>fpclassify()</i> , <i>frexp()</i> , <i>frexpf()</i> , <i>frexpl()</i> , <i>hypot()</i> , <i>hypotf()</i> , <i>hypotl()</i> , <i>ilogb()</i> , <i>ilogbf()</i> , <i>ilogbl()</i> , <i>isfinite()</i> , <i>isgreater()</i> , <i>isgreaterl()</i> , <i>isinf()</i> , <i>isless()</i> , <i>islessequal()</i> , <i>islessgreater()</i> , <i>isnan()</i> , <i>isnormal()</i> , <i>isunordered()</i> , <i>ldexp()</i> , <i>ldexpf()</i> , <i>ldexpl()</i> , <i>lgamma()</i> , <i>lgammaf()</i> , <i>lgammal()</i> , <i>llrint()</i> , <i>llrintf()</i> , <i>llrintl()</i> , <i>llround()</i> , <i>llroundf()</i> , <i>llroundl()</i> , <i>log()</i> , <i>log10()</i> , <i>log10f()</i> , <i>log10l()</i> , <i>log1p()</i> , <i>log1pf()</i> , <i>log1pl()</i> , <i>log2()</i> , <i>log2f()</i> , <i>log2l()</i> , <i>logb()</i> , <i>logbf()</i> , <i>logbl()</i> , <i>logf()</i> , <i>logl()</i> , <i>lrint()</i> , <i>lrintf()</i> , <i>lrintl()</i> , <i>lround()</i> , <i>lroundf()</i> , <i>lroundl()</i> , <i>modf()</i> , <i>modff()</i> , <i>modfl()</i> , <i>nan()</i> , <i>nanf()</i> , <i>nanl()</i> , <i>nearbyint()</i> , <i>nearbyintf()</i> , <i>nearbyintl()</i> , <i>nextafter()</i> , <i>nextafterf()</i> , <i>nextafterl()</i> , <i>nexttoward()</i> , <i>nexttowardf()</i> , <i>nexttowardl()</i> , <i>pow()</i> , <i>powf()</i> , <i>powl()</i> , <i>remainder()</i> , <i>remainderf()</i> , <i>remainderl()</i> , <i>remquo()</i> , <i>remquof()</i> , <i>remquol()</i> , <i>rint()</i> , <i>rintf()</i> , <i>rintl()</i> , <i>round()</i> , <i>roundf()</i> , <i>roundl()</i> , <i>scalbln()</i> , <i>scalblnf()</i> , <i>scalblnl()</i> , <i>scalbn()</i> , <i>scalbnf()</i> , <i>scalbnl()</i> , <i>signbit()</i> , <i>sin()</i> , <i>sinf()</i> , <i>sinh()</i> , <i>sinhf()</i> , <i>sinhl()</i> , <i>sinl()</i> , <i>sqrt()</i> , <i>sqrtf()</i> , <i>sqrtl()</i> , <i>tan()</i> , <i>tanf()</i> , <i>tanh()</i> , <i>tanhf()</i> , <i>tanhhl()</i> , <i>tanl()</i> , <i>tgamma()</i> , <i>tgammaf()</i> , <i>tgammaf()</i> , <i>trunc()</i> , <i>truncf()</i> , <i>truncl()</i>

Copyright © 2004 IEEE. All rights reserved.

Table 1-1 — POSIX.1 Units of Functionality (Continued)

Unit of Functionality	Included Interfaces
POSIX_C_LANG_SUPPORT	<i>abs()</i> , <i>asctime()</i> , <i>asctime_r()</i> , <i>atof()</i> , <i>atoi()</i> , <i>atol()</i> , <i>atoll()</i> , <i>bsearch()</i> , <i>calloc()</i> , <i>ctime()</i> , <i>ctime_r()</i> , <i>difftime()</i> , <i>div()</i> , <i>feclearexcept()</i> , <i>fegetenv()</i> , <i>fegetexceptflag()</i> , <i>fegetround()</i> , <i>fehldexcept()</i> , <i>feraiseexcept()</i> , <i>fesetenv()</i> , <i>fesetexceptflag()</i> , <i>fesetround()</i> , <i>fetestexcept()</i> , <i>feupdateenv()</i> , <i>free()</i> , <i>gmtime()</i> , <i>gmtime_r()</i> , <i>imaxabs()</i> , <i>imaxdiv()</i> , <i>isalnum()</i> , <i>isalpha()</i> , <i>isblank()</i> , <i>iscntrl()</i> , <i>isdigit()</i> , <i>isgraph()</i> , <i>islower()</i> , <i>isprint()</i> , <i>ispunct()</i> , <i>isspace()</i> , <i>isupper()</i> , <i>isxdigit()</i> , <i>labs()</i> , <i>ldiv()</i> , <i>llabs()</i> , <i>lldiv()</i> , <i>localeconv()</i> , <i>localtime()</i> , <i>localtime_r()</i> , <i>malloc()</i> , <i>memchr()</i> , <i>memcmp()</i> , <i>memcpy()</i> , <i>memmove()</i> , <i>memset()</i> , <i>mktime()</i> , <i>qsort()</i> , <i>rand()</i> , <i>rand_r()</i> , <i>realloc()</i> , <i>setlocale()</i> , <i>snprintf()</i> , <i>sprintf()</i> , <i>srand()</i> , <i>sscanf()</i> , <i>strcat()</i> , <i>strchr()</i> , <i>strcmp()</i> , <i>strcoll()</i> , <i>strcpy()</i> , <i>strcspn()</i> , <i>strerror()</i> , <i>strerror_r()</i> , <i>strftime()</i> , <i>strlen()</i> , <i>strncat()</i> , <i>strncmp()</i> , <i>strncpy()</i> , <i>strpbrk()</i> , <i>strrchr()</i> , <i>strspn()</i> , <i>strstr()</i> , <i>strtod()</i> , <i>strtof()</i> , <i>strtoimax()</i> , <i>strtok()</i> , <i>strtok_r()</i> , <i>strtol()</i> , <i>strtold()</i> , <i>strtoll()</i> , <i>strtoul()</i> , <i>strtoull()</i> , <i>strtoumax()</i> , <i>strxfrm()</i> , <i>time()</i> , <i>tolower()</i> , <i>toupper()</i> , <i>tzname</i> , <i>tzset()</i> , <i>va_arg()</i> , <i>va_copy()</i> , <i>va_end()</i> , <i>va_start()</i> , <i>vsprintf()</i> , <i>vsscanf()</i>
POSIX_C_LANG_WIDE_CHAR	<i>btowc()</i> , <i>iswalnum()</i> , <i>iswalphabet()</i> , <i>iswblank()</i> , <i>iswcntrl()</i> , <i>iswctype()</i> , <i>iswdigit()</i> , <i>iswgraph()</i> , <i>iswlower()</i> , <i>iswprint()</i> , <i>iswpunct()</i> , <i>iswspace()</i> , <i>iswupper()</i> , <i>iswxdigit()</i> , <i>mblen()</i> , <i>mbrlen()</i> , <i>mbtowc()</i> , <i>mbsinit()</i> , <i>mbsrtowcs()</i> , <i>mbstowcs()</i> , <i>mbtowc()</i> , <i>swprintf()</i> , <i>swscanf()</i> , <i>towctrans()</i> , <i>towlower()</i> , <i>towupper()</i> , <i>vwprintf()</i> , <i>vwscanf()</i> , <i>wcrtomb()</i> , <i>wcscat()</i> , <i>wcschr()</i> , <i>wscmp()</i> , <i>wscoll()</i> , <i>wscpy()</i> , <i>wcscspn()</i> , <i>wcsftime()</i> , <i>wcslength()</i> , <i>wcsncat()</i> , <i>wcsncmp()</i> , <i>wcsncpy()</i> , <i>wcspbrk()</i> , <i>wcsrchr()</i> , <i>wcsrtombs()</i> , <i>wcsspn()</i> , <i>wcssstr()</i> , <i>wcstod()</i> , <i>wcstof()</i> , <i>wcstoimax()</i> , <i>wcstok()</i> , <i>wcstol()</i> , <i>wcstold()</i> , <i>wcstoll()</i> , <i>wcstombs()</i> , <i>wcstoul()</i> , <i>wcstoull()</i> , <i>wcstoumax()</i> , <i>wcsxfrm()</i> , <i>wctob()</i> , <i>wctomb()</i> , <i>wctrans()</i> , <i>wctype()</i> , <i>wmemchr()</i> , <i>wmemcmp()</i> , <i>wmemcpy()</i> , <i>wmemmove()</i> , <i>wmemset()</i>
POSIX_DEVICE_IO	<i>clearerr()</i> , <i>close()</i> , <i>fclose()</i> , <i>fdopen()</i> , <i>feof()</i> , <i>ferror()</i> , <i>fflush()</i> , <i>fgetc()</i> , <i>fgets()</i> , <i>fileno()</i> , <i>fopen()</i> , <i>fprintf()</i> , <i>fputc()</i> , <i>fputs()</i> , <i>fread()</i> , <i>freopen()</i> , <i>fscanf()</i> , <i>fwrite()</i> , <i>getc()</i> , <i>getchar()</i> , <i>gets()</i> , <i>open()</i> , <i>perror()</i> , <i>printf()</i> , <i>putc()</i> , <i>putchar()</i> , <i>puts()</i> , <i>read()</i> , <i>scanf()</i> , <i>setbuf()</i> , <i>setvbuf()</i> , <i>stderr</i> , <i>stdin</i> , <i>stdout</i> , <i>ungetc()</i> , <i>vfprintf()</i> , <i>vscanf()</i> , <i>vprintf()</i> , <i>vscanf()</i> , <i>write()</i>

Copyright © 2004 IEEE. All rights reserved.

Table 1-1 — POSIX.1 Units of Functionality (Continued)

Unit of Functionality	Included Interfaces
POSIX_DEVICE_SPECIFIC	<i>cfgetispeed(), cfgetospeed(), cfsetispeed(), cfsetospeed(), ctermid(), isatty(), tcdrain(), tcflow(), tcflush(), tcgetattr(), tcsendbreak(), tcsetattr(), ttyname(), ttyname_r()</i>
POSIX_EVENT_MGMT	<i>FD_CLR(), FD_ISSET(), FD_SET(), FD_ZERO(), pselect(), select()</i>
POSIX_FD_MGMT	<i>dup(), dup2(), fcntl(), fgetpos(), fseek(), fseeko(), fsetpos(), ftell(), ftello(), ftruncate(), lseek(), rewind()</i>
POSIX_FIFO	<i>mkfifo()</i>
POSIX_FILE_ATTRIBUTES	<i>chmod(), chown(), fchmod(), fchown(), umask()</i>
POSIX_FILE_LOCKING	<i>flockfile(), ftrylockfile(), funlockfile(), getc_unlocked(), getchar_unlocked(), putc_unlocked(), putchar_unlocked()</i>
POSIX_FILE_SYSTEM	<i>access(), chdir(), closedir(), creat(), fpathconf(), fstat(), getcwd(), link(), mkdir(), opendir(), pathconf(), readdir(), readdir_r(), remove(), rename(), rewinddir(), rmdir(), stat(), tmpfile(), tmpnam(), unlink(), utime()</i>
POSIX_FILE_SYSTEM_EXT	<i>glob(), globfree()</i>
POSIX_JOB_CONTROL⁽¹⁾	<i>setpgid(), tcgetpgrp(), tcsetpgrp()</i>
POSIX_MULTI_PROCESS	<i>_Exit(), _exit(), assert(), atexit(), clock(), execl(), execle(), execlp(), execv(), execve(), execvp(), exit(), fork(), getpgrp(), getpid(), getppid(), setsid(), sleep(), times(), wait(), waitpid()</i>
POSIX_NETWORKING	<i>accept(), bind(), connect(), endhostent(), endnetent(), endprotoent(), endservent(), freeaddrinfo(), gai_strerror(), getaddrinfo(), gethostbyaddr(), gethostbyname(), gethostent(), gethostname(), getnameinfo(), getnetbyaddr(), getnetbyname(), getnetent(), getpeername(), getprotobyname(), getprotobynumber(), getprotoent(), getservbyname(), getservbyport(), getservent(), getsockname(), getsockopt(), h_errno, htonl(), htons(), if_freenameindex(), if_indextoname(), if_nameindex(), if_nametoindex(), inet_addr(), inet_ntoa(), inet_ntop(), inet_pton(), listen(), ntohl(), ntohs(), recv(), recvfrom(), recvmsg(), send(), sendmsg(), sendto(), sethostent(), setnetent(), setprotoent(), setservent(), setsockopt(), shutdown(), socket(), socketatmark(), socketpair()</i>
POSIX_PIPE	<i>pipe()</i>
POSIX_REGEX⁽²⁾	<i>regcomp(), regerror(), regexexec(), regfree()</i>

Copyright © 2004 IEEE. All rights reserved.

Table 1-1 — POSIX.1 Units of Functionality (Continued)

Unit of Functionality	Included Interfaces
POSIX_RW_LOCKS⁽³⁾	<i>pthread_rwlock_destroy()</i> , <i>pthread_rwlock_init()</i> , <i>pthread_rwlock_rdlock()</i> , <i>pthread_rwlock_timedrdlock()</i> ⁽⁴⁾ , <i>pthread_rwlock_timedwrlock()</i> ^d , <i>pthread_rwlock_tryrdlock()</i> , <i>pthread_rwlock_trywrlock()</i> , <i>pthread_rwlock_unlock()</i> , <i>pthread_rwlock_wrlock()</i> , <i>pthread_rwlockattr_destroy()</i> , <i>pthread_rwlockattr_getpshared()</i> ⁽⁵⁾ , <i>pthread_rwlockattr_init()</i> , <i>pthread_rwlockattr_setpshared()</i> ^e
POSIX_SHELL_FUNC	<i>pclose()</i> , <i>popen()</i> , <i>system()</i> , <i>wordexp()</i> , <i>wordfree()</i>
POSIX_SIGNALS	<i>abort()</i> , <i>alarm()</i> , <i>kill()</i> , <i>pause()</i> , <i>raise()</i> , <i>sigaction()</i> , <i>sigaddset()</i> , <i>sigdelset()</i> , <i>sigemptyset()</i> , <i>sigfillset()</i> , <i>sigismember()</i> , <i>signal()</i> , <i>sigpending()</i> , <i>sigprocmask()</i> , <i>sigsuspend()</i> , <i>sigwait()</i>
POSIX_SIGNAL_JUMP	<i>siglongjmp()</i> , <i>sigsetjmp()</i>
POSIX_SINGLE_PROCESS	<i>confstr()</i> , <i>environ</i> , <i>errno</i> , <i>getenv()</i> , <i>setenv()</i> , <i>sysconf()</i> , <i>uname()</i> , <i>unsetenv()</i>
POSIX_STRING_MATCHING	<i>fnmatch()</i> , <i>getopt()</i> , <i>optarg</i> , <i>optind</i> , <i>opterr</i> , <i>optopt</i>
POSIX_SYMBOLIC_LINKS	<i>lstat()</i> , <i>readlink()</i> , <i>symlink()</i>
POSIX_SYSTEM_DATABASE	<i>getgrgid()</i> , <i>getgrgid_r()</i> , <i>getgrnam()</i> , <i>getgrnam_r()</i> , <i>getpwnam()</i> , <i>getpwnam_r()</i> , <i>getpwuid()</i> , <i>getpwuid_r()</i>
POSIX_THREADS_BASE⁽⁶⁾	<i>pthread_atfork()</i> , <i>pthread_attr_destroy()</i> , <i>pthread_attr_getdetachstate()</i> , <i>pthread_attr_getschedparam()</i> , <i>pthread_attr_init()</i> , <i>pthread_attr_setdetachstate()</i> , <i>pthread_attr_setschedparam()</i> , <i>pthread_cancel()</i> , <i>pthread_cleanup_pop()</i> , <i>pthread_cleanup_push()</i> , <i>pthread_cond_broadcast()</i> , <i>pthread_cond_destroy()</i> , <i>pthread_cond_init()</i> , <i>pthread_cond_signal()</i> , <i>pthread_cond_timedwait()</i> , <i>pthread_cond_wait()</i> , <i>pthread_condattr_destroy()</i> , <i>pthread_condattr_init()</i> , <i>pthread_create()</i> , <i>pthread_detach()</i> , <i>pthread_equal()</i> , <i>pthread_exit()</i> , <i>pthread_getspecific()</i> , <i>pthread_join()</i> , <i>pthread_key_create()</i> , <i>pthread_key_delete()</i> , <i>pthread_kill()</i> , <i>pthread_mutex_destroy()</i> , <i>pthread_mutex_init()</i> , <i>pthread_mutex_lock()</i> , <i>pthread_mutex_trylock()</i> , <i>pthread_mutex_unlock()</i> , <i>pthread_mutexattr_destroy()</i> , <i>pthread_mutexattr_init()</i> , <i>pthread_once()</i> , <i>pthread_self()</i> , <i>pthread_setcancelstate()</i> , <i>pthread_setcanceltype()</i> , <i>pthread_setspecific()</i> , <i>pthread_sigmask()</i> , <i>pthread_testcancel()</i>

Copyright © 2004 IEEE. All rights reserved.

Table 1-1 — POSIX.1 Units of Functionality (Continued)

Unit of Functionality	Included Interfaces
POSIX_USER_GROUPS	<i>getegid(), geteuid(), getgid(), getgroups(), getlogin(), getlogin_r(), getuid(), setegid(), seteuid(), setgid(), setuid()</i>
POSIX_WIDE_CHAR_IO	<i>fgetwc(), fgetws(), fputwc(), fputws(), fwide(), fwprintf(), fwscanf(), getwc(), getwchar(), putwc(), putwchar(), ungetwc(), vfwprintf(), vfwscanf(), vwprintf(), vwscanf(), wprintf(), wscanf()</i>
XSI_C_LANG_SUPPORT	<i>_tolower(), _toupper(), a64l(), daylight(), drand48(), erand48(), ffs(), getcontext(), getdate(), getsubopt(), hcreate(), hdestroy(), hsearch(), iconv(), iconv_close(), iconv_open(), initstate(), insque(), isascii(), jrand48(), l64a(), lcong48(), lfind(), lrand48(), lsearch(), makecontext(), memccpy(), mrand48(), nrand48(), random(), remque(), seed48(), setcontext(), setstate(), signgam, srand48(), srandom(), strcasecmp(), strdup(), strfmon(), strncasecmp(), strptime(), swab(), swapcontext(), tdelete(), tfind(), timezone, toascii(), tsearch(), twalk()</i>
XSI_DBM	<i>dbm_clearerr(), dbm_close(), dbm_delete(), dbm_error(), dbm_fetch(), dbm_firstkey(), dbm_nextkey(), dbm_open(), dbm_store()</i>
XSI_DEVICE_IO	<i>fmsg(), poll(), pread(), pwrite(), readv(), writev()</i>
XSI_DEVICE_SPECIFIC	<i>grantpt(), posix_openpt(), ptsname(), unlockpt()</i>
XSI_DYNAMIC_LINKING	<i>dlclose(), dlderror(), dlopen(), dlsym()</i>
XSI_FD_MGMT	<i>truncate()</i>
XSI_FILE_SYSTEM	<i>basename(), dirname(), fchdir(), fstatvfs(), ftw(), lchown(), lockf(), mknod(), mkstemp(), nftw(), realpath(), seekdir(), statvfs(), sync(), telldir(), tempnam()</i>
XSI_I18N	<i>catclose(), catgets(), catopen(), nl_langinfo()</i>
XSI_IPC	<i>ftok(), msgctl(), msgget(), msgrcv(), msgsnd(), semctl(), semget(), semop(), shmat(), shmctl(), shmdt(), shmget()</i>
XSI_JOB_CONTROL	<i>tcgetsid()</i>
XSI_JUMP	<i>_longjmp(), _setjmp()</i>
XSI_MATH	<i>j0(), j1(), jn(), scalb(), y0(), y1(), yn()</i>
XSI_MULTI_PROCESS	<i>getpgid(), getpriority(), getrlimit(), getrusage(), getsid(), nice(), setpgid(), setpriority(), setrlimit(), ulimit(), usleep(), vfork(), waitid()</i>
XSI_SIGNALS	<i>bsd_signal(), killpg(), sigaltstack(), sighold(), sigignore(), siginterrupt(), sigpause(), sigrelse(), sigset(), ualarm()</i>
XSI_SINGLE_PROCESS	<i>gethostid(), gettimeofday(), putenv()</i>
XSI_SYSTEM_DATABASE	<i>endpwent(), getpwent(), setpwent()</i>
XSI_SYSTEM_LOGGING	<i>closelog(), openlog(), setlogmask(), syslog()</i>

Copyright © 2004 IEEE. All rights reserved.

Table 1-1 — POSIX.1 Units of Functionality (Continued)

Unit of Functionality	Included Interfaces
XSI_THREAD_MUTEX_EXT	<i>pthread_mutexattr_gettype()</i> , <i>pthread_mutexattr_settype()</i>
XSI_THREADS_EXT	<i>pthread_attr_getguardsize()</i> , <i>pthread_attr_getstack()</i> , <i>pthread_attr_setguardsize()</i> , <i>pthread_attr_setstack()</i> , <i>pthread_getconcurrency()</i> , <i>pthread_setconcurrency()</i>
XSI_TIMERS	<i>getitimer()</i> , <i>setitimer()</i>
XSI_USER_GROUPS	<i>endgrent()</i> , <i>endutxent()</i> , <i>getgrent()</i> , <i>getutxent()</i> , <i>getutxid()</i> , <i>getutxline()</i> , <i>pututxline()</i> , <i>setgrent()</i> , <i>setregid()</i> , <i>setreuid()</i> , <i>setutxent()</i>
XSI_WIDE_CHAR	<i>wcswidth()</i> , <i>wcwidth()</i>

- (1) There was a `_POSIX_JOB_CONTROL` option in an earlier version of the POSIX standards that specified these functions. All of these functions are mandatory in POSIX.1 {3}.
- (2) There was a `_POSIX_REGEX` option in an earlier version of the POSIX standards that specified these functions. All of these functions are mandatory in POSIX.1 {3}.
- (3) There was a `_POSIX_READER_WRITER_LOCKS` option in an earlier version of the POSIX standards that specified these functions. All of these functions are part of the `_POSIX_THREADS` option in POSIX.1 {3}.
- (4) Dependent on the `_POSIX_TIMEOUTS` option.
- (5) Dependent on the `_POSIX_THREAD_PROCESS_SHARED` option.
- (6) `POSIX_THREADS_BASE` is the same as the `_POSIX_THREADS` option, but without the functions belonging to the `POSIX_RW_LOCKS` Unit of Functionality.

Table 1-2 — POSIX.5 Units of Functionality (Ada Language Support)

POSIX_ADA_LANG_SUPPORT	
Package	Subprograms
System	Extra requirements specified in POSIX.5c {5}, Section 2.8.
System_Storage_Elements	All ⁽¹⁾
POSIX_Page_Alignment	All
POSIX_Supplement_To_Ada_IO	All
Ada_Task_Identification	All
Ada_Streams	All

- (1) *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.

Copyright © 2004 IEEE. All rights reserved.

Table 1-3 — 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 1-4 — 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

Copyright © 2004 IEEE. All rights reserved.

Table 1-5 — POSIX.5 Units of Functionality (Event Management)

POSIX_EVENT_MGMT	
Package	Subprograms
POSIX_Event_Management ⁽¹⁾	Make_Empty Add Remove In_Set Select_File For_Every_File_In

⁽¹⁾ The subprograms listed in this table are those under the Select option in POSIX.5c {5}. But instead of using this option, a Unit of Functionality has been created because there is no equivalent option in POSIX.1 {3}.

Table 1-6 — 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

Table 1-7 — POSIX.5 Units of Functionality (FIFO)

POSIX_FIFO	
Package	Subprograms
POSIX_Files	Create_FIFO

Table 1-8 — 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

Copyright © 2004 IEEE. All rights reserved.

Table 1-9 — 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 Is_Socket
POSIX_Process_Environment	Change_Working_Directory Get_Working_Directory
POSIX_IO	Open_Or_Create

Table 1-10 — POSIX.5 Units of Functionality (Job Control)

POSIX_JOB_CONTROL⁽¹⁾	
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

⁽¹⁾ The subprograms listed in this table are those under the Job Control option in POSIX.5c {5}. But instead of using this option, a Unit of Functionality has been created because the equivalent option in POSIX.1 {3} does not specify the functions that fall under it.

Copyright © 2004 IEEE. All rights reserved.

Table 1-11 — 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 1-12 — POSIX.5 Units of Functionality (Networking)

POSIX_NETWORKING	
Package	Subprograms
POSIX_IO	Get_Owner Set_Socket_Process_Owner Set_Socket_Group_Owner Set_Buffer Get_Buffer
POSIX_Sockets	All ⁽¹⁾
POSIX_Sockets_Local	All ^a
POSIX_Sockets_Internet	All ⁽²⁾

⁽¹⁾ The POSIX_Sockets and POSIX_Sockets_Local packages depend on the Sockets Detailed Network Interface option (and partly on the Network Management option) defined in POSIX.5c {5}, but they are included here because there are no equivalent options in POSIX.1 {3}.

⁽²⁾ The POSIX_Sockets_Internet package depends on the Sockets Detailed Network Interface option (and partly on the Internet Protocol, Internet Datagram, and Internet Stream options) defined in POSIX.5c {5}, but it is included here because there are no equivalent options in POSIX.1 {3}.

Table 1-13 — POSIX.5 Units of Functionality (Pipes)

POSIX_PIPES	
Package	Subprograms
POSIX_IO	Create_Pipe

Copyright © 2004 IEEE. All rights reserved.

Table 1-14 — 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 Install_Empty_Handler Pending_Signals Await_Signal ⁽¹⁾ Await_Signal_Or_Timeout ^a Interrupt_Task Get_Signal ⁽²⁾ Set_Signal ^b Get_Notification Set_Notification Get_Data ^b Set_Data ^b

⁽¹⁾ Return type `Signal`.

⁽²⁾ Operation on type `Signal_Event`.

Table 1-15 — POSIX.5 Units of Functionality (Single Process)

POSIX_SINGLE_PROCESS	
Package	Subprograms
POSIX	All
POSIX_Limits	All
POSIX_Options	All
POSIX_Profiles	All ⁽¹⁾
POSIX_Configurable_System_Limits	All
POSIX_Calendar	All

Copyright © 2004 IEEE. All rights reserved.

Table 1-15 — POSIX.5 Units of Functionality (Single Process)

POSIX_SINGLE_PROCESS	
Package	Subprograms
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

⁽¹⁾ The POSIX_Profiles package is defined in Annex A of this standard.

Table 1-16 — POSIX.5 Units of Functionality (System Database)

POSIX_SYSTEM_DATABASE	
Package	Subprograms
POSIX_Group_Database	All
POSIX_User_Database	All

Table 1-17 — 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

Copyright © 2004 IEEE. All rights reserved.

1.6 Summary of Profile Features

Table 1-18 through Table 1-20 summarize the requirements of the four profiles using an X character to represent a required item and a short dash (–) to represent an item that is not required. Since POSIX.1 {3} and/or POSIX.5c {5} does 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 1-17.

Table 1-18 — Units of Functionality Requirements

Unit of Functionality	PSE51	PSE52	PSE53	PSE54
POSIX_ADA_LANG_SUPPORT ⁽¹⁾	X	X	X	X
POSIX_C_LANG_JUMP ⁽²⁾	X	X	X	X
POSIX_C_LANG_MATH ^b	–	X	X	X
POSIX_C_LANG_SUPPORT ^b	X	X	X	X
POSIX_C_LANG_WIDE_CHAR ^b	–	–	–	X
POSIX_DEVICE_IO	X	X	X	X
POSIX_DEVICE_SPECIFIC	–	–	–	X
POSIX_EVENT_MGMT	–	–	X	X
POSIX_FD_MGMT	–	X	X	X
POSIX_FIFO	–	–	–	X
POSIX_FILE_ATTRIBUTES	–	–	–	X
POSIX_FILE_LOCKING ^b	X	X	X	X
POSIX_FILE_SYSTEM	–	X	X	X
POSIX_FILE_SYSTEM_EXT ^b	–	–	–	X
POSIX_JOB_CONTROL	–	–	–	X
POSIX_MULTI_PROCESS	–	–	X	X
POSIX_NETWORKING	–	–	X	X
POSIX_PIPE	–	–	X	X
POSIX_REGEX ^b	–	–	–	X
POSIX_RW_LOCKS ^b	–	–	–	–
POSIX_SHELL_FUNC ^b	–	–	–	X
POSIX_SIGNALS	X	X	X	X
POSIX_SIGNAL_JUMP ^b	–	–	X	X
POSIX_SINGLE_PROCESS	X	X	X	X
POSIX_STRING_MATCHING ^b	–	–	–	X
POSIX_SYMBOLIC_LINKS ^b	–	–	–	X
POSIX_SYSTEM_DATABASE	–	–	–	X
POSIX_THREADS_BASE ^b	X	X	X	X
POSIX_USER_GROUPS	–	–	–	X
POSIX_WIDE_CHAR_IO ^b	–	–	–	X

Copyright © 2004 IEEE. All rights reserved.

Table 1-18 — Units of Functionality Requirements (Continued)

Unit of Functionality	PSE51	PSE52	PSE53	PSE54
XSI_C_LANG_SUPPORT ^b	—	—	—	—
XSI_DBM ^b	—	—	—	—
XSI_DEVICE_IO ^b	—	—	—	—
XSI_DEVICE_SPECIFIC ^b	—	—	—	—
XSI_DYNAMIC_LINKING ^b	—	—	—	X
XSI_FD_MGMT ^b	—	—	—	—
XSI_FILE_SYSTEM ^b	—	—	—	—
XSI_I18N ^b	—	—	—	—
XSI_IPC ^b	—	—	—	—
XSI_JOB_CONTROL ^b	—	—	—	—
XSI_JUMP ^b	—	—	—	—
XSI_MATH ^b	—	—	—	—
XSI_MULTI_PROCESS ^b	—	—	—	—
XSI_SIGNALS ^b	—	—	—	—
XSI_SINGLE_PROCESS ^b	—	—	—	—
XSI_SYSTEM_DATABASE ^b	—	—	—	—
XSI_SYSTEM_LOGGING ^b	—	—	—	X
XSI_THREAD_MUTEX_EXT ^b	X	X	X	X
XSI_THREADS_EXT ^b	X	X	X	X
XSI_TIMERS ^b	—	—	—	—
XSI_USER_GROUPS ^b	—	—	—	—
XSI_WIDE_CHAR ^b	—	—	—	—

(1) Required only for the Ada language option.

(2) Required only for the C language option.

Table 1-19 — POSIX.1 Option Requirements

Option	PSE51	PSE52	PSE53	PSE54
_POSIX_ADVISORY_INFO	—	—	—	X
_POSIX_ASYNCHRONOUS_IO	—	—	X	X
_POSIX_BARRIERS	—	—	—	—
_POSIX_CHOWN_RESTRICTED	—	—	—	X
_POSIX_CLOCK_SELECTION	X	X	X	X
_POSIX_CPUTIME	—	—	X	X
_POSIX_FSYNC	X	X	X	X
_POSIX_IPV6	—	—	—	—
_POSIX_MAPPED_FILES	—	X	X	X
_POSIX_MEMLOCK	X	X	X	X
_POSIX_MEMLOCK_RANGE	X	X	X	X

Copyright © 2004 IEEE. All rights reserved.

Table 1-19 — POSIX.1 Option Requirements (Continued)

Option	PSE51	PSE52	PSE53	PSE54
_POSIX_MEMORY_PROTECTION	—	—	X	X
_POSIX_MESSAGE_PASSING	—	X	X	X
_POSIX_MONOTONIC_CLOCK	X	X	X	X
_POSIX_NO_TRUNC	X	X	X	X
_POSIX_PRIORITIZED_IO	—	—	X	X
_POSIX_PRIORITY_SCHEDULING	—	—	X	X
_POSIX_RAW_SOCKETS	—	—	X	X
_POSIX_REALTIME_SIGNALS	X	X	X	X
_POSIX_SAVED_IDS	—	—	—	X
_POSIX_SEMAPHORES	X	X	X	X
_POSIX_SHARED_MEMORY_OBJECTS	X	X	X	X
_POSIX_SPAWN	—	—	X	X
_POSIX_SPIN_LOCKS	—	—	—	—
_POSIX_SPORADIC_SERVER	—	—	X	X
_POSIX_SYNCHRONIZED_IO	X	X	X	X
_POSIX_THREAD_ATTR_STACKADDR	X	X	X	X
_POSIX_THREAD_ATTR_STACKSIZE	X	X	X	X
_POSIX_THREAD_CPU_TIME	X	X	X	X
_POSIX_THREAD_PRIO_INHERIT	X	X	X	X
_POSIX_THREAD_PRIO_PROTECT	X	X	X	X
_POSIX_THREAD_PRIORITY_SCHEDULING	X	X	X	X
_POSIX_THREAD_PROCESS_SHARED	—	—	X	X
_POSIX_THREAD_SAFE_FUNCTIONS	See Units of Functionality			
_POSIX_THREAD_SPORADIC_SERVER	X	X	X	X
_POSIX_THREADS	See Units of Functionality			
_POSIX_TIMEOUTS	X	X	X	X
_POSIX_TIMERS	X	X	X	X
_POSIX_TRACE	—	X	X	X
_POSIX_TRACE_EVENT_FILTER	—	X	X	X
_POSIX_TRACE_INHERIT	—	—	—	—
_POSIX_TRACE_LOG	—	X	X	X
_POSIX_TYPED_MEMORY_OBJECTS	—	—	—	—
_POSIX_VDISABLE	—	—	—	X
_POSIX2_C_DEV ⁽¹⁾	X ^b	X ^b	X ^b	X
_POSIX2_CHAR_TERM	—	—	—	X
_POSIX2_FORT_DEV	—	—	—	—
_POSIX2_FORT_RUN	—	—	—	X
_POSIX2_LOCALEDEF	—	—	—	—
_POSIX2_PBS	—	—	—	—
_POSIX2_PBS_ACCOUNTING	—	—	—	—
_POSIX2_PBS_CHECKPOINT	—	—	—	—

Copyright © 2004 IEEE. All rights reserved.

Table 1-19 — POSIX.1 Option Requirements (Continued)

Option	PSE51	PSE52	PSE53	PSE54
_POSIX2_PBS_LOCATE	—	—	—	—
_POSIX2_PBS_MESSAGE	—	—	—	—
_POSIX2_PBS_TRACK	—	—	—	—
_POSIX2_SW_DEV	X ⁽²⁾	X ^b	X ^b	X
_POSIX2_UPE	—	—	—	X
_XOPEN_CRYPT	—	—	—	—
_XOPEN_ENH_I18N	No interfaces fall under this option			
_XOPEN_LEGACY	—	—	—	—
_XOPEN_REALTIME	See individual suboptions			
_XOPEN_REALTIME_THREADS	See individual suboptions			
_XOPEN_SHM	No interfaces fall under this option			
_XOPEN_STREAMS	—	—	—	—
_XOPEN_UNIX	See Units of Functionality			

(1) Required only for the C language option.

(2) Required only for the development platform, which will often differ from the execution platform.

Table 1-20 — Requirements for Other Standards

Standard	PSE51	PSE52	PSE53	PSE54
POSIX.26 {4}	X	X	X	X

The correspondence between the options listed in Table 1-19 and the options described in POSIX.5c {5}, Section 2.5, are shown in Table 1-21.

Table 1-21 — POSIX.1 Options vs. POSIX.5c Options

POSIX.1 Option	POSIX.5c Option
_POSIX_ADVISORY_INFO	none
_POSIX_ASYNCHRONOUS_IO	Asynchronous I/O
_POSIX_BARRIERS	none
_POSIX_CHOWN_RESTRICTED	Change Owner Restriction
_POSIX_CLOCK_SELECTION	none
_POSIX_CPUTIME	none
_POSIX_FSYNC	File Synchronization
_POSIX_IPV6	none
_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_MONOTONIC_CLOCK	none

Copyright © 2004 IEEE. All rights reserved.

Table 1-21 — POSIX.1 Options vs. POSIX.5c Options (Continued)

POSIX.1 Option	POSIX.5c Option
<code>_POSIX_NO_TRUNC</code>	Filename Truncation ⁽¹⁾
<code>_POSIX_PRIORITIZED_IO</code>	Prioritized I/O
<code>_POSIX_PRIORITY_SCHEDULING</code>	Priority Process Scheduling
<code>_POSIX_RAW_SOCKETS</code>	none
<code>_POSIX_REALTIME_SIGNALS</code>	Realtime Signals
<code>_POSIX_SAVED_IDS</code>	Saved IDs Support
<code>_POSIX_SEMAPHORES</code>	Semaphores
<code>_POSIX_SHARED_MEMORY_OBJECTS</code>	Shared Memory Objects
<code>_POSIX_SPAWN</code>	C language-specific
<code>_POSIX_SPIN_LOCKS</code>	none
<code>_POSIX_SPORADIC_SERVER</code>	none
<code>_POSIX_SYNCHRONIZED_IO</code>	Synchronized I/O
<code>_POSIX_THREAD_ATTR_STACKADDR</code>	C language-specific
<code>_POSIX_THREAD_ATTR_STACKSIZE</code>	C language-specific
<code>_POSIX_THREAD_CPUTIME</code>	none
<code>_POSIX_THREAD_PRIO_INHERIT</code>	Mutex Priority Inheritance
<code>_POSIX_THREAD_PRIO_PROTECT</code>	Mutex Priority Ceiling
<code>_POSIX_THREAD_PRIORITY_SCHEDULING</code>	C language-specific
<code>_POSIX_THREAD_PROCESS_SHARED</code>	Process Shared
<code>_POSIX_THREAD_SAFE_FUNCTIONS</code>	C language-specific
<code>_POSIX_THREAD_SPORADIC_SERVER</code>	none
<code>_POSIX_THREADS</code>	C language-specific
<code>_POSIX_TIMEOUTS</code>	none
<code>_POSIX_TIMERS</code>	Timers
<code>_POSIX_TRACE</code>	none
<code>_POSIX_TRACE_EVENT_FILTER</code>	none
<code>_POSIX_TRACE_INHERIT</code>	none
<code>_POSIX_TRACE_LOG</code>	none
<code>_POSIX_TYPED_MEMORY_OBJECTS</code>	none
<code>_POSIX_VDISABLE</code>	C language-specific
<code>_POSIX2_C_DEV</code>	not applicable
<code>_POSIX2_CHAR_TERM</code>	not applicable
<code>_POSIX2_FORT_DEV</code>	not applicable
<code>_POSIX2_FORT_RUN</code>	not applicable
<code>_POSIX2_LOCALEDEF</code>	not applicable
<code>_POSIX2_PBS</code>	not applicable
<code>_POSIX2_PBS_ACCOUNTING</code>	not applicable
<code>_POSIX2_PBS_CHECKPOINT</code>	not applicable
<code>_POSIX2_PBS_LOCATE</code>	not applicable
<code>_POSIX2_PBS_MESSAGE</code>	not applicable
<code>_POSIX2_PBS_TRACK</code>	not applicable
<code>_POSIX2_SW_DEV</code>	not applicable
<code>_POSIX2_UPE</code>	not applicable

Copyright © 2004 IEEE. All rights reserved.

Table 1-21 — POSIX.1 Options vs. POSIX.5c Options (Continued)

POSIX.1 Option	POSIX.5c Option
<code>_XOPEN_CRYPT</code>	none
<code>_XOPEN_ENH_I18N</code>	none
<code>_XOPEN_LEGACY</code>	none
<code>_XOPEN_REALTIME</code>	none
<code>_XOPEN_REALTIME_THREADS</code>	none
<code>_XOPEN_SHM</code>	none
<code>_XOPEN_STREAMS</code>	none
<code>_XOPEN_UNIX</code>	none
Ada language-specific (mutexes are included under the <code>_POSIX_THREADS</code> option)	Mutexes

⁽¹⁾ Note that the POSIX.5c Filename Truncation option has the opposite sense relative to the POSIX.1 option `_POSIX_NO_TRUNC`

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, `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 reentrant operations defined by POSIX.5c {5} shall be per task, i.e., a blocked task cannot prevent any other task from executing. Therefore, the corresponding `Blocking_Behavior` constants shall have the value `Tasks`. (See POSIX.5c {5}, Section 2.4.1.5.)

Copyright © 2004 IEEE. All rights reserved.

Section 2: Normative References

2.1 Normative References

The following standards contain provisions which, through references in this text, constitute provisions of this standard.¹⁾ 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, *Information technology—Programming Languages—Ada*.²⁾
- {2} ISO/IEC 9899:1999, *Programming Languages—C*.
- {3} ISO/IEC 9945:2003, *Information technology—Portable Operating System Interface (POSIX®)*.³⁾
- {4} IEEE Std 1003.26-2003, *IEEE Standard for Information Technology—Portable Operating System Interface (POSIX®)—Part 26: Device Control Application Program Interface (API) [C Language]*.⁴⁾
- {5} ISO/IEC 14519:2001, *Information technology—POSIX® Ada Language Interfaces—Binding for System Application Program Interface (API)*.
- {6} ISO/IEC TR 10000-1:1998, *Information technology—Framework and taxonomy of International Standardized Profiles—Part 1: General principles and documentation framework*.
- {7} ISO/IEC TR 10000-3:1998, *Information technology—Framework and Taxonomy of International Standardized Profiles—Part 3: Principles and Taxonomy for Open System Environment Profiles*.

1) Other references to related standards and other documents can be found in Annex C of this standard. Common names for these standards can be found in 4.2.

2) 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, 25 West 43rd Street, 4th Floor, New York, NY 10036, USA (<http://www ansi.org/>).

3) Identical to IEEE Std 1003.1™-2003.

4) IEEE publications are available from the Institute of Electrical and Electronics Engineers, Inc., 445 Hoes Lane, Piscataway, NJ 08854, USA (<http://standards.ieee.org/>).

Copyright © 2004 IEEE. All rights reserved.

This page is left intentionally blank.

Section 3: Terms and Definitions

3.1 Terminology

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

3.1.1 implementation defined: Describes a value or behavior that is not defined by the standard, but is selected by an implementor. The value or behavior may vary among implementations that conform to POSIX.13. An application should not rely on the existence of the value or behavior. An application that relies on such a value or behavior cannot be assured to be portable across conforming implementations.

The implementor shall document such a value or behavior in the conformance document, so that it can be used correctly by an application.

3.1.2 may: Describes a feature or behavior that is optional for an implementation that conforms to POSIX.13. An application should not rely on the existence of the feature or behavior. An application that relies on such a feature or behavior cannot be assured to be portable across conforming implementations.

To avoid ambiguity, the opposite of *may* is expressed as *need not*, instead of *may not*.

3.1.3 shall: For an implementation that conforms to POSIX.13, describes a feature or behavior that is mandatory. An application can rely on the existence of the feature or behavior.

For an application or user, describes a behavior that is mandatory.

3.1.4 should: For an implementation that conforms to POSIX.13, describes a feature or behavior that is recommended but not mandatory. An application should not rely on the existence of the feature or behavior. An application that relies on such a feature or behavior cannot be assured to be portable across conforming implementations.

For an application, describes a feature or behavior that is recommended programming practice for optimum portability.

Copyright © 2004 IEEE. All rights reserved.

3.1.5 undefined: Describes the nature of a value or behavior not defined by POSIX.13 which results from use of an invalid program construct or invalid data input.

The value or behavior may vary among implementations that conform to POSIX.13. An application should not rely on the existence or validity of the value or behavior. An application that relies on any particular value or behavior cannot be assured to be portable across conforming implementations.

3.1.6 unspecified: Describes the nature of a value or behavior not specified by POSIX.13 which results from use of a valid program construct or valid data input.

The value or behavior may vary among implementations that conform to POSIX.13. An application should not rely on the existence or validity of the value or behavior. An application that relies on any particular value or behavior cannot be assured to be portable across conforming implementations.

3.2 Definitions

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

3.2.1 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 {7}]

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

3.2.3 Base Standard: An approved IEEE, national, regional, or international standard which defines and describes basic functionality and capability. [ISO/IEC TR 10000-1:1998 {6}]

3.2.4 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 {7}]

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

3.2.6 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.

Copyright © 2004 IEEE. All rights reserved.

3.2.7 Embedded Computer System: A computer (and its software) is considered *embedded* if it is an integral component of a larger system and is used to control and/or directly monitor that system, using special hardware devices.

3.2.8 Generic Application Environment Profile: An Application Environment Profile which is not specific to a particular community of use. [ISO/IEC TR 10000-3:1998 {7}]

3.2.9 Generic Interface Profile: An Interface Profile which is not specific to a particular community of use. [ISO/IEC TR 10000-3:1998 {7}]

3.2.10 Industry Specific Application Environment Profile: An Application Environment Profile which deals with specific industry requirements. [ISO/IEC TR 10000-3:1998 {7}]

3.2.11 Industry Specific Interface Profile: An Interface Profile which deals with specific industry requirements. [ISO/IEC TR 10000-3:1998 {7}]

3.2.12 Interface Profile: An OSE Profile defining one interface of the Open System Environment. [ISO/IEC TR 10000-3:1998 {7}]

3.2.13 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 {7}]

3.2.14 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 {7}]

3.2.15 Priority Inversion: A condition in which a thread that is waiting for a shared resource (including a CPU) is involuntarily prevented from executing by a thread with a lower application-specified priority. The delays caused by priority inversion can be extremely large in the case of unbounded priority inversion. But there are mechanisms to bound these delays to small predictable intervals. *See also: Unbounded Priority Inversion.*

3.2.16 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 {6}]

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

Copyright © 2004 IEEE. All rights reserved.

3.2.18 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.

3.2.19 Subprofiling Option Group: A Unit of Functionality. *See: Unit of Functionality.*

3.2.20 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 {7}]

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.

3.2.21 Unbounded Priority Inversion: A priority inversion condition in which the delay caused to the waiting thread cannot be bounded by the duration of the intervals during which lower priority threads hold the shared resource. For example, this can happen when a lower priority thread is holding a lock also requested by the high priority thread, and then one or more medium priority threads request execution, thus preempting the lower priority thread. *See also: Priority Inversion.*

3.2.22 Unit of Functionality: A separately implementable element of an OSE system. [ISO/IEC TR 10000-3:1998 {7}]

3.3 Rationale for Definitions (informative)

(This clause is not a normative part of IEEE Std 1003.13-2003.)

Embedded Computer System. For the definition of an embedded computer system, the following canonical examples were taken into account:

- Are programs that understand physics and/or hardware embedded? For example, one that uses finite-element methods to predict fluid flow over airplane wings? No. These programs are never considered to be embedded because they are not an integral component of a larger system.
- Is the internal microprocessor controlling a disk drive an example of an embedded system? Yes, regardless of what the disk drive is used for. The software (firmware, actually) within the disk drive controls the HDA (head disk assembly) hardware and is hard realtime as well.

Copyright © 2004 IEEE. All rights reserved.

- I/O drivers control hardware, so does presence of an I/O driver imply that the computer executing the driver is embedded? No, because that computer may be a general-purpose computer that is not part of a larger system.
- Is a PDA (Personal Digital Assistant) an embedded system? No. People often say that PDAs are embedded because they are very small and constrained and because PDA OS and application software is kept in non-volatile memory, but PDAs parallel the desktop systems used to run office productivity applications, and no special hardware is being controlled.
- Is the microprocessor controlling a cell phone an embedded system? Yes. The firmware in the cell phone is controlling the radio hardware.
- Are the computers in a big phased-array radar considered embedded? These radars are ten-story buildings with one to three 100-foot diameter radiating patches on the sloped sides of the building. Yes. These computers were generally some of the most powerful computers available when the system was built, are located in a large computer room occupying almost one whole floor of a building, and may be hundreds of meters away from the radar hardware. However, the software running in these computers controls the radar hardware; therefore, the computers are an integral component of a larger system.
- Is a traditional Flight Management System (FMS) built into an airplane cockpit considered embedded? If the FMS is not connected to the avionics and is used only for logistics computations, a function readily performed on a laptop, then the FMS is clearly not embedded.
- Are the computers in a hardware-in-the-loop (HIL) simulator embedded? Yes, both in the simulator, and in the thing being tested in the HIL simulator. Hardware is being controlled on both sides.
- Is the computer controlling a pacemaker in a person's chest an embedded computer? Yes. In this case the "system" is the combination of the pacemaker and the person's heart.
- Is the computer controlling fuel injection in an automobile engine embedded? Yes. It is part of a larger system, the engine, and it is directly monitoring and controlling the engine through special hardware.

Copyright © 2004 IEEE. All rights reserved.

This page is left intentionally blank.

Section 4: Conventions and Abbreviations

4.1 Conventions

This standard uses the following typographic conventions:

- (1) The *italic* font is used for
 - Symbolic parameters that are generally substituted with real values by the application
 - C language data types and function names
 - Global external variable names
 - Function families; references to groups of closely related functions
- (2) The **bold** font is used in tables to enhance visibility of option names.
- (3) The constant-width (Courier) font is used
 - For references to utility names and C language headers
 - For names of attributes in attributes objects
 - For references to Ada identifiers.
- (4) Normative references listed in 2.1 are represented as

{1}
- (5) 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.

Copyright © 2004 IEEE. All rights reserved.

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).

4.2 Abbreviations

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

- 4.2.1 **Ada95 RM:** ISO/IEC 8652:1995 {1}.
- 4.2.2 **C99 Standard:** ISO/IEC 9899:1999 {2}.
- 4.2.3 **COTS:** *Commercial-off-the-Shelf*.
- 4.2.4 **MMU:** *Memory Management Unit*.
- 4.2.5 **POSIX.1:** ISO/IEC 9945:2003 {3}.
- 4.2.6 **POSIX.26:** IEEE Std 1003.26-2003 {4}.
- 4.2.7 **POSIX.5c:** ISO/IEC 14519:2001 {5}.
- 4.2.8 **POSIX.13:** *This standard*.
- 4.2.9 **AEP:** *Application Environment Profile*.
- 4.2.10 **ISP:** *International Standardized Profile*.
- 4.2.11 **OSE:** *Open System Environment*.
- 4.2.12 **PSE:** *Generic Environment Profile*.
- 4.2.13 **PSE51:** *The Minimal Realtime System Profile defined herein*.
- 4.2.14 **PSE52:** *The Realtime Controller System Profile defined herein*.
- 4.2.15 **PSE53:** *The Dedicated Realtime System Profile defined herein*.
- 4.2.16 **PSE54:** *The Multi-Purpose Realtime System Profile defined herein*.
- 4.2.17 **PSE5X:** *Any one of the PSE51, PSE52, PSE53, or PSE54 profiles*.

Copyright © 2004 IEEE. All rights reserved.

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 a Strictly Conforming POSIX.13 Application.

5.1.1.2 Documentation

An implementation conforming to one or more of the profiles defined by this standard shall provide a conformance document that shall document conformance 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

Copyright © 2004 IEEE. All rights reserved.

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.
 - 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 for the C language option or in the `POSIX_Limits` package for the Ada language option), 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.

Any application that conforms to one or more of these profiles under the C language option also conforms to POSIX.1 {3}. Any application that conforms to one or more of these profiles under the Ada language option also conforms to POSIX.5c {5}.

Copyright © 2004 IEEE. All rights reserved.

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.

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.)

Copyright © 2004 IEEE. All rights reserved.

This page is left intentionally blank.

Section 6: Minimal Realtime System Profile (PSE51)

6.1 Introduction

This section specifies those standards required for conformance to the Minimal Realtime System Profile option and, where applicable, the state of any options contained in those standards.

When a referenced standard specifies services beyond those required by the Minimal Realtime System Profile, only those services included in the specified Units of Functionality referenced by this profile shall be required (see Table 1-1 through Table 1-17). All the applicable definitions in POSIX.1 {3} and/or POSIX.5c {5} shall still apply.

6.1.1 Identification

For the C language implementation, symbolic names shall be used to specify the presence or absence of each option in this profile. Names reserved for use in this profile begin with the string `_POSIX_AEP_REALTIME_`. For the Ada language implementation, a set of Boolean subtypes contained in package `POSIX_Options` (defined in POSIX.5c {5}, Section 2.5) shall be used to specify the presence or absence of each option in this profile.

6.1.2 Conformance

Conformance to the Minimal Realtime System Profile option shall be indicated as follows:

- For the C language implementation, the symbol `_POSIX_AEP_REALTIME_MINIMAL` being defined in the header `<unistd.h>` to be 200312L.
- For the Ada language implementation, the Boolean subtype `POSIX_Profiles.Realtime_Minimal` subtype having the range `True..True`,

Copyright © 2004 IEEE. All rights reserved.

and the constant `POSIX_Profiles.Realtime_AEP_Version` having the value `2003_12`.

6.1.3 Options

The presence or absence of optional features shall be indicated as follows:

- For the C language implementation, if any of the following symbols are defined in the header `<unistd.h>`, then a corresponding programming environment is supported:

`_POSIX_AEP_REALTIME_LANG_C99`

`_POSIX_AEP_REALTIME_LANG_Ada95`

- For the Ada language implementation, if any of the following Boolean subtypes has the range `True..True`, then the corresponding option is supported:

`POSIX_Profiles.Realtime_Lang_C99`

`POSIX_Profiles.Realtime_Lang_Ada95`

6.1.4 The Compilation Environment (C language option)

Certain symbols required by PSE51 are defined in headers. Some of those headers could also define symbols other than those required by PSE51, potentially conflicting with symbols used by the application. Also, POSIX.1 {3} defines symbols that are not permitted by other standards to appear in those headers without some control on the visibility of those symbols. Symbols called “feature test macros” are used to control the visibility of symbols that might be included in a header.

An application conforming to PSE51 should ensure that the feature test macro `_POSIX_AEP_RT_MINIMAL_C_SOURCE` is defined before inclusion of any header. When an application includes a header described by POSIX.1 {3} and when this feature test macro is defined to have the value `200312L`,

- (1) All symbols required by PSE51 to appear when the header is included shall be made visible.
- (2) Symbols that are explicitly permitted, but not required, by PSE51 to appear in that header (including those in reserved name spaces) may be made visible.
- (3) Additional symbols not required or explicitly permitted by PSE51 to be in that header shall not be made visible, except when enabled by another feature test macro.

Copyright © 2004 IEEE. All rights reserved.

6.2 Operating System Interface Requirements

6.2.1 POSIX.1 Interfaces (C Language Option)

The Minimal Realtime System Profile implementation shall include interfaces as defined in POSIX.1 {3} for the Units of Functionality shown in Table 6-1 (see Table 1-1 for a complete list of POSIX.1 Units of Functionality).

Table 6-1 — POSIX.1 Units of Functionality Requirements

Unit of Functionality
POSIX_C_LANG_JUMP
POSIX_C_LANG_SUPPORT
POSIX_DEVICE_IO
POSIX_FILE_LOCKING
POSIX_SIGNALS
POSIX_SINGLE_PROCESS
POSIX_THREADS_BASE
XSI_THREAD_MUTEX_EXT
XSI_THREADS_EXT

An implementation supporting the Minimal Realtime System Profile shall support the POSIX.1 options shown in Table 6-2.

Table 6-2 — POSIX.1 Option Requirements

Option
_POSIX_CLOCK_SELECTION
_POSIX_FSYNC
_POSIX_MEMLOCK
_POSIX_MEMLOCK_RANGE
_POSIX_MONOTONIC_CLOCK
_POSIX_REALTIME_SIGNALS
_POSIX_SEMAPHORES
_POSIX_SHARED_MEMORY_OBJECTS
_POSIX_SYNCHRONIZED_IO
_POSIX_THREAD_ATTR_STACKADDR
_POSIX_THREAD_ATTR_STACKSIZE
_POSIX_THREAD_CPUTIME
_POSIX_THREAD_PRIO_INHERIT
_POSIX_THREAD_PRIO_PROTECT
_POSIX_THREAD_PRIORITY_SCHEDULING
_POSIX_THREAD_SPORADIC_SERVER
_POSIX_TIMEOUTS
_POSIX_TIMERS

Copyright © 2004 IEEE. All rights reserved.

The value of `TIMER_MAX` shall be at least 64.

The value of `RTSIG_MAX` shall be at least 16.

The range of priorities associated with the `SCHED_RR` scheduling policy shall have at least 31 distinct values that are less than the maximum priority of the `SCHED_FIFO` policy.

An implementation conforming to PSE51 shall provide a mechanism to configure the system so that the scheduling allocation domain has size one, and so that the binding of threads to scheduling allocation domains remains static. The mechanism by which this requirement is achieved shall be implementation defined. In addition, a PSE51 implementation may provide other configurations or facilities to change the size of the allocation domain and the bindings of threads to allocation domains. For a description of the scheduling allocation domain, see the System Interfaces volume of POSIX.1 {3}, Section 2.9.2.

6.2.2 POSIX.26 Interfaces (C Language Option)

An implementation conforming to PSE51 shall support all the interfaces defined in POSIX.26 {4}. The mechanism to create character special files shall be implementation defined. This mechanism shall provide a binding to the device driver when the `open()` function is called with the name of the created character special file.

6.2.3 POSIX.5c Interfaces (Ada Language Option)

The Minimal Realtime System Profile implementation shall include interfaces as defined in POSIX.5c {5} for the Units of Functionality shown in Table 6-3 (see Table 1-2 through Table 1-17 for a complete list of POSIX.5c Units of Functionality).

Table 6-3 — POSIX.5c Units of Functionality Requirements

Unit of Functionality
<code>POSIX_ADA_LANG_SUPPORT</code>
<code>POSIX_DEVICE_IO</code>
<code>POSIX_FILE_LOCKING</code>
<code>POSIX_SIGNALS</code>
<code>POSIX_SINGLE_PROCESS</code>

Copyright © 2004 IEEE. All rights reserved.

The Minimal Realtime System Profile implementation shall support the POSIX.5c options shown in Table 6-4, by defining the associated option subtypes to have the range `True..True`, with the exception of the Filename Truncation option for which the associated subtype shall have the range `False..False`.

Table 6-4 — POSIX.5c Option Requirements

Option
File Synchronization
Memory Locking
Memory Range Locking
Filename Truncation
Realtime Signals
Semaphores
Shared Memory Objects
Synchronized I/O
Mutexes
Mutex Priority Inheritance
Mutex Priority Ceiling
Timers

`POSIX_Limits.Timers_Maxima'First` shall be at least 64.

`POSIX_Limits.Realtime_Signals_Maxima'First` shall be at least 16.

Regarding task priority scheduling, the implementation shall support the following requirements from POSIX.5c {5} and the Ada95 RM {1}:

- The implementation shall support the priority model defined in the Ada95 RM {1}, Section D.1, and the pragmas and package interfaces defined in the Ada95 RM {1}, Sections D.2–D.5.
- The implementation shall meet the requirements of POSIX.5c {5}, Section 13.3.1.

The blocking behavior of all reentrant operations defined by POSIX.5c {5} shall be per task, i.e., a blocked task cannot prevent any other task from executing. Therefore, the corresponding `Blocking_Behavior` constants shall have the value `Tasks`. (See POSIX.5c {5}, Section 2.4.1.5.)

Implementations of the PSE51 profile shall support the `POSIX_Profiles` package defined in Annex A of this standard.

The subprogram `POSIX_Signals.Set_Stopped_Child_Signal` shall fail silently.

The subprogram `POSIX_Signals.Stopped_Child_Signal_Enabled` shall return `False`.

`POSIX_Limits.Groups_Maxima'First` shall be zero.

Copyright © 2004 IEEE. All rights reserved.

Subprograms not supported by a given profile shall raise `POSIX_Error`, returning an error code of `Operation_Not_Supported`, except as noted otherwise.

All `Image` and `Value` functions that appear in the packages supported by a profile must be implemented.

Where an overloaded subprogram is required by a Unit of Functionality, all forms of the subprogram appearing in the referenced clause must be supported, except as otherwise noted.

6.3 Application Constraints

The Minimal Realtime System profile defined in this standard requires only specific Units of Functionality of the required standards. The absence of particular elements of these standards introduces constraints on the use of some of the features of particular operations. This clause defines the constraints that an application strictly conforming to one of the profiles shall observe when using each of the operations required by that profile.

6.3.1 Constraints related to POSIX.1 Interfaces (C Language Option)

Table 6-5 defines a set of functions that shall be either reentrant or noninterruptible by signals and shall be `async-signal-safe`. Therefore applications may invoke them, without restriction, from signal-catching functions. No other function, including those defined in the System Interfaces volume of POSIX.1 {3}, Section 2.4.3, is required to be `async-safe` in an implementation of the PSE51 profile, and thus PSE51 Strictly Conforming Applications shall not use them from inside signal handlers.

Table 6-5 — Functions required to be `async-signal-safe`

<i>alarm()</i>	<i>sigaddset()</i>	<i>sigpending()</i>	<i>timer_getoverrun()</i>
<i>clock_gettime()</i>	<i>sigdelset()</i>	<i>sigprocmask()</i>	<i>)</i>
<i>kill()</i>	<i>sigemptyset()</i>	<i>sigqueue()</i>	<i>timer_gettime()</i>
<i>raise()</i>	<i>sigfillset()</i>	<i>sigset()</i>	<i>timer_settime()</i>
<i>sem_post()</i>	<i>sigismember()</i>	<i>sysconf()</i>	<i>times()</i>
<i>sigaction()</i>	<i>signal()</i>	<i>time()</i>	<i>uname()</i>

The *sysconf()* function has the following constraints:

- (1) An application strictly conforming to the PSE51 profile shall not call the *sysconf()* function with the parameter `_POSIX_VERSION` since a meaningful value cannot be returned.¹⁾
- (2) A conforming application must act as if `CHILD_MAX=0`.

An application strictly conforming to PSE51 shall be considered erroneous if any signal results in abnormal termination of the process because this profile does not support multiple processes.

An application strictly conforming to PSE51 shall not call the *kill()* function with a negative but not `-1` argument because this profile does not require process group functionality.

An application strictly conforming to PSE51 shall be guaranteed that the file mode creation mask for any object created by any process is `S_IRWXU`; that is, the object shall be fully accessible to the creator.

An application strictly conforming to PSE51 shall not use the *open()*, *fopen()*, or *freopen()* functions to create new files, since this profile does not require general file system capabilities.

An application strictly conforming to PSE51 shall use the path or file argument for any function using a file pathname [e.g., *open()*] only to specify the name of the object without any file system semantics implied, since this profile does not require general file system semantics.

An application strictly conforming to PSE51 shall not require that any input/output function (e.g., *fclose()*, *fflush()*, *fgetc()*, *fgets()*, *fopen()*, *fprintf()*, *fputc()*, *fputs()*, *fread()*, *fscanf()*, *fwrite()*, *getc()*, *getchar()*, *gets()*, *open()*, *perror()*, *printf()*, *putc()*, *putchar()*, *puts()*, *read()*, *scanf()*, *vfprintf()*, *vfscanf()*, *vprintf()*, *vscanf()*, *write()*) update an access, creation, or modification time for the device read or written, because this profile requires no interfaces that could query such an access time.

6.3.2 Constraints related to POSIX.5c Interfaces (Ada Language Option)

An application strictly conforming to PSE51 shall not call the functions `POSIX_Configurable_System_Limits.System_POSIX_Version` or `POSIX_Configurable_System_Limits.System_POSIX_Ada_Version`, since a meaningful value cannot be returned.²⁾

1) Conformance to this profile can be checked with the symbols defined in 6.1.3.

2) Conformance to this profile can be checked with the subtypes defined in 6.1.3.

Copyright © 2004 IEEE. All rights reserved.

A conforming application must act as if `POSIX_Limits.Child_Processes_Maxima'Last=0`.

An application strictly conforming to PSE51 shall be considered erroneous if any signal results in abnormal termination of the process because this profile does not support multiple processes.

An application strictly conforming to PSE51 shall not call the form of `POSIX_Signals.Send_Signal` that takes a process group ID as an argument because this profile does not require process group functionality.

An application strictly conforming to PSE51 shall not attempt to bind a signal to a task entry.

An application strictly conforming to PSE51 shall not use the `POSIX_IO.Open_Or_Create` function to create new files, since this profile does not require general file system capabilities.

An application strictly conforming to PSE51 shall use a parameter representing a pathname (such as the `Name` parameter of `POSIX_IO.Open` or `POSIX_IO.Open_Or_Create`) only to specify the name of the object without any file system semantics implied, since this profile does not require general file system semantics.

An application strictly conforming to PSE51 shall not require that any input/output function such as `POSIX_IO.Read`, `POSIX_IO.Generic_Read`, `POSIX_IO.Write`, or `POSIX_IO.Generic_Write`, update an access, creation, or modification time for the device read or written, because this profile requires no interfaces that could query such an access time.

Implementations of PSE51 need not support the `Owner`, `Group`, and `Other` fields of the `form` parameter (see POSIX.5c {5}, Section 8.1.1.2), but may instead raise `Use_Error`. The default value used shall be `Read_Write_Execute`.

Implementations of PSE51 need not support the `File_Structure` field of the `form` parameter (see POSIX.5c {5}, Section 8.1.1.2), but may instead raise `Use_Error`. All files shall default to regular files.

In addition, the following constraints apply to the usage of the predefined Ada I/O packages:

- (1) An application strictly conforming to PSE51 shall not require any of the Input/Output operations (`Read`, `Write`, `Get`, `Put`, etc.) contained in the predefined Ada I/O packages or their instantiations to update an access, creation, or modification time for the device read or written, because this profile requires no interfaces that could query such an access time.
- (2) An application strictly conforming to PSE51 shall use the `Name` of the Open operations contained in the predefined Ada I/O packages or their instantiations only to specify the name of the object without any file system semantics implied, since this profile does not require general file system capabilities.

Copyright © 2004 IEEE. All rights reserved.

- (3) An application strictly conforming to PSE51 shall not call any of the `Create` or `Delete` operations contained in the predefined Ada I/O packages or their instantiations, since this profile does not require general file system capabilities.

6.4 Shell and Utility Requirements

An implementation of the Minimal Realtime System Profile is not required to support any of the services described in the Shell and Utilities volume of POSIX.1 {3}.

6.5 Development Platform Requirements

One or more of the development options in 6.5.1 and 6.5.2 shall be implemented.

6.5.1 C Language Development Option

If this option is provided, the implementor shall define a Development Platform and an environment capable of preparing for execution an application conformant with this standard profile. This platform shall include the `POSIX2_C_DEV` and `POSIX2_SW_DEV` options from the Shell and Utilities volume of POSIX.1 {3}.

6.5.1.1 Option Indicator

The presence of the C Language Development Option shall be indicated by the symbol `_POSIX_AEP_REALTIME_LANG_C99` being defined in the header `<unistd.h>`. In addition, the presence of the C Language Development Option may be indicated by the subtype `POSIX_Profiles.Realtime_Lang_C99` having the range `True..True`.

6.5.2 Ada Language Development Option

If this option is provided, the implementor shall define a Development Platform and an environment capable of preparing for execution an application conformant with this profile including applicable portions of the following:

Copyright © 2004 IEEE. All rights reserved.

- The Ada95 RM {1}
- POSIX.5c {5}
- The POSIX2_SW_DEV option from the Shell and Utilities volume of POSIX.1 {3}.

6.5.2.1 Option Indicator

The presence of the Ada Language Development Option shall be indicated by the subtype `POSIX_Profiles.Realtime_Lang_Ada95` having the range `True..True`. In addition, the presence of the Ada Language Development Option may be indicated by the symbol `_POSIX_AEP_REALTIME_LANG_Ada95` being defined in the header `<unistd.h>`.

6.6 Rationale for Operating System Requirements (informative)

(This clause is not a normative part of IEEE Std 1003.13-2003.)

6.6.1 Operating System Interface Requirements

After reviewing several commercially available small realtime kernels, it was concluded that the POSIX.1 threads model (with all options enabled, but without a file system) best reflected current industry practice in certain embedded realtime areas. Instead of full file system support, basic device I/O (read, write, open, close, control) is considered sufficient for kernels of this size. Systems of this size frequently do not include process isolation hardware or software; therefore, multiple processes (as opposed to threads) may not be supportable.

System options that allow an application to be upwards compatible without modifying application source code have been chosen. For example, although the assumed hardware model implies fixed address space without an MMU, the symbol `_POSIX_MEMLOCK` is still defined. This increases portability of the application code to higher level systems that do not necessarily have the same restrictions.

Copyright © 2004 IEEE. All rights reserved.

6.6.1.1 Process Primitives

Because this profile uses the POSIX.1 threads model only as the mechanism to achieve concurrency, most POSIX.1 process primitives do not apply. This includes the multi-process, pipes, and signal jump Units of Functionality, as well as the process spawn option.

The *main()* function is needed to allow application-specific information to be passed from boot code to the single (implicit) process (and its threads).

6.6.1.2 Signals

Signal services are a basic mechanism within POSIX-based systems and are required for error and event handling. Realtime systems typically have several logically concurrent software elements executing. Each such entity must respond to several cyclic and/or acyclic stimuli, often in a time-critical manner. Although purely synchronous models can supply such functionality via the use of additional processes or threads, the current realtime practice for asynchronous notification for events such as timeout, message arrival, and hardware interrupt can generally be expected to offer higher performance and lower latency. Realtime Signals provide the reliable high-performance mechanism to support such notification.

The minimum number of realtime signals that the implementation is required to support has been increased from the number specified in POSIX.1 {3}, 8, to 16. The rationale for this increase is that there are many applications that have more than 8 different kinds of events. Doubling the number of required realtime signals should have a minimum impact on the signal management overhead, while significantly increasing the number of event kinds that can be used by a strictly conforming application.

6.6.1.3 Process Environment

The functions from the POSIX.1 Process Environment group are deemed necessary to allow an application to determine and configure its system environment. This allows a single version of an application to be run on similar but differing platforms; however, conforming applications must act as if `CHILD_MAX=0`.

6.6.1.4 Files and Directories

The *open()* function is needed to do basic device I/O and also to provide device initialization. Although this requires some form of name resolution, a full pathname space is specifically not required. Directories also are not required. Units of

Copyright © 2004 IEEE. All rights reserved.

Functionality or options associated with files, such as `POSIX_FD_MGMT`, `POSIX_FIFO`, `POSIX_FILE_ATTRIBUTES`, `POSIX_FILE_SYSTEM`, `POSIX_FILE_SYSTEM_EXT`, `_POSIX_ADVISORY_INFO`, and `_POSIX_MAPPED_FILES`, are not required.

Since a file system is not a part of this realtime profile, the `_POSIX_NO_TRUNC` requirement is applied to the names of devices and shared memory objects.

The File Locking option is required in the C language option to maintain a consistent and safe way of accessing stdio (*FILE **) objects from threads, across the four realtime profiles.

6.6.1.5 Input and Output Primitives

The functions contained in the Device I/O Unit of Functionality are required to do basic I/O and device cleanup.

Asynchronous I/O is not required because it can be easily implemented using threads dedicated to I/O.

The *posix_devctl()* function defined in POSIX.26 {4} is required to support control operations on I/O devices.

6.6.1.6 Synchronized Input and Output

The Synchronized (unbuffered) I/O interface (including the File Synchronization option) is typical for basic device I/O and is required for upward portability.

6.6.1.7 Device- and Class-Specific Functions

POSIX.1 Device- or Class-Specific functions are not required, because small embedded systems usually do not require general-purpose terminal interfaces.

6.6.1.8 System Databases, Users, and Groups

Implementations are not required to support more than one user and group id since there are not multiple users and groups. No POSIX.1 System Database functions are required.

Copyright © 2004 IEEE. All rights reserved.

6.6.1.9 Synchronization

Mutexes and Condition Variables are required as part of the threads model of concurrency.

The Process Shared option is not required because there is only a single process.

Semaphores are required in the PSE51 profile for synchronization between threads to maintain compatibility with past industry practice. However, mutexes and condition variables are preferred in most current applications. It must be noted that POSIX semaphores do not have the mechanisms built in to avoid unbounded priority inversion when using them for mutually exclusive access to shared resources. Mutexes with the appropriate priority inheritance or priority ceiling (also called priority protection) protocols can be used to avoid this unbounded priority inversion.

Barriers are not required because they can easily be implemented using mutexes and condition variables. Although a direct implementation of barriers can have a significant efficiency benefit in some multiprocessor architectures, a mutex-and-condition-variable implementation will not be significantly slower in most architectures, and thus requiring barriers for all implementations is not justified.

Spin locks are not required because, although they are an efficient synchronization mechanism, they cannot be portably used with the current POSIX.1 interfaces in realtime applications. If a realtime scheduling policy such as SCHED_FIFO or SCHED_RR is used, spin locks may cause deadlock on a single processor. On multiprocessors, to avoid deadlock, it would be necessary for threads using a given lock to be allocated to different processors. There are no standard APIs in the current POSIX.1 {3} to allocate threads to specific processors.

Reader/Writer Locks are not required because they are not designed to avoid unbounded priority inversion, and thus very long delays could occur in realtime applications, with a low but nevertheless nonzero probability. It is expected that a future revision of POSIX.1 {3} will add the priority inheritance and/or priority ceiling options to reader/writer locks, which would eliminate the unbounded priority inversion.

6.6.1.10 Priority Scheduling

Thread priority scheduling is required for realtime applications. The Sporadic Server Scheduling option is also required to enhance support of applications with aperiodic timing requirements.

A common requirement of realtime systems is that they be able to run threads with realtime requirements together with threads with no realtime requirements. One common way of doing this is by having the realtime threads run under the SCHED_FIFO scheduling policy, while the non-realtime threads run at a lower

Copyright © 2004 IEEE. All rights reserved.

priority under the round-robin policy (SCHED_RR) to fairly share the available portion of the processor among them. POSIX.1 {3} requires each policy to have a range of priorities of at least 32 distinct values, but does not impose any requirements on how these priority ranges relate to each other. It could happen that most or all of the SCHED_RR priorities were larger than the SCHED_FIFO priorities, thus making it impossible to mix realtime and non-realtime threads as required above. To solve this problem in a portable way, this profile requires that there are at least 31 SCHED_RR priority levels below the maximum priority of SCHED_FIFO. In this way, a strictly conforming application can use the inclusive priority range [*max_FIFO_prio*, *max_FIFO_prio*-30] with SCHED_FIFO for realtime threads (with a total of 31 priority levels), and then use the priority value $\min(\text{max_FIFO_prio}-31, \text{max_RR_prio})$ with the SCHED_RR policy, for the non-realtime threads, with guarantee that the latter priority value is valid for the round-robin policy.

Support for a scheduling allocation domain of size one and static binding of threads to allocation domains is required in all the realtime profiles to achieve predictable scheduling behavior. The allocation domain of a thread is the set of processors on which that thread can be scheduled at any given time. POSIX.1 {3} specifies that the scheduling rules have predictable effects only if the allocation domain is of size one; hence the need for this requirement. For single-processor systems the allocation domain is generally of size one and thus the application can meet the requirement just by specifying in the conformance document that the scheduling allocation domain is of size one and that static binding of threads to allocation domains is the default behavior.

6.6.1.11 Process Memory Locking

Process memory locking is inherent in systems following this profile because most PSE51 targets have no MMU and thus swapping is not supported; code and data stay in physical memory until explicitly removed. Nevertheless, memory locking APIs are required for upward portability to allow an application developer to take code intended for a bare PSE51 target and unit test that code on a much larger and more capable platform, perhaps a PSE54, with minimal modification. In those targets not using an MMU for virtual memory, the locking functions do nothing and always report success, while in the larger profiles there really is memory to be locked. In summary, by requiring this service in the PSE51 profile, it is possible to write portable application code that runs correctly in all the profiles.

6.6.1.12 Shared Memory

Memory Mapped I/O may be implemented using the Shared Memory facility. An implementation is required to provide facilities for creating (shared) memory objects that represent ranges of physical memory that contain device control and

Copyright © 2004 IEEE. All rights reserved.

status registers or buffers. These facilities encourage the development of portable applications.

Typed Memory objects are not required because they are useful only to systems with special hardware architectures that have various often specialized kinds of memory. Implementors providing support for such special architectures always have the option to provide typed memory objects as an extension.

6.6.1.13 Clocks and Timers

High-resolution timer functions are required in most realtime systems for implementing time management operations such as periodic activations, short duration timeouts, etc. The normal POSIX.1 time management functions *sleep()* and *alarm()* only provide a time resolution of one second, but many realtime systems require finer resolution for specifying time.

The Monotonic Clock is required for realtime applications to ensure that deadlines and timing requirements are not affected by clock jumps.

The Clock Selection option is required to enable choosing the clock on which sleep operations are performed and to have access to an absolute sleep operation, which is a common requirement in realtime applications with periodic timing requirements.

CPU-Time clocks and timers are required as a means to detect and handle situations in which a thread overruns its assigned maximum execution time. Bounding the execution times of the different threads in the application increases predictability and reliability.

The Timeouts option is a general requirement for realtime applications and thus is required in this profile.

The minimum number of timers that the implementation is required to support has been increased from the number specified in POSIX.1 {3}, 32, to 64, which is the required minimum number of threads. The reason for this increase is that there are many applications that require one timer per thread (either realtime or CPU-time based).

6.6.1.14 Message Passing

In the PSE51 profile of IEEE Std 1003.13-1998, message queues were required because commercial realtime kernels available at that time with similar functionality to the Minimal Realtime System Profile typically included some form of message queueing mechanism for communication between threads.

However, many embedded realtime applications for small systems do not require message queues, and this feature makes the implementation larger. Because

Copyright © 2004 IEEE. All rights reserved.

message queues can be easily implemented by the application using mutexes and condition variables, this version of the standard has dropped the requirement to support message queues.

6.6.1.15 Threads

The basic assumption in this profile is that the system will consist of a single (implicit) process, with multiple threads. Therefore, all basic thread services are required, except for those related to multiple processes. The `POSIX_THREADS_BASE` Unit of Functionality was specified in this standard instead of the `_POSIX_THREADS` option, because this option requires reader/writer locks, but this profile does not.

6.6.1.16 Tracing

Tracing is not required for the PSE51 environment to keep the implementation of this profile small.

6.6.1.17 Networking

Although some small embedded systems require networking services, most do not, so to keep the implementation small, this Unit of Functionality is not required.

6.6.1.18 Event Management

The `select()` function is usually associated with networking facilities, which are not required for PSE51. Although the function could be used for regular device I/O operations, most kernels that do not have networking services do not support `select()`. Therefore, to keep the implementation small, the Event Management Unit of Functionality is not required.

6.6.1.19 Interfaces Related to the Shell and Utilities

Interfaces defined in the `POSIX_REGEX` and `POSIX_SHELL_FUNC` Units of Functionality are related to shells and utilities, which are not required in this profile; therefore, these Units of Functionality are not required either.

Copyright © 2004 IEEE. All rights reserved.

6.6.1.20 X/Open Units of Functionality and Options

Some XSI Units of Functionality (XSI_C_LANG_SUPPORT, XSI_DEVICE_IO, XSI_DEVICE_SPECIFIC, XSI_FD_MGMT, XSI_FILE_SYSTEM, XSI_IPC, XSI_JOB_CONTROL, XSI_JUMP, XSI_MATH, XSI_MULTI_PROCESS, XSI_SIGNALS, XSI_SINGLE_PROCESS, XSI_SYSTEM_DATABASE, XSI_TIMERS, XSI_USER_GROUPS, XSI_WIDE_CHAR) have interfaces that represent extensions or alternatives to interfaces in other Units of Functionality or POSIX.1 options, and therefore are not necessary for PSE51 environments.

The XSI_DBM Unit of Functionality includes interfaces for database management that are not required in the PSE51 application environment.

The XSI_DYNAMIC_LINKING Unit of Functionality is not required for small embedded systems, which usually operate in a static context.

The XSI_I18N Unit of Functionality provides facilities for natural language messages to the user, which are not required in small embedded systems, which typically do not have general-purpose human interfaces.

The XSI_SYSTEM_LOGGING Unit of Functionality provides facilities for logging system activities, which are not required in PSE51 environments.

The XSI_THREAD_MUTEX_EXT Unit of Functionality is required because it has options for controlling the behavior of mutexes under erroneous application use. This capability is interesting for any realtime application, including those targeted at small embedded systems.

The XSI_THREADS_EXT Unit of Functionality is required because it provides functions to better control a thread's stack. This is considered useful for any realtime application.

The _XOPEN_CRYPT option provides cryptography facilities that are not required in PSE51 environments.

The _XOPEN_LEGACY option provides facilities for backwards compatibility that are not required in PSE51 environments.

The _XOPEN_STREAMS option provides facilities that are mainly related to networking, and thus are not required for PSE51 environments, as discussed in 6.6.1.17.

6.6.1.21 Language-Specific Services for the C Programming Language

Support for the C99 Standard {2} is required in the C language option, with the exceptions of the POSIX_C_LANG_MATH and POSIX_C_LANG_WIDE_CHAR Units of Functionality. The reasons for these exceptions are that these are very large libraries that are not necessary for many of the PSE51 applications.

Copyright © 2004 IEEE. All rights reserved.

6.6.1.22 Language-Specific Services for the Ada Programming Language

Support for the Ada language-specific services defined in POSIX.5c {5} is required in the Ada language option.

6.6.2 Shell and Utility Requirements

Because the Minimal Realtime System Profile is intended for small embedded systems which usually have no terminal or graphical user interface, such a platform would be incapable of executing a shell. In such an environment the utilities described in the Shell and Utilities volume of POSIX.1 {3} are not usually required.

6.6.3 Development Platform Requirements

The embedded nature of the PSE51 execution platform makes it difficult to use as a development platform. Therefore, the implementation is required to define a development environment in which a PSE51 application can be prepared for execution on the target platform. The development platform depends on the language option chosen by the implementation.

Copyright © 2004 IEEE. All rights reserved.

Section 7: Realtime Controller System Profile (PSE52)

7.1 Introduction

This section specifies those standards required for conformance to the Realtime Controller System Profile option and, where applicable, the state of any options contained in those standards.

When a referenced standard specifies services beyond those required by the Realtime Controller System Profile, only those services included in the specified Units of Functionality referenced by this profile shall be required (see Table 1-1 through Table 1-17). All the applicable definitions in POSIX.1 {3} and/or POSIX.5c {5} still apply.

7.1.1 Identification

For the C language implementation, symbolic names shall be used to specify the presence or absence of each option in this profile. Names reserved for use in this profile begin with the string `_POSIX_AEP_REALTIME_`. For the Ada language implementation a set of Boolean subtypes contained in package `POSIX_Options` (defined in POSIX.5c {5}, Section 2.5) shall be used to specify the presence or absence of each option in this profile.

7.1.2 Conformance

Conformance to the Realtime Controller System Profile option shall be indicated as follows:

- For the C language implementation, the symbol `_POSIX_AEP_REALTIME_CONTROLLER` being defined in the header `<unistd.h>` to be 200312L.
- For the Ada language implementation, the Boolean subtype `POSIX_Profiles.Realtime_Controller` having the range `True..True`, and the constant `POSIX_Profiles.Realtime_AEP_Version` having the value `2003_12`.

Copyright © 2004 IEEE. All rights reserved.

7.1.3 Options

The presence or absence of optional features shall be indicated as follows:

- For the C language implementation, if any of the following symbols are defined in the header `<unistd.h>`, then a corresponding programming environment is supported:

`_POSIX_AEP_REALTIME_LANG_C99`

`_POSIX_AEP_REALTIME_LANG_Ada95`

- For the Ada language implementation, if any of the following Boolean subtypes has the range `True..True`, then the corresponding option is supported:

`POSIX_Profiles.Realtime_Lang_C99`

`POSIX_Profiles.Realtime_Lang_Ada95`

7.1.4 The Compilation Environment (C language option)

Certain symbols required by PSE52 are defined in headers. Some of those headers could also define symbols other than those required by PSE52, potentially conflicting with symbols used by the application. Also, POSIX.1 {3} defines symbols that are not permitted by other standards to appear in those headers without some control on the visibility of those symbols. Symbols called “feature test macros” are used to control the visibility of symbols that might be included in a header.

An application conforming to PSE52 should ensure that the feature test macro `_POSIX_AEP_RT_CONTROLLER_C_SOURCE` is defined before inclusion of any header. When an application includes a header described by POSIX.1 {3} and when this feature test macro is defined to have the value 200312L,

- (1) All symbols required by PSE52 to appear when the header is included shall be made visible.
- (2) Symbols that are explicitly permitted, but not required, by PSE52 to appear in that header (including those in reserved name spaces) may be made visible.
- (3) Additional symbols not required or explicitly permitted by PSE52 to be in that header shall not be made visible, except when enabled by another feature test macro.

Copyright © 2004 IEEE. All rights reserved.

7.2 Operating System Interface Requirements

7.2.1 POSIX.1 Interfaces (C language Option)

The Realtime Controller System Profile implementation shall include interfaces as defined in POSIX.1 {3} for the Units of Functionality shown in Table 7-1 (see Table 1-1 for a complete list of POSIX.1 Units of Functionality):

Table 7-1 — POSIX.1 Units of Functionality Requirements

Unit of Functionality
POSIX_C_LANG_JUMP
POSIX_C_LANG_MATH
POSIX_C_LANG_SUPPORT
POSIX_DEVICE_IO
POSIX_FD_MGMT
POSIX_FILE_LOCKING
POSIX_FILE_SYSTEM
POSIX_SIGNALS
POSIX_SINGLE_PROCESS
POSIX_THREADS_BASE
XSI_THREAD_MUTEX_EXT
XSI_THREADS_EXT

An implementation supporting the Realtime Controller System Profile shall support the POSIX.1 options shown in Table 7-2.

Table 7-2 — POSIX.1 Option Requirements

Option
_POSIX_CLOCK_SELECTION
_POSIX_FSYNC
_POSIX_MAPPED_FILES
_POSIX_MEMLOCK
_POSIX_MEMLOCK_RANGE
_POSIX_MESSAGE_PASSING
_POSIX_MONOTONIC_CLOCK
_POSIX_REALTIME_SIGNALS
_POSIX_SEMAPHORES
_POSIX_SHARED_MEMORY_OBJECTS
_POSIX_SYNCHRONIZED_IO
_POSIX_THREAD_ATTR_STACKADDR
_POSIX_THREAD_ATTR_STACKSIZE
_POSIX_THREAD_CPUTIME
_POSIX_THREAD_PRIO_INHERIT
_POSIX_THREAD_PRIO_PROTECT

Copyright © 2004 IEEE. All rights reserved.

Table 7-2 — POSIX.1 Option Requirements (Continued)

Option
<code>_POSIX_THREAD_PRIORITY_SCHEDULING</code>
<code>_POSIX_THREAD_SPORADIC_SERVER</code>
<code>_POSIX_TIMEOUTS</code>
<code>_POSIX_TIMERS</code>
<code>_POSIX_TRACE</code>
<code>_POSIX_TRACE_EVENT_FILTER</code>
<code>_POSIX_TRACE_LOG</code>

The value of `TIMER_MAX` shall be at least 64.

The value of `RTSIG_MAX` shall be at least 16.

The range of priorities associated with the `SCHED_RR` scheduling policy shall have at least 31 distinct values that are less than the maximum priority of the `SCHED_FIFO` policy.

An implementation conforming to PSE52 shall provide a mechanism to configure the system so that the scheduling allocation domain has size one, and so that the binding of threads to scheduling allocation domains remains static. The mechanism by which this requirement is achieved shall be implementation defined. In addition, a PSE52 implementation may provide other configurations or facilities to change the size of the allocation domain and the bindings of threads to allocation domains. For a description of the scheduling allocation domain, see the System Interfaces volume of POSIX.1 {3}, Section 2.9.2.

7.2.2 POSIX.26 Interfaces (C Language Option)

An implementation conforming to PSE52 shall support all the interfaces defined in POSIX.26 {4}. The implementation shall also support the POSIX.1 `mknod()` function, even if the XSI extension is not supported, as the portable mechanism to create character special files. Appropriate values for the `dev` parameter are implementation defined

Copyright © 2004 IEEE. All rights reserved.

7.2.3 POSIX.5c Interfaces (Ada Language Option)

The Realtime Controller System Profile implementation shall include interfaces as defined in POSIX.5c {5} for the Units of Functionality shown in Table 7-3 (see Table 1-1 for a complete list of POSIX.1 Units of Functionality).

Table 7-3 — POSIX.5c Units of Functionality Requirements

Unit of Functionality
POSIX_ADA_LANG_SUPPORT
POSIX_DEVICE_IO
POSIX_FD_MGMT
POSIX_FILE_SYSTEM
POSIX_SIGNALS
POSIX_SINGLE_PROCESS

The Realtime Controller System Profile implementation shall support the POSIX.5c options shown in Table 7-4, by defining the associated option subtypes to have the range True..True, with the exception of the Filename Truncation option for which the associated subtype shall have the range False..False.

Table 7-4 — POSIX.5c Option Requirements

Option
File Synchronization
Memory Mapped Files
Memory Locking
Memory Range Locking
Message Queues
Filename Truncation
Realtime Signals
Semaphores
Shared Memory Objects
Synchronized I/O
Mutexes
Mutex Priority Inheritance
Mutex Priority Ceiling
Timers

POSIX_Limits.Timers_Maxima'First shall be at least 64.

POSIX_Limits.Realtime_Signals_Maxima'First shall be at least 16.

Regarding task priority scheduling, the implementation shall support the following requirements from POSIX.5c {5} and the Ada95 RM {1}:

Copyright © 2004 IEEE. All rights reserved.

- The implementation shall support the priority model defined in the Ada95 RM {1}, Section D.1, and the pragmas and package interfaces defined in the Ada95 RM {1}, Sections D.2–D.5.
- The implementation shall meet the requirements of POSIX.5c {5}, Section 13.3.1.

The blocking behavior of all reentrant operations defined by POSIX.5c {5} shall be per task, i.e., a blocked task cannot prevent any other task from executing. Therefore, the corresponding `Blocking_Behavior` constants shall have the value `Tasks`. (See POSIX.5c {5}, Section 2.4.1.5.)

Implementations of the PSE52 profile shall support the `POSIX_Profiles` package defined in Annex A of this standard.

The subprogram `POSIX_Signals.Set_Stopped_Child_Signal` shall fail silently.

The subprogram `POSIX_Signals.Stopped_Child_Signal_Enabled` shall return `False`.

`POSIX_Limits.Groups_Maxima'First` shall be zero.

Subprograms not supported by a given profile shall raise `POSIX_Error`, returning an error code of `Operation_Not_Supported`, except as noted otherwise.

All `Image` and `Value` functions that appear in the packages supported by a profile must be implemented.

Where an overloaded subprogram is required by a Unit of Functionality, all forms of the subprogram appearing in the referenced clause must be supported, except as otherwise noted.

7.3 Application Constraints

The Realtime Controller System profile defined in this standard requires only specific Units of Functionality of the required standards. The absence of particular elements of these standards introduces constraints on the use of some of the features of particular operations. This clause defines the constraints that an application strictly conforming to one of the profiles shall observe when using each of the operations required by that profile.

Copyright © 2004 IEEE. All rights reserved.

7.3.1 Constraints Related to POSIX.1 Interfaces (C Language Option)

Table 7-5 defines a set of functions that shall be either reentrant or noninterruptible by signals and shall be async-signal-safe. Therefore applications may invoke them, without restriction, from signal-catching functions. No other function, including those defined in the System Interfaces volume of POSIX.1 {3}, Section 2.4.3, is required to be async-safe in an implementation of the PSE52 profile, and thus PSE52 Strictly Conforming Applications shall not use them from inside signal handlers.

Table 7-5 — Functions required to be async-signal-safe

<i>alarm()</i>	<i>sigaddset()</i>	<i>sigpending()</i>	<i>timer_getoverrun()</i>
<i>clock_gettime()</i>	<i>sigdelset()</i>	<i>sigprocmask()</i>	<i>)</i>
<i>kill()</i>	<i>sigemptyset()</i>	<i>sigqueue()</i>	<i>timer_gettime()</i>
<i>raise()</i>	<i>sigfillset()</i>	<i>sigset()</i>	<i>timer_settime()</i>
<i>sem_post()</i>	<i>sigismember()</i>	<i>sysconf()</i>	<i>times()</i>
<i>sigaction()</i>	<i>signal()</i>	<i>time()</i>	<i>uname()</i>

The *sysconf()* function has the following constraints:

- (1) An application strictly conforming to the PSE52 profile shall not call the *sysconf()* function with the parameter *_POSIX_VERSION* since a meaningful value cannot be returned.¹⁾
- (2) A conforming application must act as if *CHILD_MAX*=0.

An application strictly conforming to PSE52 shall be considered erroneous if any signal results in abnormal termination of the process because this profile does not support multiple processes.

An application strictly conforming to PSE52 shall not call the *kill()* function with a negative but not *-1* argument because this profile does not require process group functionality.

An application strictly conforming to PSE52 shall be guaranteed that the file mode creation mask for any object created by any process is *S_IRWXU*; that is, the object shall be fully accessible to the creator.

7.3.2 Constraints related to POSIX.5c Interfaces (Ada Language Option)

An application strictly conforming to PSE52 shall not call the functions *POSIX_Configurable_System_Limits.System_POSIX_Version* or

1) Conformance to this profile can be checked with the symbols defined in 7.1.3.

`POSIX_Configurable_System_Limits.System_POSIX_Ada_Version`, since a meaningful value cannot be returned.²⁾

A conforming application must act as if `POSIX_Limits.Child_Processes_Maxima'Last=0`.

An application strictly conforming to PSE52 shall be considered erroneous if any signal results in abnormal termination of the process because this profile does not support multiple processes.

An application strictly conforming to PSE52 shall not call the form of `POSIX_Signals.Send_Signal` that takes a process group ID as an argument because this profile does not require process group functionality.

An application strictly conforming to PSE52 shall not attempt to bind a signal to a task entry.

Implementations of PSE52 need not support the `File_Structure` field of the `form` parameter (see `POSIX.5c {5}`, Section 8.1.1.2), but may instead raise `Use_Error`. All files shall default to regular files.

7.4 Shell and Utility Requirements

An implementation of the Realtime Controller System Profile is not required to support any of the services described in the Shell and Utilities volume of `POSIX.1 {3}`.

7.5 Development Platform Requirements

One or more of the development options in 7.5.1 and 7.5.2 shall be implemented.

7.5.1 C Language Development Option

If this option is provided, the implementor shall define a Development Platform and an environment capable of preparing for execution an application conformant with this standard profile. This platform shall include the `POSIX2_C_DEV` and `POSIX2_SW_DEV` options from the Shell and Utilities volume of `POSIX.1 {3}`.

2) Conformance to this profile can be checked with the subtypes defined in 7.1.3.

7.5.1.1 Option Indicator

The presence of the C Language Development Option shall be indicated by the symbol `_POSIX_AEP_REALTIME_LANG_C99` being defined in the header `<unistd.h>`. In addition, the presence of the C Language Development Option may be indicated by the subtype `POSIX_Profiles.Realtime_Lang_C99` having the range `True..True`.

7.5.2 Ada Language Development Option

If this option is provided, the implementor shall define a Development Platform and an environment capable of preparing for execution an application conformant with this profile including applicable portions of the following:

- The Ada95 RM {1}
- POSIX.5c {5}
- The POSIX2_SW_DEV option from the Shell and Utilities volume of POSIX.1 {3}.

7.5.2.1 Option Indicator

The presence of the Ada Language Development Option shall be indicated by the subtype `POSIX_Profiles.Realtime_Lang_Ada95` having the range `True..True`. In addition, the presence of the Ada Language Development Option may be indicated by the symbol `_POSIX_AEP_REALTIME_LANG_Ada95` being defined in the header `<unistd.h>`.

7.6 Rationale for Operating System Requirements (informative)

(This clause is not a normative part of IEEE Std 1003.13-2003.)

7.6.1 Operating System Interface Requirements

This model introduces system functionality that is more sophisticated than in the Minimal Realtime System Profile, specifically in the area of I/O. Two general categories of services are added.

Copyright © 2004 IEEE. All rights reserved.

The first extension is support for a simplified file and directory system. These features are used in applications that require an alterable filename space, typically in systems that support secondary storage and require the ability to create, change, and delete named regular files located on a storage device. The included functions allow the creation, deletion, and changing of file attributes of regular files.

This profile assumes the following hardware model: one or more processors with local memory and one or more serial interfaces. (It is anticipated that the serial interface(s) may be removed in final production systems.) Driver-level I/O to standard and nonstandard devices are supported. In addition, a file system device is supported. The hardware is not required to provide memory management.

7.6.1.1 Process Primitives

Because this profile uses the POSIX.1 threads model only as the mechanism to achieve concurrency, most POSIX.1 process primitives do not apply. This includes the multi-process, pipes, and signal jump Units of Functionality, as well as the process spawn option. Although PSE52 has only a single (implicit) process, some interprocess APIs are required to support communication between applications.

The *main()* function is needed to allow application-specific information to be passed from boot code to the single process (and its threads).

7.6.1.2 Signals

Signal services are a basic mechanism within POSIX-based systems and are required for error and event handling. Realtime systems typically have several logically concurrent software elements executing. Each such entity must respond to several cyclic and/or acyclic stimuli, often in a time-critical manner. Although purely synchronous models can supply such functionality via the use of additional processes or threads, the current realtime practice for asynchronous notification for events such as timeout, message arrival, and hardware interrupt can generally be expected to offer higher performance and lower latency. Realtime Signals provide the reliable high-performance mechanism to support such notification.

The minimum number of realtime signals that the implementation is required to support has been increased from the number specified in POSIX.1 {3}, 8, to 16. The rationale for this increase is that there are many applications that have more than 8 different kinds of events. Doubling the number of required realtime signals should have a minimum impact on the signal management overhead, while significantly increasing the number of event kinds that can be used by a strictly conforming application.

Copyright © 2004 IEEE. All rights reserved.

7.6.1.3 Process Environment

The functions from the POSIX.1 Process Environment group are deemed necessary to allow an application to determine and configure its system environment. This allows a single version of an application to be run on similar but differing platforms; however, conforming applications must act as if `CHILD_MAX=0`.

7.6.1.4 Files and Directories

Since this profile has a file system, all POSIX.1 functions that manage basic file systems are required. However, the file system in a PSE52 platform is a simplified version of a full POSIX.1 file system, and for this reason the `POSIX_FIFO`, `POSIX_FILE_ATTRIBUTES`, and `POSIX_FILE_SYSTEM_EXT`, Units of Functionality, and the `_POSIX_ADVISORY_INFO` option are not required.

The File Locking option is required in the C language option to maintain a consistent and safe way of accessing stdio (*FILE* *) objects from threads, across the four realtime profiles.

7.6.1.5 Input and Output Primitives

The functions contained in the Device I/O and File Descriptor Management Units of Functionality are required to do basic I/O and device cleanup.

Asynchronous I/O is not required because it can be easily implemented using threads dedicated to I/O.

The `posix_devctl()` function defined in POSIX.26 {4} is required to support control operations on I/O devices.

7.6.1.6 Synchronized Input and Output

The Synchronized (unbuffered) I/O interface (including the File Synchronization option) is typical for basic device I/O and is required for upward portability.

Those realtime systems that use file management systems will frequently require synchronized I/O to provide data integrity and/or relinquish resources to other users. Synchronized I/O as defined in POSIX.1 {3} provides these mechanisms.

Copyright © 2004 IEEE. All rights reserved.

7.6.1.7 Device- and Class-Specific Functions

POSIX.1 Device- or Class-Specific functions are not required, because PSE52 systems usually do not require general-purpose terminal interfaces.

7.6.1.8 System Databases, Users, and Groups

Implementations are not required to support more than one user and group id since there are not multiple users and groups. No POSIX.1 System Database functions are required.

7.6.1.9 Synchronization

Mutexes and Condition Variables are required as part of threads model of concurrency.

The Process Shared option is not required because there is only a single process.

Semaphores are required in the PSE52 profile for synchronization between threads to maintain compatibility with past industry practice. However, mutexes and conditional variables are preferred in most current applications. It must be noted that POSIX semaphores do not have the mechanisms built in to avoid unbounded priority inversion when using them for mutually exclusive access to shared resources. Mutexes with the appropriate priority inheritance or priority ceiling (also called priority protection) protocols can be used to avoid this unbounded priority inversion.

Barriers are not required because they can easily be implemented using mutexes and condition variables. Although a direct implementation of barriers can have a significant efficiency benefit in some multiprocessor architectures, a mutex-and-condition-variable implementation will not be significantly slower in most architectures, and thus requiring barriers for all implementations is not justified.

Spin locks are not required because, although they are an efficient synchronization mechanism, they cannot be portably used with the current POSIX.1 interfaces in realtime applications. If a realtime scheduling policy such as SCHED_FIFO or SCHED_RR is used, spin locks may cause deadlock on a single processor. On multiprocessors, to avoid deadlock, it would be necessary for threads using a given lock to be allocated to different processors. There are no standard APIs in the current POSIX.1 {3} to allocate threads to specific processors.

Reader/Writer Locks are not required because they are not designed to avoid unbounded priority inversion, and thus very long delays could occur in realtime applications, with a low but nevertheless nonzero probability. It is expected that a future revision of POSIX.1 {3} will add the priority inheritance and/or priority

Copyright © 2004 IEEE. All rights reserved.

ceiling options to reader/writer locks, which would eliminate the unbounded priority inversion.

7.6.1.10 Priority Scheduling

Thread priority scheduling is required for realtime applications. The Sporadic Server Scheduling option is also required to enhance support of applications with aperiodic timing requirements.

A common requirement of realtime systems is that they be able to run threads with realtime requirements together with threads with no realtime requirements. One common way of doing this is by having the realtime threads run under the SCHED_FIFO scheduling policy, while the non-realtime threads run at a lower priority under the round-robin policy (SCHED_RR) to fairly share the available portion of the processor among them. POSIX.1 {3} requires each policy to have a range of priorities of at least 32 distinct values, but does not impose any requirements on how these priority ranges relate to each other. It could happen that most or all of the SCHED_RR priorities were larger than the SCHED_FIFO priorities, thus making it impossible to mix realtime and non-realtime threads as required above. To solve this problem in a portable way, this profile requires that there are at least 31 SCHED_RR priority levels below the maximum priority of SCHED_FIFO. In this way, a strictly conforming application can use the inclusive priority range [*max_FIFO_prio*, *max_FIFO_prio*-30] with SCHED_FIFO for realtime threads (with a total of 31 priority levels), and then use the priority value $\min(\text{max_FIFO_prio}-31, \text{max_RR_prio})$ with the SCHED_RR policy, for the non-realtime threads, with guarantee that the latter priority value is valid for the round-robin policy.

Support for a scheduling allocation domain of size one and static binding of threads to allocation domains is required in all the realtime profiles to achieve predictable scheduling behavior. The allocation domain of a thread is the set of processors on which that thread can be scheduled at any given time. POSIX.1 {3} specifies that the scheduling rules have predictable effects only if the allocation domain is of size one; hence the need for this requirement. For single-processor systems the allocation domain is generally of size one, and thus the application can meet the requirement just by specifying in the conformance document that the scheduling allocation domain is of size one and that static binding of threads to allocation domains is the default behavior.

7.6.1.11 Process Memory Locking

Process memory locking is inherent in systems following this profile because most PSE52 targets have no MMU and thus swapping is not supported; code and data stays in physical memory until explicitly removed. Nevertheless, memory locking APIs are required for upward portability to allow an application developer to take

Copyright © 2004 IEEE. All rights reserved.

code intended for a bare PSE52 target and unit test that code on a much larger and more capable platform, perhaps a PSE54, with minimal modification. In those targets not using an MMU for virtual memory, the locking functions do nothing and always report success, while in the larger profiles there really is memory to be locked. In summary, by requiring this service in the PSE52 profile, it is possible to write portable application code that runs correctly in all the profiles.

7.6.1.12 Shared Memory

Memory Mapped I/O may be implemented using the Shared Memory facility. An implementation is required to provide facilities for creating (shared) memory objects that represent ranges of physical memory that contain device control and status registers or buffers. These facilities encourage the development of portable applications.

The Memory Mapped Files option is included because the implementation has file-system capabilities, and memory-mapped files are a convenient paradigm for reading and writing information in applications following this profile. In memory-mapped files, I/O is not managed by the programmer because data can be manipulated as memory. The implementation of memory-mapped files does not require a significant amount of additional memory or execution overhead to achieve the additional capability.

System vendors are expected to implement the chosen interface in a manner that meets the needs of the applications. In particular, a rotating media-based implementation is allowed but not required by the interface definition.

Typed Memory objects are not required because they are useful only to systems with special hardware architectures that have various often specialized kinds of memory. Implementors providing support for such special architectures always have the option to provide typed memory objects as an extension.

7.6.1.13 Clocks and Timers

High-resolution timer functions are required in most realtime systems for implementing time management operations such as periodic activations, short duration timeouts, etc. The normal POSIX.1 time management functions *sleep()* and *alarm()* only provide a time resolution of one second, but many realtime systems require finer resolution for specifying time.

The Monotonic Clock is required for realtime applications to ensure that deadlines and timing requirements are not affected by clock jumps.

The Clock Selection option is required to enable choosing the clock on which sleep operations are performed and to have access to an absolute sleep operation, which

Copyright © 2004 IEEE. All rights reserved.

is a common requirement in realtime applications with periodic timing requirements.

CPU-Time clocks and timers are required as a means to detect and handle situations in which a thread overruns its assigned maximum execution time. Bounding the execution times of the different threads in the application provides temporal partitioning in realtime applications, and thus increases predictability and reliability.

The Timeouts option is a general requirement for realtime applications and thus is required in this profile.

The minimum number of timers that the implementation is required to support has been increased from the number specified in POSIX.1 {3}, 32, to 64, which is the required minimum number of threads. The reason for this increase is that there are many applications that require one timer per thread (either realtime or CPU-time based).

7.6.1.14 Message Passing

Currently available commercial realtime kernels with similar functionality to the Realtime Controller System Profile typically include some form of message queueing mechanism for communication between threads. The POSIX.1 Message Passing offers an appropriate level of performance to provide this functionality.

7.6.1.15 Threads

The basic assumption in this profile is that the system will consist of a single (implicit) process, with multiple threads. Therefore, all basic thread services are required, except for those related to multiple processes. The POSIX_THREADS_BASE Unit of Functionality was specified in this standard instead of the _POSIX_THREADS option, because this option requires reader/writer locks, but this profile does not.

7.6.1.16 Tracing

Tracing is required for the PSE52 environment because most of these systems work in an unattended mode for long periods of time, and tracing provides an excellent mechanism to support post-failure analysis, particularly for failures having a low probability of occurrence.

Copyright © 2004 IEEE. All rights reserved.

The Trace Event Filtering option is required for the system to be able to filter out those trace events that are not meaningful for the application, thus making better use of system resources by capturing only the interesting events.

The presence of a file system in the PSE52 profile facilitates the recording of the trace events, through the Trace Log option, which is required for this profile.

7.6.1.17 Networking

Although some small controller systems require networking services, most do not, so to keep the implementation small, this Unit of Functionality is not required.

7.6.1.18 Event Management

The *select()* function is usually associated with networking facilities, which are not required for PSE52. Although the function could be used for regular device I/O operations, most kernels that do not have networking services do not support *select()*. Therefore, to keep the implementation small, the Event Management Unit of Functionality is not required.

7.6.1.19 Interfaces Related to the Shell and Utilities

Interfaces defined in the POSIX_REGEX and POSIX_SHELL_FUNC Units of Functionality are related to shells and utilities, which are not required in this profile; therefore, these Units of Functionality are not required either.

7.6.1.20 X/Open Units of Functionality and Options

Some XSI Units of Functionality (XSI_C_LANG_SUPPORT, XSI_DEVICE_IO, XSI_DEVICE_SPECIFIC, XSI_FD_MGMT, XSI_FILE_SYSTEM, XSI_IPC, XSI_JOB_CONTROL, XSI_JUMP, XSI_MATH, XSI_MULTI_PROCESS, XSI_SIGNALS, XSI_SINGLE_PROCESS, XSI_SYSTEM_DATABASE, XSI_TIMERS, XSI_USER_GROUPS, XSI_WIDE_CHAR) have interfaces that represent extensions or alternatives to interfaces in other Units of Functionality or POSIX.1 options, and therefore are not necessary for PSE52 environments.

The XSI_DBM Unit of Functionality includes interfaces for database management that are not required in the PSE52 application environment.

The XSI_DYNAMIC_LINKING Unit of Functionality is not required for small embedded systems, which usually operate in a static context.

Copyright © 2004 IEEE. All rights reserved.

The XSI_I18N Unit of Functionality provides facilities for natural language messages to the user, which are not required in realtime controller systems, which typically do not have general-purpose human interfaces.

The XSI_SYSTEM_LOGGING Unit of Functionality provides facilities for logging system activities, which are not required in PSE52 environments.

The XSI_THREAD_MUTEX_EXT Unit of Functionality is required because it has options for controlling the behavior of mutexes under erroneous application use. This capability is interesting for any realtime application, including those targeted at control systems.

The XSI_THREADS_EXT Unit of Functionality is required because it provides functions to better control a thread's stack. This is considered useful for any realtime application.

The _XOPEN_CRYPT option provides cryptography facilities that are not required in PSE52 environments.

The _XOPEN_LEGACY option provides facilities for backwards compatibility that are not required in PSE52 environments.

The _XOPEN_STREAMS option provides facilities that are mainly related to networking, and thus are not required for PSE52 environments, as discussed in 7.6.1.17.

7.6.1.21 Language-Specific Services for the C Programming Language

Support for the C99 Standard {2} is required in the C language option, with the exception of the POSIX_C_LANG_WIDE_CHAR Unit of Functionality. The reason for this exception is that this is a very large library that is not necessary for many of the PSE52 applications.

7.6.1.22 Language-Specific Services for the Ada Programming Language

Support for the Ada language-specific services defined in POSIX.5c {5} is required in the Ada language option.

7.6.2 Shell and Utility Requirements

Because the Realtime Controller System Profile is intended for control systems which usually have no terminal or graphical user interface, such a platform would be incapable of executing a shell. In such an environment, the utilities described in the Shell and Utilities volume of POSIX.1 {3} are not usually required.

Copyright © 2004 IEEE. All rights reserved.

7.6.3 Development Platform Requirements

The special-purpose nature of the PSE52 execution platform makes it difficult to use as a development platform. Therefore, the implementation is required to define a development environment in which a PSE52 application can be prepared for execution on the target platform. The development platform depends on the language option chosen by the implementation.

Copyright © 2004 IEEE. All rights reserved.

Section 8: Dedicated Realtime System Profile (PSE53)

8.1 Introduction

This section specifies those standards required for conformance to the Dedicated Realtime System Profile option and, where applicable, the state of any options contained in those standards.

When a referenced standard specifies services beyond those required by the Dedicated Realtime System Profile, only those services included in the specified Units of Functionality referenced by this profile shall be required (see Table 1-1 through Table 1-17). All the applicable definitions in POSIX.1 {3} and/or POSIX.5c {5} still apply.

8.1.1 Identification

For the C language implementation, symbolic names shall be used to specify the presence or absence of each option in this profile. Names reserved for use in this profile begin with the string `_POSIX_AEP_REALTIME_`. For the Ada language implementation, a set of Boolean subtypes contained in package `POSIX_Options` (defined in POSIX.5c {5}, Section 2.5) shall be used to specify the presence or absence of each option in this profile.

8.1.2 Conformance

Conformance to the Dedicated Realtime System Profile option shall be indicated as follows:

- For the C language implementation, the symbol `_POSIX_AEP_REALTIME_DEDICATED` being defined in the header `<unistd.h>` to be 200312L.
- For the Ada language implementation, the Boolean subtype `POSIX_Profiles.Realtime_Dedicated` subtype having the range `True..True`, and the constant `POSIX_Profiles.Realtime_AEP_Version` having the value 2003_12.

Copyright © 2004 IEEE. All rights reserved.

8.1.3 Options

The presence or absence of optional features shall be indicated as follows:

- For the C language implementation, if any of the following symbols are defined in the header `<unistd.h>`, then a corresponding programming environment is supported:

`_POSIX_AEP_REALTIME_LANG_C99`

`_POSIX_AEP_REALTIME_LANG_Ada95`

- For the Ada language implementation, if any of the following Boolean subtypes has the range `True..True`, then the corresponding option is supported:

`POSIX_Profiles.Realtime_Lang_C99`

`POSIX_Profiles.Realtime_Lang_Ada95`

8.1.4 The Compilation Environment (C language option)

Certain symbols required by PSE53 are defined in headers. Some of those headers could also define symbols other than those required by PSE53, potentially conflicting with symbols used by the application. Also, POSIX.1 {3} defines symbols that are not permitted by other standards to appear in those headers without some control on the visibility of those symbols. Symbols called “feature test macros” are used to control the visibility of symbols that might be included in a header.

An application conforming to PSE53 should ensure that the feature test macro `_POSIX_AEP_RT_DEDICATED_C_SOURCE` is defined before inclusion of any header. When an application includes a header described by POSIX.1 {3} and when this feature test macro is defined to have the value `200312L`,

- (1) All symbols required by PSE53 to appear when the header is included shall be made visible.
- (2) Symbols that are explicitly permitted, but not required, by PSE53 to appear in that header (including those in reserved name spaces) may be made visible.
- (3) Additional symbols not required or explicitly permitted by PSE53 to be in that header shall not be made visible, except when enabled by another feature test macro.

Copyright © 2004 IEEE. All rights reserved.

8.2 Operating System Interface Requirements

8.2.1 POSIX.1 Interfaces (C Language Option)

The Dedicated Realtime System Profile implementation shall include interfaces as defined in POSIX.1 {3} for the Units of Functionality shown in Table 8-1 (see Table 1-1 for a complete list of POSIX.1 Units of Functionality).

Table 8-1 — POSIX.1 Units of Functionality Requirements

Unit of Functionality
POSIX_C_LANG_JUMP
POSIX_C_LANG_MATH
POSIX_C_LANG_SUPPORT
POSIX_DEVICE_IO
POSIX_EVENT_MGMT
POSIX_FD_MGMT
POSIX_FILE_LOCKING
POSIX_FILE_SYSTEM
POSIX_MULTI_PROCESS
POSIX_NETWORKING
POSIX_PIPE
POSIX_SIGNALS
POSIX_SIGNAL_JUMP
POSIX_SINGLE_PROCESS
POSIX_THREADS_BASE
XSI_THREAD_MUTEX_EXT
XSI_THREADS_EXT

An implementation supporting the Dedicated Realtime System Profile shall support the POSIX.1 options shown in Table 8-2.

Table 8-2 — POSIX.1 Option Requirements

Option
_POSIX_ASYNCHRONOUS_IO
_POSIX_CLOCK_SELECTION
_POSIX_CPUTIME
_POSIX_FSYNC
_POSIX_MAPPED_FILES
_POSIX_MEMLOCK
_POSIX_MEMLOCK_RANGE
_POSIX_MEMORY_PROTECTION
_POSIX_MESSAGE_PASSING
_POSIX_MONOTONIC_CLOCK
_POSIX_PRIORITIZED_IO

Copyright © 2004 IEEE. All rights reserved.

Table 8-2 — POSIX.1 Option Requirements (Continued)

Option
<code>_POSIX_PRIORITY_SCHEDULING</code>
<code>_POSIX_RAW_SOCKETS</code>
<code>_POSIX_REALTIME_SIGNALS</code>
<code>_POSIX_SEMAPHORES</code>
<code>_POSIX_SHARED_MEMORY_OBJECTS</code>
<code>_POSIX_SPAWN</code>
<code>_POSIX_SPORADIC_SERVER</code>
<code>_POSIX_SYNCHRONIZED_IO</code>
<code>_POSIX_THREAD_ATTR_STACKADDR</code>
<code>_POSIX_THREAD_ATTR_STACKSIZE</code>
<code>_POSIX_THREAD_CPU_TIME</code>
<code>_POSIX_THREAD_PRIO_INHERIT</code>
<code>_POSIX_THREAD_PRIO_PROTECT</code>
<code>_POSIX_THREAD_PRIORITY_SCHEDULING</code>
<code>_POSIX_THREAD_PROCESS_SHARED</code>
<code>_POSIX_THREAD_SPORADIC_SERVER</code>
<code>_POSIX_TIMEOUTS</code>
<code>_POSIX_TIMERS</code>
<code>_POSIX_TRACE</code>
<code>_POSIX_TRACE_EVENT_FILTER</code>
<code>_POSIX_TRACE_LOG</code>

The value of `TIMER_MAX` shall be at least 64.

The value of `RTSIG_MAX` shall be at least 16.

The range of priorities associated with the `SCHED_RR` scheduling policy shall have at least 31 distinct values that are less than the maximum priority of the `SCHED_FIFO` policy.

An implementation conforming to PSE53 shall support the `PTHREAD_SCOPE_SYSTEM` scheduling contention scope. In addition, it may support `PTHREAD_SCOPE_PROCESS`. For a description of the scheduling contention scope, see the System Interfaces volume of POSIX.1 {3}, Section 2.9.2.

An implementation conforming to PSE53 shall provide a mechanism to configure the system so that the scheduling allocation domain has size one, and so that the binding of threads to scheduling allocation domains remains static. The mechanism by which this requirement is achieved shall be implementation defined. In addition, a PSE53 implementation may provide other configurations or facilities to change the size of the allocation domain and the bindings of threads to allocation domains. For a description of the scheduling allocation domain, see the System Interfaces volume of POSIX.1 {3}, Section 2.9.2.

Copyright © 2004 IEEE. All rights reserved.

8.2.2 POSIX.26 Interfaces (C Language Option)

An implementation conforming to PSE53 shall support all the interfaces defined in POSIX.26 {4}. The implementation shall also support the POSIX.1 *mknod()* function, even if the XSI extension is not supported, as the portable mechanism to create character special files. Appropriate values for the *dev* parameter are implementation defined.

8.2.3 POSIX.5c Interfaces (Ada Language Option)

The Dedicated Realtime System Profile implementation shall include interfaces as defined in POSIX.5c {5} for the Units of Functionality shown in Table 8-3 (see Table 1-2 through Table 1-17 for a complete list of POSIX.5c Units of Functionality).

Table 8-3 — POSIX.5c Units of Functionality Requirements

Unit of Functionality
POSIX_ADA_LANG_SUPPORT
POSIX_DEVICE_IO
POSIX_EVENT_MGMT
POSIX_FD_MGMT
POSIX_FILE_SYSTEM
POSIX_MULTI_PROCESS ⁽¹⁾
POSIX_NETWORKING
POSIX_PIPE
POSIX_SIGNALS
POSIX_SINGLE_PROCESS

- ⁽¹⁾ The POSIX_MULTI_PROCESS Unit of Functionality shall be supported, with the provision that the package `POSIX_Unsafe_Process_Primitives` is not required

The Dedicated Realtime System Profile implementation shall support the POSIX.5c options shown in Table 8-4, by defining the associated option subtypes to have the range `True..True`, with the exception of the Filename Truncation option for which the associated subtype shall have the range `False..False`.

Table 8-4 — POSIX.5c Option Requirements

Option
Asynchronous I/O
File Synchronization
Memory Mapped Files
Memory Locking
Memory Range Locking
Memory Protection

Copyright © 2004 IEEE. All rights reserved.

Table 8-4 — POSIX.5c Option Requirements (Continued)

Option
Message Queues
Filename Truncation
Prioritized I/O
Priority Process Scheduling
Realtime Signals
Semaphores
Shared Memory Objects
Synchronized I/O
Mutexes
Mutex Priority Inheritance
Mutex Priority Ceiling
Process Shared
Timers

`POSIX_Limits.Timers_Maxima'First` shall be at least 64.

`POSIX_Limits.Realtime_Signals_Maxima'First` shall be at least 16.

Regarding task priority scheduling, the implementation shall support the following requirements from POSIX.5c {5} and the Ada95 RM {1}:

- The implementation shall support the priority model defined in the Ada95 RM {1}, Section D.1, and the pragmas and package interfaces defined in the Ada95 RM {1}, Sections D.2–D.5.
- The implementation shall meet the requirements of POSIX.5c {5}, Section 13.3.1.

Implementations of the PSE53 profile shall support the `POSIX_Profiles` package defined in Annex A of this standard.

The subprogram `POSIX_Signals.Set_Stopped_Child_Signal` shall fail silently.

The subprogram `POSIX_Signals.Stopped_Child_Signal_Enabled` shall return `False`.

`POSIX_Limits.Groups_Maxima'First` shall be zero.

Subprograms not supported by a given profile shall raise `POSIX_Error`, returning an error code of `Operation_Not_Supported`, except as noted otherwise.

All `Image` and `Value` functions that appear in the packages supported by a profile must be implemented.

Where an overloaded subprogram is required by a Unit of Functionality, all forms of the subprogram appearing in the referenced clause must be supported, except as otherwise noted.

Copyright © 2004 IEEE. All rights reserved.

8.3 Application Constraints

The Dedicated Realtime System profile defined in this standard requires only specific Units of Functionality of the required standards. The absence of particular elements of these standards introduces constraints on the use of some of the features of particular operations. This clause defines the constraints that an application strictly conforming to one of the profiles shall observe when using each of the operations required by that profile.

8.3.1 Constraints related to POSIX.1 Interfaces (C Language Option)

The *sysconf()* function has the following constraints:

- (1) An application strictly conforming to the PSE53 profile shall not call the *sysconf()* function with the parameter `_POSIX_VERSION` since a meaningful value cannot be returned.¹⁾

An application strictly conforming to PSE53 shall not call the *kill()* function with a negative argument because this profile does not require process group functionality.

An application strictly conforming to PSE53 shall be guaranteed that the file mode creation mask for any object created by any process is `S_IRWXU`; that is, the object shall be fully accessible to the creator.

8.3.2 Constraints related to POSIX.5c Interfaces (Ada Language Option)

An application strictly conforming to PSE53 shall not call the functions `POSIX_Configurable_System_Limits.System_POSIX_Version` or `POSIX_Configurable_System_Limits.System_POSIX_Ada_Version`, since a meaningful value cannot be returned.²⁾

An application strictly conforming to PSE53 shall not call the subprograms contained in the package `Posix_Unsafe_Process_Primitives`, but shall instead rely upon either `Posix_Process_Primitives.Start_Process` or `Posix_Process_Primitives.Start_Process_Search` to create new processes.

An application strictly conforming to PSE53 shall not call the form of `POSIX_Signals.Send_Signal` that takes a process group ID as an argument because this profile does not require process group functionality.

1) Conformance to this profile can be checked with the symbols defined in 8.1.3.

2) Conformance to this profile can be checked with the subtypes defined in 8.1.3.

An application strictly conforming to PSE53 shall not attempt to bind a signal to a task entry.

Implementations of PSE53 need not support the `File_Structure` field of the `form` parameter (see POSIX.5c {5}, Section 8.1.1.2), but may instead raise `Use_Error`. All files shall default to regular files.

8.4 Shell and Utility Requirements

An implementation of the Dedicated Realtime System Profile is not required to support any of the services described in the Shell and Utilities volume of POSIX.1 {3}.

8.5 Development Platform Requirements

One or more of the development options in 8.5.1 and 8.5.2 shall be implemented.

8.5.1 C Language Development Option

If this option is provided, the implementor shall define a Development Platform and an environment capable of preparing for execution an application conformant with this standard profile. This platform shall include the `POSIX2_C_DEV`, and `POSIX2_SW_DEV` options from the Shell and Utilities volume of POSIX.1 {3}.

8.5.1.1 Option Indicator

The presence of the C Language Development Option shall be indicated by the symbol `_POSIX_AEP_REALTIME_LANG_C99` being defined in the header `<unistd.h>`. In addition, the presence of the C Language Development Option may be indicated by the subtype `POSIX_Profiles.Realtime_Lang_C99` having the range `True..True`.

Copyright © 2004 IEEE. All rights reserved.

8.5.2 Ada Language Development Option

If this option is provided, the implementor shall define a Development Platform and an environment capable of preparing for execution an application conformant with this profile including applicable portions of the following:

- The Ada95 RM {1}
- POSIX.5c {5}
- The POSIX2_SW_DEV option from the Shell and Utilities volume of POSIX.1 {3}

8.5.2.1 Option Indicator

The presence of the Ada Language Development Option shall be indicated by the subtype `POSIX_Profiles.Realtime_Lang_Ada95` having the range `True..True`. In addition, the presence of the Ada Language Development Option may be indicated by the symbol `_POSIX_AEP_REALTIME_LANG_Ada95` being defined in the header `<unistd.h>`.

8.6 Rationale for Operating System Requirements (informative)

(This clause is not a normative part of IEEE Std 1003.13-2003.)

8.6.1 Operating System Interface Requirements

This profile is based on existing practice in large embedded systems (a single user is assumed). Traditionally, these applications are designed to run with either a home-grown or standard operating system providing process, I/O, time, memory, and event management services. These applications require support for a simplified file system.

Where convenient, the AEP profile working group has chosen system options that allow an application to be upwardly portable without modifying application source code.

Copyright © 2004 IEEE. All rights reserved.

8.6.1.1 Process Primitives

Applications that correspond to the Dedicated Realtime System Environment are usually large embedded systems that require multiple processes for handling multiple, concurrent activities with independent address spaces. The process control functions (which include process creation and execution) are the basic operating system services required to support multiple processes and are therefore required in these systems.

8.6.1.2 Signals

Signal services are a basic mechanism within POSIX-based systems and are required for error and event handling. Realtime systems typically have several logically concurrent software elements executing. Each such entity must respond to several cyclic and/or acyclic stimuli, often in a time-critical manner. Although purely synchronous models can supply such functionality via the use of additional processes or threads, the current realtime practice for asynchronous notification for events such as timeout, message arrival, and hardware interrupt can generally be expected to offer higher performance and lower latency. Realtime Signals provide the reliable high-performance mechanism to support such notification.

The minimum number of realtime signals that the implementation is required to support has been increased from the number specified in POSIX.1 {3}, 8, to 16. The rationale for this increase is that there are many applications that have more than 8 different kinds of events. Doubling the number of required realtime signals should have a minimum impact on the signal management overhead, while significantly increasing the number of event kinds that can be used by a strictly conforming application.

8.6.1.3 Process Environment

The functions from the POSIX.1 Process Environment group are deemed necessary to allow an application to determine and configure its system environment. This allows a single version of an application to be run on similar but differing platforms.

Since these systems require multiple processes, but not users or groups, the functions defined by the POSIX_MULTI_PROCESS Unit of Functionality are required.

Copyright © 2004 IEEE. All rights reserved.

8.6.1.4 Files and Directories

Since this profile has a file system, all POSIX.1 functions that manage basic file systems are required. However, the file system in a PSE53 platform is a simplified version of a full POSIX.1 file system, and for this reason, the `POSIX_FIFO`, `POSIX_FILE_ATTRIBUTES`, and `POSIX_FILE_SYSTEM_EXT`, Units of Functionality, and the `_POSIX_ADVISORY_INFO` option are not required.

The File Locking option is required in the C language option to maintain a consistent and safe way of accessing stdio (*FILE* *) objects from threads, across the four realtime profiles.

The File Descriptor Management Unit of Functionality is included to aid the handling of file descriptors across the process creation and program execution operations.

8.6.1.5 Input and Output Primitives

The functions contained in the Device I/O Unit of Functionality are required to do basic I/O and device cleanup.

Although asynchronous I/O can be easily implemented using threads dedicated to I/O, it is required in the PSE53 profile to support portability of applications that may have been developed before POSIX threads implementations were widely available.

The `posix_devctl()` function defined in POSIX.26 {4} is required to support control operations on I/O devices.

8.6.1.6 Synchronized Input and Output

The Synchronized (unbuffered) I/O interface (including the File Synchronization option) is typical for basic device I/O and is required for upward portability.

Those realtime systems that use file management systems will frequently require synchronized I/O to provide data integrity and/or relinquish resources to other users. Synchronized I/O as defined in POSIX.1 {3} provides these mechanisms.

8.6.1.7 Device- and Class-Specific Functions

POSIX.1 Device- or Class-Specific functions are not required, because embedded systems usually do not require general-purpose terminal interfaces.

Copyright © 2004 IEEE. All rights reserved.

8.6.1.8 System Databases, Users, and Groups

Implementations are not required to support more than one user and group id since there are not multiple users and groups. No POSIX.1 System Database functions are required.

8.6.1.9 Synchronization

Mutexes and Condition Variables are required as part of threads model of concurrency.

Semaphores are required to support portability of applications that might be using this mechanism instead of the preferred mutexes and condition variables. It must be noted, however, that POSIX semaphores do not have the mechanisms built in to avoid unbounded priority inversion when using them for mutually exclusive access to shared resources. Mutexes with the appropriate priority inheritance or priority ceiling (also called priority protection) protocols can be used to avoid this unbounded priority inversion. The Process Shared option is required to support applications requiring this mechanism for synchronization across different processes.

Barriers are not required because they can easily be implemented using mutexes and condition variables. Although a direct implementation of barriers can have a significant efficiency benefit in some multiprocessor architectures, a mutex-and-condition-variable implementation will not be significantly slower in most architectures, and thus requiring barriers for all implementations is not justified.

Spin locks are not required because, although they are an efficient synchronization mechanism, they cannot be portably used with the current POSIX.1 interfaces in realtime applications. If a realtime scheduling policy such as SCHED_FIFO or SCHED_RR is used, spin locks may cause deadlock on a single processor. On multiprocessors, to avoid deadlock, it would be necessary for threads using a given lock to be allocated to different processors. There are no standard APIs in the current POSIX.1 {3} to allocate threads to specific processors.

Reader/Writer Locks are not required because they are not designed to avoid unbounded priority inversion, and thus very long delays could occur in realtime applications, with a low but nevertheless nonzero probability. It is expected that a future revision of POSIX.1 {3} will add the priority inheritance and/or priority ceiling options to reader/writer locks, which would eliminate the unbounded priority inversion.

Copyright © 2004 IEEE. All rights reserved.

8.6.1.10 Priority Scheduling

Thread and process priority scheduling are required for realtime applications. The Sporadic Server Scheduling option is also required for processes and threads, to enhance support of applications with aperiodic timing requirements.

A common requirement of realtime systems is that they be able to run threads or processes with realtime requirements together with threads with no realtime requirements. One common way of doing this is by having the realtime threads run under the SCHED_FIFO scheduling policy, while the non-realtime threads run at a lower priority under the round-robin policy (SCHED_RR) to fairly share the available portion of the processor among them. POSIX.1 {3} requires each policy to have a range of priorities of at least 32 distinct values, but does not impose any requirements on how these priority ranges relate to each other. It could happen that most or all of the SCHED_RR priorities were larger than the SCHED_FIFO priorities, thus making it impossible to mix realtime and non-realtime threads as required above. To solve this problem in a portable way, this profile requires that there are at least 31 SCHED_RR priority levels below the maximum priority of SCHED_FIFO. In this way, a strictly conforming application can use the inclusive priority range $[max_FIFO_prio, max_FIFO_prio-30]$ with SCHED_FIFO for realtime threads (with a total of 31 priority levels), and then use the priority value $\min(max_FIFO_prio-31, max_RR_prio)$ with the SCHED_RR policy, for the non-realtime threads, with guarantee that the latter priority value is valid for the round-robin policy.

The implementation is required to support the PTHREAD_SYSTEM_SCOPE thread-scheduling contention scope. The contention scope of a thread defines the set of threads with which the thread competes for use of the processing resources. A thread created with PTHREAD_SCOPE_SYSTEM scheduling contention scope contends for resources with all other threads in the system that have the same scheduling allocation domain. This allows a consistent scheduling of threads across the system, and therefore a predictable timing behavior. As a consequence, this is the preferred method for realtime systems.

The current POSIX.1 {3} allows implementations to support either system-wide or process-wide contention scope, or both. This represents a compromise that tries to address the requirements of both realtime and non-realtime applications, but introduces a potential source for nonportability. Because the realtime profiles are specifically targeted at realtime systems, the system-wide contention scope option is required in the profiles that support multiple processes. Process-wide contention scope may also be provided, perhaps for the non-realtime threads of the application.

Support for a scheduling allocation domain of size one and static binding of threads to allocation domains is required in all the realtime profiles to achieve predictable scheduling behavior. The allocation domain of a thread is the set of processors on which that thread can be scheduled at any given time. POSIX.1 {3} specifies that the scheduling rules have predictable effects only if the allocation domain is of size one; hence the need for this requirement. For single-processor systems, the

Copyright © 2004 IEEE. All rights reserved.

allocation domain is generally of size one, and thus the application can meet the requirement just by specifying in the conformance document that the scheduling allocation domain is of size one and that static binding of threads to allocation domains is the default behavior.

8.6.1.11 Process Memory Locking

Realtime processes must be able to guarantee memory residency to reduce the latency for instruction fetches, data access, I/O operations, etc. The mechanism described in the POSIX.1 Process Memory Locking extension will satisfy this requirement.

8.6.1.12 Shared Memory

The Shared Memory Objects option provides the capability for more than one execution entity to share memory, without incurring the overhead of the shared memory object on permanent media. Memory Mapped I/O may be implemented using the Shared Memory facility. An implementation must provide facilities for creating a block of physical memory in which the application may place devices and facilities for binding to a user-provided pathname through which a device may subsequently be opened as a Shared Memory special file and mapped into the process address space for the purpose of performing I/O or other functions from applications programs.

Typed Memory objects are not required because they are useful only to systems with special hardware architectures that have various often specialized kinds of memory. Implementors providing support for such special architectures always have the option to provide typed memory objects as an extension.

8.6.1.13 Clocks and Timers

High-resolution timer functions are required in most realtime systems for implementing time management operations such as periodic activations, short duration timeouts, etc. The normal POSIX.1 time management functions *sleep()* and *alarm()* only provide a time resolution of one second, but many realtime systems require finer resolution for specifying time.

The Monotonic Clock is required for realtime applications to ensure that deadlines and timing requirements are not affected by clock jumps.

The Clock Selection option is required to enable choosing the clock on which sleep operations are performed and to have access to an absolute sleep operation, which

Copyright © 2004 IEEE. All rights reserved.

is a common requirement in realtime applications with periodic timing requirements.

CPU-Time clocks and timers are required as a means to detect and handle situations in which a thread overruns its assigned maximum execution time. Bounding the execution times of the different threads in the application provides temporal partitioning in realtime applications, and thus increases predictability and reliability.

The Timeouts option is a general requirement for realtime applications and thus is required in this profile.

The minimum number of per-process timers that the implementation is required to support has been increased from the number specified in POSIX.1 {3}, 32, to 64, which is the required minimum number of threads per process. The reason for this increase is that there are many applications that require one timer per thread (either realtime or CPU-time based).

8.6.1.14 Message Passing

These realtime systems typically include some form of message queuing mechanism for communication among processes or threads. The POSIX.1 message passing offers an appropriate level of performance to provide this functionality.

8.6.1.15 Threads

The basic assumption in this profile is that the system will consist of one or more processes with multiple threads. Therefore, all thread services are required. The POSIX_THREADS_BASE Unit of Functionality was specified in this standard instead of the _POSIX_THREADS option, because this option requires reader/writer locks, but this profile does not.

8.6.1.16 Tracing

Tracing is required for the PSE53 environment because most of these systems work in an unattended mode for long periods of time, and tracing provides an excellent mechanism to support post-failure analysis, particularly for failures having a low probability of occurrence.

The Trace Event Filtering option is required for the system to be able to filter out those trace events that are not meaningful for the application, thus making better use of system resources by capturing only the interesting events.

Copyright © 2004 IEEE. All rights reserved.

Because the PSE53 profile does not require general file system capabilities, the Trace Log option is not required for this profile.

8.6.1.17 Networking

Today, most of the platforms and applications belonging to the PSE53 environment require network communications, and thus the networking Unit of Functionality is required in this profile. The Raw Sockets option is required to aid reconfiguration of networked applications and to implement special protocols directly, without the weight of a full protocol stack. The Internet Protocol Version 6 option is not required because most applications are not using this version of the protocol yet.

8.6.1.18 Event Management

The *select()* function is usually associated with networking facilities, which are required for PSE53, and thus the Event Management Unit of Functionality is required in the PSE53 environment.

8.6.1.19 Interfaces Related to the Shell and Utilities

Interfaces defined in the POSIX_REGEX and POSIX_SHELL_FUNC Units of Functionality are related to shells and utilities, which are not required in this profile; therefore, these Units of Functionality are not required either.

8.6.1.20 X/Open Units of Functionality and Options

Some XSI Units of Functionality (XSI_C_LANG_SUPPORT, XSI_DEVICE_IO, XSI_DEVICE_SPECIFIC, XSI_FD_MGMT, XSI_FILE_SYSTEM, XSI_IPC, XSI_JOB_CONTROL, XSI_JUMP, XSI_MATH, XSI_MULTI_PROCESS, XSI_SIGNALS, XSI_SINGLE_PROCESS, XSI_SYSTEM_DATABASE, XSI_TIMERS, XSI_USER_GROUPS, XSI_WIDE_CHAR) have interfaces that represent extensions or alternatives to interfaces in other Units of Functionality or POSIX.1 options, and therefore are not necessary for PSE53 environments.

The XSI_DBM Unit of Functionality includes interfaces for database management that are not required in the PSE53 application environment.

The XSI_DYNAMIC_LINKING Unit of Functionality is not required for embedded systems, which usually operate in a static context.

Copyright © 2004 IEEE. All rights reserved.

The XSI_I18N Unit of Functionality provides facilities for natural language messages to the user, which are not required in embedded systems, which typically do not have general-purpose human interfaces.

The XSI_SYSTEM_LOGGING Unit of Functionality provides facilities for logging system activities, which are not required in PSE53 environments.

The XSI_THREAD_MUTEX_EXT Unit of Functionality is required because it has options for controlling the behavior of mutexes under erroneous application use. This capability is interesting for any realtime application, including those targeted at small embedded systems.

The XSI_THREADS_EXT Unit of Functionality is required because it provides functions to better control a thread's stack. This is considered useful for any realtime application.

The _XOPEN_CRYPT option provides cryptography facilities that are not required in most PSE53 environments.

The _XOPEN_LEGACY option provides facilities for backwards compatibility that are not required in PSE53 environments.

The _XOPEN_STREAMS option provides facilities that are not required in most PSE53 environments.

8.6.1.21 Language-Specific Services for the C Programming Language

Support for the C99 Standard {2} is required in the C language option, with the exception of the POSIX_C_LANG_WIDE_CHAR Unit of Functionality. The reason for this exception is that this is a very large library that is not necessary for many of the PSE53 applications.

8.6.1.22 Language-Specific Services for the Ada Programming Language

Support for the Ada language-specific services defined in POSIX.5c {5} is required in the Ada language option.

8.6.2 Shell and Utility Requirements

Because the Dedicated Realtime System Profile is intended for embedded systems which usually have no terminal or general-purpose graphical user interface, such a platform would be incapable of executing a shell. In such an environment, the utilities described in the Shell and Utilities volume of POSIX.1 {3} are not usually required.

Copyright © 2004 IEEE. All rights reserved.

8.6.3 Development Platform Requirements

The embedded nature of the PSE53 execution platform makes it difficult to use as a development platform. Therefore, the implementation is required to define a development environment in which a PSE53 application can be prepared for execution on the target platform. The development platform depends on the language option chosen by the implementation.

Copyright © 2004 IEEE. All rights reserved.

Section 9: Multi-Purpose Realtime System Profile (PSE54)

9.1 Introduction

This section specifies those standards required for conformance to the Multi-Purpose Realtime System Profile option and, where applicable, the state of any options contained in those standards.

When a referenced standard specifies services beyond those required by the Multi-Purpose Realtime System Profile, only those services included in the specified Units of Functionality referenced by this profile shall be required (see Table 1-1 through Table 1-17). All the applicable definitions in POSIX.1 {3} and/or POSIX.5c {5} still apply.

9.1.1 Identification

For the C language implementation, symbolic names shall be used to specify the presence or absence of each option in this profile. Names reserved for use in this profile begin with the string `_POSIX_AEP_REALTIME_`. For the Ada language implementation, a set of Boolean subtypes contained in package `POSIX_Options` (defined in POSIX.5c {5}, Section 2.5) shall be used to specify the presence or absence of each option in this profile.

9.1.2 Conformance

Conformance to the Multi-Purpose Realtime System Profile option shall be indicated as follows:

- For the C language implementation, the symbol `_POSIX_AEP_REALTIME_MULTI` being defined in the header `<unistd.h>` to be 200312L.
- For the Ada language implementation, the Boolean subtype `POSIX_Profiles.Realtime_Multi` subtype having the range `True..True`, and the constant `POSIX_Profiles.Realtime_AEP_Version` having the value 2003_12.

Copyright © 2004 IEEE. All rights reserved.

9.1.3 Options

The presence or absence of optional features shall be indicated as follows:

- For the C language implementation, if any of the following symbols are defined in the header `<unistd.h>`, then a corresponding programming environment is supported:

`_POSIX_AEP_REALTIME_LANG_C99`

`_POSIX_AEP_REALTIME_LANG_Ada95`

- For the Ada language implementation, if any of the following Boolean subtypes has the range `True..True`, then the corresponding option is supported:

`POSIX_Profiles.Realtime_Lang_C99`

`POSIX_Profiles.Realtime_Lang_Ada95`

9.1.4 The Compilation Environment (C language option)

Certain symbols required by PSE54 are defined in headers. Some of those headers could also define symbols other than those required by PSE54, potentially conflicting with symbols used by the application. Also, POSIX.1 {3} defines symbols that are not permitted by other standards to appear in those headers without some control on the visibility of those symbols. Symbols called “feature test macros” are used to control the visibility of symbols that might be included in a header.

An application conforming to PSE54 should ensure that the feature test macro `_POSIX_AEP_RT_MULTI_C_SOURCE` is defined before inclusion of any header. When an application includes a header described by POSIX.1 {3} and when this feature test macro is defined to have the value `200312L`,

- (1) All symbols required by PSE54 to appear when the header is included shall be made visible.
- (2) Symbols that are explicitly permitted, but not required, by PSE54 to appear in that header (including those in reserved name spaces) may be made visible.
- (3) Additional symbols not required or explicitly permitted by PSE54 to be in that header shall not be made visible, except when enabled by another feature test macro.

Copyright © 2004 IEEE. All rights reserved.

9.2 Operating System Interface Requirements

9.2.1 POSIX.1 Interfaces (C Language Option)

The Multi-Purpose Realtime System Profile implementation shall include interfaces as defined in POSIX.1 {3} for the Units of Functionality shown in Table 9-1 (see Table 1-1 for a complete list of POSIX.1 Units of Functionality).

Table 9-1 — POSIX.1 Units of Functionality Requirements

Unit of Functionality
POSIX_C_LANG_JUMP
POSIX_C_LANG_MATH
POSIX_C_LANG_SUPPORT
POSIX_C_LANG_WIDE_CHAR
POSIX_DEVICE_IO
POSIX_DEVICE_SPECIFIC
POSIX_EVENT_MGMT
POSIX_FD_MGMT
POSIX_FIFO
POSIX_FILE_ATTRIBUTES
POSIX_FILE_LOCKING
POSIX_FILE_SYSTEM
POSIX_FILE_SYSTEM_EXT
POSIX_JOB_CONTROL
POSIX_MULTI_PROCESS
POSIX_NETWORKING
POSIX_PIPE
POSIX_REGEX
POSIX_SHELL_FUNC
POSIX_SIGNALS
POSIX_SIGNAL_JUMP
POSIX_SINGLE_PROCESS
POSIX_STRING_MATCHING
POSIX_SYMBOLIC_LINKS
POSIX_SYSTEM_DATABASE
POSIX_THREADS_BASE
POSIX_USER_GROUPS
POSIX_WIDE_CHAR_IO
XSI_DYNAMIC_LINKING
XSI_SYSTEM_LOGGING
XSI_THREAD_MUTEX_EXT
XSI_THREADS_EXT

Copyright © 2004 IEEE. All rights reserved.

An implementation supporting the Multi-Purpose Realtime System Profile shall support the POSIX.1 options shown in Table 9-2.

Table 9-2 — POSIX.1 Option Requirements

Option
_POSIX_ADVISORY_INFO
_POSIX_ASYNCHRONOUS_IO
_POSIX_CHOWN_RESTRICTED
_POSIX_CLOCK_SELECTION
_POSIX_CPUTIME
_POSIX_FSYNC
_POSIX_MAPPED_FILES
_POSIX_MEMLOCK
_POSIX_MEMLOCK_RANGE
_POSIX_MEMORY_PROTECTION
_POSIX_MESSAGE_PASSING
_POSIX_MONOTONIC_CLOCK
_POSIX_PRIORITIZED_IO
_POSIX_PRIORITY_SCHEDULING
_POSIX_RAW_SOCKETS
_POSIX_REALTIME_SIGNALS
_POSIX_SAVED_IDS
_POSIX_SEMAPHORES
_POSIX_SHARED_MEMORY_OBJECTS
_POSIX_SPAWN
_POSIX_SPORADIC_SERVER
_POSIX_SYNCHRONIZED_IO
_POSIX_THREAD_ATTR_STACKADDR
_POSIX_THREAD_ATTR_STACKSIZE
_POSIX_THREAD_CPUTIME
_POSIX_THREAD_PRIO_INHERIT
_POSIX_THREAD_PRIO_PROTECT
_POSIX_THREAD_PRIORITY_SCHEDULING
_POSIX_THREAD_PROCESS_SHARED
_POSIX_THREAD_SAFE_FUNCTIONS
_POSIX_THREAD_SPORADIC_SERVER
_POSIX_TIMEOUTS
_POSIX_TIMERS
_POSIX_TRACE
_POSIX_TRACE_EVENT_FILTER
_POSIX_TRACE_LOG
_POSIX_VDISABLE

The type *off_t* shall be capable of storing any value contained in type *long*.

The value of `TIMER_MAX` shall be at least 64.

The value of `RTSIG_MAX` shall be at least 16.

Copyright © 2004 IEEE. All rights reserved.

The range of priorities associated with the SCHED_RR scheduling policy shall have at least 31 distinct values that are less than the maximum priority of the SCHED_FIFO policy.

An implementation conforming to PSE54 shall support the PTHREAD_SCOPE_SYSTEM scheduling contention scope. In addition, it may support PTHREAD_SCOPE_PROCESS. For a description of the scheduling contention scope, see the System Interfaces volume of POSIX.1 {3}, Section 2.9.2.

An implementation conforming to PSE54 shall provide a mechanism to configure the system so that the scheduling allocation domain has size one, and so that the binding of threads to scheduling allocation domains remains static. The mechanism by which this requirement is achieved shall be implementation defined. In addition, a PSE54 implementation may provide other configurations or facilities to change the size of the allocation domain and the bindings of threads to allocation domains. For a description of the scheduling allocation domain, see the System Interfaces volume of POSIX.1 {3}, Section 2.9.2.

9.2.2 POSIX.26 Interfaces (C Language Option)

An implementation conforming to PSE52 shall support all the interfaces defined in POSIX.26 {4}. The implementation shall also support the POSIX.1 *mknod()* function, even if the XSI extension is not supported, as the portable mechanism to create character special files. Appropriate values for the *dev* parameter are implementation defined.

9.2.3 POSIX.5c Interfaces (Ada Language Option)

The Multi-Purpose Realtime System Profile implementation shall include interfaces as defined in POSIX.5c {5} for the Units of Functionality shown in Table 9-3 (see Table 1-2 through Table 1-17 for a complete list of POSIX.5c Units of Functionality).

Table 9-3 — POSIX.1 Units of Functionality Requirements

Unit of Functionality
POSIX_ADA_LANG_SUPPORT
POSIX_DEVICE_IO
POSIX_DEVICE_SPECIFIC
POSIX_EVENT_MGMT
POSIX_FD_MGMT
POSIX_FIFO
POSIX_FILE_ATTRIBUTES
POSIX_FILE_SYSTEM

Copyright © 2004 IEEE. All rights reserved.

Table 9-3 — POSIX.1 Units of Functionality Requirements (Continued)

Unit of Functionality
POSIX_JOB_CONTROL
POSIX_MULTI_PROCESS
POSIX_NETWORKING
POSIX_PIPE
POSIX_SIGNALS
POSIX_SINGLE_PROCESS
POSIX_SYSTEM_DATABASE
POSIX_USER_GROUPS

The Multi-Purpose Realtime System Profile implementation shall support the POSIX.5c options shown in Table 9-4, by defining the associated option subtypes to have the range True..True, with the exception of the Filename Truncation option for which the associated subtype shall have the range False..False.

Table 9-4 — POSIX.5c Option Requirements

POSIX.5c Option
Asynchronous I/O
Change Owner Restriction
File Synchronization
Memory Mapped Files
Memory Locking
Memory Range Locking
Memory Protection
Message Queues
Filename Truncation
Prioritized I/O
Priority Process Scheduling
Realtime Signals
Saved IDs Support
Semaphores
Shared Memory Objects
Synchronized I/O
Mutexes
Mutex Priority Inheritance
Mutex Priority Ceiling
Process Shared
Timers

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

`POSIX_Limits.Child_Processes_Maxima'First` shall be at least 25.

`POSIX_Limits.Groups_Maxima'First` shall be at least 8.

Copyright © 2004 IEEE. All rights reserved.

`POSIX_Limits.Timers_Maxima`'First shall be at least 64.

`POSIX_Limits.Realtime_Signals_Maxima`'First shall be at least 16.

Regarding task priority scheduling, the implementation shall support the following requirements from POSIX.5c {5} and the Ada95 RM {1}:

- The implementation shall support the priority model defined in the Ada95 RM {1}, Section D.1, and the pragmas and package interfaces defined in the Ada95 RM {1}, Sections D.2–D.5.
- The implementation shall meet the requirements of POSIX.5c {5}, Section 13.3.1.

Implementations of the PSE54 profile shall support the `POSIX_Profiles` package defined in Annex A of this standard.

Subprograms not supported by a given profile shall raise `POSIX_Error`, returning an error code of `Operation_Not_Supported`, except as noted otherwise.

All `Image` and `Value` functions that appear in the packages supported by a profile must be implemented.

Where an overloaded subprogram is required by a Unit of Functionality, all forms of the subprogram appearing in the referenced clause must be supported, except as otherwise noted.

9.3 Application Constraints

The Multi-Purpose Realtime System Profile defined in this standard requires only specific Units of Functionality of the required standards. The absence of particular elements of these standards introduces constraints on the use of some of the features of particular operations. This clause defines the constraints that an application strictly conforming to one of the profiles shall observe when using each of the operations required by that profile.

9.3.1 Constraints Related to POSIX.1 Interfaces (C Language Option)

This profile has no constraints on the application related to POSIX.1 interfaces, because it requires the implementation to be POSIX.1 conforming.

Copyright © 2004 IEEE. All rights reserved.

9.3.2 Constraints Related to POSIX.5c Interfaces (Ada Language Option)

An application strictly conforming to PSE54 shall not attempt to bind a signal to a task entry.

9.4 Shell and Utility Requirements

An implementation of the Multi-Purpose Realtime System Profile shall provide all the mandatory utilities in the Shell and Utilities volume of POSIX.1 {3} with all the functional behavior described therein. The system shall support the Large File capabilities described in the Shell and Utilities volume of POSIX.1 {3}.

If the C language option is supported, the options of the Shell and Utilities volume of POSIX.1 {3} shown in Table 9-5 shall be supported.

**Table 9-5 — Shell and Utilities Option Requirements
(C Language Option)**

Option
POSIX2_C_DEV
POSIX2_CHAR_TERM
POSIX2_FORT_RUN
POSIX2_SW_DEV
POSIX2_UPE

If the Ada language option is supported, the options of the Shell and Utilities volume of POSIX.1 {3} shown in Table 9-6 shall be supported.

**Table 9-6 — Shell and Utilities Option Requirements
(Ada Language Option)**

Option
POSIX2_CHAR_TERM
POSIX2_FORT_RUN
POSIX2_SW_DEV
POSIX2_UPE

Copyright © 2004 IEEE. All rights reserved.

9.5 Development Platform Requirements

One or more of the development options in 9.5.1 and 9.5.2 shall be implemented.

9.5.1 C Language Development Option

If this option is provided, the implementor shall define a Development Platform and an environment capable of preparing for execution an application conformant with this standard profile. This platform shall include the POSIX2_C_DEV and POSIX2_SW_DEV options from the Shell and Utilities volume of POSIX.1 {3}.

9.5.1.1 Option Indicator

The presence of the C Language Development Option shall be indicated by the symbol `_POSIX_AEP_REALTIME_LANG_C99` being defined in the header `<unistd.h>`. In addition, the presence of the C Language Development Option may be indicated by the subtype `POSIX_Profiles.Realtime_Lang_C99` having the range `True..True`.

9.5.2 Ada Language Development Option

If this option is provided, the implementor shall define a Development Platform and an environment capable of preparing for execution an application conformant with this profile including applicable portions of the following:

- The Ada95 RM {1}
- POSIX.5c {5}
- The POSIX2_SW_DEV option from the Shell and Utilities volume of POSIX.1 {3}

9.5.2.1 Option Indicator

The presence of the Ada Language Development Option shall be indicated by the subtype `POSIX_Profiles.Realtime_Lang_Ada95` having the range `True..True`. In addition, the presence of the Ada Language Development Option may be indicated by the symbol `_POSIX_AEP_REALTIME_LANG_Ada95` being defined in the header `<unistd.h>`.

Copyright © 2004 IEEE. All rights reserved.

9.6 Rationale for Operating System Requirements (informative)

(This clause is not a normative part of IEEE Std 1003.13-2003.)

9.6.1 Operating System Interface Requirements

This profile is based on existing practice in realtime systems that are built using general-purpose computers, such as workstations. These systems have general-purpose computing requirements such as a full-featured file system, networking, virtual memory management, graphical user interfaces, multiuser access control, etc. In addition, they have realtime requirements and thus the need for a realtime operating system that provides a full POSIX.1 implementation and also the realtime extensions described in this profile.

9.6.1.1 Process Primitives

The process control functions (which include process creation and execution) are the basic operating system services required to support multiple processes, and are therefore required by both realtime and non-realtime applications in these realtime systems.

9.6.1.2 Signals

Signal services are a basic mechanism within POSIX-based systems and are required for error and event handling. Realtime systems typically have several logically concurrent software elements executing. Each such entity must respond to several cyclic and/or acyclic stimuli, often in a time-critical manner. Although purely synchronous models can supply such functionality via the use of additional processes or threads, the current realtime practice for asynchronous notification for events such as timeout, message arrival, and hardware interrupt can generally be expected to offer higher performance and lower latency. Realtime Signals provide the reliable high-performance mechanism to support such notification.

The minimum number of realtime signals that the implementation is required to support has been increased from the number specified in POSIX.1 {3}, 8, to 16. The rationale for this increase is that there are many applications that have more than 8 different kinds of events. Doubling the number of required realtime signals should have a minimum impact on the signal management overhead, while significantly increasing the number of event kinds that can be used by a strictly conforming application.

Copyright © 2004 IEEE. All rights reserved.

9.6.1.3 Process Environment

The functions from the POSIX.1 Process Environment group are deemed necessary to allow an application to determine and configure its system environment. This allows a single version of an application to be run on similar but differing platforms.

Since the systems will require multiple processes and multiple users, and because they must support both COTS and realtime applications, the entire set of ID functions is needed.

9.6.1.4 Files and Directories

All file and directory operations are required to support system applications and their file systems. Although only a few of the path operation functions are required to support realtime activities, the whole set is required for systems that support COTS applications.

The Advisory Information option is required to allow the application to provide hints about the way in which it is going to perform file operations, so that implementations can provide a better degree of timing predictability for those operations.

The File Locking option is required in the C language option to maintain a consistent and safe way of accessing stdio (*FILE* *) objects from threads, across the four realtime profiles.

The File Descriptor Management Unit of Functionality is included to aid the handling of file descriptors across the process creation and program execution operations.

9.6.1.5 Input and Output Primitives

The functions contained in the Device I/O Unit of Functionality are required to support I/O on devices, files, and special files.

Although asynchronous I/O can be easily implemented using threads dedicated to I/O, it is required in the PSE54 profile to support portability of applications that may have been developed before POSIX threads implementations were widely available.

The *posix_devctl()* function defined in POSIX.26 {4} is required to support control operations on I/O devices.

Copyright © 2004 IEEE. All rights reserved.

9.6.1.6 Synchronized Input and Output

These realtime systems that use file management systems will frequently require synchronized I/O to provide data integrity and/or relinquish resources to other processes. Synchronized I/O as defined in POSIX.1 {3} provides these mechanisms.

9.6.1.7 Device- and Class-Specific Functions

The terminal control functions are required for systems to support COTS applications and for the standard terminal devices that may be attached to the computer system. To support nonstandard terminal devices, additional functions may be necessary.

9.6.1.8 System Databases, Users, and Groups

The group and user database access functions are required for COTS database applications that may require them.

9.6.1.9 Synchronization

Mutexes and Condition Variables are required as part of threads model of concurrency.

Semaphores are required to synchronize a signal handler with some other process or thread. Semaphores are also required to support portability of applications that might be using this mechanism instead of the preferred mutexes and condition variables. It must be noted, however, that POSIX semaphores do not have the mechanisms built in to avoid unbounded priority inversion when using them for mutually exclusive access to shared resources. Mutexes with the appropriate priority inheritance or priority ceiling (also called priority protection) protocols can be used to avoid this unbounded priority inversion. The Process Shared option is required to support applications requiring this mechanism for synchronization across different processes.

Barriers are not required because they can easily be implemented using mutexes and condition variables. Although a direct implementation of barriers can have a significant efficiency benefit in some multiprocessor architectures, a mutex-and-condition-variable implementation will not be significantly slower in most architectures, and thus requiring barriers for all implementations is not justified.

Spin locks are not required because, although they are an efficient synchronization mechanism, they cannot be portably used with the current POSIX.1 interfaces in

Copyright © 2004 IEEE. All rights reserved.

realtime applications. If a realtime scheduling policy such as `SCHED_FIFO` or `SCHED_RR` is used, spin locks may cause deadlock on a single processor. On multiprocessors, to avoid deadlock, it would be necessary for threads using a given lock to be allocated to different processors. There are no standard APIs in the current POSIX.1 {3} to allocate threads to specific processors.

Reader/Writer Locks are not required because they are not designed to avoid unbounded priority inversion, and thus very long delays could occur in realtime applications, with a low but nevertheless nonzero probability. It is expected that a future revision of POSIX.1 {3} will add the priority inheritance and/or priority ceiling options to reader/writer locks, which would eliminate the unbounded priority inversion.

9.6.1.10 Priority Scheduling

This realtime environment requires the ability to do scheduling of concurrent processes and threads with a preemptive priority-based scheduler to ensure that hard deadlines are met. Thread and process priority scheduling are required for realtime applications. The Sporadic Server Scheduling option is also required for processes and threads, to enhance support of applications with aperiodic timing requirements.

A common requirement of realtime systems is that they be able to run threads or processes with realtime requirements together with threads with no realtime requirements. One common way of doing this is by having the realtime threads run under the `SCHED_FIFO` scheduling policy, while the non-realtime threads run at a lower priority under the round-robin policy (`SCHED_RR`) to fairly share the available portion of the processor among them. POSIX.1 {3} requires each policy to have a range of priorities of at least 32 distinct values, but does not impose any requirements on how these priority ranges relate to each other. It could happen that most or all of the `SCHED_RR` priorities were larger than the `SCHED_FIFO` priorities, thus making it impossible to mix realtime and non-realtime threads as required above. To solve this problem in a portable way, this profile requires that there are at least 31 `SCHED_RR` priority levels below the maximum priority of `SCHED_FIFO`. In this way, a strictly conforming application can use the inclusive priority range $[max_FIFO_prio, max_FIFO_prio-30]$ with `SCHED_FIFO` for realtime threads (with a total of 31 priority levels), and then use the priority value $min(max_FIFO_prio-31, max_RR_prio)$ with the `SCHED_RR` policy, for the non-realtime threads, with guarantee that the latter priority value is valid for the round-robin policy.

The implementation is required to support the `PTHREAD_SCOPE_SYSTEM` thread-scheduling contention scope. The contention scope of a thread defines the set of threads with which the thread competes for use of the processing resources. A thread created with `PTHREAD_SCOPE_SYSTEM` scheduling contention scope contends for resources with all other threads in the system that have the same scheduling allocation domain. This allows a consistent scheduling of threads

Copyright © 2004 IEEE. All rights reserved.

across the system and therefore a predictable timing behavior. As a consequence, this is the preferred method for realtime systems.

The current POSIX.1 {3} allows implementations to support either system-wide or process-wide contention scope, or both. This represents a compromise that tries to address the requirements of both realtime and non-realtime applications, but introduces a potential source for nonportability. Because the realtime profiles are specifically targeted at realtime systems, the system-wide contention scope option is required in the profiles that support multiple processes. Process-wide contention scope may also be provided, perhaps for the non-realtime threads of the application.

Support for a scheduling allocation domain of size one and static binding of threads to allocation domains is required in all the realtime profiles to achieve predictable scheduling behavior. The allocation domain of a thread is the set of processors on which that thread can be scheduled at any given time. POSIX.1 {3} specifies that the scheduling rules have predictable effects only if the allocation domain is of size one; hence the need for this requirement. For single-processor systems the allocation domain is generally of size one, and thus the application can meet the requirement just by specifying in the conformance document that the scheduling allocation domain is of size one and that static binding of threads to allocation domains is the default behavior.

9.6.1.11 Process Memory Locking

Realtime processes must be able to guarantee memory residency to reduce the latency for instruction fetches, data access, I/O operations, etc. The mechanism described in the POSIX.1 Process Memory Locking extension will satisfy this requirement.

9.6.1.12 Shared Memory

The ability to share large volumes of data among many cooperating execution streams is required. The POSIX.1 Shared Memory extension provides this capability. Memory Mapped I/O may be implemented using the Shared Memory facility. An implementation must provide facilities for creating a block of physical memory in which the application may place devices and facilities for binding to a user-provided pathname through which a device may subsequently be opened as a Shared Memory special file, and mapped into the process address space for the purpose of performing I/O or other functions from applications programs.

The Memory Mapped Files option is required because the implementation has file-system capabilities, and memory-mapped files are a convenient paradigm for reading and writing information in applications following this profile. In memory-mapped files, data can be manipulated as memory and I/O data movement can be

Copyright © 2004 IEEE. All rights reserved.

significantly reduced. The implementation of memory-mapped files does not require a significant amount of additional memory or execution overhead to achieve the additional capability.

System vendors are expected to implement the chosen interface in a manner that meets the needs of the applications. In particular, a rotating media-based implementation is not required by the interface definition.

Typed Memory objects are not required because they are useful only to systems with special hardware architectures that have various often specialized kinds of memory. Implementors providing support for such special architectures always have the option to provide typed memory objects as an extension.

9.6.1.13 Clocks and Timers

High-resolution timer functions are required in most realtime systems for implementing time management operations such as periodic activations, short duration timeouts, etc. The normal POSIX.1 time management functions *sleep()* and *alarm()* only provide a time resolution of one second, but many realtime systems require finer resolution for specifying time.

The Monotonic Clock is required for realtime applications to ensure that deadlines and timing requirements are not affected by clock jumps.

The Clock Selection option is required to enable choosing the clock on which sleep operations are performed, and to have access to an absolute sleep operation, which is a common requirement in realtime applications with periodic timing requirements.

CPU-Time clocks and timers are required as a means to detect and handle situations in which a thread overruns its assigned maximum execution time. Bounding the execution times of the different threads in the application provides temporal partitioning in realtime applications, and thus increases predictability and reliability.

The Timeouts option is a general requirement for realtime applications and thus is required in this profile.

The minimum number of per-process timers that the implementation is required to support has been increased from the number specified in POSIX.1 {3}, 32, to 64, which is the required minimum number of threads per process. The reason for this increase is that there are many applications that require one timer per thread (either realtime or CPU-time based).

Copyright © 2004 IEEE. All rights reserved.

9.6.1.14 Message Passing

These realtime systems typically include some form of message queuing mechanism for communication among processes or threads. The POSIX.1 message passing offers an appropriate level of performance to provide this functionality.

9.6.1.15 Threads

The basic assumption in this profile is that the system will consist of one or more processes with multiple threads. Therefore, all thread services are required. The `_POSIX_THREADS_BASE` Unit of Functionality was specified in this standard instead of the `_POSIX_THREADS` option, because this option requires reader/writer locks, but this profile does not.

9.6.1.16 Tracing

Tracing is required for the PSE54 environment because it provides an excellent mechanism to support post-failure analysis, particularly for failures having a low probability of occurrence.

The Trace Event Filtering option is required for the system to be able to filter out those trace events that are not meaningful for the application, thus making better use of system resources by capturing only the interesting events.

Because the PSE54 profile requires general file system capabilities, the Trace Log option is required for this profile.

9.6.1.17 Networking

Today, virtually all of the platforms and applications belonging to the PSE54 environment require network communications, and thus the networking Unit of Functionality is required in this profile. The Raw Sockets option is required to aid reconfiguration of networked applications and to implement special protocols directly, without the weight of a full protocol stack. The Internet Protocol Version 6 option is not required because most applications are not using this version of the protocol yet.

Copyright © 2004 IEEE. All rights reserved.

9.6.1.18 Event Management

The *select()* function is usually associated with networking facilities, which are required for PSE54, and thus the Event Management Unit of Functionality is required in the PSE54 environment.

9.6.1.19 Interfaces Related to the Shell and Utilities

The interfaces defined in the POSIX_REGEX and POSIX_SHELL_FUNC are required in PSE54 environments, because of their general-purpose computing requirements.

9.6.1.20 X/Open Units of Functionality and Options

Some XSI Units of Functionality (XSI_C_LANG_SUPPORT, XSI_DEVICE_IO, XSI_DEVICE_SPECIFIC, XSI_FD_MGMT, XSI_FILE_SYSTEM, XSI_IPC, XSI_JOB_CONTROL, XSI_JUMP, XSI_MATH, XSI_MULTI_PROCESS, XSI_SIGNALS, XSI_SINGLE_PROCESS, XSI_SYSTEM_DATABASE, XSI_TIMERS, XSI_USER_GROUPS, XSI_WIDE_CHAR) have interfaces that represent extensions or alternatives to interfaces in other Units of Functionality or POSIX.1 options, and therefore are not necessary for PSE54 environments.

The XSI_DBM Unit of Functionality includes interfaces for database management that are not required in the PSE54 application environment.

The XSI_DYNAMIC_LINKING Unit of Functionality is required for PSE54 systems, which usually execute a mixture of realtime and non-realtime activities in a typically dynamic context.

The XSI_I18N Unit of Functionality provides facilities for natural language messages to the user, which are not required all PSE54 systems. It remains as an optional feature.

The XSI_SYSTEM_LOGGING Unit of Functionality provides facilities for logging system activities, which are usually required in PSE54 environments. Therefore, this Unit of Functionality is required.

The XSI_THREAD_MUTEX_EXT Unit of Functionality is required because it has options for controlling the behavior of mutexes under erroneous application use. This capability is interesting for any realtime application, including those targeted at small embedded systems.

The XSI_THREADS_EXT Unit of Functionality is required because it provides functions to better control a thread's stack. This is considered useful for any realtime application.

Copyright © 2004 IEEE. All rights reserved.

The `_XOPEN_CRYPT` option provides cryptography facilities that are not required in all PSE54 environments. It remains as an optional feature.

The `_XOPEN_LEGACY` option provides facilities for backwards compatibility that are not required in most PSE54 environments.

The `_XOPEN_STREAMS` option provides facilities that are not required in most PSE54 environments.

9.6.1.21 Language-Specific Services for the C Programming Language

Full support for the C99 Standard {2} is required in the C language option.

9.6.1.22 Language-Specific Services for the Ada Programming Language

Support for the Ada language-specific services defined in POSIX.5c {5} is required in the Ada language option.

9.6.2 Shell and Utility Requirements

The mandatory utilities and facilities described in the Shell and Utilities volume of POSIX.1 {3} as well as the options appearing in Table 9-5 and Table 9-6 (for their respective language options) are required in PSE54 environments.

9.6.3 Development Platform Requirements

The implementation is required to define a development environment in which a PSE54 application can be prepared for execution on the target platform. For this profile, in most cases the development and the target platform roles will be combined in the same system.

Copyright © 2004 IEEE. All rights reserved.

Annex A: POSIX Profiles Package (Ada Language)

(Normative)

The package `POSIX_Profiles` shall be supported by all profiles. The Boolean subtypes contained in this package shall indicate the profiles and options supported by the implementation. Supported profiles and options shall be indicated by the appropriate identifier having the range `True..True`; unsupported profiles and options shall have the range `False..False`.

```

package POSIX_Profiles is

  -- Profile options
  subtype Realtime_Minimal    is Boolean range <Implementation Defined>;
  subtype Realtime_Controller is Boolean range <Implementation Defined>;
  subtype Realtime_Dedicated  is Boolean range <Implementation Defined>;
  subtype Realtime_Multi     is Boolean range <Implementation Defined>;

  -- Language development options
  subtype Realtime_Lang_C99    is Boolean range <Implementation Defined>;
  subtype Realtime_Lang_Ada95 is Boolean range <Implementation Defined>;

  -- Version constant
  Realtime_AEP_Version : constant := 2003_12;

end POSIX_Profiles;
```

Copyright © 2004 IEEE. All rights reserved.

This page is left intentionally blank.

Annex B: Description of Optional Interfaces

(Informative)

B.1 POSIX.1 Options

Table B-1 shows the functions included under each of the options specified in the System Interfaces volume of POSIX.1 {3}. Each row of this table contains all the functions included under the first named option and also under combinations of that option with other options.

**Table B-1 — Functions under each POSIX.1
System Interface Option**

_POSIX_ADVISORY_INFO <i>posix_fadvise(), posix_fallocate(), posix_memalign()</i> _POSIX_ADVISORY_INFO and either _POSIX_MAPPED_FILES or _POSIX_SHARED_MEMORY_OBJECTS <i>posix_madvise()</i>
_POSIX_ASYNCHRONOUS_IO <i>aio_cancel(), aio_error(), aio_fsync(), aio_read(), aio_return(), aio_suspend(), aio_write(), lio_listio()</i>
_POSIX_BARRIERS and _POSIX_THREADS <i>pthread_barrier_destroy(), pthread_barrier_init(), pthread_barrier_wait(), pthread_barrierattr_destroy(), pthread_barrierattr_init(),</i> POSIX_BARRIERS, _POSIX_THREADS and _POSIX_THREAD_PROCESS_SHARED <i>pthread_barrierattr_getpshared(), pthread_barrierattr_setpshared()</i>
_POSIX_CHOWN_RESTRICTED No functions under this option.
_POSIX_CLOCK_SELECTION <i>clock_nanosleep()</i> _POSIX_CLOCK_SELECTION and _POSIX_THREADS <i>pthread_condattr_getclock(), pthread_condattr_setclock()</i>
_POSIX_CPUTIME <i>clock_getcpuclockid()</i>
_POSIX_FSYNC <i>fsync()</i>

Copyright © 2004 IEEE. All rights reserved.

**Table B-1 — Functions under each POSIX.1
System Interface Option (Continued)**

_POSIX_IPV6 No functions under this option.
_POSIX_MAPPED_FILES or _POSIX_SHARED_MEMORY_OBJECTS or _POSIX_TYPED_MEMORY_OBJECTS <i>mmap()</i> , <i>munmap()</i>
_POSIX_MAPPED_FILES and _POSIX_SYNCHRONIZED_IO <i>msync()</i>
_POSIX_MAPPED_FILES and _POSIX_ADVISORY_INFO <i>posix_madvise()</i>
_POSIX_MEMLOCK <i>mlockall()</i> , <i>munlockall()</i>
_POSIX_MEMLOCK_RANGE <i>mlock()</i> , <i>munlock()</i>
_POSIX_MEMORY_PROTECTION <i>mprotect()</i>
_POSIX_MESSAGE_PASSING <i>mq_close()</i> , <i>mq_getattr()</i> , <i>mq_notify()</i> , <i>mq_open()</i> , <i>mq_receive()</i> , <i>mq_send()</i> , <i>mq_setattr()</i> , <i>mq_unlink()</i> , _POSIX_MESSAGE_PASSING and _POSIX_TIMEOUTS <i>mq_timedreceive()</i> , <i>mq_timedsend()</i>
_POSIX_MONOTONIC_CLOCK No functions under this option.
_POSIX_PRIORITIZED_IO No functions under this option.
_POSIX_PRIORITY_SCHEDULING <i>sched_get_priority_max()</i> , <i>sched_get_priority_min()</i> , <i>sched_getparam()</i> , <i>sched_getscheduler()</i> , <i>sched_rr_get_interval()</i> , <i>sched_setparam()</i> , <i>sched_setscheduler()</i> _POSIX_PRIORITY_SCHEDULING or _POSIX_THREADS <i>sched_yield()</i> , _POSIX_PRIORITY_SCHEDULING and _POSIX_SPAWN <i>posix_spawnattr_getschedparam()</i> , <i>posix_spawnattr_setschedparam()</i> , <i>posix_spawnattr_getschedpolicy()</i> , <i>posix_spawnattr_setschedpolicy()</i>
_POSIX_RAW_SOCKETS No functions under this option.
_POSIX_REALTIME_SIGNALS <i>sigqueue()</i> , <i>sigtimedwait()</i> , <i>sigwaitinfo()</i>
_POSIX_SAVED_IDS No functions under this option.

Copyright © 2004 IEEE. All rights reserved.

**Table B-1 — Functions under each POSIX.1
System Interface Option (Continued)**

<p><u>_POSIX_SEMAPHORES</u></p> <p><i>sem_close(), sem_destroy(), sem_getvalue(), sem_init(), sem_open(), sem_post(), sem_trywait(), sem_wait(), sem_unlink()</i></p> <p><u>_POSIX_SEMAPHORES and _POSIX_TIMEOUTS</u></p> <p><i>sem_timedwait()</i></p>
<p><u>_POSIX_SHARED_MEMORY_OBJECTS</u></p> <p><i>shm_open(), shm_unlink()</i></p> <p><u>_POSIX_SHARED_MEMORY_OBJECTS and _POSIX_ADVISORY_INFO</u></p> <p><i>posix_madvise()</i></p> <p><u>_POSIX_SHARED_MEMORY_OBJECTS or _POSIX_MAPPED_FILES</u></p> <p><i>mmap(), munmap()</i></p>
<p><u>_POSIX_SPAWN</u></p> <p><i>posix_spawn(), posix_spawn_file_actions_addclose(), posix_spawn_file_actions_adddup2(), posix_spawn_file_actions_addopen(), posix_spawn_file_actions_destroy(), posix_spawn_file_actions_init(), posix_spawnattr_destroy(), posix_spawnattr_getflags(), posix_spawnattr_getpgroup(), posix_spawnattr_getsigdefault(), posix_spawnattr_getsigmask(), posix_spawnattr_init(), posix_spawnattr_setflags(), posix_spawnattr_setpgroup(), posix_spawnattr_setsigdefault(), posix_spawnattr_setsigmask(), posix_spawnp()</i></p> <p><u>_POSIX_SPAWN and _POSIX_PRIORITY_SCHEDULING</u></p> <p><i>posix_spawnattr_getschedparam(), posix_spawnattr_setschedparam(), posix_spawnattr_getschedpolicy(), posix_spawnattr_setschedpolicy()</i></p>
<p><u>_POSIX_SPIN_LOCKS and _POSIX_THREADS</u></p> <p><i>pthread_spin_destroy(), pthread_spin_init(), pthread_spin_lock(), pthread_spin_trylock(), pthread_spin_unlock()</i></p>
<p><u>_POSIX_SPORADIC_SERVER</u></p> <p>No functions under this option.</p>
<p><u>_POSIX_SYNCHRONIZED_IO</u></p> <p><i>fdatasync()</i></p> <p><u>_POSIX_SYNCHRONIZED_IO and _POSIX_MAPPED_FILES</u></p> <p><i>msync()</i></p>
<p><u>_POSIX_THREAD_ATTR_STACKADDR and _POSIX_THREADS</u></p> <p><i>pthread_attr_getstackaddr(), pthread_attr_setstackaddr()</i></p> <p><u>_POSIX_THREAD_ATTR_STACKADDR, _POSIX_THREADS and _POSIX_THREAD_ATTR_STACKSIZE</u></p> <p><i>pthread_attr_getstack(), pthread_attr_setstack()</i></p>

Copyright © 2004 IEEE. All rights reserved.

**Table B-1 — Functions under each POSIX.1
System Interface Option (Continued)**

_POSIX_THREAD_ATTR_STACKSIZE and _POSIX_THREADS <i>pthread_attr_getstacksize(), pthread_attr_setstacksize()</i> ⁽¹⁾
_POSIX_THREAD_ATTR_STACKSIZE, _POSIX_THREADS and _POSIX_THREAD_ATTR_STACKADDR <i>pthread_attr_getstack(), pthread_attr_setstack()</i>
_POSIX_THREAD_CPUTIME and _POSIX_THREADS <i>pthread_getcpuclockid()</i>
_POSIX_THREAD_PRIO_INHERIT and _POSIX_THREADS <i>pthread_mutexattr_getprotocol(), pthread_mutexattr_setprotocol()</i>
_POSIX_THREAD_PRIO_PROTECT and _POSIX_THREADS <i>pthread_mutex_getprioceiling(), pthread_mutex_setprioceiling(), pthread_mutexattr_getprioceiling(), pthread_mutexattr_getprotocol(), pthread_mutexattr_setprioceiling(), pthread_mutexattr_setprotocol()</i>
_POSIX_THREAD_PRIORITY_SCHEDULING and _POSIX_THREADS <i>pthread_attr_getinheritsched(), pthread_attr_getschedpolicy(), pthread_attr_getscope(), pthread_attr_setinheritsched(), pthread_attr_setschedpolicy(), pthread_attr_setscope(), pthread_getschedparam(), pthread_setschedparam(), pthread_setschedprio(), sched_get_priority_max(), sched_get_priority_min(), sched_rr_get_interval()</i>
_POSIX_THREAD_PROCESS_SHARED and _POSIX_THREADS <i>pthread_condattr_getpshared(), pthread_condattr_setpshared(), pthread_mutexattr_getpshared(), pthread_mutexattr_setpshared(), pthread_rwlockattr_getpshared(), pthread_rwlockattr_setpshared()</i>
_POSIX_THREAD_PROCESS_SHARED, _POSIX_BARRIERS and _POSIX_THREADS <i>pthread_barrierattr_getpshared(), pthread_barrierattr_setpshared()</i>
_POSIX_THREAD_SAFE_FUNCTIONS <i>asctime_r(), ctime_r(), flockfile(), frylockfile(), funlockfile(), getc_unlocked(), getchar_unlocked(), getgrgid_r(), getgrnam_r(), getlogin_r(), getpwnam_r(), getpwuid_r(), gmtime_r(), localtime_r(), putc_unlocked(), putchar_unlocked(), rand_r(), readdir_r(), strerror_r(), strtok_r(), ttyname_r()</i>
_POSIX_THREAD_SPORADIC_SERVER No functions under this option.

Copyright © 2004 IEEE. All rights reserved.

**Table B-1 — Functions under each POSIX.1
System Interface Option (Continued)**

<u>_POSIX_THREADS</u>
<i>pthread_atfork(), pthread_attr_destroy(), pthread_attr_getdetachstate(), pthread_attr_getschedparam(), pthread_attr_init(), pthread_attr_setdetachstate(), pthread_attr_setschedparam(), pthread_cancel(), pthread_cleanup_pop(), pthread_cleanup_push(), pthread_cond_broadcast(), pthread_cond_destroy(), pthread_cond_init(), pthread_cond_signal(), pthread_cond_timedwait(), pthread_cond_wait(), pthread_condattr_destroy(), pthread_condattr_init(), pthread_create(), pthread_detach(), pthread_equal(), pthread_exit(), pthread_getspecific(), pthread_join(), pthread_key_create(), pthread_key_delete(), pthread_kill(), pthread_mutex_destroy(), pthread_mutex_init(), pthread_mutex_lock(), pthread_mutex_trylock(), pthread_mutex_unlock(), pthread_mutexattr_destroy(), pthread_mutexattr_init(), pthread_once(), pthread_self(), pthread_setcancelstate(), pthread_setcanceltype(), pthread_setspecific(), pthread_sigmask(), pthread_testcancel(), pthread_rwlock_destroy(), pthread_rwlock_init(), pthread_rwlock_rdlock(), pthread_rwlock_tryrdlock(), pthread_rwlock_trywrlock(), pthread_rwlock_unlock(), pthread_rwlock_wrlock(), pthread_rwlockattr_destroy(), pthread_rwlockattr_init()</i>
<u>_POSIX_THREADS and _POSIX_CLOCK_SELECTION</u>
<i>pthread_condattr_getclock(), pthread_condattr_setclock()</i>
<u>_POSIX_THREADS and _POSIX_BARRIERS</u>
<i>pthread_barrier_destroy(), pthread_barrier_init(), pthread_barrier_wait(), pthread_barrierattr_destroy(), pthread_barrierattr_init(),</i>
<u>_POSIX_THREADS, _POSIX_BARRIERS and _POSIX_THREAD_PROCESS_SHARED</u>
<i>pthread_barrierattr_getpshared(), pthread_barrierattr_setpshared()</i>
<u>_POSIX_THREADS and _POSIX_SPIN_LOCKS</u>
<i>pthread_spin_destroy(), pthread_spin_init(), pthread_spin_lock(), pthread_spin_trylock(), pthread_spin_unlock()</i>
<u>_POSIX_THREADS and _POSIX_THREAD_ATTR_STACKADDR</u>
<i>pthread_attr_getstackaddr(), pthread_attr_setstackaddr()</i>
<u>_POSIX_THREADS, _POSIX_THREAD_ATTR_STACKADDR and _POSIX_THREAD_ATTR_STACKSIZE</u>
<i>pthread_attr_getstack(), pthread_attr_setstack()</i>
<u>_POSIX_THREADS and _POSIX_THREAD_ATTR_STACKSIZE</u>
<i>pthread_attr_getstacksize(), pthread_attr_setstacksize()^a</i>
<u>_POSIX_THREADS and _POSIX_THREAD_CPU_TIME</u>
<i>pthread_getcpuclockid()</i>
<i>This table row continued on next page...</i>

Copyright © 2004 IEEE. All rights reserved.

**Table B-1 — Functions under each POSIX.1
System Interface Option (Continued)**

...table row continued from previous page	
<u>_POSIX_THREADS</u> and either <u>_POSIX_THREAD_PRIO_INHERIT</u> or <u>_POSIX_THREAD_PRIO_PROTECT</u>	<i>pthread_mutexattr_getprotocol(), pthread_mutexattr_setprotocol()</i>
<u>_POSIX_THREADS</u> and <u>_POSIX_THREAD_PRIO_PROTECT</u>	<i>pthread_mutex_getprioceiling(), pthread_mutex_setprioceiling(), pthread_mutexattr_getprioceiling(), pthread_mutexattr_setprioceiling()</i>
<u>_POSIX_THREADS</u> and <u>_POSIX_THREAD_PRIORITY_SCHEDULING</u>	<i>pthread_attr_getinheritsched(), pthread_attr_getschedpolicy(), pthread_attr_getscope(), pthread_attr_setinheritsched(), pthread_attr_setschedpolicy(), pthread_attr_setscope(), pthread_getschedparam(), pthread_setschedparam(), pthread_setschedprio(), sched_get_priority_max(), sched_get_priority_min(), sched_rr_get_interval()</i>
<u>_POSIX_THREADS</u> and <u>_POSIX_THREAD_PROCESS_SHARED</u>	<i>pthread_condattr_getpshared(), pthread_condattr_setpshared(), pthread_mutexattr_getpshared(), pthread_mutexattr_setpshared(), pthread_rwlockattr_getpshared(), pthread_rwlockattr_setpshared()</i>
<u>_POSIX_THREADS</u> and <u>POSIX_TIMEOUTS</u>	<i>pthread_mutex_timedlock(), pthread_rwlock_timedrdlock(), pthread_rwlock_timedwrlock()</i>
<u>_POSIX_THREADS</u> or <u>_POSIX_PRIORITY_SCHEDULING</u>	<i>sched_yield()</i>
<u>_POSIX_TIMEOUTS</u> and <u>_POSIX_MESSAGE_PASSING</u>	<i>mq_timedreceive(), mq_timedsend()</i>
<u>_POSIX_TIMEOUTS</u> and <u>_POSIX_SEMAPHORES</u>	<i>sem_timedwait()</i>
<u>_POSIX_TIMEOUTS</u> and <u>_POSIX_THREADS</u>	<i>pthread_mutex_timedlock(), pthread_rwlock_timedrdlock(), pthread_rwlock_timedwrlock()</i>
<u>_POSIX_TIMEOUTS</u> and <u>_POSIX_TRACE</u>	<i>posix_trace_timedgetnext_event()</i>
<u>_POSIX_TIMERS</u>	<i>clock_getres(), clock_gettime(), clock_settime(), nanosleep(), timer_create(), timer_delete(), timer_getoverrun(), timer_gettime(), timer_settime()</i>

Copyright © 2004 IEEE. All rights reserved.

**Table B-1 — Functions under each POSIX.1
System Interface Option (Continued)**

<p><u>_POSIX_TRACE</u></p> <p><i>posix_trace_attr_destroy(), posix_trace_attr_getclockres(), posix_trace_attr_getcreatetime(), posix_trace_attr_getgenversion(), posix_trace_attr_getname(), posix_trace_attr_getstreamfullpolicy(), posix_trace_attr_getmaxdatasize(), posix_trace_attr_getmaxsystemeventsizes(), posix_trace_attr_getmaxusereventsizes(), posix_trace_attr_getstreamsize(), posix_trace_attr_init(), posix_trace_attr_setname(), posix_trace_attr_setstreamfullpolicy(), posix_trace_attr_setmaxdatasize(), posix_trace_attr_setstreamsize(), posix_trace_clear(), posix_trace_create(), posix_trace_event(), posix_trace_eventid_open(), posix_trace_eventid_equal(), posix_trace_eventid_get_name(), posix_trace_eventtypelist_getnext_id(), posix_trace_eventtypelist_rewind(), posix_trace_get_attr(), posix_trace_get_status(), posix_trace_getnext_event(), posix_trace_shutdown(), posix_trace_start(), posix_trace_stop(), posix_trace_trygetnext_event()</i></p>
<p><u>_POSIX_TRACE and _POSIX_TIMEOUTS</u></p> <p><i>posix_trace_timedgetnext_event()</i></p>
<p><u>_POSIX_TRACE and _POSIX_TRACE_INHERIT</u></p> <p><i>posix_trace_attr_getinherited(), posix_trace_attr_setinherited()</i></p>
<p><u>_POSIX_TRACE and _POSIX_TRACE_LOG</u></p> <p><i>posix_trace_attr_getlogfullpolicy(), posix_trace_attr_getlogsize(), posix_trace_attr_setlogfullpolicy(), posix_trace_attr_setlogsize(), posix_trace_close(), posix_trace_open(), posix_trace_rewind(), posix_trace_create_withlog(), posix_trace_flush()</i></p>
<p><u>_POSIX_TRACE and _POSIX_TRACE_EVENT_FILTER</u></p> <p><i>posix_trace_eventset_add(), posix_trace_eventset_del(), posix_trace_eventset_empty(), posix_trace_eventset_fill(), posix_trace_eventset_ismember(), posix_trace_get_filter(), posix_trace_set_filter(), posix_trace_trid_eventid_open()</i></p>
<p><u>_POSIX_TRACE_EVENT_FILTER and _POSIX_TRACE</u></p> <p><i>posix_trace_eventset_add(), posix_trace_eventset_del(), posix_trace_eventset_empty(), posix_trace_eventset_fill(), posix_trace_eventset_ismember(), posix_trace_get_filter(), posix_trace_set_filter(), posix_trace_trid_eventid_open()</i></p>
<p><u>_POSIX_TRACE_INHERIT and _POSIX_TRACE</u></p> <p><i>posix_trace_attr_getinherited(), posix_trace_attr_setinherited()</i></p>
<p><u>_POSIX_TRACE_LOG and _POSIX_TRACE</u></p> <p><i>posix_trace_attr_getlogfullpolicy(), posix_trace_attr_getlogsize(), posix_trace_attr_setlogfullpolicy(), posix_trace_attr_setlogsize(), posix_trace_close(), posix_trace_open(), posix_trace_rewind(), posix_trace_create_withlog(), posix_trace_flush()</i></p>

Copyright © 2004 IEEE. All rights reserved.

**Table B-1 — Functions under each POSIX.1
System Interface Option (Continued)**

<u>_POSIX_TYPED_MEMORY_OBJECTS</u> <i>posix_mem_offset(), posix_typed_mem_get_info(), posix_typed_mem_open()</i>
<u>_POSIX_TYPED_MEMORY_OBJECTS</u> or <u>_POSIX_MAPPED_FILES</u> or <u>_POSIX_SHARED_MEMORY_OBJECTS</u> <i>mmap(), munmap()</i>
<u>_POSIX_VDISABLE</u> No functions under this option.
<u>_XOPEN_CRYPT</u> <i>crypt(), encrypt(), setkey()</i>
<u>_XOPEN_ENH_I18N</u> No functions under this option.
<u>_XOPEN_LEGACY</u> <i>bcmp(), bcopy(), bzero(), ecvt(), fcvt(), ftime(), gcvt(), getwd(), index(), mktemp(), rindex(), utimes(), wcs wcs()</i>
<u>_XOPEN_REALTIME</u> This Option Group consists of the set of the following options from within POSIX.1 {3}: <div style="margin-left: 40px;"> <u>_POSIX_ASYNCHRONOUS_IO</u> <u>_POSIX_FSYNC</u> <u>_POSIX_MAPPED_FILES</u> <u>_POSIX_MEMLOCK</u> <u>_POSIX_MEMLOCK_RANGE</u> <u>_POSIX_MEMORY_PROTECTION</u> <u>_POSIX_MESSAGE_PASSING</u> <u>_POSIX_PRIORITIZED_IO</u> <u>_POSIX_PRIORITY_SCHEDULING</u> <u>_POSIX_REALTIME_SIGNALS</u> <u>_POSIX_SEMAPHORES</u> <u>_POSIX_SHARED_MEMORY_OBJECTS</u> <u>_POSIX_SYNCHRONIZED_IO</u> <u>_POSIX_TIMERS</u> </div>
<u>_XOPEN_REALTIME_THREADS</u> This Option Group consists of the set of the following options from within POSIX.1 {3}: <div style="margin-left: 40px;"> <u>_POSIX_THREAD_PRIO_INHERIT</u> <u>_POSIX_THREAD_PRIO_PROTECT</u> <u>_POSIX_THREAD_PRIORITY_SCHEDULING</u> </div>
<u>_XOPEN_SHM</u> This option is included in the XSI_IPC Unit of Functionality.
<u>_XOPEN_STREAMS</u> <i>fattach(), fdetach(), getmsg(), getpmsg(), ioctl(), isastream(), putmsg(), putpmsg(),</i>

Copyright © 2004 IEEE. All rights reserved.

- ⁽¹⁾ The `pthread_attr_getstacksize()` and `pthread_attr_setstacksize()` functions are wrongly listed under the `_POSIX_THREAD_STACK_ADDRESS` option in POSIX.1 {3}, but should be under the `_POSIX_THREAD_STACK_SIZE` option.

Table B-2 shows the utilities included under each of the options specified in the Shell and Utilities volume of POSIX.1 {3}:

Table B-2 — Utilities under each POSIX.1 Shell and Utilities Option

_POSIX2_C_DEV c99, lex, yacc
_POSIX2_CHAR_TERM No utilities under this option.
_POSIX2_FORT_DEV fort77
_POSIX2_FORT_RUN asa
_POSIX2_LOCALEDEF No utilities under this option.
_POSIX2_PBS qalter, qdel, qhold, qmove, qmsg, qrerun, qrls, qselect, qsig, qstat, qsub
_POSIX2_PBS_ACCOUNTING No utilities under this option.
_POSIX2_PBS_CHECKPOINT No utilities under this option.
_POSIX2_PBS_LOCATE No utilities under this option.
_POSIX2_PBS_MESSAGE No utilities under this option.
_POSIX2_PBS_TRACK No utilities under this option.
_POSIX2_SW_DEV ar, make, strip
_POSIX2_SW_DEV and _POSIX2_UPE nm
_POSIX2_UPE alias, at, batch, bg, command, crontab, csplit, ctags, df, du, ex, expand, fc, fg, file, jobs, mesg, more, newgrp, nice, patch, ps, renice, split, strings, tabs, talk, time, tput, unalias, unexpand, udecode, uencode, vi, who, write
_POSIX2_UPE and _POSIX2_SW_DEV nm

Copyright © 2004 IEEE. All rights reserved.

B.2 POSIX.5c Options

Table B-3 shows the subprograms included under each of the options specified in POSIX.5c {5}:

Table B-3 — Packages and Subprograms under Each POSIX.5c Option

Package	Subprogram
Asynchronous I/O POSIX_Asynchonus_IO	All except the two subprograms below.
Asynchronous I/O and Synchronized I/O POSIX_Asynchonus_IO	Synchronize_File Synchronize_Data
Change Owner Restriction	None
File Synchronization POSIX_IO	Synchronize_File
Filename Truncation	None
Memory Mapped Files or Shared Memory Objects POSIX_IO	Change_Permissions Truncate_File
POSIX_Memory_Mapping	Map_Memory ⁽¹⁾ Unmap_Memory
Memory Mapped Files and Synchronized I/O POSIX_Memory_Mapping	Synchronize_Memory
Memory Locking POSIX_Memory_Locking	All
Memory Protection POSIX_Memory_Mapping	Change_Protection
Memory Range Locking POSIX_Memory_Range_Locking	All
Message Queues POSIX_Message_Queues	All
Mutexes POSIX_Mutexes	All except the subprograms below.
POSIX_Condition_Variables	All except the subprograms below.
Mutexes and Process Shared POSIX_Mutexes	Get_Process_Shared Set_Process_Shared
POSIX_Condition_Variables	Get_Process_Shared Set_Process_Shared
Mutexes and MutexPriority Ceiling POSIX_Mutexes	Set_Ceiling_Priority ^a Get_Ceiling_Priority ^a
Mutexes and either Mutex Priority Inheritance or MutexPriority Ceiling POSIX_Mutexes	Set_Locking_Policy Get_Locking_Policy

Copyright © 2004 IEEE. All rights reserved.

**Table B-3 — Packages and Subprograms under
Each POSIX.5c Option (Continued)**

Package	Subprogram
Mutex Priority Ceiling and Mutexes POSIX_Mutexes	Set_Ceiling_Priority ^a Get_Ceiling_Priority ^a Set_Locking_Policy Get_Locking_Policy
Mutex Priority Inheritance and Mutexes POSIX_Mutexes	Set_Locking_Policy Get_Locking_Policy
Network Management and Sockets Detailed Network Interface POSIX_Sockets	Set_Flags Get_Flags Set_Family Get_Family Set_Socket_Type Get_Socket_Type Set_Protocol_Number Get_Protocol_Number Get_Canonical_Name Get_Socket_Address_Info Get_Socket_Address_Info For_Every_Item
Poll POSIX_Event_Management	Get_File Set_File Get_Events Set_Events Get_Returned_Events Set_Returned_Events Poll
Prioritized I/O	None
Priority Process Scheduling POSIX_Process_Scheduling	All
Process Shared and Mutexes POSIX_Mutexes POSIX_Condition_Variables	Get_Process_Shared Set_Process_Shared Get_Process_Shared Set_Process_Shared
Realtime Signals POSIX_Signals	Enable_Queueing Disable_Queueing Await_Signal ⁽²⁾ Await_Signal_Or_Timeout ^b Queue_Signal
Saved IDs Support	None

Copyright © 2004 IEEE. All rights reserved.

**Table B-3 — Packages and Subprograms under
Each POSIX.5c Option (Continued)**

Package	Subprogram
Select POSIX_Event_Management	Add Remove In_Set Select_File ^a
Semaphores POSIX_Semaphores	All
Shared Memory Objects POSIX_Shared_Memory_Objects POSIX_Generic_Shared_Memory	All All
Shared Memory Objects and Memory Range Locking POSIX_Generic_Shared_Memory	Lock_Shared_Memory Unlock_Shared_Memory
Shared Memory Objects or Memory Mapped Files POSIX_IO	Truncate_File
Sockets Detailed Network Interface POSIX_Sockets	All except the subprograms below.
Sockets Detailed Network Interface and Network Management POSIX_Sockets	Set_Flags Get_Flags Set_Family Get_Family Set_Socket_Type Get_Socket_Type Set_Protocol_Number Get_Protocol_Number Get_Canonical_Name Get_Socket_Address_Info Get_Socket_Address_Info For_Every_Item
Synchronized I/O POSIX_IO	Synchronize_Data
Synchronized I/O and Memory Mapped Files POSIX_Memory_Mapping	Synchronize_Memory
Timers POSIX_Timers	All
XTI Detailed Network Interface POSIX_XTI	All

(1) All versions.

(2) Return type Signal_Info.

Copyright © 2004 IEEE. All rights reserved.

Annex C: Bibliography

(Informative)

This annex contains lists of related open systems standards and suggested reading on historical implementations and application programming.

C.1 Related Open Systems Standards

- {B1} IEEE 100, *The Authoritative Dictionary of IEEE Standards Terms*, Seventh Edition.¹⁾
- {B2} ISO/IEC 8859-1:1998, *Information technology—8-Bit Single-Byte Coded Graphic Character Sets—Part 1: Latin Alphabet No. 1*.²⁾
- {B3} ISO/IEC 10646:2003, *Information technology—Universal Multiple-Octet Coded Character Set (UCS)*.
- {B4} ISO/IEC TR 10000-2:1998, *Information technology—Framework and Taxonomy of International Standardized Profiles—Part 2: Principles and Taxonomy for OSI Profiles*.

C.2 Other Documents

- {B5} *The Authorized Guide to the Single UNIX Specification*, Version 3, The Open Group, March 2002. UK ISBN: 1-85912-277-9. US ISBN 1-931624-13-5.³⁾

-
- 1) IEEE publications are available from the Institute of Electrical and Electronics Engineers, Inc., 445 Hoes Lane, Piscataway, NJ 08854, USA (<http://standards.ieee.org/>).
 - 2) 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, 25 West 43rd Street, 4th Floor, New York, NY 10036, USA (<http://www.ansi.org/>).
 - 3) This publication is available from The Open Group at <http://www.unix-systems.org/version3/theguide.html>.

Copyright © 2004 IEEE. All rights reserved.

This page is left intentionally blank.

Alphabetic Topical Index

Symbols

- `<limits.h>` header... 34
- `<unistd.h>` header... 34, 37, 38, 45, 46, 55, 56, 63, 73, 74, 80, 81, 91, 92, 99
- `_Exit()` function... 7
- `_exit()` function... 7
- `_longjmp()` function... 9
- `_POSIX_ADVISORY_INFO` option... 18, 20, 48, 65, 83, 94
- `_POSIX_AEP_REALTIME_` format... 31
- `_POSIX_AEP_REALTIME_` option... 37, 55, 73, 91
- `_POSIX_AEP_REALTIME_CONTROLLED` option... 55
- `_POSIX_AEP_REALTIME_DEDICATED` option... 73
- `_POSIX_AEP_REALTIME_LANG_Ada95` option... 38, 46, 56, 63, 74, 81, 92, 99
- `_POSIX_AEP_REALTIME_LANG_C99` option... 38, 45, 56, 63, 74, 80, 92, 99
- `_POSIX_AEP_REALTIME_MINIMAL` option... 37
- `_POSIX_AEP_REALTIME_MULTI` option... 91
- `_POSIX_AEP_RT_CONTROLLER_C_SOURCE` feature test macro... 56
- `_POSIX_AEP_RT_DEDICATED_C_SOURCE` feature test macro... 74
- `_POSIX_AEP_RT_MINIMAL_C_SOURCE` feature test macro... 38
- `_POSIX_AEP_RT_MULTI_C_SOURCE` feature test macro... 92
- `_POSIX_ASYNCHRONOUS_IO` option... 18, 20, 75, 94, 118
- `_POSIX_BARRIERS` option... 18, 20
- `_POSIX_CHOWN_RESTRICTED` option... 18, 20, 94
- `_POSIX_CLOCK_SELECTION` option... 18, 20, 39, 57, 75, 94
- `_POSIX_CPUTIME` option... 18, 20, 75, 94
- `_POSIX_FSYNC` option... 18, 20, 39, 57, 75, 94, 118
- `_POSIX_IPV6` option... 18, 20
- `_POSIX_JOB_CONTROL` option... 10
- `_POSIX_MAPPED_FILES` option... 18, 20, 48, 57, 75, 94, 118
- `_POSIX_MEMLOCK` option... 18, 20, 39, 46, 57, 75, 94, 118
- `_POSIX_MEMLOCK_RANGE` option... 18, 20, 39, 57, 75, 94, 118
- `_POSIX_MEMORY_PROTECTION` option... 19, 20, 75, 94, 118
- `_POSIX_MESSAGE_PASSING` option... 19, 20, 57, 75, 94, 118
- `_POSIX_MONOTONIC_CLOCK` option... 19, 20, 39, 57, 75, 94
- `_POSIX_NO_TRUNC` option... 19, 21, 22, 48
- `_POSIX_PRIORITIZED_IO` option... 19, 21, 75, 94, 118
- `_POSIX_PRIORITY_SCHEDULING` option... 19, 21, 76, 94, 118
- `_POSIX_RAW_SOCKETS` option... 19, 21, 76, 94
- `_POSIX_READER_WRITER_LOCKS` option... 10
- `_POSIX_REALTIME_SIGNALS` option... 19, 21, 39, 57, 76, 94, 118
- `_POSIX_REGEX` option... 10
- `_POSIX_SAVED_IDS` option... 19, 21, 94
- `_POSIX_SEMAPHORES` option... 19, 21, 39, 57, 76, 94, 118
- `_POSIX_SHARED_MEMORY_OBJECTS` option... 19, 21, 39, 57, 76, 94, 118
- `_POSIX_SPAWN` option... 19, 21, 76, 94
- `_POSIX_SPIN_LOCKS` option... 19, 21
- `_POSIX_SPORADIC_SERVER` option... 19, 21, 76, 94
- `_POSIX_SYNCHRONIZED_IO` option... 19, 21, 39, 57, 76, 94, 118
- `_POSIX_THREAD_ATTR_STACKADDR` option... 19, 21, 39, 57, 76, 94
- `_POSIX_THREAD_ATTR_STACKSIZE` option... 19, 21, 39, 57, 76, 94
- `_POSIX_THREAD_CPUTIME` option... 19, 21, 39, 57, 76, 94
- `_POSIX_THREAD_PRIO_INHERIT` option... 19, 21, 39, 57, 76, 94, 118
- `_POSIX_THREAD_PRIO_PROTECT`

Copyright © 2004 IEEE. All rights reserved.

option... 19, 21, 39, 57, 76, 94, 118
 _POSIX_THREAD_PRIORITY_SCHEDULING option... 19, 21, 39, 58, 76, 94, 118
 _POSIX_THREAD_PROCESS_SHARED option... 10
 _POSIX_THREAD_PROCESS_SHARED option... 19, 21, 76, 94
 _POSIX_THREAD_SAFE_FUNCTIONS option... 19, 21, 94
 _POSIX_THREAD_SPORADIC_SERVER option... 19, 21, 39, 58, 76, 94
 _POSIX_THREAD_STACK_ADDRESS option... 119
 _POSIX_THREAD_STACK_SIZE option... 119
 _POSIX_THREADS option... 10, 19, 21, 22, 52, 69, 87, 106
 _POSIX_TIMEOUTS option... 10
 _POSIX_TIMEOUTS option... 19, 21, 39, 58, 76, 94
 _POSIX_TIMERS option... 19, 21, 39, 58, 76, 94, 118
 _POSIX_TRACE option... 19, 21, 58, 76, 94
 _POSIX_TRACE_EVENT_FILTER option... 19, 21, 58, 76, 94
 _POSIX_TRACE_INHERIT option... 19, 21
 _POSIX_TRACE_LOG option... 19, 21, 58, 76, 94
 _POSIX_TYPED_MEMORY_OBJECTS option... 19, 21
 _POSIX_VDISABLE option... 19, 21, 22, 94
 _POSIX_VERSION option... 43, 61, 79
 _POSIX2_C_DEV option... 19, 21
 _POSIX2_CHAR_TERM option... 19, 21
 _POSIX2_FORT_DEV option... 19, 21
 _POSIX2_FORT_RUN option... 19, 21
 _POSIX2_LOCALEDEF option... 19, 21
 _POSIX2_PBS option... 19, 21
 _POSIX2_PBS_ACCOUNTING option... 19, 21
 _POSIX2_PBS_CHECKPOINT option... 19, 21
 _POSIX2_PBS_LOCATE option... 20, 21
 _POSIX2_PBS_MESSAGE option... 20, 21
 _POSIX2_PBS_TRACK option... 20, 21
 _POSIX2_SW_DEV option... 20, 21
 _POSIX2_UPE option... 20, 21
 _setjmp() function... 9
 _tolower() function... 9
 _toupper() function... 9
 _XOPEN_CRYPT option... 20, 22, 53, 71, 89, 108

_XOPEN_ENH_I18N option... 20, 22
 _XOPEN_LEGACY option... 20, 22, 53, 71, 89, 108
 _XOPEN_REALTIME option... 20, 22
 _XOPEN_REALTIME_THREADS option... 20, 22
 _XOPEN_SHM option... 20, 22
 _XOPEN_STREAMS option... 20, 22, 53, 71, 89, 108
 _XOPEN_UNIX option... 20, 22

A

a64l() function... 9
 Abbreviations... 32
abort() function... 8
abs() function... 6
accept() function... 7
access() function... 7
 Accessibility subprogram... 13
acos() function... 5
acosf() function... 5
acosh() function... 5
acoshf() function... 5
acoshl() function... 5
acosl() function... 5
 Ada language option... 34, 40, 43, 59, 61, 71, 77, 79, 89, 95, 98, 108
 Ada_Streams package... 10
 Ada_Task_Identification package... 10
 Ada95 RM, defined... 32
 Ada-Language option... 18, 34
 Add subprogram... 12, 122
 Add_All_Signals subprogram... 15
 Add_Signal subprogram... 15
 Advisory Information option... 101
 AEP... 26, 32
aio_cancel() function... 111
aio_error() function... 111
aio_fsync() function... 111
aio_read() function... 111
aio_return() function... 111
aio_suspend() function... 111
aio_write() function... 111
alarm() function... 8, 42, 51, 61, 68, 86, 105
 alias utility... 119
 Application Conformance... 34
 Application Environment Profile... 26
 application environment profile... 26, 27, 32
 Application Platform... 26
 ar utility... 119

Copyright © 2004 IEEE. All rights reserved.

Argument_List subprogram... 16
 asa utility... 119
 asctime() function... 6
 asctime_r() function... 6, 114
 asin() function... 5
 asinf() function... 5
 asinh() function... 5
 asinhf() function... 5
 asinhl() function... 5
 asinl() function... 5
 assert() function... 7
 Asynchronous I/O option... 20, 77, 96, 120
 at utility... 119
 atan() function... 5
 atan2() function... 5
 atan2f() function... 5
 atan2l() function... 5
 atanf() function... 5
 atanh() function... 5
 atanhf() function... 5
 atanhhl() function... 5
 atanl() function... 5
 atexit() function... 7
 atof() function... 6
 atoi() function... 6
 atol() function... 6
 atoll() function... 6
 Await_Signal subprogram... 15, 121
 Await_Signal_Or_Timeout
 subprogram... 15, 121

B

Base Standard... 26
 base standard... 26
 basename() function... 9
 batch utility... 119
 bcmp() function... 118
 bcopy() function... 118
 bg utility... 119
 Bibliography... 123
 bind() function... 7
 Bits_Per_Character_Of subprogram...
 11
 Block_Signals subprogram... 15
 Blocked_Signals subprogram... 15
 Blocking_Behavior constant... 22
 Boolean type... 37, 38, 55, 56, 73, 74, 91, 92,
 109
 bsd_signal() function... 9
 bsearch() function... 6

btowc() function... 6
 bzero() function... 118

C

C Language Option... 98
 C language option... 18, 20, 34, 38, 39, 40, 42,
 56, 57, 58, 61, 71, 74, 75, 77, 79, 89, 92, 93,
 95, 97, 108
 C99 Standard... 32, 53, 71, 89, 108
 c99 utility... 119
 cabs() function... 5
 cabsf() function... 5
 cabsl() function... 5
 cacos() function... 5
 cacosf() function... 5
 cacosh() function... 5
 cacoshf() function... 5
 cacoshl() function... 5
 cacosl() function... 5
 calloc() function... 6
 carg() function... 5
 cargf() function... 5
 cargl() function... 5
 casin() function... 5
 casinf() function... 5
 casinh() function... 5
 casinhf() function... 5
 casinhl() function... 5
 casinl() function... 5
 catan() function... 5
 catanf() function... 5
 catanh() function... 5
 catanhf() function... 5
 catanhl() function... 5
 catanl() function... 5
 catclose() function... 9
 catgets() function... 9
 catopen() function... 9
 cbrt() function... 5
 cbrtf() function... 5
 cbrtl() function... 5
 ccos() function... 5
 ccosf() function... 5
 ccosh() function... 5
 ccoshf() function... 5
 ccoshl() function... 5
 ccosl() function... 5
 ceil() function... 5
 ceilf() function... 5
 ceill() function... 5

Copyright © 2004 IEEE. All rights reserved.

- cexp()* function... 5
- cexpf()* function... 5
- cexpl()* function... 5
- cfgetispeed()* function... 7
- cfgetospeed()* function... 7
- cfsetispeed()* function... 7
- cfsetospeed()* function... 7
- Change Owner Restriction option... 20, 96, 120
- Change_Owner_And_Group subprogram... 12
- Change_Permissions subprogram... 12, 120
- Change_Protection subprogram... 120
- Change_Working_Directory subprogram... 13
- chdir()* function... 7
- CHILD_MAX option... 43, 61
- chmod()* function... 7
- chown()* function... 7
- cimag()* function... 5
- cimagf()* function... 5
- cimagl()* function... 5
- Clear_Environment subprogram... 16
- clearerr()* function... 6
- Clock Selection option... 51, 68, 86, 105
- clock()* function... 7
- clock_getcpuclockid()* function... 111
- clock_getres()* function... 116
- clock_gettime()* function... 42, 61, 116
- clock_nanosleep()* function... 111
- clock_settime()* function... 116
- clog()* function... 5
- clogf()* function... 5
- clogl()* function... 5
- Close subprogram... 11
- close()* function... xiv, 6
- closedir()* function... 7
- closelog()* function... 9
- command utility... 119
- Component Profile... 26
- component profile... 26
- Conformance... 33
- conformance document... 26, 28, 33
- Conformant Application... 35
- Conformant Application Using Extensions... 35
- conforming application strictly... 33
- conforming implementation... 33
- confstr()* function... 8
- conj()* function... 5
- conjf()* function... 5
- conjl()* function... 5
- connect()* function... 7
- constant
 - Blocking_Behavior... 22
 - False... 22
 - False..False... 41, 59, 77, 96, 109
 - File_Structure... 44, 62, 80
 - Group... 44
 - Operation_Not_Implemented... 22, 96
 - Operation_Not_Supported... 42, 60, 78, 97
 - Other... 44
 - Owner... 44
 - POSIX_Limits.Child_Processes_Maxima'Last... 44, 62
 - POSIX_Limits.Groups_Maxima'First... 22
 - POSIX_Limits.Groups_Maxima'First... 41, 60, 78
 - POSIX_Profiles.Realtime_AEP_Version... 38, 55, 73, 91
 - PTHREAD_SCOPE_PROCESS... 76, 95
 - PTHREAD_SCOPE_SYSTEM... 76, 85, 95, 103
 - Read_Write_Execute... 44
 - SCHED_FIFO... 40, 49, 50, 58, 67, 76, 85, 95, 103
 - SCHED_RR... 40, 50, 58, 67, 76, 85, 95, 103
 - True..True... 37, 38, 41, 45, 46, 55, 56, 59, 63, 73, 74, 77, 80, 81, 91, 92, 96, 99, 109
- constant-width format... 31
- Conventions... 31
- Copy_Environment subprogram... 16
- Copy_From_Current_Environment subprogram... 16
- Copy_To_Current_Environment subprogram... 16
- copysign()* function... 5
- copysignf()* function... 5
- copysignl()* function... 5
- cos()* function... 5
- cosf()* function... 5
- cosh()* function... 5
- coshf()* function... 5
- coshl()* function... 5
- cosl()* function... 5
- COTS... 32
- cpow()* function... 5

Copyright © 2004 IEEE. All rights reserved.

- cpowf()* function... 5
- cpowl()* function... 5
- cproj()* function... 5
- cprojf()* function... 5
- cprojl()* function... 5
- creal()* function... 5
- crealf()* function... 5
- creall()* function... 5
- creat()* function... xv, 7
- Create subprogram... 45
- Create_Directory subprogram... 13
- Create_FIFO subprogram... 12
- Create_Pipe subprogram... 14
- Create_Process_Group subprogram... 13
- Create_Session subprogram... 16
- crontab utility... 119
- crypt()* function... 118
- csin()* function... 5
- csinf()* function... 5
- csinh()* function... 5
- csinhf()* function... 5
- csinhl()* function... 5
- csinl()* function... 5
- csplit* utility... 119
- csqrt()* function... 5
- csqrtf()* function... 5
- csqrtl()* function... 5
- ctags utility... 119
- ctan()* function... 5
- ctanf()* function... 5
- ctanh()* function... 5
- ctanhf()* function... 5
- ctanhl()* function... 5
- ctanl()* function... 5
- ctermid()* function... 7
- ctime()* function... 6
- ctime_r()* function... 6, 114
- D**
- daylight()* variable... 9
- dbm_clearerr()* function... 9
- dbm_close()* function... 9
- dbm_delete()* function... 9
- dbm_error()* function... 9
- dbm_fetch()* function... 9
- dbm_firstkey()* function... 9
- dbm_nextkey()* function... 9
- dbm_open()* function... 9
- dbm_store()* function... 9
- Dedicated Realtime System Profile... 3, 73
- Define_Bits_Per_Character subprogram... 11
- Define_Input_Baud_Rate subprogram... 11
- Define_Input_Time subprogram... 11
- Define_Minimum_Input_Count subprogram... 11
- Define_Output_Baud_Rate subprogram... 11
- Define_Special_Control_Character subprogram... 11
- Define_Terminal_Modes subprogram... 11
- Definitions... 26
- Delete subprogram... 45
- Delete_All_Signals subprogram... 15
- Delete_Environment_Variable subprogram... 16
- Delete_Signal subprogram... 15
- Development Environment... 4
- Development Platform... 26
- development platform... 26
- df utility... 119
- difftime()* function... 6
- dirname()* function... 9
- Disable_Control_Character subprogram... 11
- Disable_Queueing subprogram... 121
- Discard_Data subprogram... 11
- div()* function... 6
- dlclose()* function... 9
- dlderror()* function... 9
- dlopen()* function... 9
- dlsym()* function... 9
- documentation... 33
- Drain subprogram... 11
- drand48()* function... 9
- du utility... 119
- dup()* function... 7
- dup2()* function... 7
- Duplicate subprogram... 12
- Duplicate_And_Close subprogram... 12
- E**
- ecvt()* function... 118
- Embedded Computer System... 27
- Enable_Queueing subprogram... 121
- encrypt()* function... 118
- endgrent()* function... 10
- endhostent()* function... 7

Copyright © 2004 IEEE. All rights reserved.

- endnetent()* function... 7
 - endprotoent()* function... 7
 - endpwent()* function... 9
 - endservent()* function... 7
 - endutxent()* function... 10
 - environ()* variable... 8
 - environment
 - open system... 27
 - environment, open system... 32
 - Environment_Value_Of subprogram... 16
 - erand48()* function... 9
 - erf()* function... 5
 - erfc()* function... 5
 - erfcf()* function... 5
 - erfcl()* function... 5
 - erff()* function... 5
 - erfl()* function... 5
 - errno()* variable... 8
 - ex utility... 119
 - exception
 - POSIX_Error... 22, 42, 60, 78, 96, 97
 - Use_Error... 44, 62, 80
 - execl()* function... 7
 - execle()* function... 7
 - execlp()* function... 7
 - execv()* function... 7
 - execve()* function... 7
 - execvp()* function... 7
 - Existence subprogram... 13
 - exit()* function... 7
 - exp()* function... 5
 - exp2()* function... 5
 - exp2f()* function... 5
 - exp2l()* function... 5
 - expand utility... 119
 - expf()* function... 5
 - expl()* function... 5
 - expm1()* function... 5
 - expm1f()* function... 5
 - expm1l()* function... 5
- F**
- fabs()* function... 5
 - fabsf()* function... 5
 - fabsl()* function... 5
 - False constant... 22
 - False..False constant... 41, 59, 77, 96, 109
 - fattach()* function... 118
 - fc utility... 119
 - fchdir()* function... 9
 - fchmod()* function... 7
 - fchown()* function... 7
 - fclose()* function... 6, 43
 - fcntl()* function... 7
 - fcvt()* function... 118
 - FD_CLR()* function... 7
 - FD_ISSET()* function... 7
 - FD_SET()* function... 7
 - FD_ZERO()* function... 7
 - fdatasync()* function... 113
 - fdetach()* function... 118
 - fdim()* function... 5
 - fdimf()* function... 5
 - fdiml()* function... 5
 - fdopen()* function... 6
 - feature test macro
 - _POSIX_AEP_RT_CONTROLLER_C_SOURCE... 56
 - _POSIX_AEP_RT_DEDICATED_C_SOURCE... 74
 - _POSIX_AEP_RT_MINIMAL_C_SOURCE... 38
 - _POSIX_AEP_RT_MULTI_C_SOURCE... 92
 - feclearexcept()* function... 6
 - fegetenv()* function... 6
 - fegetexceptflag()* function... 6
 - fegetround()* function... 6
 - fehldexcept()* function... 6
 - feof()* function... 6
 - feraiseexcept()* function... 6
 - ferror()* function... 6
 - fesetenv()* function... 6
 - fesetexceptflag()* function... 6
 - fesetround()* function... 6
 - fetestexcept()* function... 6
 - feupdateenv()* function... 6
 - fflush()* function... 6, 43
 - ffs()* function... 9
 - fg utility... 119
 - fgetc()* function... 6, 43
 - fgetpos()* function... 7
 - fgets()* function... 6, 43
 - fgetwc()* function... 9
 - fgetws()* function... 9
 - FILE * type... 48, 65, 83, 101
 - File Locking... 83
 - File Locking option... 48, 65, 83, 101
 - File Synchronization option... 48, 65, 83
 - File Synchronization option... 20, 41, 59, 77, 96, 120

Copyright © 2004 IEEE. All rights reserved.

- file utility... 119
- File_Position subprogram... 12
- File_Size subprogram... 12
- File_Structure constant... 44, 62, 80
- Filename Truncation option... 41, 59, 77, 96
- Filename Truncation option... 21, 22, 41, 59, 78, 96, 120
- Filename_Of subprogram... 13
- fileno()* function... 6
- flockfile()* function... 7, 114
- floor()* function... 5
- floorf()* function... 5
- floorl()* function... 5
- Flow subprogram... 11
- fma()* function... 5
- fmaf()* function... 5
- fmal()* function... 5
- fmax()* function... 5
- fmaxf()* function... 5
- fmaxl()* function... 5
- fmin()* function... 5
- fminf()* function... 5
- fminl()* function... 5
- fmod()* function... 5
- fmodf()* function... 5
- fmodl()* function... 5
- fmsg()* function... 9
- fnmatch()* function... 8
- open()* function... 6, 43
- For_Every_Current_Environment_Variable subprogram... 16
- For_Every_Directory_Entry subprogram... 13
- For_Every_Environment_Variable subprogram... 16
- For_Every_File_In subprogram... 12
- For_Every_Item subprogram... 121, 122
- fork()* function... 7
- format
 - _POSIX_AEP_REALTIME_*... 31
 - constant-width... 31
- format* function family... 31
- fort77 utility... 119
- fpathconf()* function... 7
- fpclassify()* function... 5
- fprintf()* function... 6, 43
- fputc()* function... 6, 43
- fputs()* function... 6, 43
- fputwc()* function... 9
- fputws()* function... 9
- fread()* function... 6, 43
- free()* function... 6
- freeaddrinfo()* function... 7
- freopen()* function... 6, 43
- frexp()* function... 5
- frexpf()* function... 5
- frexpl()* function... 5
- fscanf()* function... 6, 43
- fsck* utility... xvi
- fseek()* function... 7
- fseeko()* function... 7
- fsetpos()* function... 7
- fstat()* function... 7
- fstatvfs()* function... 9
- fsync()* function... 111
- ftell()* function... 7
- ftello()* function... 7
- ftime()* function... 118
- ftok()* function... 9
- ftruncate()* function... 7
- ftwlockfile()* function... 7, 114
- ftw()* function... 9
- function
 - _Exit()*... 7
 - _exit()*... 7
 - _longjmp()*... 9
 - _setjmp()*... 9
 - _tolower()*... 9
 - _toupper()*... 9
 - a64l()*... 9
 - abort()*... 8
 - abs()*... 6
 - accept()*... 7
 - access()*... 7
 - acos()*... 5
 - acosf()*... 5
 - acosh()*... 5
 - acoshf()*... 5
 - acoshl()*... 5
 - acosl()*... 5
 - aio_cancel()*... 111
 - aio_error()*... 111
 - aio_fsync()*... 111
 - aio_read()*... 111
 - aio_return()*... 111
 - aio_suspend()*... 111
 - aio_write()*... 111
 - alarm()*... 8, 42, 51, 61, 68, 86, 105
 - asctime()*... 6
 - asctime_r()*... 6, 114
 - asin()*... 5
 - asinf()*... 5
 - asinh()*... 5
 - asinhf()*... 5

Copyright © 2004 IEEE. All rights reserved.

<i>asinh</i> ()... 5	<i>catopen</i> ()... 9
<i>asinl</i> ()... 5	<i>cbrt</i> ()... 5
<i>assert</i> ()... 7	<i>cbrtf</i> ()... 5
<i>atan</i> ()... 5	<i>cbrtl</i> ()... 5
<i>atan2</i> ()... 5	<i>ccos</i> ()... 5
<i>atan2f</i> ()... 5	<i>ccosf</i> ()... 5
<i>atan2l</i> ()... 5	<i>ccosh</i> ()... 5
<i>atanf</i> ()... 5	<i>ccoshf</i> ()... 5
<i>atanh</i> ()... 5	<i>ccoshl</i> ()... 5
<i>atanhf</i> ()... 5	<i>ccosl</i> ()... 5
<i>atanhl</i> ()... 5	<i>ceil</i> ()... 5
<i>atanl</i> ()... 5	<i>ceilf</i> ()... 5
<i>atexit</i> ()... 7	<i>ceill</i> ()... 5
<i>atof</i> ()... 6	<i>cexp</i> ()... 5
<i>atoi</i> ()... 6	<i>cexpf</i> ()... 5
<i>atol</i> ()... 6	<i>cexpl</i> ()... 5
<i>atoll</i> ()... 6	<i>cfgetispeed</i> ()... 7
<i>basename</i> ()... 9	<i>cfgetospeed</i> ()... 7
<i>bcmp</i> ()... 118	<i>cfsetispeed</i> ()... 7
<i>bcopy</i> ()... 118	<i>cfsetospeed</i> ()... 7
<i>bind</i> ()... 7	<i>chdir</i> ()... 7
<i>bsd_signal</i> ()... 9	<i>chmod</i> ()... 7
<i>bsearch</i> ()... 6	<i>chown</i> ()... 7
<i>btowc</i> ()... 6	<i>cimag</i> ()... 5
<i>bzero</i> ()... 118	<i>cimagf</i> ()... 5
<i>cabs</i> ()... 5	<i>cimagl</i> ()... 5
<i>cabsf</i> ()... 5	<i>clearerr</i> ()... 6
<i>cabsl</i> ()... 5	<i>clock</i> ()... 7
<i>cacos</i> ()... 5	<i>clock_getcpuclockid</i> ()... 111
<i>cacosf</i> ()... 5	<i>clock_getres</i> ()... 116
<i>cacosh</i> ()... 5	<i>clock_gettime</i> ()... 42, 61, 116
<i>cacoshf</i> ()... 5	<i>clock_nanosleep</i> ()... 111
<i>cacoshl</i> ()... 5	<i>clock_settime</i> ()... 116
<i>cacosl</i> ()... 5	<i>clog</i> ()... 5
<i>calloc</i> ()... 6	<i>clogf</i> ()... 5
<i>carg</i> ()... 5	<i>clogl</i> ()... 5
<i>cargf</i> ()... 5	<i>close</i> ()... xiv, 6
<i>cargl</i> ()... 5	<i>closedir</i> ()... 7
<i>casin</i> ()... 5	<i>closelog</i> ()... 9
<i>casinf</i> ()... 5	<i>confstr</i> ()... 8
<i>casinh</i> ()... 5	<i>conj</i> ()... 5
<i>casinhf</i> ()... 5	<i>conjf</i> ()... 5
<i>casinhl</i> ()... 5	<i>conjl</i> ()... 5
<i>casinl</i> ()... 5	<i>connect</i> ()... 7
<i>catan</i> ()... 5	<i>copysign</i> ()... 5
<i>catanf</i> ()... 5	<i>copysignf</i> ()... 5
<i>catanh</i> ()... 5	<i>copysignl</i> ()... 5
<i>catanhf</i> ()... 5	<i>cos</i> ()... 5
<i>catanhl</i> ()... 5	<i>cosf</i> ()... 5
<i>catanl</i> ()... 5	<i>cosh</i> ()... 5
<i>catclose</i> ()... 9	<i>coshf</i> ()... 5
<i>catgets</i> ()... 9	<i>coshl</i> ()... 5

Copyright © 2004 IEEE. All rights reserved.

<i>cosl()</i> ...	5	<i>endhostent()</i> ...	7
<i>cpow()</i> ...	5	<i>endnetent()</i> ...	7
<i>cpowf()</i> ...	5	<i>endprotoent()</i> ...	7
<i>cpowl()</i> ...	5	<i>endpwent()</i> ...	9
<i>cproj()</i> ...	5	<i>endservent()</i> ...	7
<i>cprojf()</i> ...	5	<i>endutxent()</i> ...	10
<i>cprojl()</i> ...	5	<i>erand48()</i> ...	9
<i>creal()</i> ...	5	<i>erf()</i> ...	5
<i>crealf()</i> ...	5	<i>erfc()</i> ...	5
<i>creall()</i> ...	5	<i>erfcf()</i> ...	5
<i>creat()</i> ...	xv, 7	<i>erfcl()</i> ...	5
<i>crypt()</i> ...	118	<i>erff()</i> ...	5
<i>csin()</i> ...	5	<i>erfl()</i> ...	5
<i>csinf()</i> ...	5	<i>execl()</i> ...	7
<i>csinh()</i> ...	5	<i>execle()</i> ...	7
<i>csinhf()</i> ...	5	<i>execlp()</i> ...	7
<i>csinh1()</i> ...	5	<i>execv()</i> ...	7
<i>csinl()</i> ...	5	<i>execve()</i> ...	7
<i>csqrt()</i> ...	5	<i>execvp()</i> ...	7
<i>csqrtf()</i> ...	5	<i>exit()</i> ...	7
<i>csqrtl()</i> ...	5	<i>exp()</i> ...	5
<i>ctan()</i> ...	5	<i>exp2()</i> ...	5
<i>ctanf()</i> ...	5	<i>exp2f()</i> ...	5
<i>ctanh()</i> ...	5	<i>exp2l()</i> ...	5
<i>ctanhf()</i> ...	5	<i>expf()</i> ...	5
<i>ctanh1()</i> ...	5	<i>expl()</i> ...	5
<i>ctanl()</i> ...	5	<i>expm1()</i> ...	5
<i>ctermid()</i> ...	7	<i>expm1f()</i> ...	5
<i>ctime()</i> ...	6	<i>expm1l()</i> ...	5
<i>ctime_r()</i> ...	6, 114	<i>fabs()</i> ...	5
<i>dbm_clearerr()</i> ...	9	<i>fabsf()</i> ...	5
<i>dbm_close()</i> ...	9	<i>fabs1()</i> ...	5
<i>dbm_delete()</i> ...	9	<i>fattach()</i> ...	118
<i>dbm_error()</i> ...	9	<i>fchdir()</i> ...	9
<i>dbm_fetch()</i> ...	9	<i>fchmod()</i> ...	7
<i>dbm_firstkey()</i> ...	9	<i>fchown()</i> ...	7
<i>dbm_nextkey()</i> ...	9	<i>fclose()</i> ...	6, 43
<i>dbm_open()</i> ...	9	<i>fcntl()</i> ...	7
<i>dbm_store()</i> ...	9	<i>fcvt()</i> ...	118
<i>difftime()</i> ...	6	<i>FD_CLR()</i> ...	7
<i>dirname()</i> ...	9	<i>FD_ISSET()</i> ...	7
<i>div()</i> ...	6	<i>FD_SET()</i> ...	7
<i>dlclose()</i> ...	9	<i>FD_ZERO()</i> ...	7
<i>dLError()</i> ...	9	<i>fdatasync()</i> ...	113
<i>dlopen()</i> ...	9	<i>fdetach()</i> ...	118
<i>dlsym()</i> ...	9	<i>fdim()</i> ...	5
<i>drand48()</i> ...	9	<i>fdimf()</i> ...	5
<i>dup()</i> ...	7	<i>fdiml()</i> ...	5
<i>dup2()</i> ...	7	<i>fdopen()</i> ...	6
<i>ecvt()</i> ...	118	<i>feclearexcept()</i> ...	6
<i>encrypt()</i> ...	118	<i>fegetenv()</i> ...	6
<i>endgrent()</i> ...	10	<i>fegetexceptflag()</i> ...	6

Copyright © 2004 IEEE. All rights reserved.

<i>fegetround()</i> ... 6	<i>fscanf()</i> ... 6, 43
<i>fehexcept()</i> ... 6	<i>fseek()</i> ... 7
<i>feof()</i> ... 6	<i>fseeko()</i> ... 7
<i>feraiseexcept()</i> ... 6	<i>fsetpos()</i> ... 7
<i>ferror()</i> ... 6	<i>fstat()</i> ... 7
<i>fesetenv()</i> ... 6	<i>fstatvfs()</i> ... 9
<i>fesetexceptflag()</i> ... 6	<i>fsync()</i> ... 111
<i>fesetround()</i> ... 6	<i>ftell()</i> ... 7
<i>fetestexcept()</i> ... 6	<i>ftello()</i> ... 7
<i>feupdateenv()</i> ... 6	<i>ftime()</i> ... 118
<i>fflush()</i> ... 6, 43	<i>ftok()</i> ... 9
<i>ffs()</i> ... 9	<i>ftruncate()</i> ... 7
<i>fgetc()</i> ... 6, 43	<i>ftrylockfile()</i> ... 7, 114
<i>fgetpos()</i> ... 7	<i>ftw()</i> ... 9
<i>fgets()</i> ... 6, 43	<i>funlockfile()</i> ... 7, 114
<i>fgetwc()</i> ... 9	<i>fwide()</i> ... 9
<i>fgetws()</i> ... 9	<i>fwprintf()</i> ... 9
<i>fileno()</i> ... 6	<i>fwrite()</i> ... 6, 43
<i>flockfile()</i> ... 7, 114	<i>fwscanf()</i> ... 9
<i>floor()</i> ... 5	<i>gai_strerror()</i> ... 7
<i>floorf()</i> ... 5	<i>gcvt()</i> ... 118
<i>floorl()</i> ... 5	<i>getaddrinfo()</i> ... 7
<i>fma()</i> ... 5	<i>getc()</i> ... 6, 43
<i>fmaf()</i> ... 5	<i>getc_unlocked()</i> ... 7, 114
<i>fmal()</i> ... 5	<i>getchar()</i> ... 6, 43
<i>fmax()</i> ... 5	<i>getchar_unlocked()</i> ... 7, 114
<i>fmaxf()</i> ... 5	<i>getcontext()</i> ... 9
<i>fmaxl()</i> ... 5	<i>getcwd()</i> ... 7
<i>fmin()</i> ... 5	<i>getdate()</i> ... 9
<i>fminf()</i> ... 5	<i>getegid()</i> ... 9
<i>fminl()</i> ... 5	<i>getenv()</i> ... 8
<i>fmod()</i> ... 5	<i>geteuid()</i> ... 9
<i>fmodf()</i> ... 5	<i>getgid()</i> ... 9
<i>fmodl()</i> ... 5	<i>getgrent()</i> ... 10
<i>fmtmsg()</i> ... 9	<i>getgrgid()</i> ... 8
<i>fnmatch()</i> ... 8	<i>getgrgid_r()</i> ... 8, 114
<i>fopen()</i> ... 6, 43	<i>getgrnam()</i> ... 8
<i>fork()</i> ... 7	<i>getgrnam_r()</i> ... 8, 114
<i>fpathconf()</i> ... 7	<i>getgroups()</i> ... 9
<i>fpclassify()</i> ... 5	<i>gethostbyaddr()</i> ... 7
<i>fprintf()</i> ... 6, 43	<i>gethostbyname()</i> ... 7
<i>fputc()</i> ... 6, 43	<i>gethostent()</i> ... 7
<i>fputs()</i> ... 6, 43	<i>gethostid()</i> ... 9
<i>fputwc()</i> ... 9	<i>gethostname()</i> ... 7
<i>fputws()</i> ... 9	<i>getitimer()</i> ... 10
<i>fread()</i> ... 6, 43	<i>getlogin()</i> ... 9
<i>free()</i> ... 6	<i>getlogin_r()</i> ... 9, 114
<i>freeaddrinfo()</i> ... 7	<i>getmsg()</i> ... 118
<i>freopen()</i> ... 6, 43	<i>getnaminfo()</i> ... 7
<i>frexp()</i> ... 5	<i>getnetbyaddr()</i> ... 7
<i>frexpf()</i> ... 5	<i>getnetbyname()</i> ... 7
<i>frexpl()</i> ... 5	<i>getnetent()</i> ... 7

Copyright © 2004 IEEE. All rights reserved.

<i>getopt()</i> ... 8	<i>if_nameindex()</i> ... 7
<i>getpeername()</i> ... 7	<i>if_nameindex()</i> ... 7
<i>getpgid()</i> ... 9	<i>ilogb()</i> ... 5
<i>getpgrp()</i> ... 7	<i>ilogbf()</i> ... 5
<i>getpid()</i> ... 7	<i>ilogbl()</i> ... 5
<i>getpm sg()</i> ... 118	<i>imaxabs()</i> ... 6
<i>getppid()</i> ... 7	<i>imaxdiv()</i> ... 6
<i>getpriority()</i> ... 9	<i>index()</i> ... 118
<i>getprotobynam e()</i> ... 7	<i>inet_addr()</i> ... 7
<i>getprotobynum ber()</i> ... 7	<i>inet_ntoa()</i> ... 7
<i>getprotoent()</i> ... 7	<i>inet_ntop()</i> ... 7
<i>getpwent()</i> ... 9	<i>inet_pton()</i> ... 7
<i>getpwnam ()</i> ... 8	<i>initstate()</i> ... 9
<i>getpwnam _r()</i> ... 8, 114	<i>insque()</i> ... 9
<i>getpwuid()</i> ... 8	<i>ioctl()</i> ... xiv, 118
<i>getpwuid _r()</i> ... 8, 114	<i>isalnum()</i> ... 6
<i>getrlim it()</i> ... 9	<i>isalpha()</i> ... 6
<i>getrusage()</i> ... 9	<i>isascii()</i> ... 9
<i>gets()</i> ... 6, 43	<i>isastream()</i> ... 118
<i>getservbynam e()</i> ... 7	<i>isatty()</i> ... 7
<i>getservbyport()</i> ... 7	<i>isblank()</i> ... 6
<i>getservent()</i> ... 7	<i>iscntrl()</i> ... 6
<i>getsid()</i> ... 9	<i>isdigit()</i> ... 6
<i>getsocknam e()</i> ... 7	<i>isfinite()</i> ... 5
<i>getsockopt()</i> ... 7	<i>isgraph()</i> ... 6
<i>getsubopt()</i> ... 9	<i>isgreater()</i> ... 5
<i>gettime eofday()</i> ... 9	<i>isgreaterequal()</i> ... 5
<i>getuid()</i> ... 9	<i>isinf()</i> ... 5
<i>getutxent()</i> ... 10	<i>isless()</i> ... 5
<i>getutxid()</i> ... 10	<i>islessequal()</i> ... 5
<i>getutxline()</i> ... 10	<i>islessgreater()</i> ... 5
<i>getwc()</i> ... 9	<i>islower()</i> ... 6
<i>getwchar()</i> ... 9	<i>isnan()</i> ... 5
<i>getwd()</i> ... 118	<i>isnormal()</i> ... 5
<i>glob()</i> ... 7	<i>isprint()</i> ... 6
<i>globfree()</i> ... 7	<i>ispunct()</i> ... 6
<i>gmtime()</i> ... 6	<i>isspace()</i> ... 6
<i>gmtime _r()</i> ... 6, 114	<i>isunordered()</i> ... 5
<i>grantpt()</i> ... 9	<i>isupper()</i> ... 6
<i>hcreate()</i> ... 9	<i>iswalnum()</i> ... 6
<i>hdestroy()</i> ... 9	<i>iswalpha()</i> ... 6
<i>hsearch()</i> ... 9	<i>iswblank()</i> ... 6
<i>htonl()</i> ... 7	<i>iswcntrl()</i> ... 6
<i>htons()</i> ... 7	<i>iswctype()</i> ... 6
<i>hypot()</i> ... 5	<i>iswdigit()</i> ... 6
<i>hypotf()</i> ... 5	<i>iswgraph()</i> ... 6
<i>hypotl()</i> ... 5	<i>iswlower()</i> ... 6
<i>iconv()</i> ... 9	<i>iswprint()</i> ... 6
<i>iconv _close()</i> ... 9	<i>iswpunct()</i> ... 6
<i>iconv _open()</i> ... 9	<i>iswspace()</i> ... 6
<i>if_freenameindex()</i> ... 7	<i>iswupper()</i> ... 6
<i>if_inde xtonam e()</i> ... 7	<i>iswxdigit()</i> ... 6

Copyright © 2004 IEEE. All rights reserved.

<i>isxdigit()</i> ... 6	<i>lrintf()</i> ... 5
<i>j0()</i> ... 9	<i>lrintl()</i> ... 5
<i>j1()</i> ... 9	<i>lround()</i> ... 5
<i>jn()</i> ... 9	<i>lroundf()</i> ... 5
<i>jrnd48()</i> ... 9	<i>lroundl()</i> ... 5
<i>kill()</i> ... 8, 42, 43, 61, 79	<i>lsearch()</i> ... 9
<i>killpg()</i> ... 9	<i>lseek()</i> ... 7
<i>l64a()</i> ... 9	<i>lstat()</i> ... 8
<i>labs()</i> ... 6	<i>main()</i> ... 47, 64
<i>lchown()</i> ... 9	<i>makecontext()</i> ... 9
<i>lcong48()</i> ... 9	<i>malloc()</i> ... 6
<i>ldexp()</i> ... 5	<i>mblen()</i> ... 6
<i>ldexpf()</i> ... 5	<i>mbrlen()</i> ... 6
<i>ldexpl()</i> ... 5	<i>mbrtowc()</i> ... 6
<i>ldiv()</i> ... 6	<i>mbstowcs()</i> ... 6
<i>lfind()</i> ... 9	<i>mbstowcs()</i> ... 6
<i>lgamma()</i> ... 5	<i>mbtowc()</i> ... 6
<i>lgammaf()</i> ... 5	<i>memcpy()</i> ... 9
<i>lgammal()</i> ... 5	<i>memchr()</i> ... 6
<i>link()</i> ... xv, 7	<i>memcmp()</i> ... 6
<i>lio_listio()</i> ... 111	<i>memcpy()</i> ... 6
<i>listen()</i> ... 7	<i>memmove()</i> ... 6
<i>llabs()</i> ... 6	<i>memset()</i> ... 6
<i>lldiv()</i> ... 6	<i>mkdir()</i> ... xv, 7
<i>llrint()</i> ... 5	<i>mkfifo()</i> ... 7
<i>llrintf()</i> ... 5	<i>mknod()</i> ... 9, 58, 77, 95
<i>llrintl()</i> ... 5	<i>mkstemp()</i> ... 9
<i>llround()</i> ... 5	<i>mktemp()</i> ... 118
<i>llroundf()</i> ... 5	<i>mktime()</i> ... 6
<i>llroundl()</i> ... 5	<i>mlock()</i> ... 112
<i>localeconv()</i> ... 6	<i>mlockall()</i> ... 112
<i>localtime()</i> ... 6	<i>mmap()</i> ... 112, 113, 118
<i>localtime_r()</i> ... 6, 114	<i>modf()</i> ... 5
<i>lockf()</i> ... 9	<i>modff()</i> ... 5
<i>log()</i> ... 5	<i>modfl()</i> ... 5
<i>log10()</i> ... 5	<i>mprotect()</i> ... 112
<i>log10f()</i> ... 5	<i>mq_close()</i> ... 112
<i>log10l()</i> ... 5	<i>mq_getattr()</i> ... 112
<i>loglp()</i> ... 5	<i>mq_notify()</i> ... 112
<i>loglpf()</i> ... 5	<i>mq_open()</i> ... 112
<i>loglpl()</i> ... 5	<i>mq_receive()</i> ... 112
<i>log2()</i> ... 5	<i>mq_send()</i> ... 112
<i>log2f()</i> ... 5	<i>mq_setattr()</i> ... 112
<i>log2l()</i> ... 5	<i>mq_timedreceive()</i> ... 112, 116
<i>logb()</i> ... 5	<i>mq_timedsend()</i> ... 112, 116
<i>logbf()</i> ... 5	<i>mq_unlink()</i> ... 112
<i>logbl()</i> ... 5	<i>mrnd48()</i> ... 9
<i>logf()</i> ... 5	<i>msgctl()</i> ... 9
<i>logl()</i> ... 5	<i>msgget()</i> ... 9
<i>longjmp()</i> ... 5	<i>msgrcv()</i> ... 9
<i>lrnd48()</i> ... 9	<i>msgsnd()</i> ... 9
<i>lrint()</i> ... 5	

Copyright © 2004 IEEE. All rights reserved.

<i>msync()</i> ... 112, 113	<i>posix_spawnattr_getpgroup()</i> ... 113
<i>munlock()</i> ... 112	<i>posix_spawnattr_getschedparam()</i> ...
<i>munlockall()</i> ... 112	112, 113
<i>munmap()</i> ... 112, 113, 118	<i>posix_spawnattr_getschedpolicy()</i> ... 112,
<i>nan()</i> ... 5	113
<i>nanf()</i> ... 5	<i>posix_spawnattr_getsigdefault()</i> ... 113
<i>nanl()</i> ... 5	<i>posix_spawnattr_getsigmask()</i> ... 113
<i>nanosleep()</i> ... 116	<i>posix_spawnattr_init()</i> ... 113
<i>nearbyint()</i> ... 5	<i>posix_spawnattr_setflags()</i> ... 113
<i>nearbyintf()</i> ... 5	<i>posix_spawnattr_setpgroup()</i> ... 113
<i>nearbyintl()</i> ... 5	<i>posix_spawnattr_setschedparam()</i> ...
<i>nextafter()</i> ... 5	112, 113
<i>nextafterf()</i> ... 5	<i>posix_spawnattr_setschedpolicy()</i> ... 112,
<i>nextafterl()</i> ... 5	113
<i>nexttoward()</i> ... 5	<i>posix_spawnattr_setsigdefault()</i> ... 113
<i>nexttowardf()</i> ... 5	<i>posix_spawnattr_setsigmask()</i> ... 113
<i>nexttowardl()</i> ... 5	<i>posix_spawnnp()</i> ... 113
<i>nftw()</i> ... 9	<i>posix_trace_attr_destroy()</i> ... 117
<i>nice()</i> ... 9	<i>posix_trace_attr_getclockres()</i> ... 117
<i>nl_langinfo()</i> ... 9	<i>posix_trace_attr_getcreatetime()</i> ... 117
<i>nrnd48()</i> ... 9	<i>posix_trace_attr_getgenversion()</i> ... 117
<i>ntohl()</i> ... 7	<i>posix_trace_attr_getinherited()</i> ... 117
<i>ntohs()</i> ... 7	<i>posix_trace_attr_getlogfullpolicy()</i> ... 117
<i>open()</i> ... xiv, 6, 40, 43, 47	<i>posix_trace_attr_getlogsize()</i> ... 117
<i>opendir()</i> ... 7	<i>posix_trace_attr_getmaxdatasize()</i> ... 117
<i>openlog()</i> ... 9	<i>posix_trace_attr_getmaxsystemeventsiz</i>
<i>pathconf()</i> ... 7	<i>e()</i> ... 117
<i>pause()</i> ... 8	<i>posix_trace_attr_getmaxusereventsize()</i>
<i>pclose()</i> ... 8	.. 117
<i>perror()</i> ... 6, 43	<i>posix_trace_attr_getname()</i> ... 117
<i>pipe()</i> ... 7	<i>posix_trace_attr_getstreamfullpolicy()</i> ...
<i>poll()</i> ... 9	117
<i>popen()</i> ... 8	<i>posix_trace_attr_getstreamsize()</i> ... 117
<i>posix_devctl()</i> ... xiv, 48, 65, 83, 101	<i>posix_trace_attr_init()</i> ... 117
<i>posix_fadvise()</i> ... 111	<i>posix_trace_attr_setinherited()</i> ... 117
<i>posix_fallocate()</i> ... 111	<i>posix_trace_attr_setlogfullpolicy()</i> ... 117
<i>posix_madvise()</i> ... 111, 112, 113	<i>posix_trace_attr_setlogsize()</i> ... 117
<i>posix_mem_offset()</i> ... 118	<i>posix_trace_attr_setmaxdatasize()</i> ... 117
<i>posix_memalign()</i> ... 111	<i>posix_trace_attr_setname()</i> ... 117
<i>posix_openpt()</i> ... 9	<i>posix_trace_attr_setstreamfullpolicy()</i> ...
<i>posix_spawn()</i> ... 113	117
<i>posix_spawn_file_actions_addclose()</i> ...	<i>posix_trace_attr_setstreamsize()</i> ... 117
113	<i>posix_trace_clear()</i> ... 117
<i>posix_spawn_file_actions_adddup2()</i> ...	<i>posix_trace_close()</i> ... 117
113	<i>posix_trace_create()</i> ... 117
<i>posix_spawn_file_actions_addopen()</i> ...	<i>posix_trace_create_withlog()</i> ... 117
113	<i>posix_trace_event()</i> ... 117
<i>posix_spawn_file_actions_destroy()</i> ...	<i>posix_trace_eventid_equal()</i> ... 117
113	<i>posix_trace_eventid_get_name()</i> ... 117
<i>posix_spawn_file_actions_init()</i> ... 113	<i>posix_trace_eventid_open()</i> ... 117
<i>posix_spawnattr_destroy()</i> ... 113	<i>posix_trace_eventset_add()</i> ... 117
<i>posix_spawnattr_getflags()</i> ... 113	<i>posix_trace_eventset_del()</i> ... 117

Copyright © 2004 IEEE. All rights reserved.

<i>posix_trace_eventset_empty()</i> ...	117		
<i>posix_trace_eventset_fill()</i> ...	117		
<i>posix_trace_eventset_ismember()</i> ...	117		
<i>posix_trace_eventtypelist_getnext_id()</i> ...	117		
<i>posix_trace_eventtypelist_rewind()</i> ...	117		
<i>posix_trace_flush()</i> ...	117		
<i>posix_trace_get_attr()</i> ...	117		
<i>posix_trace_get_filter()</i> ...	117		
<i>posix_trace_get_status()</i> ...	117		
<i>posix_trace_getnext_event()</i> ...	117		
<i>posix_trace_open()</i> ...	117		
<i>posix_trace_rewind()</i> ...	117		
<i>posix_trace_set_filter()</i> ...	117		
<i>posix_trace_shutdown()</i> ...	117		
<i>posix_trace_start()</i> ...	117		
<i>posix_trace_stop()</i> ...	117		
<i>posix_trace_timedgetnext_event()</i> ...	116, 117		
<i>posix_trace_trid_eventid_open()</i> ...	117		
<i>posix_trace_trygetnext_event()</i> ...	117		
<i>posix_typed_mem_get_info()</i> ...	118		
<i>posix_typed_mem_open()</i> ...	118		
<i>pow()</i> ...	5		
<i>powf()</i> ...	5		
<i>powl()</i> ...	5		
<i>pread()</i> ...	9		
<i>printf()</i> ...	6, 43		
<i>pselect()</i> ...	7		
<i>pthread_atfork()</i> ...	8, 115		
<i>pthread_attr_destroy()</i> ...	8, 115		
<i>pthread_attr_getdetachstate()</i> ...	8, 115		
<i>pthread_attr_getguardsize()</i> ...	10		
<i>pthread_attr_getinheritsched()</i> ...	114, 116		
<i>pthread_attr_getschedparam()</i> ...	8, 115		
<i>pthread_attr_getschedpolicy()</i> ...	114, 116		
<i>pthread_attr_getscope()</i> ...	114, 116		
<i>pthread_attr_getstack()</i> ...	10, 113, 114, 115		
<i>pthread_attr_getstackaddr()</i> ...	113, 115		
<i>pthread_attr_getstacksize()</i> ...	114, 115, 119		
<i>pthread_attr_init()</i> ...	8, 115		
<i>pthread_attr_setdetachstate()</i> ...	8, 115		
<i>pthread_attr_setguardsize()</i> ...	10		
<i>pthread_attr_setinheritsched()</i> ...	114, 116		
<i>pthread_attr_setschedparam()</i> ...	8, 115		
<i>pthread_attr_setschedpolicy()</i> ...	114, 116		
<i>pthread_attr_setscope()</i> ...	114, 116		
<i>pthread_attr_setstack()</i> ...	10, 113, 114, 115		
<i>pthread_attr_setstackaddr()</i> ...	113, 115		
<i>pthread_attr_setstacksize()</i> ...	114, 115, 119		
<i>pthread_barrier_destroy()</i> ...	111, 115		
<i>pthread_barrier_init()</i> ...	111, 115		
<i>pthread_barrier_wait()</i> ...	111, 115		
<i>pthread_barrierattr_destroy()</i> ...	111, 115		
<i>pthread_barrierattr_getpshared()</i> ...	111, 114, 115		
<i>pthread_barrierattr_init()</i> ...	111, 115		
<i>pthread_barrierattr_setpshared()</i> ...	111, 114, 115		
<i>pthread_cancel()</i> ...	8, 115		
<i>pthread_cleanup_pop()</i> ...	8, 115		
<i>pthread_cleanup_push()</i> ...	8, 115		
<i>pthread_cond_broadcast()</i> ...	8, 115		
<i>pthread_cond_destroy()</i> ...	8, 115		
<i>pthread_cond_init()</i> ...	8, 115		
<i>pthread_cond_signal()</i> ...	8, 115		
<i>pthread_cond_timedwait()</i> ...	8, 115		
<i>pthread_cond_wait()</i> ...	8, 115		
<i>pthread_condattr_destroy()</i> ...	8, 115		
<i>pthread_condattr_getclock()</i> ...	111, 115		
<i>pthread_condattr_getpshared()</i> ...	114, 116		
<i>pthread_condattr_init()</i> ...	8, 115		
<i>pthread_condattr_setclock()</i> ...	111, 115		
<i>pthread_condattr_setpshared()</i> ...	114, 116		
<i>pthread_create()</i> ...	8, 115		
<i>pthread_detach()</i> ...	8, 115		
<i>pthread_equal()</i> ...	8, 115		
<i>pthread_exit()</i> ...	8, 115		
<i>pthread_getconcurrency()</i> ...	10		
<i>pthread_getcpuclockid()</i> ...	114, 115		
<i>pthread_getschedparam()</i> ...	114, 116		
<i>pthread_getspecific()</i> ...	8, 115		
<i>pthread_join()</i> ...	8, 115		
<i>pthread_key_create()</i> ...	8, 115		
<i>pthread_key_delete()</i> ...	8, 115		
<i>pthread_kill()</i> ...	8, 115		
<i>pthread_mutex_destroy()</i> ...	8, 115		
<i>pthread_mutex_getprioceiling()</i> ...	114, 116		
<i>pthread_mutex_init()</i> ...	8, 115		
<i>pthread_mutex_lock()</i> ...	8, 115		
<i>pthread_mutex_setprioceiling()</i> ...	114, 116		
<i>pthread_mutex_timedlock()</i> ...	116		
<i>pthread_mutex_trylock()</i> ...	8, 115		
<i>pthread_mutex_unlock()</i> ...	8, 115		

Copyright © 2004 IEEE. All rights reserved.

<i>pthread_mutexattr_destroy()</i> ... 8, 115	<i>putmsg()</i> ... 118
<i>pthread_mutexattr_getprioceiling()</i> ...	<i>putpmsg()</i> ... 118
114, 116	<i>puts()</i> ... 6, 43
<i>pthread_mutexattr_getprotocol()</i> ... 114,	<i>pututxline()</i> ... 10
116	<i>putwc()</i> ... 9
<i>pthread_mutexattr_getpshared()</i> ... 114,	<i>putwchar()</i> ... 9
116	<i>pwrite()</i> ... 9
<i>pthread_mutexattr_gettype()</i> ... 10	<i>qsort()</i> ... 6
<i>pthread_mutexattr_init()</i> ... 8, 115	<i>raise()</i> ... 8, 42, 61
<i>pthread_mutexattr_setprioceiling()</i> ...	<i>rand()</i> ... 6
114, 116	<i>rand_r()</i> ... 6, 114
<i>pthread_mutexattr_setprotocol()</i> ... 114,	<i>random()</i> ... 9
116	<i>read()</i> ... xiv, xv, 6, 43
<i>pthread_mutexattr_setpshared()</i> ... 114,	<i>readdir()</i> ... 7
116	<i>readdir_r()</i> ... 7, 114
<i>pthread_mutexattr_settype()</i> ... 10	<i>readlink()</i> ... 8
<i>pthread_once()</i> ... 8, 115	<i>readv()</i> ... 9
<i>pthread_rwlock_destroy()</i> ... 8, 115	<i>realloc()</i> ... 6
<i>pthread_rwlock_init()</i> ... 8, 115	<i>realpath()</i> ... 9
<i>pthread_rwlock_rdlock()</i> ... 8, 115	<i>recv()</i> ... 7
<i>pthread_rwlock_timedrdlock()</i> ... 8, 116	<i>recvfrom()</i> ... 7
<i>pthread_rwlock_timedwrlock()</i> ... 8, 116	<i>recvmsg()</i> ... 7
<i>pthread_rwlock_tryrdlock()</i> ... 8, 115	<i>regcomp()</i> ... 7
<i>pthread_rwlock_trywrlock()</i> ... 8, 115	<i>regerror()</i> ... 7
<i>pthread_rwlock_unlock()</i> ... 8, 115	<i>regexexec()</i> ... 7
<i>pthread_rwlock_wrlock()</i> ... 8, 115	<i>regfree()</i> ... 7
<i>pthread_rwlockattr_destroy()</i> ... 8, 115	<i>remainder()</i> ... 5
<i>pthread_rwlockattr_getpshared()</i> ... 8,	<i>remainderf()</i> ... 5
114, 116	<i>remainderl()</i> ... 5
<i>pthread_rwlockattr_init()</i> ... 8, 115	<i>remove()</i> ... 7
<i>pthread_rwlockattr_setpshared()</i> ... 8,	<i>remque()</i> ... 9
114, 116	<i>remquo()</i> ... 5
<i>pthread_self()</i> ... 8, 115	<i>remquoof()</i> ... 5
<i>pthread_setcalcelstate()</i> ... 8, 115	<i>remquol()</i> ... 5
<i>pthread_setcanceltype()</i> ... 8, 115	<i>rename()</i> ... xv, 7
<i>pthread_setconcurrency()</i> ... 10	<i>rewind()</i> ... 7
<i>pthread_setschedparam()</i> ... 114, 116	<i>rewinddir()</i> ... 7
<i>pthread_setschedprio()</i> ... 114, 116	<i>rindex()</i> ... 118
<i>pthread_setspecific()</i> ... 8, 115	<i>rint()</i> ... 5
<i>pthread_sigmask()</i> ... 8, 115	<i>rintf()</i> ... 5
<i>pthread_spin_destroy()</i> ... 113, 115	<i>rintl()</i> ... 5
<i>pthread_spin_init()</i> ... 113, 115	<i>rmdir()</i> ... xv, 7
<i>pthread_spin_lock()</i> ... 113, 115	<i>round()</i> ... 5
<i>pthread_spin_trylock()</i> ... 113, 115	<i>roundf()</i> ... 5
<i>pthread_spin_unlock()</i> ... 113, 115	<i>roundl()</i> ... 5
<i>pthread_testcancel()</i> ... 8, 115	<i>scalb()</i> ... 9
<i>ptsname()</i> ... 9	<i>scalbln()</i> ... 5
<i>putc()</i> ... 6, 43	<i>scalblnf()</i> ... 5
<i>putc_unlocked()</i> ... 7, 114	<i>scalblnl()</i> ... 5
<i>putchar()</i> ... 6, 43	<i>scalbn()</i> ... 5
<i>putchar_unlocked()</i> ... 7, 114	<i>scalbnf()</i> ... 5
<i>putenv()</i> ... 9	<i>scalbnl()</i> ... 5

Copyright © 2004 IEEE. All rights reserved.

<i>scanf()</i> ... 6, 43	<i>setsockopt()</i> ... 7
<i>sched_get_priority_max()</i> ... 112, 114, 116	<i>setstate()</i> ... 9
<i>sched_get_priority_min()</i> ... 112, 114, 116	<i>setuid()</i> ... 9
<i>sched_getparam()</i> ... 112	<i>setutxent()</i> ... 10
<i>sched_getscheduler()</i> ... 112	<i>setvbuf()</i> ... 6
<i>sched_rr_get_interval()</i> ... 112, 114, 116	<i>shm_open()</i> ... 113
<i>sched_setparam()</i> ... 112	<i>shm_unlink()</i> ... 113
<i>sched_setscheduler()</i> ... 112	<i>shm_at()</i> ... 9
<i>sched_yield()</i> ... 112, 116	<i>shm_ctl()</i> ... 9
<i>seed48()</i> ... 9	<i>shmdt()</i> ... 9
<i>seekdir()</i> ... 9	<i>shmget()</i> ... 9
<i>select()</i> ... 7, 52, 70, 88, 107	<i>shutdown()</i> ... 7
<i>sem_close()</i> ... 113	<i>sigaction()</i> ... 8, 42, 61
<i>sem_destroy()</i> ... 113	<i>sigaddset()</i> ... 8, 42, 61
<i>sem_getvalue()</i> ... 113	<i>sigaltstack()</i> ... 9
<i>sem_init()</i> ... 113	<i>sigdelset()</i> ... 8, 61
<i>sem_open()</i> ... 113	<i>sigemptyset()</i> ... 8, 42, 61
<i>sem_post()</i> ... 42, 61, 113	<i>sigfillset()</i> ... 8, 42, 61
<i>sem_timedwait()</i> ... 113, 116	<i>sighold()</i> ... 9
<i>sem_trywait()</i> ... 113	<i>sigignore()</i> ... 9
<i>sem_unlink()</i> ... 113	<i>siginterrupt()</i> ... 9
<i>sem_wait()</i> ... 113	<i>sigismember()</i> ... 8, 42, 61
<i>semctl()</i> ... 9	<i>siglongjmp()</i> ... 8
<i>semget()</i> ... 9	<i>signal()</i> ... 8, 42, 61
<i>semop()</i> ... 9	<i>signbit()</i> ... 5
<i>send()</i> ... 7	<i>sigpause()</i> ... 9
<i>sendmsg()</i> ... 7	<i>sigpending()</i> ... 8, 42, 61
<i>sendto()</i> ... 7	<i>sigprocmask()</i> ... 8, 42, 61
<i>setbuf()</i> ... 6	<i>sigqueue()</i> ... 42, 61, 112
<i>setcontext()</i> ... 9	<i>sigrelse()</i> ... 9
<i>setegid()</i> ... 9	<i>sigset()</i> ... 42, 61
<i>setenv()</i> ... 8	<i>sigsetjmp()</i> ... 8
<i>seteuid()</i> ... 9	<i>sigsuspend()</i> ... 8
<i>setgid()</i> ... 9	<i>sigtimedwait()</i> ... 112
<i>setgrent()</i> ... 10	<i>sigwait()</i> ... 8
<i>sethostent()</i> ... 7	<i>sigwaitinfo()</i> ... 112
<i>setitimer()</i> ... 10	<i>sin()</i> ... 5
<i>setjmp()</i> ... 5	<i>sinf()</i> ... 5
<i>setkey()</i> ... 118	<i>sinh()</i> ... 5
<i>setlocale()</i> ... 6	<i>sinhf()</i> ... 5
<i>setlogmask()</i> ... 9	<i>sinhl()</i> ... 5
<i>setnetent()</i> ... 7	<i>sinl()</i> ... 5
<i>setpgid()</i> ... 7	<i>sleep()</i> ... 7, 51, 68, 86, 105
<i>setpgrp()</i> ... 9	<i>snprintf()</i> ... 6
<i>setpriority()</i> ... 9	<i>socketatmark()</i> ... 7
<i>setprotoent()</i> ... 7	<i>socket()</i> ... 7
<i>setpwent()</i> ... 9	<i>socketpair()</i> ... 7
<i>setregid()</i> ... 10	<i>sprintf()</i> ... 6
<i>setreuid()</i> ... 10	<i>sqrt()</i> ... 5
<i>setrlimit()</i> ... 9	<i>sqrtf()</i> ... 5
<i>setservent()</i> ... 7	<i>sqrtl()</i> ... 5
<i>setsid()</i> ... 7	<i>srand()</i> ... 6

Copyright © 2004 IEEE. All rights reserved.

<i>srand48()</i> ... 9	<i>tanh()</i> ... 5
<i>srandom()</i> ... 9	<i>tanl()</i> ... 5
<i>sscanf()</i> ... 6	<i>tcdrain()</i> ... 7
<i>stat()</i> ... 7	<i>tcflow()</i> ... 7
<i>statvfs()</i> ... 9	<i>tcflush()</i> ... 7
<i>strcasecmp()</i> ... 9	<i>tcgetattr()</i> ... 7
<i>strcat()</i> ... 6	<i>tcgetpgrp()</i> ... 7
<i>strchr()</i> ... 6	<i>tcgetsid()</i> ... 9
<i>strcmp()</i> ... 6	<i>tcsendbreak()</i> ... 7
<i>strcoll()</i> ... 6	<i>tcsetattr()</i> ... 7
<i>strcpy()</i> ... 6	<i>tcsetpgrp()</i> ... 7
<i>strcspn()</i> ... 6	<i>tdelete()</i> ... 9
<i>strdup()</i> ... 9	<i>telldir()</i> ... 9
<i>strerror()</i> ... 6	<i>tempnam()</i> ... 9
<i>strerror_r()</i> ... 6, 114	<i>tfind()</i> ... 9
<i>strfmon()</i> ... 9	<i>tgamma()</i> ... 5
<i>strftime()</i> ... 6	<i>tgammaf()</i> ... 5
<i>strlen()</i> ... 6	<i>tgammal()</i> ... 5
<i>strncasecmp()</i> ... 9	<i>time()</i> ... 6, 42, 61
<i>strncat()</i> ... 6	<i>timer_create()</i> ... 116
<i>strncmp()</i> ... 6	<i>timer_delete()</i> ... 116
<i>strncpy()</i> ... 6	<i>timer_getoverrun()</i> ... 42, 61, 116
<i>strpbrk()</i> ... 6	<i>timer_gettime()</i> ... 42, 61, 116
<i>strptime()</i> ... 9	<i>timer_settime()</i> ... 42, 61, 116
<i>strrchr()</i> ... 6	<i>times()</i> ... 7, 42, 61
<i>strspn()</i> ... 6	<i>tmpfile()</i> ... 7
<i>strstr()</i> ... 6	<i>tmpnam()</i> ... 7
<i>strtod()</i> ... 6	<i>toascii()</i> ... 9
<i>strtof()</i> ... 6	<i>tolower()</i> ... 6
<i>strtoimax()</i> ... 6	<i>toupper()</i> ... 6
<i>strtok()</i> ... 6	<i>towctrans()</i> ... 6
<i>strtok_r()</i> ... 6, 114	<i>towlower()</i> ... 6
<i>strtol()</i> ... 6	<i>toupper()</i> ... 6
<i>strtold()</i> ... 6	<i>trunc()</i> ... 5
<i>strtoll()</i> ... 6	<i>truncate()</i> ... 9
<i>strtoul()</i> ... 6	<i>truncf()</i> ... 5
<i>strtoull()</i> ... 6	<i>truncl()</i> ... 5
<i>strtoumax()</i> ... 6	<i>tsearch()</i> ... 9
<i>strxfrm()</i> ... 6	<i>ttynam()</i> ... 7
<i>swab()</i> ... 9	<i>ttynam_r()</i> ... 7, 114
<i>swapcontext()</i> ... 9	<i>twalk()</i> ... 9
<i>swprintf()</i> ... 6	<i>tzset()</i> ... 6
<i>swscanf()</i> ... 6	<i>ualarm()</i> ... 9
<i>symlink()</i> ... 8	<i>ulimit()</i> ... 9
<i>sync()</i> ... 9	<i>umask()</i> ... 7
<i>sysconf()</i> ... 8, 42, 43, 61, 79	<i>uname()</i> ... 8, 42, 61
<i>syslog()</i> ... 9	<i>ungetc()</i> ... 6
<i>system()</i> ... 8	<i>ungetwc()</i> ... 9
<i>tan()</i> ... 5	<i>unlink()</i> ... xv, 7
<i>tanf()</i> ... 5	<i>unlockpt()</i> ... 9
<i>tanh()</i> ... 5	<i>unsetenv()</i> ... 8
<i>tanhf()</i> ... 5	<i>usleep()</i> ... 9

Copyright © 2004 IEEE. All rights reserved.

utime()... 7
utimes()... 118
va_arg()... 6
va_copy()... 6
va_end()... 6
va_start()... 6
vfork()... 9
vfprintf()... 6, 43
vfprintf()... 6, 43
vfwprintf()... 9
vfwscanf()... 9
vprintf()... 6, 43
vscanf()... 6, 43
vsnprintf()... 6
vsprintf()... 6
vsscanf()... 6
vswprintf()... 6
vswscanf()... 6
vwprintf()... 9
vwscanf()... 9
wait()... 7
waitid()... 9
waitpid()... 7
wcrtomb()... 6
wscat()... 6
wchr()... 6
wscmp()... 6
wscoll()... 6
wscpy()... 6
wscspn()... 6
wcsftime()... 6
wcslen()... 6
wcsncat()... 6
wcsncmp()... 6
wcsncpy()... 6
wcspbrk()... 6
wcsrchr()... 6
wcsrtombs()... 6
wcsspn()... 6
wcsstr()... 6
wctod()... 6
wctof()... 6
wctoimax()... 6
wctok()... 6
wctol()... 6
wctold()... 6
wctoll()... 6
wctombs()... 6
wctoul()... 6
wctoull()... 6
wctoumax()... 6
wcswcs()... 118

wcswidth()... 10
wcsxfrm()... 6
wctob()... 6
wctomb()... 6
wctrans()... 6
wctype()... 6
wcwidth()... 10
wmemchr()... 6
wmemcmp()... 6
wmemcpy()... 6
wmemmove()... 6
wmemset()... 6
wordexp()... 8
wordfree()... 8
wprintf()... 9
write()... xiv, xv, 6, 43
writew()... 9
wscanf()... 9
y0()... 9
y1()... 9
yn()... 9
 function family
 format... 31
 functionality
 unit of... 28
funlockfile() function... 7, 114
fwide() function... 9
fwprintf() function... 9
fwrite() function... 6, 43
fwscanf() function... 9

G

gai_strerror() function... 7
gcvt() function... 118
 Generic Application Environment Profile...
 27
 generic application environment profile... 27
 generic environment profile... 32
 generic interface profile... 27
 Generic_Read subprogram... 11
 Generic_Write subprogram... 11
 Get subprogram... 44
 Get_Allowed_Process_Permissions
 subprogram... 12
 Get_Buffer subprogram... 14
 Get_Canonical_Name subprogram... 121,
 122
 Get_Ceiling_Priority subprogram...
 120, 121
 Get_Close_On_Exec subprogram... 12

Copyright © 2004 IEEE. All rights reserved.

Get_Controlling_Terminal_Name subprogram... 11	<i>getgrgid()</i> function... 8
Get_Data subprogram... 15	<i>getgrgid_r()</i> function... 8, 114
Get_Effective_Group_ID subprogram... 16	<i>getgrnam()</i> function... 8
Get_Effective_User_ID subprogram... 16	<i>getgrnam_r()</i> function... 8, 114
Get_Events subprogram... 121	<i>getgroups()</i> function... 9
Get_Family subprogram... 121, 122	<i>gethostbyaddr()</i> function... 7
Get_File subprogram... 121	<i>gethostbyname()</i> function... 7
Get_File_Control subprogram... 12	<i>gethostent()</i> function... 7
Get_Flags subprogram... 121, 122	<i>gethostid()</i> function... 9
Get_Groups subprogram... 16	<i>gethostname()</i> function... 7
Get_Locking_Policy subprogram... 120, 121	<i>getitimer()</i> function... 10
Get_Login_Name subprogram... 16	<i>getlogin()</i> function... 9
Get_Notification subprogram... 15	<i>getlogin_r()</i> function... 9, 114
Get_Owner subprogram... 14	<i>getmsg()</i> function... 118
Get_Parent_Process_Id subprogram... 14	<i>getnameinfo()</i> function... 7
Get_Process_Group_Id subprogram... 16	<i>getnetbyaddr()</i> function... 7
Get_Process_Group_Id subprogram... 13	<i>getnetbyname()</i> function... 7
Get_Process_Id subprogram... 14	<i>getnetent()</i> function... 7
Get_Process_Shared subprogram... 120, 121	<i>getopt()</i> function... 8
Get_Protocol_Number subprogram... 121, 122	<i>getpeername()</i> function... 7
Get_Real_Group_Id subprogram... 16	<i>getpgid()</i> function... 9
Get_Real_User_Id subprogram... 16	<i>getpgrp()</i> function... 7
Get_Returned_Events subprogram... 121	<i>getpid()</i> function... 7
Get_Signal subprogram... 15	<i>getpmmsg()</i> function... 118
Get_Socket_Address_Info subprogram... 121, 122	<i>getppid()</i> function... 7
Get_Socket_Type subprogram... 121, 122	<i>getpriority()</i> function... 9
Get_Terminal_Characteristics subprogram... 11	<i>getprotobyname()</i> function... 7
Get_Terminal_Name subprogram... 11	<i>getprotoent()</i> function... 7
Get_Working_Directory subprogram... 13	<i>getpwent()</i> function... 9
<i>getaddrinfo()</i> function... 7	<i>getpwnam()</i> function... 8
<i>getc()</i> function... 6, 43	<i>getpwnam_r()</i> function... 8, 114
<i>getc_unlocked()</i> function... 7, 114	<i>getpwuid()</i> function... 8
<i>getchar()</i> function... 6, 43	<i>getpwuid_r()</i> function... 8, 114
<i>getchar_unlocked()</i> function... 7, 114	<i>getrlimit()</i> function... 9
<i>getcontext()</i> function... 9	<i>getrusage()</i> function... 9
<i>getcwd()</i> function... 7	<i>gets()</i> function... 6, 43
<i>getdate()</i> function... 9	<i>getservbyname()</i> function... 7
<i>getegid()</i> function... 9	<i>getservbyport()</i> function... 7
<i>getenv()</i> function... 8	<i>getservent()</i> function... 7
<i>geteuid()</i> function... 9	<i>getsid()</i> function... 9
<i>getgid()</i> function... 9	<i>getsockname()</i> function... 7
<i>getgrent()</i> function... 10	<i>getsockopt()</i> function... 7
	<i>getsubopt()</i> function... 9
	<i>gettimeofday()</i> function... 9
	<i>getuid()</i> function... 9
	<i>getutxent()</i> function... 10
	<i>getutxid()</i> function... 10
	<i>getutxline()</i> function... 10
	<i>getwc()</i> function... 9
	<i>getwchar()</i> function... 9
	<i>getwd()</i> function... 118

Copyright © 2004 IEEE. All rights reserved.

glob() function... 7
globfree() function... 7
gmtime() function... 6
gmtime_r() function... 6, 114
grantpt() function... 9
 Group constant... 44

H

h_errno() variable... 7
hcreate() function... 9
hdestroy() function... 9
 header
 <limits.h>... 34
 <unistd.h>... 34, 37, 38, 45, 46, 55,
 56, 63, 73, 74, 80, 81, 91, 92, 99
hsearch() function... 9
htonl() function... 7
htons() function... 7
hypot() function... 5
hypotf() function... 5
hypotl() function... 5

I

iconv() function... 9
iconv_close() function... 9
iconv_open() function... 9
if_freenameindex() function... 7
if_indexname() function... 7
if_nameindex() function... 7
if_nameindex() function... 7
Ignore_Signal subprogram... 15
ilogb() function... 5
ilogbf() function... 5
ilogbl() function... 5
 Image subprogram... 10, 42, 60, 78, 97
imaxabs() function... 6
imaxdiv() function... 6
 Implementation Conformance... 33
 implementation defined... 34, 35, 40, 58, 76,
 77, 95
 terminology... 25
In_Set subprogram... 12, 122
index() function... 118
 industry specific interface profile... 27
 industry specific profile... 27
inet_addr() function... 7
inet_ntoa() function... 7
inet_ntop() function... 7

inet_pton() function... 7
initstate() function... 9
 Input_Baud_Rate_Of subprogram... 11
 Input_Time_Of subprogram... 11
insque() function... 9
 Install_Empty_Handler subprogram...
 15
 interface profile... 27
 international standardized profile... 27, 32
 Internet Datagram option... 14
 Internet Protocol option... 14
 Internet Protocol Version 6 option... 88, 106
 Internet Stream option... 14
 Interrupt_Task subprogram... 15
ioctl() function... xiv, 118
 Is... 15
Is_A_Terminal subprogram... 11
Is_Accessible subprogram... 13
Is_Block_Special_File subprogram...
 13
Is_Character_Special_File
 subprogram... 13
Is_Directory subprogram... 13
Is_Environment_Variable
 subprogram... 16
Is_FIFO subprogram... 13
Is_File subprogram... 13
Is_File_Present subprogram... 13
Is_Ignored subprogram... 15
Is_Member subprogram... 15
Is_Open subprogram... 11
Is_Socket subprogram... 13
isalnum() function... 6
isalpha() function... 6
isascii() function... 9
isastream() function... 118
isatty() function... 7
isblank() function... 6
iscntrl() function... 6
isdigit() function... 6
isfinite() function... 5
isgraph() function... 6
isgreater() function... 5
isgreaterequal() function... 5
isinf() function... 5
isless() function... 5
islessequal() function... 5
islessgreater() function... 5
islower() function... 6
isnan() function... 5
isnormal() function... 5
 ISO/IEC Conformant Application... 35

Copyright © 2004 IEEE. All rights reserved.

ISP... 27, 32
isprint() function... 6
ispunct() function... 6
isspace() function... 6
isunordered() function... 5
isupper() function... 6
iswalnum() function... 6
iswalpha() function... 6
iswblank() function... 6
iswcntrl() function... 6
iswctype() function... 6
iswdigit() function... 6
iswgraph() function... 6
iswlower() function... 6
iswprint() function... 6
iswpunct() function... 6
iswspace() function... 6
iswupper() function... 6
iswxdigit() function... 6
isxdigit() function... 6

J

j0() function... 9
j1() function... 9
jn() function... 9
 Job Control option... 13
 jobs utility... 119
rand48() function... 9

K

kill() function... 8, 42, 43, 61, 79
killpg() function... 9

L

l64a() function... 9
labs() function... 6
lchown() function... 9
lcong48() function... 9
ldexp() function... 5
ldexpf() function... 5
ldexpl() function... 5
ldiv() function... 6
 Length subprogram... 16
 lex utility... 119
lfind() function... 9

lgamma() function... 5
lgammaf() function... 5
lgammal() function... 5
 limit

RTSIG_MAX... 40, 58, 76, 94

TIMER_MAX... 40, 58, 76, 94

Link subprogram... 13
link() function... xv, 7
lio_listio() function... 111
listen() function... 7
llabs() function... 6
lldiv() function... 6
llrint() function... 5
llrintf() function... 5
llrintl() function... 5
llround() function... 5
llroundf() function... 5
llroundl() function... 5
localeconv() function... 6
localtime() function... 6
localtime_r() function... 6, 114
 Lock_Shared_Memory subprogram... 122
lockf() function... 9
log() function... 5
log10() function... 5
log10f() function... 5
log10l() function... 5
loglp() function... 5
loglpf() function... 5
loglpl() function... 5
log2() function... 5
log2f() function... 5
log2l() function... 5
logb() function... 5
logbf() function... 5
logbl() function... 5
logf() function... 5
logl() function... 5
long type... 94
longjmp() function... 5
lrnd48() function... 9
lrint() function... 5
lrintf() function... 5
lrintl() function... 5
lround() function... 5
lroundf() function... 5
lroundl() function... 5
lsearch() function... 9
lseek() function... 7
lstat() function... 8

Copyright © 2004 IEEE. All rights reserved.

M

macro

S_IRWXU... 43, 61, 79

main() function... 47, 64

make utility... 119

Make_Empty subprogram... 12

makecontext() function... 9*malloc()* function... 6

Map_Memory subprogram... 120

may

terminology... 25

mblen() function... 6*mbrlen()* function... 6*mbtowc()* function... 6*mbstowcs()* function... 6*mbstowcs()* function... 6*mbtowc()* function... 6*memccpy()* function... 9*memchr()* function... 6*memcmp()* function... 6*memcpy()* function... 6*memmove()* function... 6

Memory Locking option... 20, 41, 59, 77, 96,

120

Memory Mapped Files option... 68

Memory Mapped Files option... 20, 59, 77, 96,

120, 122

Memory Protection option... 20, 77, 96, 120

Memory Range option... 122

Memory Range Locking option... 20, 41, 59,

77, 96, 120

memset() function... 6

mesg utility... 119

Message Queues option... 20, 59, 78, 96, 120

Minimal Realtime System Profile... 2, 37

Minimum_Input_Count_Of subprogram...

11

mkdir() function... xv, 7*mkfifo()* function... 7*mknod()* function... 9, 58, 77, 95*mkstemp()* function... 9*mktemp()* function... 118*mtime()* function... 6*lock()* function... 112*lockall()* function... 112*map()* function... 112, 113, 118

MMU... 32

modf() function... 5*modff()* function... 5*modfl()* function... 5

Monotonic Clock option... 51, 68, 86, 105

more utility... 119

mprotect() function... 112*mq_close()* function... 112*mq_getattr()* function... 112*mq_notify()* function... 112*mq_open()* function... 112*mq_receive()* function... 112*mq_send()* function... 112*mq_setattr()* function... 112*mq_timedreceive()* function... 112, 116*mq_timedsend()* function... 112, 116*mq_unlink()* function... 112*rand48()* function... 9*msgctl()* function... 9*msgget()* function... 9*msgrcv()* function... 9*msgsnd()* function... 9*sync()* function... 112, 113

Multi-Purpose Realtime System Profile... 3,

91

unlock() function... 112*unlockall()* function... 112*unmap()* function... 112, 113, 118

Mutex Priority Ceiling option... 21, 41, 59, 78,

96, 121

Mutex Priority Inherit option... 120

Mutex Priority Inheritance option... 21, 41,

59, 78, 96, 121

Mutexes option... 22, 41, 59, 78, 96, 120, 121

MutexPriority Ceiling option... 120

N*nan()* function... 5*nanf()* function... 5*nanl()* function... 5*nanosleep()* function... 116

National Body Conformant POSIX.13

Application... 35

nearbyint() function... 5*nearbyintf()* function... 5*nearbyintl()* function... 5

Network Management option... 121, 122

newgrp utility... 119

nextafter() function... 5*nextafterf()* function... 5*nextafterl()* function... 5*nexttoward()* function... 5*nexttowardf()* function... 5*nexttowardl()* function... 5

Copyright © 2004 IEEE. All rights reserved.

nftw() function... 9
nice utility... 119
nice() function... 9
nl_langinfo() function... 9
 nm utility... 119
 Normative References... 23
nrnd48() function... 9
ntohl() function... 7
ntohs() function... 7

O

off_t type... 94
 Open subprogram... 11, 44
 open system environment... 27, 32
open() function... xiv, 6, 40, 43, 47
 Open_Or_Create subprogram... 13
opendir() function... 7
openlog() function... 9
 Operation_Not_Implemented
 constant... 22, 96
 Operation_Not_Supported
 constant... 42, 60, 78, 97
optarg() variable... 8
opterr() variable... 8
optind() variable... 8
 option
 _POSIX_ADVISORY_INFO... 18, 20,
 48, 65, 83, 94
 _POSIX_AEP_REALTIME... 37, 55,
 73, 91
 _POSIX_AEP_REALTIME_CONTROL
 LER... 55
 _POSIX_AEP_REALTIME_DEDICAT
 ED... 73
 _POSIX_AEP_REALTIME_LANG_Ad
 a95... 38, 46, 56, 63, 74, 81, 92, 99
 _POSIX_AEP_REALTIME_LANG_C99
 ... 38, 45, 56, 63, 74, 80, 92, 99
 _POSIX_AEP_REALTIME_MINIMAL
 .. 37
 _POSIX_AEP_REALTIME_MULTI...
 91
 _POSIX_ASYNCHRONOUS_IO... 18,
 20, 75, 94, 118
 _POSIX_BARRIERS... 18, 20
 _POSIX_CHOWN_RESTRICTED... 18,
 20, 94
 _POSIX_CLOCK_SELECTION... 18,
 20, 39, 57, 75, 94
 _POSIX_CPUTIME... 18, 20, 75, 94
 _POSIX_FSYNC... 18, 20, 39, 57, 75, 94,
 118
 _POSIX_IPV6... 18, 20
 _POSIX_JOB_CONTROL... 10
 _POSIX_MAPPED_FILES... 18, 20, 48,
 57, 75, 94, 118
 _POSIX_MEMLOCK... 18, 20, 39, 46,
 57, 75, 94, 118
 _POSIX_MEMLOCK_RANGE... 18, 20,
 39, 57, 75, 94, 118
 _POSIX_MEMORY_PROTECTION...
 19, 20, 75, 94, 118
 _POSIX_MESSAGE_PASSING... 19,
 20, 57, 75, 94, 118
 _POSIX_MONOTONIC_CLOCK... 19,
 20, 39, 57, 75, 94
 _POSIX_NO_TRUNC... 19, 21, 22, 48
 _POSIX_PRIORITIZED_IO... 19, 21, 75,
 94, 118
 _POSIX_PRIORITY_SCHEDULING...
 19, 21, 76, 94, 118
 _POSIX_RAW_SOCKETS... 19, 21, 76,
 94
 _POSIX_READER_WRITER_LOCKS...
 10
 _POSIX_REALTIME_SIGNALS... 19,
 21, 39, 57, 76, 94, 118
 _POSIX_REGEX... 10
 _POSIX_SAVED_IDS... 19, 21, 94
 _POSIX_SEMAPHORES... 19, 21, 39,
 57, 76, 94, 118
 _POSIX_SHARED_MEMORY_OBJEC
 TS... 19, 21, 39, 57, 76, 94, 118
 _POSIX_SPAWN... 19, 21, 76, 94
 _POSIX_SPIN_LOCKS... 19, 21
 _POSIX_SPORADIC_SERVER... 19,
 21, 76, 94
 _POSIX_SYNCHRONIZED_IO... 19,
 21, 39, 57, 76, 94, 118
 _POSIX_THREAD_ATTR_STACKAD
 DR... 19, 21, 39, 57, 76, 94
 _POSIX_THREAD_ATTR_STACKSIZ
 E... 19, 21, 39, 57, 76, 94
 _POSIX_THREAD_CPUTIME... 19, 21,
 39, 57, 76, 94
 _POSIX_THREAD_PRIO_INHERIT...
 19, 21, 39, 57, 76, 94, 118
 _POSIX_THREAD_PRIO_PROTECT...
 19, 21, 39, 57, 76, 94, 118
 _POSIX_THREAD_PRIORITY_SCHE
 DULING... 19, 21, 39, 58, 76, 94,
 118

Copyright © 2004 IEEE. All rights reserved.

<u>_POSIX_THREAD_PROCESS_SHARE</u> D... 10	<u>_XOPEN_UNIX...</u> 20, 22
<u>_POSIX_THREAD_PROCESS_SHARE</u> D... 19, 21, 76, 94	Ada language... 18, 34, 40, 43, 59, 61, 71, 77, 79, 89, 95, 98, 108
<u>_POSIX_THREAD_SAFE_FUNCTION</u> S... 19, 21, 94	Advisory Information... 101
<u>_POSIX_THREAD_SPORADIC_SERV</u> ER... 19, 21, 39, 58, 76, 94	Asynchronous I/O... 20, 77, 96, 120
<u>_POSIX_THREAD_STACK_ADDRESS</u> ... 119	C Language... 98
<u>_POSIX_THREAD_STACK_SIZE...</u> 119	C language... 34, 38, 39, 40, 42, 56, 57, 58, 61, 71, 74, 75, 77, 79, 89, 92, 93, 95, 97, 108
<u>_POSIX_THREADS...</u> 10, 19, 21, 22, 52, 69, 87, 106	Change Owner Restriction... 20, 96, 120
<u>_POSIX_TIMEOUTS...</u> 10	CHILD_MAX... 43, 61
<u>_POSIX_TIMEOUTS...</u> 19, 21, 39, 58, 76, 94	C-Language... 18, 34
<u>_POSIX_TIMERS...</u> 19, 21, 39, 58, 76, 94, 118	C-language... 20
<u>_POSIX_TRACE...</u> 19, 21, 58, 76, 94	Clock Selection... 51, 68, 86, 105
<u>_POSIX_TRACE_EVENT_FILTER...</u> 19, 21, 58, 76, 94	File Locking... 48, 65, 101
<u>_POSIX_TRACE_INHERIT...</u> 19, 21	File Synchronization... 48, 65, 83
<u>_POSIX_TRACE_LOG...</u> 19, 21, 58, 76, 94	File Synchronization... 20, 41, 59, 77, 96, 120
<u>_POSIX_TYPED_MEMORY_OBJECT</u> S... 19, 21	Filename Truncation... 41, 59, 77, 96
<u>_POSIX_VDISABLE...</u> 19, 21, 22, 94	Filename Truncation... 21, 22, 41, 59, 78, 96, 120
<u>_POSIX_VERSION...</u> 43, 61, 79	Internet Datagram... 14
<u>_POSIX2_C_DEV...</u> 19, 21	Internet Protocol... 14
<u>_POSIX2_CHAR_TERM...</u> 19, 21	Internet Protocol Version 6... 88, 106
<u>_POSIX2_FORT_DEV...</u> 19, 21	Internet Stream... 14
<u>_POSIX2_FORT_RUN...</u> 19, 21	Job Control... 13
<u>_POSIX2_LOCALEDEF...</u> 19, 21	Memory Locking... 20, 41, 59, 77, 96, 120
<u>_POSIX2_PBS...</u> 19, 21	Memory Mapped Files... 68
<u>_POSIX2_PBS_ACCOUNTING...</u> 19, 21	Memory Mapped Files... 20, 59, 77, 96, 120, 122
<u>_POSIX2_PBS_CHECKPOINT...</u> 19, 21	Memory Protection... 20, 77, 96, 120
<u>_POSIX2_PBS_LOCATE...</u> 20, 21	Memory Range... 122
<u>_POSIX2_PBS_MESSAGE...</u> 20, 21	Memory Range Locking... 20, 41, 59, 77, 96, 120
<u>_POSIX2_PBS_TRACK...</u> 20, 21	Message Queues... 20, 59, 78, 96, 120
<u>_POSIX2_SW_DEV...</u> 20, 21	Monotonic Clock... 51, 68, 86, 105
<u>_POSIX2_UPE...</u> 20, 21	Mutex Priority Ceiling... 21, 41, 59, 78, 96, 121
<u>_XOPEN_CRYPT...</u> 20, 22, 53, 71, 89, 108	Mutex Priority Inherit... 120
<u>_XOPEN_ENH_I18N...</u> 20, 22	Mutex Priority Inheritance... 21, 41, 59, 78, 96, 121
<u>_XOPEN_LEGACY...</u> 20, 22, 53, 71, 89, 108	Mutexes... 22, 41, 59, 78, 96, 120, 121
<u>_XOPEN_REALTIME...</u> 20, 22	MutexPriority Ceiling... 120
<u>_XOPEN_REALTIME_THREADS...</u> 20, 22	Network Management... 121, 122
<u>_XOPEN_SHM...</u> 20, 22	Poll... 121
<u>_XOPEN_STREAMS...</u> 20, 22, 53, 71, 89, 108	POSIX2_C_DEV... 4, 45, 62, 80, 98, 99
	POSIX2_CHAR_TERM... 98
	POSIX2_FORT_RUN... 98
	POSIX2_SW_DEV... 4, 45, 46, 62, 63, 80, 81, 98, 99
	POSIX2_UPE... 98
	Prioritized I/O... 21, 78, 96, 121

Copyright © 2004 IEEE. All rights reserved.

- Priority Process Scheduling... 21, 78, 96, 121
 - Process Shared... 49, 66, 84, 102
 - Process Shared... 21, 78, 96, 120
 - Process Shared and Mutexes... 121
 - Raw Sockets... 88, 106
 - Realtime Signals... 21, 41, 59, 78, 96, 121
 - Required... 18
 - Saved IDs Support... 21, 96, 121
 - Select... 12
 - Select... 122
 - Semaphores... 21, 41, 59, 78, 96, 122
 - Server Scheduling... 67
 - Shared Memory... 120
 - Shared Memory Objects... 86
 - Shared Memory Objects... 21, 41, 59, 78, 96, 122
 - Sockets Detailed... 121
 - Sockets Detailed Network Interface... 14
 - Sockets Detailed Network Interface... 122
 - spawn... 64
 - Sporadic Server Scheduling... 49, 85, 103
 - Synchronized I/O... 21, 41, 59, 78, 96, 120, 122
 - Timeouts... 51, 69, 87, 105
 - Timers... 21, 41, 59, 78, 96, 122
 - Trace Event Filtering... 70, 87, 106
 - Trace Log... 70, 88, 106
 - XTI Detailed Network Interface... 122
 - optopt()* variable... 8
 - OSE... 27, 32
 - Other constant... 44
 - Output_Baud_Rate_Of subprogram... 11
 - Owner constant... 44
- P**
- package
 - Ada_Streams... 10
 - Ada_Task_Identification... 10
 - POSIX... 15
 - POSIX_Calendar... 15
 - POSIX_Condition_Variables... 120, 121
 - POSIX_Configurable_File_Limits... 13
 - POSIX_Configurable_System_Limits... 15
 - POSIX_Event_Management... 12, 121, 122
 - POSIX_File_Locking... 12
 - POSIX_File_Status... 13
 - POSIX_Files... 12, 13
 - POSIX_Generic_Shared_Memory... 122
 - POSIX_Group_Database... 16
 - POSIX_IO... 11, 12, 13, 14, 122
 - POSIX_Limits... 15, 34
 - POSIX_Memory_Mapping... 122
 - POSIX_Mutexes... 120, 121
 - POSIX_Options... 15, 37, 55, 73, 91
 - POSIX_Page_Alignment... 10
 - POSIX_Permissions... 12
 - POSIX_Process_Environment... 13, 16
 - POSIX_Process_Identification... 13, 14, 16
 - POSIX_Process_Primitives... 14
 - POSIX_Process_Scheduling... 121
 - POSIX_Process_Times... 14
 - POSIX_Profiles... 15, 16, 41, 60, 78, 97, 109
 - POSIX_Semaphores... 122
 - POSIX_Shared_Memory_Objects... 122
 - POSIX_Signals... 13, 15, 121
 - POSIX_Sockets... 14, 121, 122
 - POSIX_Sockets_Internet... 14
 - POSIX_Sockets_Local... 14
 - POSIX_Supplement_To_Ada_IO... 10
 - POSIX_Terminal_Functions... 11, 13
 - POSIX_Timers... 122
 - POSIX_Unsafe_Process_Primitive... 14, 77
 - POSIX_User_Database... 16
 - POSIX_XTI... 122
 - System... 10
 - System_Storage_Elements... 10
 - patch utility... 119
 - pathconf()* function... 7
 - pause()* function... 8
 - pclose()* function... 8
 - Pending_Signals subprogram... 15
 - perror()* function... 6, 43
 - pipe()* function... 7
 - platform
 - application... 26
 - development... 26
 - Poll option... 121
 - Poll subprogram... 121
 - poll()* function... 9

Copyright © 2004 IEEE. All rights reserved.

- popen()* function... 8
- POSIX package... 15
- POSIX.1, defined... 32
- POSIX.26, defined... 32
- POSIX.5c, defined... 32
- POSIX_ADA_LANG_SUPPORT Unit of
 - Functionality... 10, 17, 40, 59, 77, 95
- POSIX_C_LANG_JUMP Unit of
 - Functionality... 5, 17, 39, 57, 75, 93
- POSIX_C_LANG_MAT Unit of
 - Functionality... 57
- POSIX_C_LANG_MATH Unit of
 - Functionality... 5, 17, 53, 75, 93
- POSIX_C_LANG_SUPPOR Unit of
 - Functionality... 57
- POSIX_C_LANG_SUPPORT Unit of
 - Functionality... 6, 17, 39, 75, 93
- POSIX_C_LANG_WIDE_CHAR Unit of
 - Functionality... 6, 17, 53, 71, 89, 93
- POSIX_Calendar package... 15
- POSIX_Condition_Variables package... 120, 121
- POSIX_Configurable_File_Limits package... 13
- POSIX_Configurable_System_Limits package... 15
- POSIX_Configurable_System_Limits.
 - System_POSIX_Ada_Version subprogram... 43, 62, 79
- POSIX_Configurable_System_Limits.
 - System_POSIX_Version subprogram... 43, 61, 79
- posix_devctl()* function... xiv, 48, 65, 83, 101
- POSIX_DEVICE_IO Unit of
 - Functionality... 6, 11, 17, 39, 40, 57, 59, 75, 77, 93, 95
- POSIX_DEVICE_SPECIFIC Unit of
 - Functionality... 7, 11, 17, 93, 95
- POSIX_Error exception... 22, 42, 60, 78, 96, 97
- POSIX_Event_Management package... 12, 121, 122
- POSIX_EVENT_MGMT Unit of
 - Functionality... 7, 12, 17, 75, 77, 93, 95
- posix_fadvise()* function... 111
- posix_fallocate()* function... 111
- POSIX_FD_MGMT Unit of Functionality... 7, 12, 17, 48, 57, 59, 75, 77, 93, 95
- POSIX_FIFO Unit of Functionality... 7, 12, 17, 48, 65, 83, 93, 95
- POSIX_FILE_ATTRIBUTES Unit of
 - Functionality... 7, 12, 17, 48, 65, 83, 93, 95
- POSIX_File_Locking package... 12
- POSIX_FILE_LOCKING Unit of
 - Functionality... 7, 17, 39, 40, 57, 75, 93
- POSIX_File_Status package... 13
- POSIX_FILE_SYSTEM Unit of
 - Functionality... 7, 13, 17, 48, 57, 59, 75, 77, 93, 95
- POSIX_FILE_SYSTEM_EXT Unit of
 - Functionality... 7, 17, 48, 65, 83, 93
- POSIX_Files package... 12, 13
- POSIX_Generic_Shared_Memory package... 122
- POSIX_Group_Database package... 16
- POSIX_IO package... 11, 12, 13, 14, 122
- POSIX_IO.Generic_Read subprogram... 44
- POSIX_IO.Generic_Write subprogram... 44
- POSIX_IO.Open subprogram... 44
- POSIX_IO.Open_Or_Create subprogram... 44
- POSIX_IO.Read subprogram... 44
- POSIX_IO.Write subprogram... 44
- POSIX_JOB_CONTROL Unit of
 - Functionality... 7, 13, 17, 22, 93, 96
- POSIX_Limits package... 15, 34
- POSIX_Limits.Child_Processes_Max
 - axima'Last constant... 44, 62
- POSIX_Limits.Child_Processes_Maxi
 - ma'First type... 96
- POSIX_Limits.Groups_Maxima'Fir
 - st constant... 22
- POSIX_Limits.Groups_Maxima'Fir
 - st constant... 41, 60, 78
- POSIX_Limits.Groups_Maxima'First
 - type... 96
- POSIX_Limits.Realtime_Signals_Max
 - ima'First type... 41, 59, 78, 97
- POSIX_Limits.Timers_Maxima'First
 - type... 41, 59, 78, 97
- posix_madvise()* function... 111, 112, 113
- posix_mem_offset()* function... 118
- posix_memalign()* function... 111
- POSIX_Memory_Mapping package... 122
- POSIX_MULTI_PROCESS Unit of
 - Functionality... 7, 14, 17, 75, 77, 93, 96
- POSIX_Mutexes package... 120, 121
- POSIX_NETWORKING Unit of
 - Functionality... 7, 14, 17, 75, 77, 93, 96
- posix_openpt()* function... 9
- POSIX_Options package... 15, 37, 55, 73, 91
- POSIX_Page_Alignment package... 10

Copyright © 2004 IEEE. All rights reserved.

- POSIX_Permissions package... 12
- POSIX_PIPE Unit of Functionality... 7, 17, 75, 77, 93, 96
- POSIX_PIPES Unit of Functionality... 14
- POSIX_Process_Environment package... 13, 16
- POSIX_Process_Identification package... 13, 14, 16
- POSIX_Process_Primitives package... 14
- Posix_Process_Primitives.Start_Process subprogram... 79
- Posix_Process_Primitives.Start_Process_Search subprogram... 79
- POSIX_Process_Scheduling package... 121
- POSIX_Process_Times package... 14
- POSIX_Profiles package... 15, 16, 41, 60, 78, 97, 109
- POSIX_Profiles.type... 38, 45, 56, 63, 74, 80, 92, 99
- POSIX_Profiles.Realtime_AEP_Version constant... 38, 55, 73, 91
- POSIX_Profiles.Realtime_Controller type... 55
- POSIX_Profiles.Realtime_Dedicated type... 73
- POSIX_Profiles.Realtime_Lang_Ada95 type... 38, 46, 56, 63, 74, 81, 92, 99
- POSIX_Profiles.Realtime_Minimal type... 37
- POSIX_Profiles.Realtime_Multi type... 91
- POSIX_REGEX Unit of Functionality... 7, 17, 52, 70, 88, 93, 107
- POSIX_RW_LOCKS Unit of Functionality... 8, 10, 17
- POSIX_Semaphores package... 122
- POSIX_Shared_Memory_Objects package... 122
- POSIX_SHELL_FUNC Unit of Functionality... 8, 17, 52, 70, 88, 93, 107
- POSIX_SIGNAL_JUMP Unit of Functionality... 8, 17, 75, 93
- POSIX_Signals package... 13, 15, 121
- POSIX_SIGNALS Unit of Functionality... 8, 15, 17, 39, 40, 57, 59, 75, 77, 93, 96
- POSIX_Signals.Set_Stopped_Child_Signal subprogram... 22
- POSIX_Signals.Set_Stopped_Child_Signal subprogram... 41, 60, 78
- POSIX_Signals.Stopped_Child_Signal_Enabled subprogram... 22
- POSIX_Signals.Stopped_Child_Signal_Enabled subprogram... 41, 60, 78
- POSIX_SINGLE_PROCESS Unit of Functionality... 8, 15, 17, 39, 40, 57, 59, 75, 77, 93, 96
- POSIX_Sockets package... 14, 121, 122
- POSIX_Sockets_Internet package... 14
- POSIX_Sockets_Local package... 14
- posix_spawn()* function... 113
- posix_spawn_file_actions_addclose()* function... 113
- posix_spawn_file_actions_adddup2()* function... 113
- posix_spawn_file_actions_addopen()* function... 113
- posix_spawn_file_actions_destroy()* function... 113
- posix_spawn_file_actions_init()* function... 113
- posix_spawnattr_destroy()* function... 113
- posix_spawnattr_getflags()* function... 113
- posix_spawnattr_getpgroup()* function... 113
- posix_spawnattr_getschedparam()* function... 112, 113
- posix_spawnattr_getschedpolicy()* function... 112, 113
- posix_spawnattr_getsigdefault()* function... 113
- posix_spawnattr_getsigmask()* function... 113
- posix_spawnattr_init()* function... 113
- posix_spawnattr_setflags()* function... 113
- posix_spawnattr_setpgroup()* function... 113
- posix_spawnattr_setschedparam()* function... 112, 113
- posix_spawnattr_setschedpolicy()* function... 112, 113
- posix_spawnattr_setsigdefault()* function... 113
- posix_spawnattr_setsigmask()* function... 113
- posix_spawnnp()* function... 113
- POSIX_STRING_MATCHING Unit of Functionality... 8, 17, 93
- POSIX_Supplement_To_Ada_IO package... 10
- POSIX_SYMBOLIC_LINKS Unit of Functionality... 8, 17, 93
- POSIX_SYSTEM_DATABASE Unit of Functionality... 8, 16, 17, 93, 96
- POSIX_Terminal_Functions package...

Copyright © 2004 IEEE. All rights reserved.

- 11, 13
- POSIX_Terminal_Functions.Disable_Control_Character subprogram... 22
- POSIX_Terminal_Functions.Disable_Control_Character subprogram... 22, 96
- POSIX_THREADS_BASE Unit of Functionality... 8, 10, 17, 39, 52, 57, 69, 75, 87, 93, 106
- POSIX_Timers package... 122
- posix_trace_attr_destroy()* function... 117
- posix_trace_attr_getclockres()* function... 117
- posix_trace_attr_getcreatetime()* function... 117
- posix_trace_attr_getgenversion()* function... 117
- posix_trace_attr_getinherited()* function... 117
- posix_trace_attr_getlogfullpolicy()* function... 117
- posix_trace_attr_getlogsize()* function... 117
- posix_trace_attr_getmaxdatasize()* function... 117
- posix_trace_attr_getmaxsystemeventsize()* function... 117
- posix_trace_attr_getmaxusereventsize()* function... 117
- posix_trace_attr_getname()* function... 117
- posix_trace_attr_getstreamfullpolicy()* function... 117
- posix_trace_attr_getstreamsize()* function... 117
- posix_trace_attr_init()* function... 117
- posix_trace_attr_setinherited()* function... 117
- posix_trace_attr_setlogfullpolicy()* function... 117
- posix_trace_attr_setlogsize()* function... 117
- posix_trace_attr_setmaxdatasize()* function... 117
- posix_trace_attr_setname()* function... 117
- posix_trace_attr_setstreamfullpolicy()* function... 117
- posix_trace_attr_setstreamsize()* function... 117
- posix_trace_clear()* function... 117
- posix_trace_close()* function... 117
- posix_trace_create()* function... 117
- posix_trace_create_withlog()* function... 117
- posix_trace_event()* function... 117
- posix_trace_eventid_equal()* function... 117
- posix_trace_eventid_get_name()* function... 117
- posix_trace_eventid_open()* function... 117
- posix_trace_eventset_add()* function... 117
- posix_trace_eventset_del()* function... 117
- posix_trace_eventset_empty()* function... 117
- posix_trace_eventset_fill()* function... 117
- posix_trace_eventset_ismember()* function... 117
- posix_trace_eventtypelist_getnext_id()* function... 117
- posix_trace_eventtypelist_rewind()* function... 117
- posix_trace_flush()* function... 117
- posix_trace_get_attr()* function... 117
- posix_trace_get_filter()* function... 117
- posix_trace_get_status()* function... 117
- posix_trace_getnext_event()* function... 117
- posix_trace_open()* function... 117
- posix_trace_rewind()* function... 117
- posix_trace_set_filter()* function... 117
- posix_trace_shutdown()* function... 117
- posix_trace_start()* function... 117
- posix_trace_stop()* function... 117
- posix_trace_timedgetnext_event()* function... 116, 117
- posix_trace_trid_eventid_open()* function... 117
- posix_trace_trygetnext_event()* function... 117
- posix_typed_mem_get_info()* function... 118
- posix_typed_mem_open()* function... 118
- POSIX_Unsafe_Process_Primitives package... 14, 77
- Posix_Unsafe_Process_Primitives subprogram... 79
- POSIX_User_Database package... 16
- POSIX_USER_GROUPS Unit of Functionality... 9, 16, 17, 93, 96
- POSIX_WIDE_CHAR_IO Unit of Functionality... 9, 17, 93
- POSIX_XTI package... 122
- POSIX2_C_DEV option... 4, 45, 62, 80, 98, 99
- POSIX2_CHAR_TERM option... 98
- POSIX2_FORT_RUN option... 98
- POSIX2_SW_DEV option... 4, 45, 46, 62, 63, 80, 81, 98, 99
- POSIX2_UPE option... 98
- pow()* function... 5
- powf()* function... 5
- powl()* function... 5
- pread()* function... 9

Copyright © 2004 IEEE. All rights reserved.

- printf()* function... 6, 43
- Prioritized I/O option... 21, 78, 96, 121
- priority ceiling protocol... 49, 66, 84, 102
- priority inheritance protocol... 49, 66, 84, 102
- Priority Inversion... 27
- priority inversion... 49, 66, 84, 102
- Priority Process Scheduling option... 21, 78, 96, 121
- priority protection protocol
 - see priority ceiling protocol
- Process Shared and Mutexes option... 121
- Process Shared option... 49, 66, 84, 102
- Process Shared option... 21, 78, 96, 120
- profile
 - application environment... 26, 27
 - component... 26
 - for ISO standardization... 27
 - generic application environment... 27
 - generic interface... 27
 - industry specific interface... 27
 - interface... 27
 - international standardized... 27, 32
 - realtime environment... 27
 - system... 28
- profile, generic environment... 32
- protocol
 - priority ceiling... 49, 66, 84, 102
 - priority inheritance... 49, 66, 84, 102
- ps utility... 119
- PSE... 32
- PSE, defined... 32
- PSE51... 2, 37
- PSE51, defined... 32
- PSE52... 3, 55
- PSE52, defined... 32
- PSE53... 3, 73
- PSE53, defined... 32
- PSE54... 3, 91
- PSE54, defined... 32
- PSE5X, defined... 32
- pselect()* function... 7
- pthread_atfork()* function... 8, 115
- pthread_attr_destroy()* function... 8, 115
- pthread_attr_getdetachstate()* function... 8, 115
- pthread_attr_getguardsize()* function... 10
- pthread_attr_getinheritsched()* function... 114, 116
- pthread_attr_getschedparam()* function... 8, 115
- pthread_attr_getschedpolicy()* function... 114, 116
- pthread_attr_getscope()* function... 114, 116
- pthread_attr_getstack()* function... 10, 113, 114, 115
- pthread_attr_getstackaddr()* function... 113, 115
- pthread_attr_getstacksize()* function... 114, 115, 119
- pthread_attr_init()* function... 8, 115
- pthread_attr_setdetachstate()* function... 8, 115
- pthread_attr_setguardsize()* function... 10
- pthread_attr_setinheritsched()* function... 114, 116
- pthread_attr_setschedparam()* function... 8, 115
- pthread_attr_setschedpolicy()* function... 114, 116
- pthread_attr_setscope()* function... 114, 116
- pthread_attr_setstack()* function... 10, 113, 114, 115
- pthread_attr_setstackaddr()* function... 113, 115
- pthread_attr_setstacksize()* function... 114, 115, 119
- pthread_barrier_destroy()* function... 111, 115
- pthread_barrier_init()* function... 111, 115
- pthread_barrier_wait()* function... 111, 115
- pthread_barrierattr_destroy()* function... 111, 115
- pthread_barrierattr_getpshared()* function... 111, 114, 115
- pthread_barrierattr_init()* function... 111, 115
- pthread_barrierattr_setpshared()* function... 111, 114, 115
- pthread_cancel()* function... 8, 115
- pthread_cleanup_pop()* function... 8, 115
- pthread_cleanup_push()* function... 8, 115
- pthread_cond_broadcast()* function... 8, 115
- pthread_cond_destroy()* function... 8, 115
- pthread_cond_init()* function... 8, 115
- pthread_cond_signal()* function... 8, 115
- pthread_cond_timedwait()* function... 8, 115
- pthread_cond_wait()* function... 8, 115
- pthread_condattr_destroy()* function... 8, 115
- pthread_condattr_getclock()* function... 111, 115
- pthread_condattr_getpshared()* function... 114, 116
- pthread_condattr_init()* function... 8, 115
- pthread_condattr_setclock()* function... 111,

Copyright © 2004 IEEE. All rights reserved.

- 115
pthread_condattr_setpshared() function... 114, 116
pthread_create() function... 8, 115
pthread_detach() function... 8, 115
pthread_equal() function... 8, 115
pthread_exit() function... 8, 115
pthread_getconcurrency() function... 10
pthread_getcpuclockid() function... 114, 115
pthread_getschedparam() function... 114, 116
pthread_getspecific() function... 8, 115
pthread_join() function... 8, 115
pthread_key_create() function... 8, 115
pthread_key_delete() function... 8, 115
pthread_kill() function... 8, 115
pthread_mutex_destroy() function... 8, 115
pthread_mutex_getprioceiling() function... 114, 116
pthread_mutex_init() function... 8, 115
pthread_mutex_lock() function... 8, 115
pthread_mutex_setprioceiling() function... 114, 116
pthread_mutex_timedlock() function... 116
pthread_mutex_trylock() function... 8, 115
pthread_mutex_unlock() function... 8, 115
pthread_mutexattr_destroy() function... 8, 115
pthread_mutexattr_getprioceiling() function... 114, 116
pthread_mutexattr_getprotocol() function... 114, 116
pthread_mutexattr_getpshared() function... 114, 116
pthread_mutexattr_gettype() function... 10
pthread_mutexattr_init() function... 8, 115
pthread_mutexattr_setprioceiling() function... 114, 116
pthread_mutexattr_setprotocol() function... 114, 116
pthread_mutexattr_setpshared() function... 114, 116
pthread_mutexattr_settype() function... 10
pthread_once() function... 8, 115
pthread_rwlock_destroy() function... 8, 115
pthread_rwlock_init() function... 8, 115
pthread_rwlock_rdlock() function... 8, 115
pthread_rwlock_timedrdlock() function... 8, 116
pthread_rwlock_timedwrlock() function... 8, 116
pthread_rwlock_tryrdlock() function... 8, 115
pthread_rwlock_trywrlock() function... 8, 115
pthread_rwlock_unlock() function... 8, 115
pthread_rwlock_wrlock() function... 8, 115
pthread_rwlockattr_destroy() function... 8, 115
pthread_rwlockattr_getpshared() function... 8, 114, 116
pthread_rwlockattr_init() function... 8, 115
pthread_rwlockattr_setpshared() function... 8, 114, 116
PTHREAD_SCOPE_PROCESS constant... 76, 95
PTHREAD_SCOPE_SYSTEM constant... 76, 85, 95, 103
pthread_self() function... 8, 115
pthread_setcalcelstate() function... 8, 115
pthread_setcanceltype() function... 8, 115
pthread_setconcurrency() function... 10
pthread_setschedparam() function... 114, 116
pthread_setschedprio() function... 114, 116
pthread_setspecific() function... 8, 115
pthread_sigmask() function... 8, 115
pthread_spin_destroy() function... 113, 115
pthread_spin_init() function... 113, 115
pthread_spin_lock() function... 113, 115
pthread_spin_trylock() function... 113, 115
pthread_spin_unlock() function... 113, 115
pthread_testcancel() function... 8, 115
ptsname() function... 9
Put subprogram... 44
putc() function... 6, 43
putc_unlocked() function... 7, 114
putchar() function... 6, 43
putchar_unlocked() function... 7, 114
putenv() function... 9
putmsg() function... 118
putpmsg() function... 118
puts() function... 6, 43
pututxline() function... 10
putwc() function... 9
putwchar() function... 9
pwrite() function... 9
- ## Q
- qalter utility... 119
qdel utility... 119
qhold utility... 119
qmove utility... 119

Copyright © 2004 IEEE. All rights reserved.

qmsg utility... 119
 qrerun utility... 119
 qrls utility... 119
 qselect utility... 119
 qsig utility... 119
 qsort() function... 6
 qstat utility... 119
 qsub utility... 119
 Queue_Signal subprogram... 121

R

raise() function... 8, 42, 61
 rand() function... 6
 rand_r() function... 6, 114
 random() function... 9
 Raw Sockets option... 88, 106
 Read subprogram... 11, 44
 read() function... xiv, xv, 6, 43
 Read_Write_Execute constant... 44
 readdir() function... 7
 readdir_r() function... 7, 114
 readlink() function... 8
 readv() function... 9
 realloc() function... 6
 realpath() function... 9
 Realtime Controller System Profile... 3, 55
 realtime environment profile... 27
 Realtime Signals option... 21, 41, 59, 78, 96, 121
 Realtime System Profiles... 2
 Realtime_Lang_C99 type... 38, 45, 56, 63, 74, 80, 92, 99
 recv() function... 7
 recvfrom() function... 7
 recvmsg() function... 7
 regcomp() function... 7
 regerror() function... 7
 regexec() function... 7
 regfree() function... 7
 Related Open Systems Standards... 123
 remainder() function... 5
 remainderf() function... 5
 remainderl() function... 5
 Remove subprogram... 12, 122
 remove() function... 7
 Remove_Directory subprogram... 13
 remque() function... 9
 remquo() function... 5
 remquof() function... 5
 remquol() function... 5

Rename subprogram... 13
 rename() function... xv, 7
 renice utility... 119
 Required option... 18
 rewind() function... 7
 rewinddir() function... 7
 rindex() function... 118
 rint() function... 5
 rintf() function... 5
 rintl() function... 5
 rmdir() function... xv, 7
 round() function... 5
 roundf() function... 5
 roundl() function... 5
 RTSIG_MAX limit... 40, 58, 76, 94

S

S_IRWXU macro... 43, 61, 79
 Saved IDs Support option... 21, 96, 121
 scalb() function... 9
 scalbln() function... 5
 scalblnf() function... 5
 scalblnl() function... 5
 scalbn() function... 5
 scalbnf() function... 5
 scalbnl() function... 5
 scanf() function... 6, 43
 SCHED_FIFO constant... 40, 49, 50, 58, 67, 76, 85, 95, 103
 sched_get_priority_max() function... 112, 114, 116
 sched_get_priority_min() function... 112, 114, 116
 sched_getparam() function... 112
 sched_getscheduler() function... 112
 SCHED_RR constant... 40, 50, 58, 67, 76, 85, 95, 103
 sched_rr_get_interval() function... 112, 114, 116
 sched_setparam() function... 112
 sched_setscheduler() function... 112
 sched_yield() function... 112, 116
 seed48() function... 9
 Seek subprogram... 12
 seekdir() function... 9
 Select option... 12
 Select option... 122
 select() function... 7, 52, 70, 88, 107
 Select_File subprogram... 12, 122
 sem_close() function... 113

Copyright © 2004 IEEE. All rights reserved.

<i>sem_destroy()</i> function... 113	subprogram... 13
<i>sem_getvalue()</i> function... 113	Set_Terminal_Characteristics
<i>sem_init()</i> function... 113	subprogram... 11
<i>sem_open()</i> function... 113	Set_User_ID subprogram... 16
<i>sem_post()</i> function... 42, 61, 113	<i>setbuf()</i> function... 6
<i>sem_timedwait()</i> function... 113, 116	<i>setcontext()</i> function... 9
<i>sem_trywait()</i> function... 113	<i>setegid()</i> function... 9
<i>sem_unlink()</i> function... 113	<i>setenv()</i> function... 8
<i>sem_wait()</i> function... 113	<i>seteuid()</i> function... 9
Semaphores option... 21, 41, 59, 78, 96, 122	<i>setgid()</i> function... 9
<i>semctl()</i> function... 9	<i>setgrent()</i> function... 10
<i>semget()</i> function... 9	<i>sethostent()</i> function... 7
<i>semop()</i> function... 9	<i>setitimer()</i> function... 10
<i>send()</i> function... 7	<i>setjmp()</i> function... 5
Send_Break subprogram... 11	<i>setkey()</i> function... 118
Send_Signal subprogram... 15	<i>setlocale()</i> function... 6
<i>sendmsg()</i> function... 7	<i>setlogmask()</i> function... 9
<i>sendto()</i> function... 7	<i>setnetent()</i> function... 7
Server Scheduling option... 67	<i>setpgid()</i> function... 7
Set_Allowed_Process_Permissions	<i>setpgrp()</i> function... 9
subprogram... 12	<i>setpriority()</i> function... 9
Set_Blocked_Signals subprogram... 15	<i>setprotoent()</i> function... 7
Set_Buffer subprogram... 14	<i>setpwent()</i> function... 9
Set_Ceiling_Priority subprogram...	<i>setregid()</i> function... 10
120, 121	<i>setreuid()</i> function... 10
Set_Close_On_Exec subprogram... 12	<i>setrlimit()</i> function... 9
Set_Data subprogram... 15	<i>setservent()</i> function... 7
Set_Environment_Variable	<i>setsid()</i> function... 7
subprogram... 16	<i>setsockopt()</i> function... 7
Set_Events subprogram... 121	<i>setstate()</i> function... 9
Set_Family subprogram... 121, 122	<i>setuid()</i> function... 9
Set_File subprogram... 121	<i>setutxent()</i> function... 10
Set_File_Control subprogram... 12	<i>setvbuf()</i> function... 6
Set_File_Times subprogram... 13	shall
Set_Flags subprogram... 121, 122	terminology... 25
Set_Group_ID subprogram... 16	Shared Memory option... 120
Set_Locking_Policy subprogram... 120,	Shared Memory Objects option... 86
121	Shared Memory Objects option... 21, 41, 59,
Set_Notification subprogram... 15	78, 96, 122
Set_Process_Group_Id subprogram... 13	<i>shm_open()</i> function... 113
Set_Process_Shared subprogram... 120,	<i>shm_unlink()</i> function... 113
121	<i>shmat()</i> function... 9
Set_Protocol_Number subprogram... 121,	<i>shmctl()</i> function... 9
122	<i>shmdt()</i> function... 9
Set_Returned_Events subprogram... 121	<i>shmget()</i> function... 9
Set_Signal subprogram... 15	should
Set_Socket_Group_Owner subprogram...	terminology... 25
14	<i>shutdown()</i> function... 7
Set_Socket_Process_Owner	<i>sigaction()</i> function... 8, 42, 61
subprogram... 14	<i>sigaddset()</i> function... 8, 42, 61
Set_Socket_Type subprogram... 121, 122	<i>sigaltstack()</i> function... 9
Set_Stopped_Child_Signal	<i>sigdelset</i> function... 42

Copyright © 2004 IEEE. All rights reserved.

sigdelset() function... 8, 61
sigemptyset() function... 8, 42, 61
sigfillset() function... 8, 42, 61
sighold() function... 9
sigignore() function... 9
siginterrupt() function... 9
sigismember() function... 8, 42, 61
siglongjmp() function... 8
Signal type... 15
signal() function... 8, 42, 61
Signal_Event type... 15
Signal_Info type... 122
signbit() function... 5
siggam() variable... 9
sigpause() function... 9
sigpending() function... 8, 42, 61
sigprocmask() function... 8, 42, 61
sigqueue() function... 42, 61, 112
sigrelse() function... 9
sigset type... 9
sigset() function... 42, 61
sigsetjmp() function... 8
sigsuspend() function... 8
sigtimedwait() function... 112
sigwait() function... 8
sigwaitinfo() function... 112
sin() function... 5
sinf() function... 5
sinh() function... 5
sinhf() function... 5
sinhl() function... 5
sinl() function... 5
sleep() function... 7, 51, 68, 86, 105
snprintf() function... 6
socketmark() function... 7
socket() function... 7
socketpair() function... 7
Sockets Detailed option... 121
Sockets Detailed Network Interface option... 14
Sockets Detailed Network Interface option... 122
spawn option... 64
Special_Control_Character_Of subprogram... 11
split utility... 119
Sporadic Server Scheduling option... 49, 85, 103
sprintf() function... 6
sqrt() function... 5
sqrtf() function... 5
sqrtl() function... 5
srand() function... 6
srand48() function... 9
srandom() function... 9
sscanf() function... 6
standard
 base... 26
stat() function... 7
statvfs() function... 9
stderr() variable... 6
stdin() variable... 6
stdout() variable... 6
Stopped_Child_Signal_Enabled subprogram... 13
strcasecmp() function... 9
strcat() function... 6
strchr() function... 6
strcmp() function... 6
strcoll() function... 6
strcpy() function... 6
strcspn() function... 6
strdup() function... 9
strerror() function... 6
strerror_r() function... 6, 114
strfmon() function... 9
strftime() function... 6
Strictly Conforming Application... 35
strings utility... 119
strip utility... 119
strlen() function... 6
strncasecmp() function... 9
strncat() function... 6
strncmp() function... 6
strncpy() function... 6
strpbrk() function... 6
strptime() function... 9
strrchr() function... 6
strspn() function... 6
strstr() function... 6
strtod() function... 6
strtof() function... 6
strtoimax() function... 6
strtok() function... 6
strtok_r() function... 6, 114
strtol() function... 6
strtold() function... 6
strtoll() function... 6
strtoul() function... 6
strtoull() function... 6
strtoumax() function... 6
strxfrm() function... 6
Subprofiling Option Group... 28
subprogram

Copyright © 2004 IEEE. All rights reserved.

Accessibility... 13	Flow... 11
Add... 12, 122	For_Every_Current_Environment_
Add_All_Signals... 15	Variable... 16
Add_Signal... 15	For_Every_Directory_Entry... 13
Argument_List... 16	For_Every_Environment_Variable
Await_Signal... 15, 121	... 16
Await_Signal_Or_Timeout... 15, 121	For_Every_File_In... 12
Bits_Per_Character_Of... 11	For_Every_Item... 121, 122
Block_Signals... 15	Generic_Read... 11
Blocked_Signals... 15	Generic_Write... 11
Change_Owner_And_Group... 12	Get... 44
Change_Permissions... 12, 120	Get_Allowed_Process_Permission
Change_Protection... 120	s... 12
Change_Working_Directory... 13	Get_Buffer... 14
Clear_Environment... 16	Get_Canonical_Name... 121, 122
Close... 11	Get_Ceiling_Priority... 120, 121
Copy_Environment... 16	Get_Close_On_Exec... 12
Copy_From_Current_Environment...	Get_Controlling_Terminal_Name...
16	11
Copy_To_Current_Environment...	Get_Data... 15
16	Get_Effective_Group_ID... 16
Create... 45	Get_Effective_User_ID... 16
Create_Directory... 13	Get_Events... 121
Create_FIFO... 12	Get_Family... 121, 122
Create_Pipe... 14	Get_File... 121
Create_Process_Group... 13	Get_File_Control... 12
Create_Session... 16	Get_Flags... 121, 122
Define_Bits_Per_Character... 11	Get_Groups... 16
Define_Input_Baud_Rate... 11	Get_Locking_Policy... 120, 121
Define_Input_Time... 11	Get_Login_Name... 16
Define_Minimum_Input_Count... 11	Get_Notification... 15
Define_Output_Baud_Rate... 11	Get_Owner... 14
Define_Special_Control_Character...	Get_Parent_Process_Id... 14
er... 11	Get_Process_Group_ID... 16
Define_Terminal_Modes... 11	Get_Process_Group_Id... 13
Delete... 45	Get_Process_Id... 14
Delete_All_Signals... 15	Get_Process_Shared... 120, 121
Delete_Environment_Variable...	Get_Protocol_Number... 121, 122
16	Get_Real_Group_ID... 16
Delete_Signal... 15	Get_Real_User_ID... 16
Disable_Control_Character... 11	Get_Returned_Events... 121
Disable_Queueing... 121	Get_Signal... 15
Discard_Data... 11	Get_Socket_Address_Info... 121,
Drain... 11	122
Duplicate... 12	Get_Socket_Type... 121, 122
Duplicate_And_Close... 12	Get_Terminal_Characteristics...
Enable_Queueing... 121	11
Environment_Value_Of... 16	Get_Terminal_Name... 11
Existence... 13	Get_Working_Directory... 13
File_Position... 12	Ignore_Signal... 15
File_Size... 12	Image... 10, 42, 60, 78, 97
Filename_Of... 13	In_Set... 12, 122

Copyright © 2004 IEEE. All rights reserved.

Input_Baud_Rate_Of... 11	s... 79
Input_Time_Of... 11	Put... 44
Install_Empty_Handler... 15	Queue_Signal... 121
Interrupt_Task... 15	Read... 11, 44
Is_A_Terminal... 11	Remove... 12, 122
Is_Accessible... 13	Remove_Directory... 13
Is_Block_Special_File... 13	Rename... 13
Is_Character_Special_File... 13	Seek... 12
Is_Directory... 13	Select_File... 12, 122
Is_Environment_Variable... 16	Send_Break... 11
Is_FIFO... 13	Send_Signal... 15
Is_File... 13	Set_Allowed_Process_Permission
Is_File_Present... 13	s... 12
Is_Ignored... 15	Set_Blocked_Signals... 15
Is_Member... 15	Set_Buffer... 14
Is_Open... 11	Set_Ceiling_Priority... 120, 121
Is_Socket... 13	Set_Close_On_Exec... 12
Length... 16	Set_Data... 15
Link... 13	Set_Environment_Variable... 16
Lock_Shared_Memory... 122	Set_Events... 121
Make_Empty... 12	Set_Family... 121, 122
Map_Memory... 120	Set_File... 121
Minimum_Input_Count_Of... 11	Set_File_Control... 12
Open... 11, 44	Set_File_Times... 13
Open_Or_Create... 13	Set_Flags... 121, 122
Output_Baud_Rate_Of... 11	Set_Group_ID... 16
Pending_Signals... 15	Set_Locking_Policy... 120, 121
Poll... 121	Set_Notification... 15
POSIX_Configurable_System_Limits.System_POSIX_Ada_Version... 43, 62, 79	Set_Process_Group_Id... 13
POSIX_Configurable_System_Limits.System_POSIX_Version... 43, 61, 79	Set_Process_Shared... 120, 121
POSIX_IO.Generic_Read... 44	Set_Protocol_Number... 121, 122
POSIX_IO.Generic_Write... 44	Set_Returned_Events... 121
POSIX_IO.Open... 44	Set_Signal... 15
POSIX_IO.Open_Or_Create... 44	Set_Socket_Group_Owner... 14
POSIX_IO.Read... 44	Set_Socket_Process_Owner... 14
POSIX_IO.Write... 44	Set_Socket_Type... 121, 122
Posix_Process_Primitives.Start_Process... 79	Set_Stopped_Child_Signal... 13
Posix_Process_Primitives.Start_Process_Search... 79	Set_Terminal_Characteristics... 11
POSIX_Signals.Set_Stopped_Child_Signal... 22, 41, 60, 78	Set_User_ID... 16
POSIX_Signals.Stopped_Child_Signal_Enabled... 22, 41, 60, 78	Special_Control_Character_Of... 11
POSIX_Terminal_Functions.Disable_Control_Character... 22, 96	Stopped_Child_Signal_Enabled... 13
Posix_Unsafe_Process_Primitive	Synchronize_Data... 120, 122
	Synchronize_File... 120
	Synchronize_Memory... 120, 122
	Terminal_Modes_Of... 11
	Truncate_File... 120, 122
	Unblock_Signals... 15
	Unignore_Signal... 15
	Unlink... 13

Copyright © 2004 IEEE. All rights reserved.

- Unlock_Shared_Memory... 122
- Unmap_Memory... 120
- Value... 10, 42, 60, 78, 97
- Write... 11, 44
- Summary of Profile Features... 17
- swab*() function... 9
- swapcontext*() function... 9
- swprintf*() function... 6
- swscanf*() function... 6
- symlink*() function... 8
- sync*() function... 9
- Synchronize_Data subprogram... 120, 122
- Synchronize_File subprogram... 120
- Synchronize_Memory subprogram... 120, 122
- Synchronized I/O option... 21, 41, 59, 78, 96, 120, 122
- sysconf*() function... 8, 42, 43, 61, 79
- syslog*() function... 9
- system documentation... 28
- System package... 10
- system profile... 28
- system*() function... 8
- System_Storage_Elements package... 10
- T**
- tabs utility... 119
- talk utility... 119
- tan*() function... 5
- tanf*() function... 5
- tanh*() function... 5
- tanhf*() function... 5
- tanhf_l*() function... 5
- tanl*() function... 5
- tcdrain*() function... 7
- tcflow*() function... 7
- tcflush*() function... 7
- tcgetattr*() function... 7
- tcgetpgrp*() function... 7
- tcgetsid*() function... 9
- tcsendbreak*() function... 7
- tcsetattr*() function... 7
- tcsetpgrp*() function... 7
- tdelete*() function... 9
- telldir*() function... 9
- tempnam*() function... 9
- Terminal_Modes_Of subprogram... 11
- Terminology... 25
- tfind*() function... 9
- tgamma*() function... 5
- tgammaf*() function... 5
- tgammal*() function... 5
- time utility... 119
- time*() function... 6, 42, 61
- Timeouts option... 51, 69, 87, 105
- timer_create*() function... 116
- timer_delete*() function... 116
- timer_getoverrun*() function... 42, 61, 116
- timer_gettime*() function... 42, 61, 116
- TIMER_MAX limit... 40, 58, 76, 94
- timer_settime*() function... 42, 61, 116
- Timers option... 21, 41, 59, 78, 96, 122
- times*() function... 7, 42, 61
- timezone*() variable... 9
- tmpfile*() function... 7
- tmpnam*() function... 7
- toascii*() function... 9
- tolower*() function... 6
- toupper*() function... 6
- towctrans*() function... 6
- towlower*() function... 6
- towupper*() function... 6
- tput utility... 119
- Trace Event Filtering option... 70, 87, 106
- Trace Log option... 70, 88, 106
- True . . True constant... 37, 38, 41, 45, 46, 55, 56, 59, 63, 73, 74, 77, 80, 81, 91, 92, 96, 99, 109
- trunc*() function... 5
- truncate*() function... 9
- Truncate_File subprogram... 120, 122
- truncf*() function... 5
- truncl*() function... 5
- tsearch*() function... 9
- ttyname*() function... 7
- ttyname_r*() function... 7, 114
- twalk*() function... 9
- type
 - Boolean... 37, 38, 55, 56, 73, 74, 91, 92, 109
 - FILE *... 48, 65, 83, 101
 - long... 94
 - off_t... 94
 - POSIX_Limits.Child_Processes_Maxima'First... 96
 - POSIX_Limits.Groups_Maxima'First... 96
 - POSIX_Limits.Realtime_Signals_Maxima'First... 41, 59, 78, 97
 - POSIX_Limits.Timers_Maxima'First... 41, 59, 78, 97
 - POSIX_Profiles.... 38, 45, 56, 63, 74,

Copyright © 2004 IEEE. All rights reserved.

80, 92, 99
 POSIX_Profiles.Realtime_Controller... 55
 POSIX_Profiles.Realtime_Dedicated... 73
 POSIX_Profiles.Realtime_Lang_Ada95... 38, 46, 56, 63, 74, 81, 92, 99
 POSIX_Profiles.Realtime_Minimal... 37
 POSIX_Profiles.Realtime_Multi... 91
 Realtime_Lang_C99... 38, 45, 56, 63, 74, 80, 92, 99
 Signal... 15
 Signal_Event... 15
 Signal_Info... 122
 sigset... 9
 tzname() variable... 6
 tzset() function... 6

U

ualarm() function... 9
 ulimit() function... 9
 umask() function... 7
 unalias utility... 119
 uname() function... 8, 42, 61
 Unblock_Signals subprogram... 15
 Unbounded Priority Inversion... 28
 undefined... 34
 terminology... 26
 unexpand utility... 119
 ungetc() function... 6
 ungetwc() function... 9
 Unignore_Signal subprogram... 15
 Unit of Functionality... 28
 POSIX_ADA_LANG_SUPPORT... 10, 17, 40, 59, 77, 95
 POSIX_C_LANG_JUMP... 5, 17, 39, 57, 75, 93
 POSIX_C_LANG_MAT... 57
 POSIX_C_LANG_MATH... 5, 17, 53, 75, 93
 POSIX_C_LANG_SUPPORT... 57
 POSIX_C_LANG_SUPPORT... 6, 17, 39, 75, 93
 POSIX_C_LANG_WIDE_CHAR... 6, 17, 53, 71, 89, 93
 POSIX_DEVICE_IO... 6, 11, 17, 39, 40, 57, 59, 75, 77, 93, 95

POSIX_DEVICE_SPECIFIC... 7, 11, 17, 93, 95
 POSIX_EVENT_MGMT... 7, 12, 17, 75, 77, 93, 95
 POSIX_FD_MGMT... 7, 12, 17, 48, 57, 59, 75, 77, 93, 95
 POSIX_FIFO... 7, 12, 17, 48, 65, 83, 93, 95
 POSIX_FILE_ATTRIBUTES... 7, 12, 17, 48, 65, 83, 93, 95
 POSIX_FILE_LOCKING... 7, 17, 39, 40, 57, 75, 93
 POSIX_FILE_SYSTEM... 7, 13, 17, 48, 57, 59, 75, 77, 93, 95
 POSIX_FILE_SYSTEM_EXT... 7, 17, 48, 65, 83, 93
 POSIX_JOB_CONTROL... 7, 13, 17, 22, 93, 96
 POSIX_MULTI_PROCESS... 7, 14, 17, 75, 77, 93, 96
 POSIX_NETWORKING... 7, 14, 17, 75, 77, 93, 96
 POSIX_PIPE... 7, 17, 75, 77, 93, 96
 POSIX_PIPES... 14
 POSIX_REGEX... 7, 17, 52, 70, 88, 93, 107
 POSIX_RW_LOCKS... 8, 10, 17
 POSIX_SHELL_FUNC... 8, 17, 52, 70, 88, 93, 107
 POSIX_SIGNAL_JUMP... 8, 17, 75, 93
 POSIX_SIGNALS... 8, 15, 17, 39, 40, 57, 59, 75, 77, 93, 96
 POSIX_SINGLE_PROCESS... 8, 15, 17, 39, 40, 57, 59, 75, 77, 93, 96
 POSIX_STRING_MATCHING... 8, 17, 93
 POSIX_SYMBOLIC_LINKS... 8, 17, 93
 POSIX_SYSTEM_DATABASE... 8, 16, 17, 93, 96
 POSIX_THREADS_BASE... 8, 10, 17, 39, 52, 57, 69, 75, 87, 93, 106
 POSIX_USER_GROUPS... 9, 16, 17, 93, 96
 POSIX_WIDE_CHAR_IO... 9, 17, 93
 XSI_C_LANG_SUPPORT... 9, 18, 53, 70, 88, 107
 XSI_DBM... 9, 18, 53, 70, 88, 107
 XSI_DEVICE_IO... 9, 18, 53, 70, 88, 107
 XSI_DEVICE_SPECIFIC... 9, 18, 53, 70, 88, 107
 XSI_DYNAMIC_LINKING... 9, 18, 53, 70, 88, 93, 107

Copyright © 2004 IEEE. All rights reserved.

XSI_FD_MGMT... 9, 18, 53, 70, 88, 107	du... 119
XSI_FILE_SYSTEM... 9, 18, 53, 70, 88, 107	ex... 119
XSI_I18N... 9, 18, 53, 71, 89, 107	expand... 119
XSI_IPC... 9, 18, 53, 70, 88, 107, 118	fc... 119
XSI_JOB_CONTROL... 9, 18, 53, 70, 88, 107	fg... 119
XSI_JUMP... 9, 18, 53, 70, 88, 107	file... 119
XSI_MATH... 9, 18, 53, 70, 88, 107	fort77... 119
XSI_MULTI_PROCESS... 9, 18, 53, 70, 88, 107	fsck... xvi
XSI_SIGNALS... 9, 18, 53, 70, 88, 107	jobs... 119
XSI_SINGLE_PROCESS... 9, 18, 53, 70, 88, 107	lex... 119
XSI_SYSTEM_DATABASE... 9, 18, 53, 70, 88, 107	make... 119
XSI_SYSTEM_LOGGING... 9, 18, 53, 71, 89, 93, 107	mesg... 119
XSI_THREAD_MUTEX_EXT... 10, 18, 39, 53, 57, 71, 75, 89, 93, 107	more... 119
XSI_THREADS_EXT... 10, 18, 39, 53, 57, 71, 75, 89, 93, 107	newgrp... 119
XSI_TIMERS... 10, 18, 53, 70, 88, 107	nice... 119
XSI_USER_GROUPS... 10, 18, 53, 70, 88, 107	nm... 119
XSI_WIDE_CHAR... 10, 18, 53, 70, 88, 107	patch... 119
Units of Functionality... 4	ps... 119
Unlink subprogram... 13	qalter... 119
<i>unlink()</i> function... xv, 7	qdel... 119
Unlock_Shared_Memory subprogram... 122	qhold... 119
<i>unlockpt()</i> function... 9	qmove... 119
Unmap_Memory subprogram... 120	qmsg... 119
<i>unsetenv()</i> function... 8	qrerun... 119
unspecified... 34, 35	qrls... 119
terminology... 26	qselect... 119
Use_Error exception... 44, 62, 80	qsig... 119
<i>usleep()</i> function... 9	qstat... 119
utility	qsub... 119
alias... 119	renice... 119
ar... 119	split... 119
asa... 119	strings... 119
at... 119	strip... 119
batch... 119	tabs... 119
bg... 119	talk... 119
c99... 119	time... 119
command... 119	tput... 119
crontab... 119	unalias... 119
csplit... 119	unexpand... 119
ctags... 119	uudecode... 119
df... 119	uuencode... 119
	vi... 119
	who... 119
	write... 119
	yacc... 119
	<i>utime()</i> function... 7
	<i>utimes()</i> function... 118
	uudecode utility... 119
	uuencode utility... 119

Copyright © 2004 IEEE. All rights reserved.

V

va_arg() function... 6
va_copy() function... 6
va_end() function... 6
va_start() function... 6
 Value subprogram... 10, 42, 60, 78, 97
 variable
 daylight()... 9
 environ()... 8
 errno()... 8
 h_errno()... 7
 optarg()... 8
 opterr()... 8
 optind()... 8
 optopt()... 8
 siggam()... 9
 stderr()... 6
 stdin()... 6
 stdout()... 6
 timezone()... 9
 tzname()... 6
vfork() function... 9
vfprintf() function... 6, 43
vfscanf() function... 6, 43
vfwprintf() function... 9
vfwscanf() function... 9
vi utility... 119
vprintf() function... 6, 43
vscanf() function... 6, 43
vsnprintf() function... 6
vsprintf() function... 6
vsscanf() function... 6
vswprintf() function... 6
vswscanf() function... 6
vwprintf() function... 9
vwsscanf() function... 9

W

wait() function... 7
waitid() function... 9
waitpid() function... 7
wertomb() function... 6
wscat() function... 6
wcschr() function... 6
wscmp() function... 6
wscoll() function... 6
wscpy() function... 6
wscspn() function... 6
wcsftime() function... 6

wcslen() function... 6
wcsncat() function... 6
wcsncmp() function... 6
wcsncpy() function... 6
wcsprk() function... 6
wcsrchr() function... 6
wcsrtombs() function... 6
wcsspn() function... 6
wcsstr() function... 6
westod() function... 6
westof() function... 6
westoimax() function... 6
westok() function... 6
westol() function... 6
westold() function... 6
westoll() function... 6
westombs() function... 6
westoul() function... 6
westoull() function... 6
westoumax() function... 6
wswcs() function... 118
wswidth() function... 10
wcsxfrm() function... 6
wctob() function... 6
wctomb() function... 6
wctrans() function... 6
wctype() function... 6
wcwidth() function... 10
who utility... 119
wmemchr() function... 6
wmemcmp() function... 6
wmemcpy() function... 6
wmemmove() function... 6
wmemset() function... 6
wordexp() function... 8
wordfree() function... 8
wprintf() function... 9
 Write subprogram... 11, 44
write utility... 119
write() function... xiv, xv, 6, 43
writew() function... 9
wscanf() function... 9

X

XSI_C_LANG_SUPPORT Unit of
 Functionality... 9, 18, 53, 70, 88, 107
 XSI_DBM Unit of Functionality... 9, 18, 53,
 70, 88, 107
 XSI_DEVICE_IO Unit of Functionality... 9,
 18, 53, 70, 88, 107

Copyright © 2004 IEEE. All rights reserved.

XSI_DEVICE_SPECIFIC Unit of	Functionality... 9, 18, 53, 70, 88, 107
XSI_DYNAMIC_LINKING Unit of	Functionality... 9, 18, 53, 70, 88, 93, 107
XSI_FD_MGMT Unit of	Functionality... 9, 18, 53, 70, 88, 107
XSI_FILE_SYSTEM Unit of	Functionality... 9, 18, 53, 70, 88, 107
XSI_I18N Unit of	Functionality... 9, 18, 53, 71, 89, 107
XSI_IPC Unit of	Functionality... 9, 18, 53, 70, 88, 107, 118
XSI_JOB_CONTROL Unit of	Functionality... 9, 18, 53, 70, 88, 107
XSI_JUMP Unit of	Functionality... 9, 18, 53, 70, 88, 107
XSI_MATH Unit of	Functionality... 9, 18, 53, 70, 88, 107
XSI_MULTI_PROCESS Unit of	Functionality... 9, 18, 53, 70, 88, 107
XSI_SIGNALS Unit of	Functionality... 9, 18, 53, 70, 88, 107
XSI_SINGLE_PROCESS Unit of	Functionality... 9, 18, 53, 70, 88, 107
XSI_SYSTEM_DATABASE Unit of	Functionality... 9, 18, 53, 70, 88, 107
	XSI_THREADS_EXT Unit of
	Functionality... 10, 18, 39, 53, 57, 71, 75, 89, 93, 107
	XSI_TIMERS Unit of
	Functionality... 10, 18, 53, 70, 88, 107
	XSI_USER_GROUPS Unit of
	Functionality... 10, 18, 53, 70, 88, 107
	XSI_WIDE_CHAR Unit of
	Functionality... 10, 18, 53, 70, 88, 107
	XTI Detailed Network Interface option...
	122
Y	
	<i>y0()</i> function... 9
	<i>y1()</i> function... 9
	yacc utility... 119
	<i>yn()</i> function... 9

Copyright © 2004 IEEE. All rights reserved.