Ada/POSIX Binding
A Focused Ada Investigation

Sue LeGrand
SofTech, Inc.

October 17, 1988

Cooperative Agreement NCC 9-16
Research Activity SE.17

NASA Headquarters
NASA Space Station Program Office

Research Institute for Computing and Information Systems
University of Houston - Clear Lake

T·E·C·H·N·I·C·A·L R·E·P·O·R·T

The RICIS Concept

The University of Houston-Clear Lake established the Research Institute for Computing and Information systems in 1986 to encourage NASA Johnson Space Center and local industry to actively support research in the computing and information sciences. As part of this endeavor, UH-Clear Lake proposed a partnership with JSC to jointly define and manage an integrated program of research in advanced data processing technology needed for JSC's main missions, including administrative, engineering and science responsibilities. JSC agreed and entered into a three-year cooperative agreement with UH-Clear Lake beginning in May, 1986, to jointly plan and execute such research through RICIS. Additionally, under Cooperative Agreement NCC 9-16, computing and educational facilities are shared by the two institutions to conduct the research.

The mission of RICIS is to conduct, coordinate and disseminate research on computing and information systems among researchers, sponsors and users from UH-Clear Lake, NASA/JSC, and other research organizations. Within UH-Clear Lake, the mission is being implemented through interdisciplinary involvement of faculty and students from each of the four schools: Business, Education, Human Sciences and Humanities, and Natural and Applied Sciences.

Other research organizations are involved via the "gateway" concept. UH-Clear Lake establishes relationships with other universities and research organizations, having common research interests, to provide additional sources of expertise to conduct needed research.

A major role of RICIS is to find the best match of sponsors, researchers and research objectives to advance knowledge in the computing and information sciences. Working jointly with NASA/JSC, RICIS advises on research needs, recommends principals for conducting the research, provides technical and administrative support to coordinate the research, and integrates technical results into the cooperative goals of UH-Clear Lake and NASA/JSC.

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Preface

This research was conducted under the auspices of the Research Institute for Computing and Information Systems by Sue Legrand for SofTech, Inc. Charles McKay, Director of SERC, served as RICIS technical representative for this activity.

Funding has been provided by Space Station Program Office, NASA/JSC through Cooperative Agreement NCC 9-16 between NASA Johnson Space Center and the University of Houston-Clear Lake. The NASA technical monitor for this activity was Robert MacDonald, Assistant to the Director, Research, Education, and University Programs, Mission Support Directorate, NASA/JSC.

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RICIS Report, Contract SE.17

Prepared for

NASA Space Station Program Office
NASA Headquarters

Prepared by

Sue LeGrand
SofTech, Inc.
1300 Hercules Drive, Suite 105
Houston, TX 77058-2747

Ada/POSIX Binding

Preface

NASA is seeking an Operating System Interface Definition (OSID) for the Space Station Program (SSP) in order to take advantage of the commercial off-the-shelf (COTS) products available today and the many that are expected in the future. NASA would also like to avoid the reliance on any one source for operating system, information system, communication system or instruction set architecture. One possible solution is to use the Portable Operating System Interface for Computer Environments (POSIX). Since Ada is already the language of choice for SSP, the question of an Ada/POSIX binding is an appropriate one.

Background

The National Institute of Standards and Technology (NIST, Formerly National Bureau of Standards) has adopted an interim Federal Information Processing Standard (FIPS) for POSIX, based on the IEEE Draft 12 of the standard. The final standard will be similar to the IEEE POSIX standard, based on Draft 13, which was recently approved by the IEEE P1003.1 Review Committee as a full-use standard.

There is an International Standards (ISO) Working Group (WG) 15 whose charter is to make POSIX an international standard. They will use the IEEE standard as a draft. Their next work item is to define a standard binding between Ada and POSIX. They will use the work done by the IEEE WG P1003.5 as a draft for the Ada/POSIX binding standard.

Overview

According to Stowe Boyd, Co-chairman of the IEEE P1003.5 Working Group, the intent of the binding is to provide access to the POSIX standard operating system (OS) interface and environment, by which application portability of Ada applications will be supported at the source code level. A guiding principle of Ada/POSIX binding development is a clear conformance of the Ada interface with the functional definition of POSIX. The interface is intended to be used by both application developers and system implementors. The objective is to provide a standard that allows a strictly conforming application source program that can be compiled to execute on any conforming implementation. Special emphasis is placed on first providing those functions and facilities that are needed in a wide variety of commercial applications.

The following areas are outside of the scope of the P1003.5 standard:

User interface (shell) and associated commands
Network protocols
Graphics and windowing interfaces
Database management system interfaces
Object or binary code portability

Dr. Charles McKay, Director of the Software Engineering Research Center, University of Houston - Clear Lake, has proposed the following criteria for using an Ada/POSIX binding in the NASA OSID:

1. The OSID should be baselined as a catalog of interface features and options which would include more than the issues addressed by the present POSIX standard. Each NASA location would use those portions of the binding which are appropriate to the work being done, and extend or replace those portions as they are appropriate.

2. The OSID will reflect Ada packages which are loosely coupled and tightly cohesive. That is, the logically related units will have a minimum interdependence upon one another and will be closely related in their internal functionality for providing services and resources.

3. An appropriate Ada/POSIX binding will provide an abstract interface specification which hides all implementation details beneath the interface from all compilation units of the application software and major application support sub-systems.

4. The OSID would include an abstract interface specification which would enable the construction of a validation test suite to insure conformance to all features and options in the catalogue mentioned in item 1.

Format for Standard

The format of the P1003.5 Ada/POSIX Binding document is to be patterned after the P1103.1 POSIX Standard document. The list of chapters are as follows:

1. Scope
2. Definitions & General Requirements
3. Process Primitives
4. Process Environments
5. Files & Directories
6. Input & Output Primitives
7. Device & Class-Specific Functions
8. Ada Language Library
9. System Databases
10. Data Interchange Format

Each chapter will be outlined approximately as follows:

```
Chapter X
X.1  Introduction
X.2  Package Specifications
<for each package>
  X.3  Description of <package name>
  X.3.1  Overview of package <package name>
  <for each group of operations in the package>
    X.3.2  <group of operations>
    X.3.2.1  Synopsis
    X.3.2.2  Description
    X.3.2.3  Error Handling
    X.3.2.4  References
X.5  Implementation Extensions and Dependencies
X.6  Rationale
X.6.1  Requirements from P1003.1
X.6.2  Rationale for the Current Design
X.6.3  Alternate Designs
X.6.4  Implementors Guide
X.6.5  Users Guide
```

Plan for Creating P1003.5

The standard is being written in an iterative fashion, beginning with the more straight-forward parts. The later, more complex iterations will cover the following sections:

Section 2.6	Principal System Types
Section 3.3	Signals
Section 3.4	Timer
Section 6.5	File Control Operations
Section 7.1,2	General Terminal Interface

Milestones are based on the 3 or 4 meetings held each year. The following milestones and dates are currently identified:

July 88	First Working Draft (easy/early parts)
September 88	Second Working Draft (easy/early parts)
February 89	First Working Draft (hard/later parts)

The following milestones are still to be scheduled:

First Draft for Sponsor Ballot
Sponsor Ballot Initiated
Sponsor Ballot responses received
Comments resolved
Submit to IEEE Standards Board

Stowe Boyd, Co-Chairman of the IEEE Ada/POSIX Working Group, stated that they hoped to have the binding resolved by the end of 1989. He cautioned, however, that much depended on the time required for IEEE balloting and resolution of balloting issues. Interested parties should contact him in order to participate in the balloting.

Issues

The following issues were identified and reviewed by the researchers listed in the annotated directory:

1. General Issues

a. How can interoperability of resources be maximized?
b. How will processes be managed?
c. How can distributed systems be supported?
d. How can security and access control of resources be assured?
e. Can a fault tolerant system be built with Ada on POSIX?
f. Can a POSIX operating system (OS) coexist in an environment with another necessary OS? How would the following be handled?

    Efficiency
    Real Time Execution
    Redundant services (paradigms)
    Missing services

2. Binding Issues

a. Should the C language or Ada naming conventions be used to name functions, procedures and exceptions?
b. Should a C function be broken into many Ada entities?
c. Can an Ada entity subsume many C functions?
d. Can Ada packages be structured on POSIX with loose coupling and tight cohesion?
e. How much should Ada generics be used?
f. Can POSIX support Ada type structure?
g. Are object handles appropriate for object identification?
h. How will site specific constants be handled?
i. What standard packages may need to be extended?

3. Data Base Issues:

a. How should file permissions be represented and handled?
b. How should file status be represented and handled?
c. How should file descriptors be typed?
d. How should group lists be handled?
e. How should a current directory be accessed?

4. Tools

a. What is required in order to put COTS UNIX Ada tools on a POSIX OS?
b. What is required in order to put COTS non-UNIX Ada tools on POSIX?
c. How can existing Ada compilers be cost effectively revalidated for use on a POSIX OS?
d. Can device drivers be provided in Ada on POSIX?

5. Run Time Issues

a. How should an Ada run time system be implemented on POSIX?
b. How should dynamic contexts (e.g. Ada tasks) be implemented?
c. What program level concepts need to be considered?
d. How should the blocking of Ada tasks be handled?
e. How should Ada processes be managed?
f. How should shared resources be controlled?
g. How should interrupts and errors be handled?

Issues Being Studied by Each Group

The following table compares the researchers with the previous list of issues.

Table 1

Group / / Issues	1 General a	b	c	d	e	f	2 Binding a	b	c	d	e	f	g	h	i	3 DB a	b	c	d	e	4 Tools a	b	c	d	5 Run Time a	b	c	d	e	f	g
Adaware S Wong	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																
Alsys Corp. M Gart	X	X	X	X	X	X																									
Draper Labs R Racine	X	X	X	X	X	X																				X	X	X	X	X	X
Draper Labs B Brown	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																
Honeywell B Damania	X	X	X	X	X	X										X	X	X	X	X											
IBM J Moore	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X											X	X	X	X	X	X
Mark V Systems H Fischer	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X						
Meridian S Boyd	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X						X	X	X	X	X	X	X	X	X	X	X
MITRE D Emery	X	X	X	X	X	X										X	X	X	X	X											
SERC P Rogers	X	X	X	X	X	X															X	X	X	X	X	X	X	X	X	X	X
SofTech, Inc. C Coflin	X	X	X	X	X	X										X	X	X	X	X						X	X	X	X	X	X
Un. Lowell, MA A Anya	X	X	X	X	X	X																									
Verdix S Deller	X	X	X	X	X	X																									

Annotated Directory of Researchers

The following activities have been identified that are of interest to those concerned with the issues of an Ada/POSIX binding:

Adaware - Investigating use of IBM-PC compatibles on a network as Ada development stations supporting embedded targets.

Comment: Application developers need clean system calls.

Contact: S. Y. Wong
Adaware
5200 Topeka Dr.
Tarzana, CA 91356
(818) 345-6274

Alsys Corp. - Active in IEEE Ada/POSIX Standard Working Group

Contact: Mitch Gart
Alsys Corp.
1432 Main St.
Waltham, MA 02154
(617) 890-0030

Draper Labs - Studying the applicability of System V Interface Definition (SVID) for use as the Operating System Interface Definition (OSID) for the Space Station Data Management System (DMS).

Document: [11]

Contact: Roger Racine
Charles Stark Draper Laboratory, Inc.
555 Technology Square
Cambridge, MA 02139
(617) 258-2489

Draper Labs - Active on the IEEE Ada/POSIX Working Group

Contact: Bob Brown
Charles Stark Draper Laboratory, Inc.
555 Technology Square
Cambridge, MA 02139
(617)0 258-2489

Honeywell - Active on the IEEE Ada/POSIX Working Group

Contact: Bhavesh Damania
MN65-2100
Honeywell, Inc.
Systems and Research Center
3660 Technology Dr.
Minneapolis, Minnesota 55418
(612) 782-7324

IBM - Active on IEEE Ada/POSIX Working Group

Document: [7]

Contact: Jim Moore
IBM Federal Systems Div.
1755 Jefferson Davis Hwy.
Suite 600
Arlington, VA 22202
(703) 769-2233

Mark V Systems - Designed an Ada interface for the UNIX-based Portable Common Tool Environment (PCTE)

Documents: [1], [2], [8]

Contact: Herm Fischer
Mark V Systems
16400 Ventura Blvd. #201
Encino, CA 91436
(818) 995-4671

Meridian - Developing a Ada/POSIX implementation on Sun workstations, due second quarter, 1989.
- Co-Chairing IEEE Ada/POSIX Working Group.

Contact: Stowe Boyd
Meridian Software Systems, Inc.
23141 Verdugo Dr.
Suite 105
Laguna Hills, CA 92653
(714) 380-9800

MITRE - Active on IEEE Ada/POSIX Working Group.

Contact: David Emery
MITRE Corp.
MSA 156
Bedford, MA 01730
(617) 271-2915

Software Engineering Research Center (SERC) - Investigating the use of POSIX for SSPO applications.

Comment: When organizing the parts of the standard, common types should be put into their own package and imported via context clauses to the necessary dependent units.

Documents: [9], [12]

Contact: Patrick Rogers
SERC
University of Houston - Clear Lake
Box 447
2700 Bay Area Blvd.
Houston, TX 77058
(713) 488-9490

SofTech, Inc. - Designed an Ada environment for a UNIX-based OS for Nippon Telephone & Telegraph, Japan.

- Wrote Revision A of the Common APSE Interface Set (CAIS-A)

Comment: After careful study, this group found that UNIX is unsuitable if proper behavior of Ada tasks is required.

Contact: Rich Thall
SofTech, Inc.
460 Totten Pond Rd.
Waltham, Mass. 02254-9197
(617) 890-6900

University of Lowell, MA - Developing the requirements specifications for an Ada/POSIX binding on a bare VAX.

Contact: Dr. Arun Anya
Computer Science Dept.
Lowell, MA 01854
(617) 452-5000 X2668

Verdix - Active on the IEEE Ada/POSIX Working Group

Contact: S Deller
Verdix Corp.
14130-A Sullyfield Circle
Chantilly, VA 22021
(703) 378-7600

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[1] Fischer, Herman, "Comparing Proposals for CAIS-A and PCTE Ada I/F," Software Engineering Environments Conference, University of Keele, England, April, 10, 1987.

[2] Fischer, Herman, "Developments in PCTE Ada Interfaces," Software Engineering Environments Conference, University of Keele, England, April, 10, 1987.

[3] Head, Steve, "Thoughts on a Network Interface Extension for POSIX," Hewlett-Packard Company, Revised July 27, 1988.

[4] IEEE, "Portable Operating System Interface for Computer Environments," P1003.1/Draft 12, Technical Committee on Operating Systems of the IEEE Computer Society, October 12, 1987.

[5] IEEE, "Real Time Extension for Portable Operating Systems," P1003.4/Draft 4, August 5, 1988.

[6] IEEE, "Standard for Test Methods for Measuring Conformance to POSIX," P1003.3/Draft 7.0, August 2, 1988.

[7] Locke, C. Douglass, "Real-Time Ada in POSIX," IBM Systems Integration Division, September 6, 1988.

[8] Mark V Business Systems, "PCTE Ada Conceptual Design", Version 2, 1987.

[9] McKay, Charles W., "A 2 A.M. Position Paper on the Use of the Current Version of POSIX for the Target Environment of the Space Station Program," University of Houston-Clear Lake, Software Engineering Research Center, High Technologies Laboratory, 4 March 1988.

[10] Mills, Kevin L., "Portable Networking," National Bureau of Standards, Gaithersburg, MD.

[11] Racine, Roger, "SVID as the OSID for the Space Station," The Charles Stark Draper Laboratory, Inc., May 2, 1988.

[12] Rogers, Pat, "Issues Concerning the Creation of an OSID," SERC, HTL, University of Houston-Clear Lake.

[13] Rose, Marshall T., Baker, Timothy C., Eisler, Michael, R., "Proposal for a Uniform Networked Interface for POSIX-compliant Operating Systems," June 7, 1988.

[14] Shiderly, Roy, "Overview of Software Portability and the POSIX Standard-Draft," Digital Equipment Corporation and National Bureau of Standards.