JOHNSON GRANT
IN-61-CR
312533

(NASA-CR-187389) AdaNET RESEARCH PROJECT Final Report (MountainNet) 183 p CSCL 09B

N91-13092

Unclas
G3/61 0312533

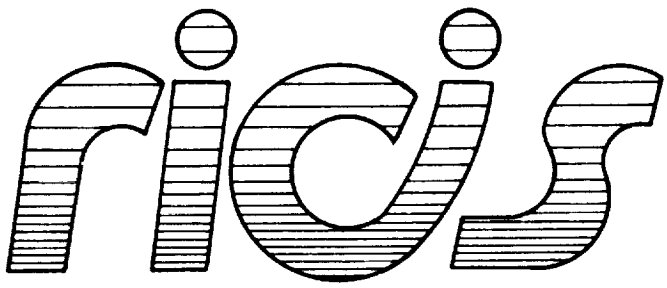
AdaNET Research Project

R. Michael Digman

MountainNet, Inc.

August 1988

Cooperative Agreement NCC 9-16
Research Activity No. SE.18



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.

AdaNET
Research Project

Preface

This research was conducted under the auspices of the Research Institute for Computing and Information Systems at the University of Houston-Clear Lake, by R. Michael Digman, President and AdaNET Project Director, MountainNet, Inc., under the direction of Peter Bishop, RICIS /AdaNET Project Manager.

Funding has been provided by the NASA Office of Commercial Programs through Cooperative Agreement NCC 9-16 between NASA Johnson Space Center and the University of Houston-Clear Lake. The Technical Director for this activity was Bob MacDonald, Assistant Director of Research, Education and University Programs, Mission Support Directorate, NASA/Johnson Space Center. The NASA Program Manager for this activity was Roy Bivins, Technology Utilization Division, NASA/JSC.

The views and conclusions contained in this report are those of the authors and should not be interpreted as representative of the official policies, either express or implied, of NASA or the United States Government.

AdaNET Research Project

Final Report

Executive Summary

MountainNet, Inc. is researching and developing AdaNET in response to the needs of the United States industrial base. This NASA, Department of Commerce (DOC) and Department of Defense co-sponsored initiative will combine the strengths of software engineering and Ada technology.

The U.S. Department of Defense recognized that proliferation of computers and resultant software was requiring an unacceptable level of funding and other resources to field and reliably maintain critical defense systems. In response to this, the Ada language was developed and introduced. Ada has achieved a successful introduction in the defense and space communities. In addition, experts in software engineering have recognized the applicability of Ada in the commercial sector; most notably in process control applications, factory automation techniques, communications and management information systems.

The goal of the AdaNET project is to transfer existing and emerging software engineering technology from the federal government to the private sector. As a change agent introduced into the infrastructure of US industry, AdaNET will provide a distributed information base on software engineering and Ada as well as a library of reusable software.

Reautomation is essential to maintain US industrial competitiveness in the global marketplace. AdaNET's key service will be to significantly aid this process. First, the AdaNET Information Services (AIS) will provide users with insight into the Ada community and it's related software engineering technology. This will be accomplished through value added information services detailing training opportunities, government initiatives, technology breakthroughs and marketplace information. Additionally, AdaNET will act as an automated "clearinghouse" gateway into other information sources. Second, the Dynamic Software Inventory (DSI) will contain software "profiles" and "parts" which can be used to build a portion of, or an entire, software subsystem. These components will be part of a software lifecycle inventory which will include requirements statements, software architecture design and components, or parts. Such documentation is extremely important in order for software reuse to be more widely practiced.

Creating the environment to promote good software engineering practices is a key ingredient to AdaNET. Beginning with the existing Ada community, AdaNET will reach out to the U.S. business and manufacturing communities. This change agent function will serve to speed up the transition of technology and enhance the ability

of U.S. industry to integrate factory floor, management information and distribution systems.

AdaNET is being designed and implemented by MountainNet, Inc., a West Virginia based software engineering and communications company. Funding is being provided by the NASA Technology Utilization Division and the DoD Ada Joint Program Office, through the Johnson Space Center, under subcontract to the University of Houston - Clear Lake. Support for the program is being provided by NASA's Technology Utilization Division, the DoD Ada Joint Program Office, the Department of Commerce, Office of Productivity, Technology and Innovation, and the DoD Department of the Army.

Disclaimer Notice

The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies or recommendations of the Technology Utilization Division of the National Aeronautics and Space Administration, the Ada Joint Program Office of the U. S. Department of Defense, the Office of Productivity, Technology and Innovation of the U. S. Department of Commerce, or the U. S. Army.

Overview

This is MountainNet, Inc.'s research report for The Initial Study of the Feasibility and Commercialization of an Ada Technology Transfer Network. The National Aeronautics and Space Administration Technology Utilization Division and the Department of Defense Ada Joint Program Office, through the Johnson Space Center, are supporting this technology transition initiative, under the direction of the the University of Houston–Clear Lake. All participating government agencies look to use AdaNET in helping to extend software engineering and Ada technology beyond the aerospace and defense industries, to US business and manufacturing communities.

As the initial feasibility study of the commercialization of an Ada Technology Transition Network, with plans for implementation of this network, this report details those components necessary for success. The objective of UHCL's Research Institute for Computing and Information Sciences (RICIS) was to "obtain a comprehensive plan for organization and operation of an Ada technology transfer activity which, within a reasonable time, has a high probability of being self supporting and which will effectively promote the increased utilization of Ada in commercial applications."

This report was prepared by MountainNet, Inc., a software engineering and communications company located in Morgantown, WV. MountainNet recommends that additional funding be designated for the purpose implementing and studying the use of AdaNET services. During the initial funding period for implementation, MountainNet will track revenues versus expenditures, with evaluation of resources utilization and user activity in specific services areas, so as to more clearly identify which services are most useful and how they can become self supporting.

This report contains:

Organizational Plan This report presents the planned organizational structure for services development and technology transition of AdaNET services to potential user communities;

Business Plan The plan to operate the AdaNET service as a commercial venture;

Technical Plan The plan from which the AdaNET can be designed, including detailed requirements analysis;

Analysis of User Fees and Charges and Proposed Fee Schedule

Report
On The
Initial Study of the Feasibility
and
Commercialization
of an
Ada Technology Transfer Network

August, 1988

Subcontract No. 002
Cooperative Agreement NCC9-16
Project No. RICIS No. SE. 18

Submitted to:
University of Houston - Clear Lake
2700 Bay Area Boulevard
Houston, TX 77058-1096

Restricted Rights Notice

Use, reproduction, or disclosure is subject to restrictions set forth in Government Cooperative Agreement Number NCC9-16 between the National Aeronautics and Space Administration and the University of Houston-Clear Lake and a subcontract thereunder, Number 002, RICIS No. SE.18 between the University of Houston-Clear Lake and MountainNet, Inc.

Prepared by:
MountainNet, Inc.
Eastgate Plaza
P. O. Box 370
Dellslow, WV 26531-0370

® AdaNET, MountainNet and the AdaNET logo are registered trademarks of MountainNet Inc.

Report
On The
Initial Study of the Feasibility
and
Commercialization
of an
Ada Technology Transfer Network

August, 1988

Subcontract No. 002
Cooperative Agreement NCC9-16
Project No. RICIS No. SE. 18

Submitted to:
University of Houston – Clear Lake
2700 Bay Area Boulevard
Houston, TX 77058-1096

James W. Rautner, Program Director

Linda K. Braun, Contract Administator

R. Michael Digman, President
MountainNet, Inc.

Contents

1 Organizational Structure 11

1.1 Project Activity 12

1.2 Organizational Structure 13

1.2.1 History of the Concept 13

1.2.2 Current Structure 15

1.2.3 Internal Audit Controls 16

1.2.4 For-Profit Development Model 18

1.2.5 Internal Development Structure 20

1.2.6 Advisory Panels 20

Federal Advisory Panel 22

Mission and Goal Statement 23

The Business and Industry Council 25

Mission and Goal Statement 25

Technology Advisory Council 26

Mission and Goal Statement 27

1.2.7 Long Term Interaction with University of Houston - Clear Lake 29

1.2.8 Interaction With SEAD 29

1.2.9 Incorporation of New Project Sponsors 31

1.2.10 Interaction with NASA Affiliates 32

1.2.11 Incorporation of Private Sector Participants 32

1.3 Outline of Project Activity 33

1.3.1 AdaNET Project Meetings 33

1.3.2 Initial AdaNET Survey 34
1.3.3 AdaNET Participant Communications 34
1.3.4 Network Planning 36
1.3.5 Current Network Implementation 37
1.3.6 User Survey and Marketing Implications 37
AdaNET Brochure 37
General Impressions 38
Initial Market Survey 39

2 Business Plan **42**
2.1 Business Plan Summary 43
2.1.1 The Company 43
2.1.2 MountainNet's AdaNET Services 43
2.1.3 The Market 44
2.1.4 Financial Projections 45
2.2 Background 46
2.3 The Market 48
2.3.1 The Software Engineering and Ada Marketplace 48
Ada in a Software Engineering Environment 48
The Current Ada Marketplace 49
2.3.2 Market Trends 51
2.3.3 Market Participants 52
2.3.4 Market Composition 53
2.3.5 Market Segments 54
2.3.6 Distribution Media 55
2.3.7 Complementary Services 56
2.4 Market Strategy 59
2.5 Products 62
2.5.1 Description 62
2.5.2 Dynamic Software Inventory (DSI) 63
Dynamic Software Inventory (DSI) 63

2.5.3 AdaNET Information Services (AIS) 65
Professional Information 65
2.5.4 Spinoffs 66
2.5.5 Revenue Classes 66
2.6 Management 68
2.7 Financial 69

3 Technical Plan **70**
3.1 Scope 71
3.1.1 Goal 71
3.1.2 AdaNET System Overview 72
Participating Organizations Views 74
Applicable documents 75
3.1.3 Schedule Constraints 75
3.2 AdaNET Functional Requirements 75
3.2.1 Networking and Communications 76
Existing Elements 76
Planned Expansion 76
3.2.2 Hardware 81
Present Configuration 81
Future Expansion 83
3.2.3 Software 84
Off-the Shelf 84
Developmental Activities 87
3.2.4 Data and Information Sources 87
3.2.5 Operational Considerations 88
Expected Volume 90
Distribution Media 90
User Assistance 90
Service Revenue Structures 91
Telephone Support 91

User Documentation 91
On-Line Access 92
Microcomputer Access 93
3.2.6 Dynamic Software Inventory (DSI) 94
Background 94
Reuseable Ada Software 94
Other Life Cycle Objects 94
Documentation 94
Metrics 95
Profile Information 95
Reuse Database/Taxonomy 96
Retrieval/Duplication 96
Tutorials 96
3.2.7 AdaNET Information Services (AIS) 96
User Forums 96
AdaNET Bibliographic System 96
Educational Materials 97
Electronic Communications 97
Full Text Information 97
Directories/Publications 97
Other Repositories and Services 97
3.2.8 Access Security 98
3.3 Tasks and Deliverables 99
3.3.1 AdaNET System Design 99
3.3.2 Data Gathering 100
3.3.3 System Documentation 100
3.3.4 AdaNET Information Services (AIS) 101
3.3.5 Dynamic Software Inventory (DSI) Design 103
Object Evaluation 104
Object Inquiry 104
Object Retrieval 105

Library/System Configuration 106
3.3.6 Initial Network Introduction 106
3.3.7 Growth Plan for Additional Services 107
Spinoffs 107
Medium Term 108
Long Term Goals 110
3.4 Quality and Standards Assurance 110
3.4.1 Verification Requirements 110
Networking and Communications 111
Hardware 111
Software 111
Data and Information Sources 112
Operational Considerations 112
Dynamic Software Inventory (DSI) 112
Database 112
AdaNET Information Services (AIS) 112
3.4.2 Validation Demonstration 112
3.4.3 Process Standards Compliance 113
3.5 Additional Resource Requirements 114
3.5.1 Hardware 114
3.5.2 Software 114
3.5.3 Networking and Communications 115
3.5.4 Personnel 115
AdaNET Organizational Structure 115

4 Revenue Plan **117**
4.1 Overview 118
4.2 Products and Services 119
4.2.1 Dynamic Software Inventory (DSI) 119
Reusable Ada Software 119
Other Life Cycle Objects 119

Documentation 119
Metrics 120
Profile Information 120
Retrieval/Duplication 120
Reuse Database/Taxonomy 121
Tutorials 121
4.2.2 AdaNET Information Services (AIS) 121
User Forums 121
AdaNET Bibliographic System 121
Educational Materials 122
Electronic Communications 122
Full Text Information 122
Directories/Publications 122
Other Repositories and Services 122
Consultant Services 123
Seminars and Workshops 123
4.3 Target Market 123
4.3.1 Market Segments 123
4.3.2 Market Composition 124
4.3.3 Initial Market Survey 125
4.4 Sources of Ada Software and Technology 127
4.5 Revenue Structures 127
Revenue Classes for AdaNET Services 130
4.5.1 Defraying Costs of Operation 131
4.5.2 Maintaining Commercial Competitiveness 132
4.5.3 Standardizing Revenue Structures 132
4.5.4 Implementing Incentive Programs 132
4.5.5 Providing Economically Disadvantaged Discounts 132
4.5.6 Reimbursing of Direct Contributions 133
4.6 Comparative Pricing 133
4.6.1 On-Line Services Delivery 133

Communications Fees 133
Connect Time Charges 134
Print or Display Charges 134
Per Search Term Charges 134
Flat Rates 135
Annual "Password" Fees 135
Deposit Account Charges 135
Credits 135
4.6.2 Alternate Distribution Media 135
CD-ROM Products 135
Floppy Disk Products 136
Magnetic Tape 136
Printed Media 136
Workshops, Seminars and Consultants 136

5 Acronyms **137**
5.1 List of Acronyms 137
5.2 Appendix A: Initial Marketing Survey Results for the AdaEXPO–Boston, MA, December, 1987 141
Respondent Profile 142
Affiliation With Professional Organizations 142
Survey Data–Raw Results 143
Questions in Order of Perceived Importance 144
Ranking of Importance 144
Appendix B: Project Participants 145
Appendix C: Project Deliverables 146
Appendix D: Ada Market Survey 147
Appendix E: Mail Registration Form 149
Appendix F: Agenda 152
Appendix G: Brochure "Step–Pages" 154
Appendix H: Financial 157

Bibliography 167

List of Figures

1.1 New Organizational Chart 17
1.2 AdaNET Service Implementation Model 19

3.1 AdaNET Gateway/Clearinghouse Functional Overview 73
3.2 AdaNET Network Connectivity 82
3.3 AdaNET Proposed Systems Configuration 85
3.4 Sources of Software Engineering and Ada Technology 89
3.5 AdaNET Organizational Structure 116

4.1 Source of Ada Software and Technology 128

Chapter 1

Organizational Structure

1.1 Project Activity

This chapter describes the organizational structure of the AdaNET project. As, such, it reflects the views and inputs of the sponsoring government agencies and supporting organizations. Topics covered include:

- Use of For-Profit Development Model
- Internal Development Structure
- Advisory Panels
- Interaction with UHCL RICIS and SEAD
- Incorporation of New Project Sponsors
- Interaction with NASA Affiliates
- Incorporation of Private Sector Participants

Another section of this document outlines the current activity on the AdaNET project, including technical and network planning and team development, and initial assessments of the Ada community's interests and needs. A description of AdaNET related activities at the AdaEXPO '87 is also included, as well as the December 10, 1987 project meeting including a list of attendees, and information concerning:

- the initial AdaNET survey,
- facilitation of AdaNET participant communications,
- network planning and implementation, and
- marketing implications of the initial survey.

An agenda of the this Project Meeting held in Boston during the Ada Expo is also included as Attachment F.

1.2 Organizational Structure

There has been much discussion about what organizational structure would best serve the mission and goals of the AdaNET project and promote effective interaction between its sponsoring agencies. AdaNET must serve both the public and private sectors, as both a catalyst and a clearinghouse for the acquisition and use of advanced software technologies. However, while encouraging re-use of Ada software technology by governmental organizations is obviously one of the project's goals, its primary focus is to encourage the application and use of sound software engineering practices in the private sector.

These are diverse goals, and may seem contradictory in nature. It is essential that the service develop cost recovery measures to insure its long term survivability; however, it is just as important that services be provided in such a way that small businesses, manufacturers and educational institutions with limited resources experience no economic barriers to acquiring the information available. Such users represent those sectors which should experience the most benefit from the AdaNET service.

In light of such considerations, it is critical that the correct mechanisms be put in place in the early stages of AdaNET's development to allow flexible interaction with public and private sector organizations.

The following topics are discussed in this chapter:

- Use of For-Profit Development Model
- Internal Development Structure
- Advisory Panels
- Incorporation of New Project Sponsors
- Interaction with NASA Affiliates
- Incorporation of Private Sector Participants

1.2.1 History of the Concept

MountainNet, Inc. was organized as a for–profit West Virginia corporation in 1983. The foundation of its business plan involves development of software, information services, and related telecommunications required for their delivery. MountainNet

presently offers access to Ada, artificial intelligence and expert systems software, and office automation software tools on its own host computer system. Access is provided through a private network consisting of 17 nodes within West Virginia, and nationally via the Telenet Public Access Dial Network. MountainNet also provides an internetwork gateway with The West Virginia Network for Educational Telecomputing (WVNET), and organization that provides host computer and telecommunications services for all state-supported higher education institutions in West Virginia.

MountainNet first conceived the AdaNET service in 1986 in response to projections of explosive growth of Ada technology and related software engineering tools as part of its own business planning. Despite a large and growing investment by the government in Ada and software engineering, important elements of the infrastructure required to produce gains in real terms in software reuse and software engineering productivity have been lacking.

MountainNet's concept involves building a set of services to be offered primarily to commercial software developers and government agencies to which those developers contract. Such a service would have three major components:

Ada Information Services (AIS). A value–added information service detailing training opportunities, government initiatives, technology breakthroughs and marketplace information.

Dynamic Software Inventory (DSI) Software parts which can be reused to build a portion of, or an entire system. The DSI will include related requirements statements, software architecture design and component (detailed) design.

Host Systems and Telecommunications Infrastructure elements required to deliver and support AIS and DSI.

Design of these services would be driven by input from relevant commercial software developers and government agencies. The services would be operated by MountainNet, with revenue from operations complemented by basic research funding from government agencies where appropriate.

In October, 1987, federal funding for initial research and planning was announced. The DoD Ada Joint Program Office and the U. S. Department of Commerce entered an interagency agreement with NASA to provide basic support for the AdaNET service. In March, 1988, the Department of the Army also entered into a cooperative agreement with NASA.

1.2.3 Internal Audit Controls

It has been recognized that appropriate mechanisms to ensure accountability for federal and other funds be established, particularly to observe the need to avoid the appearance of impropriety resulting from comingling of funds or from unfair competition with private businesses. To this end, MountainNet has implemented accounting systems to ensure complete audit trail traceability of individual activity centers. Therefore, MountainNet's research activity with UHCL has an unique activity center designation, apart and separate from any other activity. While receiving government support for research into the development of this facility, MountainNet will provide AdaNET services on a no-fee basis to its governmental sponsors.

PRECEDING PAGE BLANK NOT FILMED

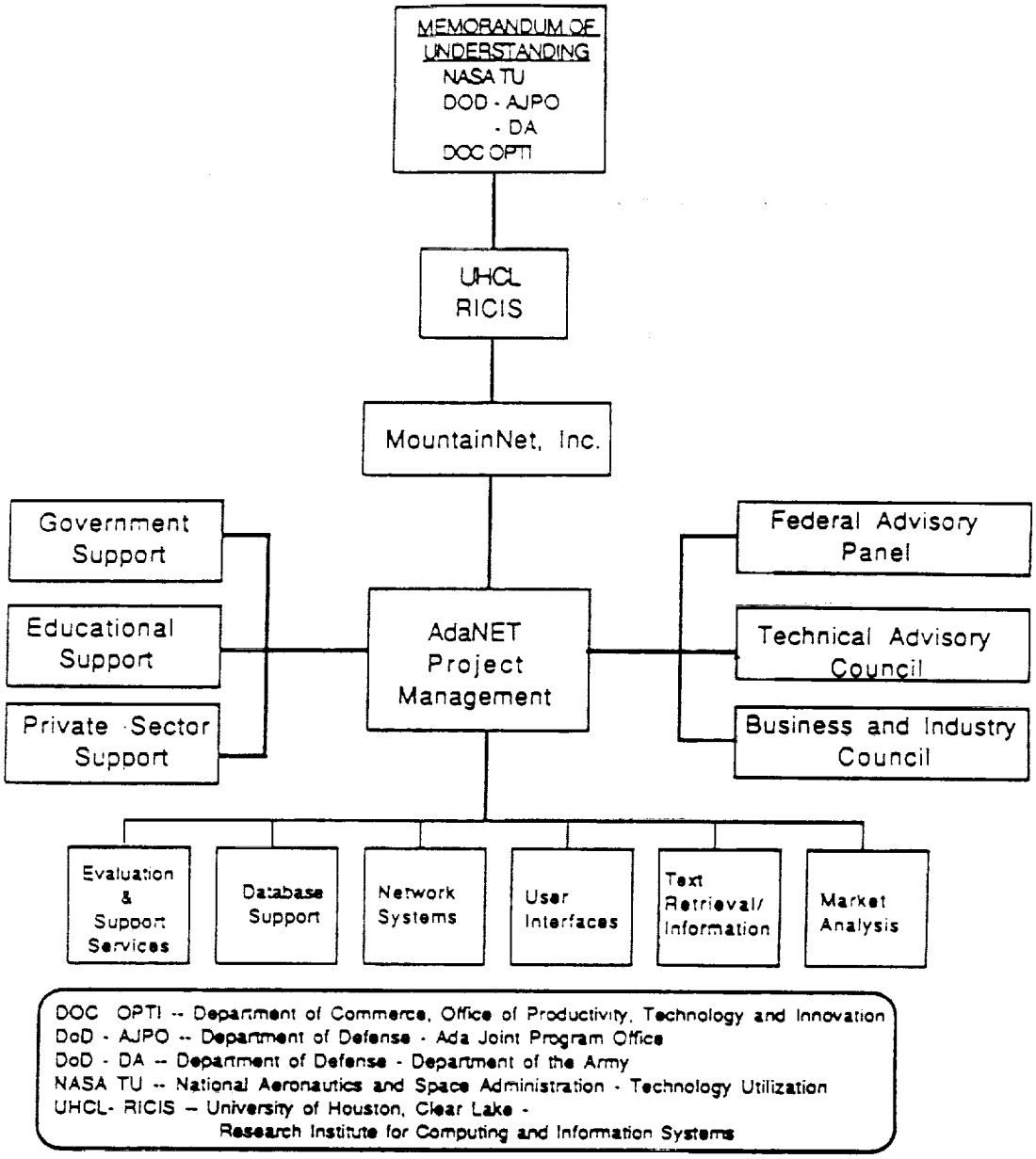


Figure 1.1: New Organizational Chart

ORIGINAL PAGE IS
OF POOR QUALITY

1.2.4 For-Profit Development Model

AdaNET has two primary purposes:

1. to provide a transfer mechanism for government developed Ada and software engineering technology to the commercial sector, and

2. to provide such services with cost recovery measures.

Figure 1.1, *Basic Federal Funding and Program Management of the AdaNET Service* is the profile of funding requirements. Figure 1.2, *AdaNET Service Implementation Model* shows how the AdaNET services would be delivered.

There is specific advantage in the service maintaining a for-profit focus. Aggressive marketing approaches will be necessary to maximize the likelihood of success in achieving the stated goals of the service. This approach also allows a more active emphasis in areas necessary to gain commercial recognition and use, such as marketing, advertising, revenue planning, and corporate teaming.

Keeping a for-profit focus will avoid problems resulting from operation of a commercial service by a government entity. This is of particular concern when considering:

- the orientation of AdaNET towards commercial applications in addition to research;
- AdaNET's level of visibility, commercial activities and interaction;
- the number of different private sector entities that will be asked to participate;
- the level of commercial influence possible, and
- the long term goal of independent operational status.
- difficulties arising from private use of government facilities

While the service will concentrate on its for-profit mode of operation, some activities will emphasize areas that have traditionally been serviced by non-profit, educational entities. One such activity might be the development and operation of a national center for advanced software technology. This would require major support from the educational institutions that are already participants in the AdaNET service and from those institutions which may participate in the future.

Commercial support will be provided through contracted work to develop specific services, or through actual use of the AdaNET service. This is in keeping with the goal of establishing other bases of support that are commercially based and longer term than governmental funding. It also serves to heighten responsiveness to the

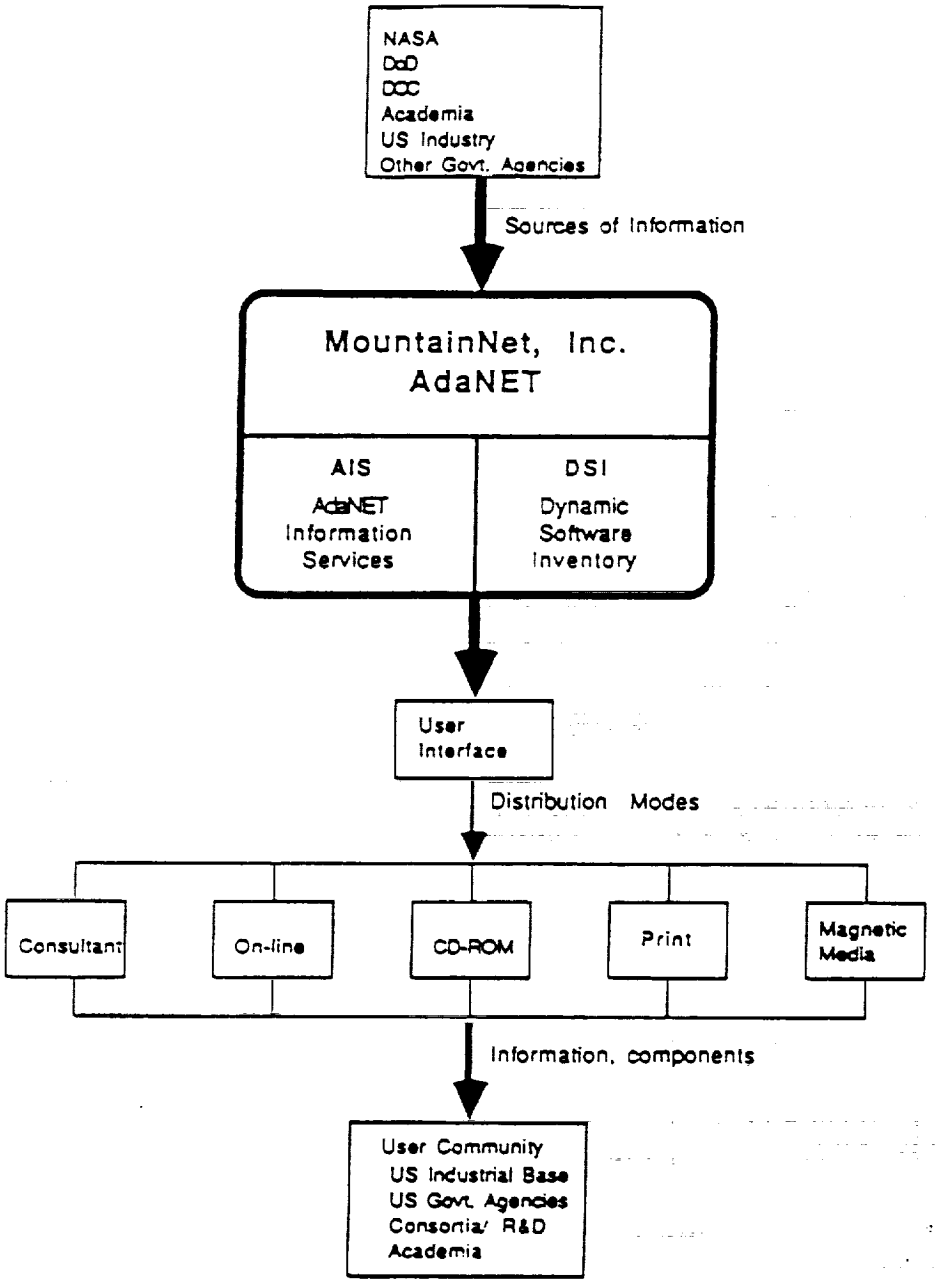


Figure 1.2: AdaNET Service Implementation Model

commercial marketplace; the service will not attain commercial viability without that responsiveness.

1.2.5 Internal Development Structure

The most critical element for successful implementation of the AdaNET service is the development of teams for administering data and library management, systems and telecommunications, strategic planning, market development, user services, and prototype development. These teams will be responsible for both internal development, as well as the coordination and delivery of services.

Private sector participants represent another resource to which AdaNET users can be directed. AdaNET will utilize the resources of many commercial and educational organizations, thereby enlarging the available pool of expertise. MountainNet is entering into corporate teaming agreements with commercial organizations with areas of expertise that will also be valuable to development of the AdaNET service. Such agreements are of strategic importance in the development and long term support of the service; this concept will continue to be used as the service matures. As part of these agreements, private sector participants will be able to maintain their proprietary interests.

In keeping with the role of AdaNET as both a catalyst and clearinghouse, it is not the intent of MountainNet to develop all required capabilities and expertise internally, or to offer only internally developed services. MountainNet's goal is to provide an open architecture into which organizations providing valuable information, services or expertise can offer their resources as part of the total pool of services available. Likewise, the public information and technology available through AdaNET will not be held to any closed group. The success of the service is based on the interaction with as many participants as possible. Its use and growth are synergetic: information and technology are put into the service, and users take out what they need, in turn developing their own bases of expertise. Through continued participation, these same users can become additional resources available to other AdaNET users.

1.2.6 Advisory Panels

Much time has been spent trying to define organizational relationships that facilitate effective interaction between MountainNet's AdaNET service, its governmental sponsors, and the private sector organizations either providing support to or using the

services. Three panels will be formed. Earlier discussions referred to these panels as:

- Board of Governors
- Business and Industry Council
- Technology Advisory Board

After subsequent deliberation and inquiry into the various federal laws regulating governmental and private sector interaction, the following names will be adopted:

- Federal Advisory Panel
- Business and Industry Council
- Technology Advisory Council

Following sections will discuss the purpose of each of these panels. The Office of Productivity, Technology and Innovation has researched the potential legal implications of these organizational structures with respect to public and private sector representatives holding seats on the same panel, and has determined that the organizational structures defined in this document are well within allowable federal guidelines.

The major difference in focus between the organizations defined early in the project and those defined in this document is the separation of governmental and private sector interaction with the AdaNET service. The organizational panels have maintained the same focus; however, the governmental and private sector representatives have been separated on two of the panels. The Federal Advisory Panel is now composed entirely of governmental representatives, and the Business and Industry Council consists solely of private sector representatives. The Technology Advisory Council still has representation from both sectors.

The intent in creating the original Board of Governors was to facilitate participation by organizations committing resources or "sponsoring" AdaNET development. All organizations meeting this criteria are governmental organizations.

The Business and Industry Council will serve as the main point of interaction with identified economic communities, industries, professional organizations, or individual companies that desire a higher level of input and involvement with the AdaNET service than that of being only an end user of services. It also provides an initial point for interaction with those organizations that represent additional resources for development and service offerings, and potential new user communities.

The Technology Advisory Council will provide the focus for those organizations working more closely with development, providing technical focus in all areas necessary. These include not just areas of competence within the field of hardware and software engineering and communications, but also include expertise in marketing, advertising, corporate teaming and partnering, finance, business plan analysis and strategic planning. The Technology Advisory Panel consists of representatives from both public and private sector organizations.

The University of Houston - Clear Lake will serve as the focal point for communications and coordination of the three advisory panels.

Federal Advisory Panel

A way to coordinate between the three sponsoring government agencies is needed. Cooperation and communication between these partners needs to occur to insure mutually successful returns on participation. Some structure is necessary to facilitate the process.

Participation on the Federal Advisory Panel will provide this mechanism. Representatives from the three government agencies supporting the AdaNET service will determine the initial membership of this panel.

The Federal Advisory Panel will consist of those government organizations with the highest levels of resources committed to the project. The individuals on this panel will hold positions within their organizations from which they can direct the resources that are to be applied to the AdaNET service. As was true of the previous structure, the Executive Council of this Federal Advisory Panel will likely be that subset of the participants that represent those government organizations who are the original stakeholder participants, and those organizations with the the highest level of committed resources.

The Federal Advisory Panel will:

- provide a common forum for the resolution of questions relating to interagency interactions,
- provide input into the direction of project focus and deliverables, and
- establish a common point for regular interaction and working sessions.

Within the current government organizations supporting the AdaNET service, there is an ongoing need to explicitly define the deliverables and schedules that satisfy the goals of individual participants. Each organization has specific returns that are sought for supporting the service and specific milestones and deliverables are desired to build those returns. The Federal Advisory Panel will be used as the vehicle for such discussions. The agencies now participating in this interagency cooperative will use this forum to determine mutually acceptable project deliverables.

These same agencies need to address general panel operating guidelines, especially pertaining to the admission of new project sponsors to the Federal Advisory Panel. Issues for consideration include:

- Definition of criterion for new membership
- Criterion for continuance or termination of membership
- Process of incorporation of new members' goals with those of existing members

Discussion has indicated that it is the consensus of the agency participants that criteria for membership on this panel should be established. One generally accepted criterion is that all organizations represented must have made a substantial committment to the AdaNET service of the types of resources described in the statement of mission and goals. This topic is further addressed in a later section entitled **Incorporation of New Project Sponsors**.

Mission and Goal Statement

The mission of the AdaNET Federal Advisory Panel is to provide assistance and guidance throughout the development and operation of AdaNET services. The Federal Advisory Panel links the AdaNET service with the government organizations and communities it serves, reflecting the ideas, focuses, and needs of each sponsor. The panel is composed of key individuals from the governmental sector who have been instrumental in encouraging and committing their respective organization's support of the AdaNET service. Each of the Federal Advisory Panel members shall hold such positions within their respective organizations to be able to govern, direct or allocate

resources, including human, fiscal, informational and/or technical, as appropriate, to further the mission and goals of the service.

The panel will give assistance and guidance in the following functional project categories:

- Guidance in Organizational and Operational Policies
- Determination of Milestones and Deliverables
- Identification of Sponsors' Individual Goals
- Identification of Sponsors' Participation and Commitments
- Coordination of Governmental Sponsors' Efforts
- Incorporation of New Governmental Sponsors

These recommendations will keep the AdaNET service responsive to its service base.

The panel plans to meet quarterly to be apprised of the current status of operations, as well as to provide assistance and guidance in the above referenced functional project categories. The use of electronic communications will provide on-going communications between all members of the panel. More active participation may be established by each member through the identification of representatives from within their respective organizations to provide concentrated technical support to the AdaNET service. The initial number of members of the Federal Advisory Panel shall be set at eleven (11) charter members. These charter members shall serve as the nominating committee for additional members. At no time shall the Federal Advisory Panel exceed twenty-one (21) members. Organizations will maintain representation on the Federal Advisory Panel for a period of up to nine months following the organization's termination of support.

A standing Executive Committee of no more than seven but at all times at least five members shall be initially constituted from the Charter organizations providing human, monetary and/or technology resources in support of the AdaNET service. The Executive Committee will make policy recommendations for ratification by a majority of the Federal Advisory Panel.

Revised June 1988
AdaNET Project Staff

The Business and Industry Council

The Business and Industry Council shall serve as the mechanism for bringing commercial and other private sector entities into participation with the AdaNET service. Organizations looking for additional ways to utilize the technology available through the AdaNET service should initially interact at this level; such organizations may include major industry and manufacturing concerns, large and small businesses representing additional resources of Ada technology expertise, and professional organizations. This provides an initial mechanism for their interaction, as well as allows those organizations not wanting higher level involvement to maintain a tie with the activities and developments. Representatives on the Business and Industry Council should somewhat parallel the authority represented on the the Federal Advisory Board. These individuals may elect to nominate representatives to the Technology Advisory Panel, to provide more technically oriented interaction with the AdaNET service.

This panel provides direction for outreach and support activities. It will also provide a link between those industrial entities who currently have strong established bases of technology and those organizations trying to develop such expertise. Activity on the Business and Industry Council represents a more "arms-length" relationship with the AdaNET service than that of the governmental sponsors or the organizations with subcontract or corporate teaming agreements in place. Many organizations initially interacting only at these board levels may recognize that a higher level of interaction is warranted by their capabilities and expertise, as well as the recognition of how participation supports their individual self-interests. Such organizations may migrate into roles on the development and support team.

Mission and Goal Statement

The mission of the Business and Industry Council is to provide assistance and guidance throughout the development and operation of the AdaNET service. The Business and Industry Council links the services with the organizations and communities it serves, reflecting the ideas, focuses, and needs of each participating and targeted segment of these organizations and communities. The council is composed of individuals from key commercial sector organizations who have demonstrated leadership in innovation, research, development and the application of technology for America's productivity enhancement. Each of the Business and Industry Council members shall

hold such positions within their respective organizations to be able to influence the participation with or support for the AdaNET service by their respective industries, companies, or professional organizations.

The council will give assistance and guidance to MountainNet in the following functional project categories:

- Target sector identification and needs
- Service recommendations
- Organizational participation and resources
- Productivity enhancement applications

These recommendations will serve to keep the AdaNET service responsive to its service base.

The board shall meet semi-annually, to be apprised of the current status of operations, as well as to provide assistance and guidance in the above referenced broad based functional project categories. More active interaction may be established by each member through the nomination of representatives from within their organization to serve on the Technology Advisory Council. No limitation has been set on the number or organizations with representation on the Business and Industry Council.

A standing Executive Committee of no more than seven but at all times at least five members shall be initially constituted. The Executive Committee will convey recommendations made by the Business and Industry Council.

Revised June 1988
AdaNET Project Staff

Technology Advisory Council

The Technology Advisory Council provides the technical applications interface between the AdaNET service and organizations represented on the Business and Industry Council, as well as organizations working more closely in subcontract/teaming arrangements as part of the development and support team.

While interaction with and support of and the AdaNET service can occur without a formal structure, this council will help to organize and coordinate the efforts of this highly diverse and potentially very large group more effectively. Meetings will allow interaction of the whole council that would otherwise not occur. Such interaction is

valuable to both the AdaNET service and the members themselves in allowing for a wider ranging flow of communications, ideas, and creativity.

Mission and Goal Statement

The mission of the Technology Advisory Council is to provide technical assistance in specific areas of expertise throughout the development and operation of the AdaNET service. The Technology Advisory Council provides an interactive technical resource from each organization. The areas of technical expertise represented on the Technology Advisory Council will be maintained to reflect the diverse ideas, focuses, and needs of each participating and impacted segment of the organizations and communities served by the AdaNET service. The council is composed of individuals from each of the commercial and educational sector organizations supporting the AdaNET service, who possess areas of expertise needed to round out the base of available talent and knowledge required for successful development and maintenance of the AdaNET service. Each Technology Advisory Council member shall provide regular and on-going technical support and input.

The council will give technical assistance and guidance in the following functional project categories:

- Research, development and maintenance of repository functions
- Services development
- Market research
- Revenue planning
- Fiscal planning and analysis
- Operations research
- Productivity enhancement measurements

This technical input will provide a base of technical emphasis that would be unavailable within any one organization.

Due to its diversity and potentially large number of participants, the board shall meet semi-annually, to be apprised of the current status of operations, as well as to report on each functional area of activity. The Technology Advisory Council shall be functionally segmented. Members of the Technology Advisory Council also may also serve as the active representatives of organizations with membership on the Business and Industry Council. No specific limitation has been set for a maximum number of members of the Technology Advisory Council.

Revised June 1988
AdaNET Project Staff

1.2.7 Long Term Interaction with University of Houston - Clear Lake

MountainNet has held discussions with representatives of UHCL RICIS to explore potential long term interaction of UHCL RICIS with MountainNet's AdaNET service, once AdaNET is commercially self-supporting. The following are under consideration:

- Support in coordination of the Technology Advisory Panel: MountainNet proposes that University of Houston - Clear Lake host its meetings.
- Access to resources and information maintained by MountainNet in support of the AdaNET project to support RICIS research activities; this may include hardware, software, research library and staff resources. Such resources may be provided through telecommunications access, or on-site research at MountainNet facilities, under sponsored research programs. Continuing discussions will define the scope and structure of such arrangements.
- Incorporation of RICIS programs as part of the service offerings available through AdaNET. In addition to interaction with SEAD (detailed in the following section), services provided by the Space Business Research Center and the Software Engineering Professional Education Center could be offered through AdaNET.

1.2.8 Interaction With SEAD

One of the topics for further discussion involves the RICIS Software Engineering and Ada Database (SEAD). Specifically, it is desired to increase SEAD's commercial focus.

Discussions with Morris Liaw, Principal Investigator of the SEAD project and others at UHCL have identified the following levels of potential interaction between MountainNet's AdaNET Information Services (AIS) and UHCL's SEAD:

1. No integration;

2. Communications integration: MountainNet provides a telecommunications link into the SEAD for access to the SEAD by AdaNET users;

3. Data integration: AIS and SEAD exchange data on a regular basis; or,

4. Full integration: Merging AIS and SEAD under same name, structure and user interface.

The first option would indicate that no valuable interaction can occur between the two efforts and that the AdaNET service can do little to help expand SEAD or to provide commercialization support; this is believed to be false, and hence is not considered as a viable option.

MountainNet believes a combination of both 2) and 3) to be the most effective level of interaction, for the following reasons:

- The combination of choices allows MountainNet to achieve its goal of providing support in augmenting information available through SEAD (through regular updates to the SEAD of information collected in the AIS); and
- Through establishment of telecommunications connections, provide additional commercialization support to SEAD, by expanding its base of potential users to include all users of the AdaNET service;
- There would be very little restructuring of the service functions and goals of either SEAD or AIS;

Complete integration as defined in 4) is not believed to be desirable for the following reasons:

- AIS and SEAD services are currently targeted to two separate user communities. SEAD currently services internal NASA organizations and NASA contractors/subcontractors who access SEAD via NASA internal telecommunications networks. AdaNET's primary focus is on private sector users. Clarification has not yet been given on whether SEAD can expand its services for general private sector use, and still maintain its direct linkages to its NASA users (due to network security concerns);
- Elimination of the AIS as a major service within AdaNET will radically reduce the value of information presented through AdaNET, and hence its commercial viability; the alternative, merging of SEAD into AdaNET, is not considered a reasonable alternative to the developers of SEAD;

- Presentational formats and retrieval mechanisms for information to be contained in the AIS differ from those of SEAD; MountainNet has evaluated various users interfaces and retrieval mechanisms for on-line information. The method chosen (text retrieval/ hypertext systems) is deemed to be the most desirable for the AdaNET environment. It is suggested that a quantitative study be conducted to assess relative user responsiveness/usage levels on both systems, to evaluate (where information may be duplicated) user-preferred methods of delivery.

Before further planning of AdaNET/SEAD interaction can occur, additional planning by the SEAD staff must be completed. As stated above, one major decision will be whether SEAD will be allowed to incorporate non-NASA private sector users while maintaining its linkage into NASA networks. Additionally, clarification as to the SEAD's ultimate host machine will aid greatly in determining the level of data exchange possible and specific requirements for establishing telecommunications linkages. Further elaboration of RICIS goals for SEAD commercialization are necessary, in order to completely address how MountainNet, through its AdaNET service can help add other commercialization support services.

1.2.9 Incorporation of New Project Sponsors

New government sponsors may become active in supporting development of the AdaNET service. Such support could be provided through either interagency agreement and support through the existing cooperative, or through additional contracting mechanisms. In the prior case, a standard Memorandum of Understanding with NASA, (as the contracting agency), based on the one signed by the three original sponsors, will be established.

It is agreed upon by all existing sponsors that as other governmental organizations apply their resources to development of the AdaNET service, those organizations should be given representation on the Federal Advisory Panel. This has positive results for both the newcomers and the existing sponsors, since all participants will have a common forum for sharing information about their respective goals in the project, and the resolution of potential conflicts in those goals. The new sponsors' agendas will need to be incorporated into the common agenda of the existing sponsors, and project milestones and deliverables will need to be adjusted and expanded accordingly.

1.2.10 Interaction with NASA Affiliates

A strong working relationship is evolving with NASA affiliate organizations identified to support the AdaNET service. The support, participation and resources contributed by these organizations is currently being underwritten by NASA as part of its in-kind contribution to the service. This participation is intended to provide early returns to all participants:

For example:

- A base of resources and expertise will be made available to apply to various facets of development of the AdaNET service; such support will help in "lessons learned" and in applying existing technology solutions to planning development, and implementation.
- These organizations represent additional sources of expertise and technology that will be made available to users of the AdaNET service.
- Through markets identified, additional opportunities for commercial/private sector support will be afforded to participating affiliates.
- MountainNet will perform catalyst and networking functions, placing entities needing specific technology solutions in touch with those organizations possessing such expertise.

See Appendix B for a listing of those NASA affiliates currently providing support.

1.2.11 Incorporation of Private Sector Participants

MountainNet's interaction with the private sector will be as both provider and user of services and expertise. The delineation between those organizations that are providers of resources and those that are users should be almost impossible. The same groups using services and utilizing the information, software and expertise available, should also represent, in time, an additional resource that can be added to the team of organizations supporting the AdaNET services.

The AdaNET project staff will serve as the focal point for communications and coordination between governmental and commercial sector interests. This is appropriate to the service's main focus on commercial sector organizations; this will provide

the mechanism to recruit the involvement of commercial sector interests both as additional resources and as users of services. The AdaNET project staff will identify the needs of those private sector communities with which it interacts, and then work through the Federal Advisory Panel to bring those needs to the attention of the federal agency sponsors. Private companies listed as users of software and services should eventually come full circle in the process, until they are also providers of software and technology to the AdaNET user base.

1.3 Outline of Project Activity

Initial presentation of plans for the AdaNET service was made to attendees of the Ada Expo '87 and ACM SIGAda conferences. The week's activities were centered around:

- AdaNET Project Meetings
- Ada Users Survey
- Network Planning and Implementation
- Initial Market and Services Analysis

1.3.1 AdaNET Project Meetings

Project meetings were held on on the evening of December 10, 1987, following completion of the Ada Expo '87. The first meeting held included only representatives of the sponsoring agencies. Specific points for discussion focused on the need for higher level coordination between governmental participants, MountainNet, and the University of Houston - Clear Lake. Discussion was also held on the participation of the Department of the Army DISC4 in the AdaNET project.

A second meeting was held, with the following in attendance:

Virginia Castor - DOD AJPO
Edward Liebhardt - DoA DISC4
Charles McKay - RICIS
Mike Digman - MountainNet
Kevin Dyer - Financial Alternatives
John Heizer - DOD OPTI
Roy Bivens - NASA TU
Henry Clarks - NASA TU
Paul McWilliams - NIAC
James Rautner - MountainNet
Frances Van Scoy - WVU
Robert Wallace - TA

Topics for discussion included:

- Changes to Organizational Views report
- General update on AdaNET's Ada Expo '87 activities;
- Discussion of project deliverables;
- Organizational planning.

The views expressed in that meeting are reflected in this chapter. The agenda of this meeting is included as Appendix F.

1.3.2 Initial AdaNET Survey

An initial survey was conducted at Ada Expo '87; copies of the survey instrument were distributed at the Ada Expo '87 with brochures about the AdaNET project. This survey was intended to gather the following types of information:

- general demographic information,
- Ada applications areas represented at the conferences,
- levels of interest in potential service offerings, and
- current hardware and telecommunications utilization.

The survey, while only a sampling of those in attendance, yielded interesting information about the current interests, among those participating in the Ada marketplace. The survey was designed with a limited number of very focused questions, to increase the likelihood of response, as well as to get initial information about those areas needing more extensive follow-up. The demographic information provided is enabling the AdaNET project staff to follow up with mailings and further survey activities. Some findings from the survey are noted in the sections which follow.

1.3.3 AdaNET Participant Communications

Two factors have created a need for a means of communication and exchange of textual information regarding the AdaNET project. There are:

- the wide geographic distribution of participants in AdaNET project oversight and technical development, and
- the difficulty in coordinating schedules for meetings and expense of travel to meetings.

Many of the individuals involved already participate in one or more computer networks or services. These services include:

- Defense Data Network (DDN)
- NASA's electronic mail system
- ARPANET
- BITNET
- Dialcom
- Telenet electronic mail
- Compuserve
- MCI mail
- Source
- Other commercial networks and private host computer systems

There is no practical method for creating inter-network gateways among all the different networks that would be required for every project participant to be able to use that participant's own host system for electronic mail and document transfer activities. In view of this, the project team has implemented an electronic mail and document service for AdaNET project participants hosted on a DEC Vax computer system. The service is menu-oriented, very easy to use, and can be accessed at no charge to the user through Telenet.

Terminal emulations that are presently supported include DEC VT series, Data General, Lear Siegler, Televideo, ADDS, and other video terminals and emulators. (Responses to an item on the Ada Expo '87 questionnaire suggest that DEC, IBM PC, and Apple computers and video terminals are by far the most common hardware used by the respondents.) Copies of the Kermit communication and file transfer protocol which typically provides DEC VT series emulation are available from MountainNet for virtually any model of microcomputer.

An AdaNET Document Transfer and Electronic Mail Service User Requirements Documentation form has been prepared and distributed to the various agencies and organizations participating in the project at this point. Attachment D of this document is the standardized form developed for establishment of usernames for project participants. Completion of this form by each project participant is required prior to account activation.

1.3.4 Network Planning

In order to ascertain the extent to which some of the various electronic mail and document transfer systems are used by potential AdaNET users, a question regarding network use was asked on the informal questionnaire distributed at the Ada Expo '87. The following table summarizes responses to that question:

Electronic Mail and Networks Used
by Ada Expo Attendees

Network Name	Frequency	Percent
DDN	20	23.3
ARPANET	32	37.2
NASA MAIL	02	02.3
BITNET	09	10.5
TELENET	15	17.4
MCI	00	0
COMPUSERVE	12	14.0
DIALCOM	02	02.3
SOURCE	04	04.7
USENET	03	03.5
TYMNET	01	01.2
CSNET	03	03.5
OTHERS	09	10.5

Notes: Number of respondents = 86; respondents were asked to mark all those networks that apply.

Though use of various network services for electronic mail and document transfer is common among this group, even ARPANET, the most commonly used network, was used by less than 40 percent of the respondents. As already noted, responses to a second item on the Ada Expo '87 questionnaire suggest that DEC, IBM PC, and Apple computers and video terminals are by far the most common hardware used by the respondents.

1.3.5 Current Network Implementation

Two host computer systems are initially being used to support planning and development activities: a Digital Equipment Corporation Vax 11/780 located in Buckhannon, WV; and a Data General MV8000 located in Dellslow, WV.

These host computer systems are connected to MountainNet's own telecommunications network. That network is linked to Telenet and the West Virginia Network for Educational Telecomputing, which is in turn connected to ARPANET, BITNET, and Suranet. Through these network gateways, host computer systems are available via local direct or dialup access from most of the continental United States.

1.3.6 User Survey and Marketing Implications

Approximately 550 project brochures with market survey forms included were distributed, individually, at the conference. Eighty-six (86) completed market survey forms were completed at the conference, a response rate of 16 percent. Since the conference additional surveys have been returned, some with cover letters expressing further interest in becoming involved with the support and use of AdaNET. Some have also responded with telephone inquiries about the project.

AdaNET Brochure

Included with the market survey, the brochure incorporated three "step-pages" of information describing the AdaNET project, the government agencies and private businesses involved in its inception, and the value-added services and products it will provide. These are included as Attachment F. A summary of the intent of these pages follows:

AdaNET
The Advanced Development Network
For Ada Software Applications

This page explains the AdaNET service as an effort involving government, education and the private sector, and its reason for being; that is, to gather, refine and disseminate information regarding the Ada computer language and software engineer-

ing in order to encourage use of Ada for better software engineering and improved productivity.

AdaNET
The Ada Soft-Where-House

This page outlines how the AdaNET services and products will be stored, classified and made available to the commercial market place, and academic and government organizations, and describes a few of these organizations that should benefit immediately and directly. The Ada Soft-Where-House represents the focus for access to the reusable components, objects and information services.

AdaNET
Value-added Services and Products

This page is a detailed Listing of the services and products that are to be offered.

General Impressions

The AdaNET project staff had discussions with many attendees of the Ada Expo'87 Conference, both on the floor of the display area and in small informal discussion groups. The impressions gleaned from these discussions and from the communications which have taken place since the conference have resulted in the general impression that the primary questions regarding the AdaNET service are:

1. How soon will it be available?
2. How can one access AdaNET?
3. How much will access cost?

A fourth impression is that many attendees felt that the AdaNET project represents a needed and timely step.

Initial Market Survey

A preliminary analysis of the initial market survey revealed some interesting characteristics, which are under further analysis for distribution to the project participants in the near future. The complete form is included as Attachment C. Here is a summary of the three questions posed to survey respondents:

1. **With which Ada-related professional organizations are you affiliated?**
2. **Is your organization involved in Ada software development? If yes, please check all that apply** (various categories were listed).
3. **Which AdaNET services or information would you find useful?** (various services were listed; users responded that each service was "Not Useful", "Useful", or "Very Useful")

The results to question one were as follows:

	YES		NO	
	N	Percent	N	Percent
SIGAda	61	70.9	25	29.1
AdaJUG	12	14.0	74	86.0
IEEE	34	39.5	52	60.0

As was expected, considering the audience that was being addressed, a significant number of respondents, 70.9%, indicated a membership in SIGAda. The balance

of the respondents show 14.0% membership in AdaJUG, and 39.5% membership in IEEE. The total adds to more than 100% due to multiple membership affiliations by some respondents.

From these respondents, most of whom are members of professional Ada organizations and who represent a sophisticated population, significant indicators are beginning to emerge. From the responses of this group to the third question, the most useful services are those listed below. These areas were the areas that elicited a "very useful" response from over 66% of the respondents.

- Ada Faceted Classifications for Reuse
- Ada-Specific Metrics
- Software Engineering Methodology
- Topical Search Categories for Reuse

Services or information which were viewed as "useful" include:

- Commercial products and services
- Contracting opportunities
- Documentation and information
- Project management software
- User Communications

Services or information viewed as "not useful" are as follows:

- On-line tutorials
- Computer based training
- Telephone Help Line

Respondents who indicated that Ada-faceted Classifications for Reuse, Topical Search Categories for Reuse, and Software Engineering Methodology were "very-useful" tended to fall into the following software development categories:

- Data Bases
- Education
- Engineering
- MIS Functions
- Process Control
- Scientific
- Telecommunications
- Tools
- Weapons

Ada-specific Metrics were found to be "very useful" for the following software development categories:

- Scientific
- Data Bases
- Engineering
- Telecommunications
- Weapons

Initial service offerings will be concentrated upon those categories which this preliminary survey indicates would have the highest tendency to be probable value-added migration paths for technology transfer offerings.

Chapter 2

Business Plan

2.1 Business Plan Summary

This plan describes the development of the AdaNET service, the purpose of which is to disseminate software engineering and Ada technology and aid in the transition of this important technology. Since Ada's first commercial availability in 1982, there has been continual development of Ada applications in both the public and private sectors, nationally and internationally. MountainNet, Inc., is developing AdaNET as a means to capture and reuse the increasing volumes of Ada software technology and related information being generated by public sector activities. Through value-added information services and reusable Ada software, AdaNET will offer technology solutions not previously available. AdaNET development is supported jointly by the Technology Utilization Division (TU) of National Aeronautics and Space Administration (NASA), the Ada Joint Program Office (AJPO) of the Department of Defense (DoD), and the Office of Productivity, Technology and Innovation (OPTI) of the Department of Commerce (DOC).

2.1.1 The Company

MountainNet, Inc., is a communications and software engineering company formed in 1983. MountainNet currently serves the government, commercial and educational communities. In 1985, MountainNet recognized the vast potential market for Ada related services. The DoD developed the Ada computer language for mission-critical systems, but Ada technology seemed to have broad potential beyond the defense community. This potential, plus the fact that very few companies existed with established expertise in Ada technology, combined to present an excellent market opportunity.

In response, MountainNet developed AdaNET, a service designed to address the need for specialized software and information for the software engineering and Ada technology market, and submitted an unsolicited proposal for design and development of a prototype service.

2.1.2 MountainNet's AdaNET Services

MountainNet is using its telecommunications, information distribution and Ada technology expertise to develop a system that will coordinate information from a multitude of sources for consolidated direct access by AdaNET subscribers. Services will include access through a variety of media to:

- Ada software;
- Information about that software;
- Communications among Ada professionals;
- Retrieval systems for general Ada related information;
- Catalogs of government sponsored Ada programs and technology;
- Catalogs of existing software engineering/Ada products and services;
- Third party services representing areas of Ada related expertise.

An important part of the AdaNET system will be the development and ongoing support of a Dynamic Software Inventory (DSI), a library of reusable Ada components and their associated life cycle products. Specialized value-added services to encourage reuse of this software will also be provided. These services include software classifications, testing, performance metrics, documentation, tutorials, and quality ratings. Ada repositories currently exist, but the incorporation of these value-added services and accessibility to a wide market base make the AdaNET system unique. AdaNET will complement and augment existing related public and private sector services.

The AdaNET service, will capture for reuse the growing amount of Ada technology being developed for NASA and DoD programs. This technology will be collected, organized, evaluated, and made available to the private sector to encourage transition to use of Ada technology. MountainNet through its Related Projects Working Group will also identify current activities within various government organizations to lessen potential duplication of effort. Another goal of the AdaNET system is to apply acquired software technology to Computer Integrated Manufacturing/Flexible Computer Integrated Manufacturing (CIM/FCIM) and industrial automation activities in the United States.

The revenue structure will utilize standard subscriptions, incremental fees, and ongoing research contracts. MountainNet will provide quality information at affordable rates to encourage widespread usage of software engineering and Ada technology.

2.1.3 The Market

Markets for AdaNET software and information services include:

- Existing Ada community
- International software industry
- Manufacturing and automation communities
- Educational communities
- Government organizations

Initial technology transition efforts will be directed to the existing Ada community, as well as that portion of the traditional software industry seeking entry in the software engineering and Ada marketplace.

Many of the services offered through AdaNET will be of use to all of these target user groups, and additional services will be offered to cater to other specific user communities. AdaNET services will be offered in many forms, including seminars, workshops, professional consulting, and the DSI with its supporting information. This information will be distributed through a variety of methods, including on-line, CD-ROM, diskette, and print.

The market for Ada products will be several hundred million dollars in 1988, and is expected to exceed one billion dollars by 1991, surpassing four billion dollars by 1995, according to a survey conducted by IRDI. The most immediate potential user base is the current software engineering and Ada community. Preliminary market surveys conducted by MountainNet indicate that there is interest and perceived need for the types of services to be offered through AdaNET.

2.1.4 Financial Projections

Support for AdaNET development is being provided by a subcontract from the University of Houston - Clear Lake (UHCL). Full implementation of planned services will enable research and development of computer based resources and value-added services, facilitate acquisition of necessary computer and network resources, and support aggressive technology transition plans. Full financial projections are contained in section 2.7 of this document.

2.2 Background

MountainNet, Inc., a West Virginia business, was incorporated in 1983 to provide telecommunications and software engineering services. MountainNet currently maintains 17 dial-in nodes across the state, with internetwork linkages to the West Virginia Network for Educational Telecomputing (WVNET), a state supported network, and the commercial international Telenet network. The MountainNet network is used to access a variety of computer hosts and other networks by governmental, commercial and educational users of on-line information services. For example, MountainNet provides telecommunications access to a computer hosting an on-line information system supported by the West Virginia Department of Energy. The Software Valley Bulletin Board, a free public access electronic bulletin board service, is made available through a cooperative effort of MountainNet and MPL Corporation, an affiliated computer services corporation.

MountainNet is entering the software engineering and Ada technology information services market with development of the AdaNET system. Through AdaNET, MountainNet will collect and disseminate software and information in the fields of software engineering and the Ada computer language. Interest in Ada technology has rapidly increased in both the public and private sectors, nationally and internationally, since Ada's first commercial availability in 1982. AdaNET's purpose is to encourage greater growth of the Ada community in the private sector, as well as to capture for reuse the vast, ever increasing amounts of Ada software and related information being generated by public sector activities. The information available through AdaNET will be offered with accompanying value-added services, resulting in a source of information which will be unique in the Ada market.

MountainNet has found that several major barriers exist for new companies trying to enter the Ada technology marketplace. Critical information about training and software engineering/Ada technology is difficult and expensive to obtain, and very few support services exist to aid in the collection and use of this information. In addition, the rapidly expanding base of public domain Ada software has not been organized effectively for widespread distribution and reuse. Such information has primarily existed in disparate centers serving focused user bases, with little information sharing between such activities. There is a market for efficient, reliable access to this information by both the existing Ada market and by new market entrants. AdaNET will provide such access.

An important part of AdaNET will be the development and ongoing support of

an Ada software library, with accompanying specialized services to encourage reuse of this software. This library will be unique to the industry. Only recently has the software industry as a whole recognized the need for technologies supporting reuse of software. Current activities in developing software reuse technologies and methodologies are primarily government supported. As these new technologies become available, MountainNet will apply them the AdaNET reusable software library.

With software life cycle costs continuing to increase, and the need for new software systems in both the public and private sector rising each year, the demand for more efficient technologies to manage this "software crisis" has never been greater. Through AdaNET, MountainNet will provide a central information source for such emerging technologies, and will use these technologies in building its own reusable components libraries. Anyone producing software engineering or Ada software products in this market is a potential AdaNET user. AdaNET should also encourage new entrants into the software engineering and Ada market by making the technology more accessible, particularly in the area of CIM/FCIM software development.

AdaNET will provide its user base with the following:

- A telecommunication linkage for government, academic and commercial entities;
- A clearinghouse of information for professional, educational, and current events news;
- Contracting information to encourage greater competitiveness in the software engineering and Ada marketplace;
- Access to other market participants for:
  - Potential teaming opportunities
  - Expertise in a variety of areas related to software engineering and Ada technology
- Access to Ada software libraries, aiding users in software reuse;

AdaNET will be directed initially to two target markets: the existing Ada community; and the traditional software development community seeking entry into the Ada market. The buyers of AdaNET services will include:

- Software engineers and developers
- Software managers
- Contractors and subcontractors
- Government agencies

- Educational communities

MountainNet currently has 12 full time equivalent (FTE) personnel, of which ten are assigned to AdaNET. During future phases of the project, MountainNet will add to its internal technical and technology transition staff, reflecting the shift from initial project planning to full scale AdaNET implementation. MountainNet will add approximately six people during the next year. Long term growth of the company is anticipated to peak between 20–30 FTE personnel.

MountainNet has maintained controlled growth by subcontracting services whenever possible. This approach has allowed a high degree of flexibility in response to market demands. MountainNet will subcontract with a variety of companies representing areas of expertise essential to successful AdaNET development. MountainNet is currently working with eleven companies and organizations, and is discussing formalizing relationships with several major technology and industry leaders, thus broadening the base of available resources.

2.3 The Market

This section describes initial marketing plan for the AdaNET service. It discusses the current marketplace, presents results of an intial market survey and describes the beginning implementation plan for AdaNET.

2.3.1 The Software Engineering and Ada Marketplace

This section discusses the use of Ada in a software engineering environment, describes the current Ada marketplace and offers a view of Ada as applied to the commercial sector of the economy.

Ada in a Software Engineering Environment

Ada is a tool for software engineering in embedded computer applications. Although initially defined as a language for DoD mission-critical computer resources, Ada is being recognized as a language which has much broader applications. For example, most process control systems in place on factory floors require the same degree of tightly controlled development as DoD applications. Implementation of object-

oriented design, information hiding and packaging concepts using Ada is appropriate for the development of the automated factory of the future.

One of the most critical elements of Ada is that it encourages the use of good software engineering practices. When used properly, Ada can reduce costs and enhance the engineers' ability to reuse components in new systems. The AdaNET Information Service (AIS) will provide necessary information that will aid in the proper use of software engineering principles.

While originally developed for embedded systems development, similar benefits from use of Ada are being experienced in development and support of applications software, such as management information systems, database systems, and software tools.

The Current Ada Marketplace

The initial Ada technology market was completely driven by the United States government, and more particularly, by DoD demand. Development of the Ada language was sponsored by the DoD in an effort to control software costs in vital defense and weapons systems. Ada's development was intended to:

- Establish one standardized language that would be used by all DoD agencies in the development of mission-critical systems;
- Hold down the rising costs and improve the reliability of developing and maintaining software by encouraging good software engineering design;
- Encourage reuse of software by including features that would enhance the potential for reuse of software components.

The process of developing Ada, from its early specifications documents through the first commercial compilers, spanned the period from 1975 to 1982. Hence, the Ada market is just emerging from its infancy. Major development efforts using Ada in the United States have been, for the most part, government sponsored activities. Internationally, the use of Ada in the commercial market has been more widespread; banking, telecommunications, and aerospace systems have been developed using Ada technology. One of the largest companies to adopt Ada early on was the Japanese Nippon Telegraph-Telephone (NTT), which began developing their software in Ada shortly after the first commercial compilers became available.

However, the market demand created by defense applications has been significant. A DoD directive issued in 1983 mandated that Ada must be used for all new mission-critical applications. In 1985, North Atlantic Treaty Organization (NATO) directed

that all NATO-developed systems developed after January 1986 must use Ada. In 1986, a DoD directive expanded the use of Ada to all new weapons systems development. The defense market for Ada applications alone generated more than than 100 million dollars per year.

Three areas historically holding back Ada's widespread adoption were the lack of commercial compilers and tools for many popular computer systems, the general lack of trained professionals in the field, and the lack of technology and market information.

Ada use is rapidly spreading to the commercial applications market, now that its advantages in software productivity and reliability are being realized. Major applications in supporting real time control systems are being developed. Weirton Steel, in Weirton, West Virginia, is undertaking a 300 million dollar modernization project for new hot rolling mill technology that will use Ada as its control language. The development is being done by General Electric Corporation. Ada is also being used in the United States to program microwave ovens, commercial aircraft navigational systems, telecommunications, database management systems, and many other applications.

The government market continues to drive the process of Ada's adoption by the world's software industry:

- In December 1987, NASA awarded a 1 billion dollar contract to Boeing Corporation for the development of a space station, to be completed in the mid-1990's. The software will be written in Ada and is estimated to require 10.5 million lines of code.
- A 508 million dollar contract was released by the DoD in January, 1988, to Martin Marietta Corporation for the development of the Strategic Defense Initiative (SDI) National Test Bed. This project will be developed using Ada.
- The Software Technologies for Adaptable, Reliable Systems (STARS) has solicited proposals for major research to be conducted simultaneously by three major prime contractors for developing new technologies that will encourage software reusability in Ada. STARS has indicated that a centralized software repository to coordinate the results of this research is needed.
- The Federal Aviation Administration (FAA) (Department of Transportation) has chosen Ada as its standard development language.

Recent commercial sector activities are also significant:

- Ada compilers and tools are proliferating; there are currently 123 commercially available compilers listed in the Ada Information Clearinghouse (AdaIC), which run on the most common mainframe, mini and micro computers.

- Ada education is also expanding, with Ada and software engineering courses being offered at many small colleges, as well as at most major universities. The number of companies providing Ada education for the existing professional market has also increased.
- The Software Productivity Consortium (SPC), a research consortium established by the nation's largest defense and aerospace companies to develop new automation, knowledge based systems, and reuse technologies, is using Ada as its primary development language.
- Space Industries, Incorporated, a Texas company which proposed the development of the Industrial Space Facility (ISF), a parallel program to NASA's space station, is using Ada technology to support its development.
- A study released by International Resource Development, Incorporated (IRD) in December, 1986, has determined that Ada market opportunities for 1988 total several hundred million dollars. Such growth is introducing many newcomers to the Ada marketplace. The need for skilled Ada software engineers far exceeds the number currently available. Major corporations and leading defense contractors have undertaken internal training programs to develop enough expertise to meet their current contract demands. Newcomers to the market still have extreme difficulty locating educational and professional information, gaining access to currently existing technology and compilers, and finding contracting and subcontracting opportunities.

It is apparent that the software engineering and Ada technology market is on a steep upward climb. The government market alone will continue to support steady growth, thus creating a base of long term stability in the Ada market. However, significant accompanying growth in private sector use of Ada is also probable, as the use of software engineering principles become more common and advantages in real cost and reliability savings are realized. IRD's study indicates that the market for Ada technology in 1991 alone will have grown to more than a billion dollars.

2.3.2 Market Trends

AdaNET's immediate markets are the existing Ada community, and companies making entry to that community. New companies will continue to enter the market as the government demand for Ada software continues to grow and as the cost savings of using Ada technology are realized. Such savings include reduced life cycle costs, increased software reliability, and savings through reuse of software components. The

languages and technologies used in the past are now unable to meet the growing demands for larger, more reliable, longer term software solutions. Companies are finding Ada an attractive alternative.

The heightened emphasis on interconnectivity and standardization in all facets of communications is causing many companies to favor use of the standardized Ada language. With the shift to Ada technology to support the government market, it is becoming more cost-effective for government software producers to use Ada for all their applications.

As more software companies increase their competitiveness by adopting Ada, others will be forced to explore the transition to the Ada market in order to maintain a competitive market position or even to remain in the market at all. To support this transition, developers are seeking sources of software engineering/Ada related technology, educational, and market information. In spite of radically increased use of Ada, such sources are still scarce. To realize the advantages of software reuse encouraged by software engineering/Ada technology, developers are seeking new tools, design and evaluation methodologies, and access to the millions of dollars of government developed Ada software that is in the public domain.

2.3.3 Market Participants

Current products in the Ada market are summarized as follows:

- Ada Compilers
- Applications Software (e.g., CRI's Relate 3000 relational database system)
- Customer Specific Applications (e.g., Weirton Steel's hot rolling mill)
- Software Development Environments (e.g., CASE products)
- Computers (e.g., Rational computers)
- Educational Materials
- Metrics (e.g., McCabe and Associates, Autometrics)
- Newsletters (e.g., Ada Strategies, AdaData, AdaIC)
- Seminars (e.g., EVB Software Engineering, Texel Putnam Associates)
- Tools (e.g., program design languages, configuration management)

While all the Ada product areas listed above represent potential users of AdaNET services, MountainNet views the producers of Applications/Customer Specific Applications as the potentially largest group of AdaNET users.

MountainNet is conducting an ongoing market assessment as part of the planning to provide continuing refinement to the Technical Plan and Revenue Structures reports. The following questions are being researched for each of the service areas listed:

- How many companies are producing software engineering and Ada training materials?
- How is the service made available to users?
- What is the anticipated growth in this market by number of market participants and total market share?

These statistics will be used as the basis for final revenue projections, by applying service revenue structures to each of these markets. Independent market growth projections in each area, coupled with final results of MountainNet's own market studies, will allow more accurate predictions of growth in each service sector. Current projections are made on baseline minimum use for each service area in the current market environment.

2.3.4 Market Composition

MountainNet has identified several major professional areas represented within each of its potential market segments:

- Software Engineers/Developers
- Managers/Administrators
- Educators
- Applications End Users

The initial market survey conducted at Ada Expo '87, indicated that these individual user communities have interests in specific service areas:

- **Software Engineers/Developers already working with Ada technology** were interested in software engineering methodologies, Ada specific metrics, reusable software, and Ada faceted classifications for reuse. They had little interest in Education and Support, or Contract Opportunities/Market Trend information.

- Those representing **Administrative or Business oriented functions** within their organizations, whether governmental or commercial, registered interest in

services providing contracting/subcontracting information, current events, market trends, governmental activities with respect to the use of Ada, and information about companies and products in the Ada market. They had little interest in technically oriented services.

- **Educators**, fewest in number of those groups represented in the sampling, indicated the strongest interest in technically oriented information, such as: Ada faceted classifications for reuse; software engineering methodology; topical search categories for reuse; and Ada tutorials. All other areas registered median interest, with the exception of contracting, products, and telephone help line, which were of little or no interest.

- The last category includes potential **Manufacturing/Industrial** communities examining Ada technology as part of an overall advance technology solution to aid in their productivity, competitiveness and reliability. Areas of interest to representatives actively involved in the development Ada applications include: information about current industrial applications, educational and professional information, and information about companies possessing specific areas of Ada technology expertise.

This survey, along with more in-depth inquiries, is being distributed to a much broader sampling of both the Ada and non-Ada communities. For a more detailed analysis of the data collected at the Ada Expo, see appendix A.

2.3.5 Market Segments

MountainNet has identified five separate market segments which represent the key areas in its implementation strategy:

- Current Ada market participants
- New entrants to the Ada market
- Educational institutions
- Government organizations
- Industrial/Manufacturing

The current Ada market represents the most immediate market for AdaNET services. MountainNet is gradually becoming established in that community, through activity in professional organizations and through MountainNet's expanding base of

government contacts. Based on preliminary surveys, the professional Ada community will comprise the initial base-line of services planned by AdaNET. Particular interest has been expressed in reusable software components and supporting value-added services, professional papers, and general information services such as market trends and contract opportunities. Development of these services must occur before expansion into later markets, such as the industrial and manufacturing markets.

The educational community does not represent a potentially high level revenue base. However, those colleges and universities that have established bases of Ada expertise will be some of AdaNET's most valuable sources of new research, development and emerging technology. For those institutions trying to gain Ada technology expertise, AdaNET's purpose will be to provide as much high quality, low cost information and support as possible, as they begin to incorporate Ada and software engineering into their curriculums.

The government market represents a highly stable, proactive environment for AdaNET's services. While AdaNET's stated purpose is the transfer of software engineering and government developed Ada software to the private sector, another implicit role that has emerged for AdaNET is to inventory available software within various government agencies. Much time has been spent in AdaNET's planning phase to determine the scope of existing Ada and software engineering information and related projects in progress at various NASA field centers. In discussions with DOC, NASA, and DoD organizations, it has become apparent that there is duplication of efforts within these organizations. AdaNET will provide a means by which these agencies can communicate to coordinate their Ada related activities. This information can be shared, allowing faster development and greater technological advances.

Entry into the industrial/manufacturing market will require a more prolonged effort. Significant pre-market education will probably be required for individual communities to see the direct advantages of applying software engineering/Ada technology to their specific applications. AdaNET will provide educational and consultant support for successful long term software engineering/Ada technology transfer in such areas as Paperless Order Processing (POP), Just In Time Inventory (JIT), CIM/FCIM, and other real time control systems.

2.3.6 Distribution Media

AdaNET services will be delivered through a variety of distribution media. On-line computerized AdaNET services will be available internationally through Mountain-

Net's network, as well as through internetwork gateways to commercial, educational and governmental telecommunications carriers. Other distribution formats will include hardcopy, magnetic tape, diskette and CD-ROM. A centralized point of distribution will be established for each medium. Wherever possible, MountainNet will seek alternate distribution channels, to increase the overall market base for its services. MountainNet is currently in discussions with distributors of CD-ROM information about potential use of existing distribution channels for AdaNET's CD-ROM based services. Similar possibilities will be examined in the diskette duplication market.

2.3.7 Complementary Services

Currently, there are few sources for the information services that MountainNet will be providing. Other sources of related information do exist, but those services either do not provide the same kinds of value-added services, or are limited in the range of information provided. MountainNet views the organizations listed below as potential partners in building AdaNET resources and providing additional complementary resources to the AdaNET user base. It is a goal of the AdaNET project to form cooperative relationships with any organizations that can provide valuable services to AdaNET subscribers. MountainNet will seek to provide services that complement and augment existing services rather than duplicate their efforts.

Publications and Bulletin Boards:

AdaData: A monthly publication by IRD provides information about market trends and commercial development in Ada software, services and equipment.

Ada Information Clearinghouse (AdaIC): An activity sponsored by the DoD AJPO, publishes a quarterly newsletter with information primarily about DoD related activities, as well as current developments in the Ada compilers and software tools market, and current events updates. Newsletters and other information are made available on a PC-based bulletin board system operated by the AdaIC. Since both AdaNET and the AdaIC are projects sponsored by the AJPO, both groups will work to coordinate their activities to avoid duplication of effort. Discussions are in process now.

Software Engineering and Ada Database (SEAD): An on-line database service operated by UHCL for JSC, NASA. As part of MountainNet's Phase I and II Statement of Work with UHCL, MountainNet has investigated ways in which AdaNET can augment the information contained in SEAD, and explore how SEAD could be made available through MountainNet's developing AdaNET network.

Ada Strategies: A monthly periodical by Cutter Publications providing information about the commercial and governmental Ada market, current events and trends. Ralph Crafts, editor of Ada Strategies, has recently signed a teaming agreement on behalf of his company, Software Strategies and Tactics, with MountainNet to provide marketing support to MountainNet for AdaNET development. These services may include general Ada market assessment, evaluation of AdaNET charges, services evaluation, and target marketing.

Software service activities (providing access to public domain software):

Alde Publishing: Operating a CD-ROM based service with duplications of the Ada Software Repository (ASR) and other public domain software, primarily serving the Minnesota market area, where its major users are Honeywell and CDC. No value-added functions are provided in analysis or support of the software.

Initial discussions with Alde Publishing have indicated that Alde would be highly interested in serving as a distribution channel for the CD-ROM services MountainNet will be establishing.

Army White Sands Ada Software Repository (ASR): Located on the Army's SIMTEL-20 node of the MIL-NET, and serving as the major clearinghouse for public domain DoD Ada software. The service provides on-line access to subscribers for a $2000 annual fee. Remote software requests from accounts on the Defense Data Network (DDN) are serviced, as are remote requests from educational networks. SIMTEL-20 and DDN accounts are limited to DoD organizations and contractors. Due to resource limitations, restrictions are set on the volume of software transmitted per request. Low level testing is performed on software, with no verification, metrics, or evaluation for potential reusability of subcomponents being performed. Due to the

volunteer nature of much of the service, there is typically a backlog of duplication requests.

Through discussions with Richard Conn, originator of the ASR, it was discovered that AdaNET can service the private sector with access to the the Ada software information that the ASR is providing to the defense market. ASR is currently receiving more electronic and written requests for software than it can effectively provide. Many of the incremental services AdaNET will offer, such as verification and metrics applications, are not expected to become standard ASR offerings. MountainNet currently has copies of the ASR as well as other software collections, such as the Common Ada Missile Packages (CAMP), available on its computer systems.

Computer Science Management and Information Center (COSMIC): NASA's repository for collected NASA software system that are general enough for redistribution to the public and private sectors. Both COSMIC and AdaNET receive funding from NASA's TU division. NASA TU has stated the need for cooperation between AdaNET and COSMIC. One way in which AdaNET could work with COSMIC is to provide on-line access to COSMIC's software directory, hence broadening COSMIC's marketing channels. Discussions are being held with John Gibson, COSMIC Director, about possible cooperative relationships. A Memorandum of Understanding between University of Georgia (COSMIC's operator) and MountainNet is currently being put in place, to identify service areas addressed by each organization and specific areas of interaction.

Science Applications International Corporation (SAIC): Currently under contract to STARS to provide no cost private sector access to ASR and Naval Ocean Systems Command (NOSC) software. This software is made available on magnetic tape. No value-added functions are provided in analysis or support of the software.

Proprietary Ada Software Libraries:

EVB Software Engineering's Generic Reusable Ada Components for Engineering (GRACE): Some proprietary Ada software libraries are now being marketed, of which GRACE is the most widely known. The components supply fun-

damental data structures and functions, indexed by a taxonomy refined from that proposed in the book, "Software Components with Ada", by Grady Booch. The components are tested, supported, and are highly portable. Costs for the system depend on the buyer's host computer. MountainNet believes that more companies will enter the reusable components market as that market matures.

2.4 Market Strategy

Based on the five key market segments previously identified, MountainNet has chosen two specific areas in which to establish its initial AdaNET service base:

- Ada Information Services (AIS), technology information services
- Dynamic Software Inventory (DSI), Ada reusable software and associated life cycle products

MountainNet is utilizing the following strategies to develop its technology base and gain exposure to the most current trends and developments, as well as to become integrated into the Ada culture:

- **Identification of existing NASA technologies:** This includes collection of publications and standards produced by various NASA field centers and divisions, identification of related projects and technologies, and communication with the individuals involved in such activities.

- **Development and broadening of AdaNET's support infrastructure:** MountainNet is creating organizations for the formal interaction of public and private sector entities with AdaNET. These organizations are the Federal Advisory Panel, the Technology Advisory Council, and the Business and Industry Council. Discussions with representatives of other NASA organizations, as well as other government agencies, will be ongoing. As part of this effort, AdaNET is participating in NASA's Software Management and Assurance Workshop and in the National Bureau of Standards' FEDMAIN working group. As a result of continuing discussions with the executive council of the ACM's SIGAda, the council has indicated interest in using AdaNET as their electronic communications medium.

MountainNet approach in developing AdaNET revenue structures is to offer affordable, general baseline services to a wide user audience and to provide incremental services at additional cost for high end or specialized user requests. The three major goals of this fee structure are to be able to provide a large amount of information across a wide variety of media, to keep individual user starting costs low, and to distribute part of the high costs of expense services across other low cost categories.

In order to stimulate AdaNET customers to become new sources of Ada technology for the AdaNET information base, the AdaNET services information group will develop special incentive programs. One possibility would be a system of AdaNET credit points. Users who submit new, reusable objects or refinements to existing objects could be awarded points based on the quality and quantity of their submissions. Point values could be periodically adjusted to reflect changing supply and demand needs in the inventory of reusable components. For example, bonus points could be offered during a specified time period to users who submit a particular component lacking in the DSI but in high demand from subscribers. These points would make the holders eligible for special recognition, additional benefits, and special services. This creative method of soliciting high-demand components has the potential to make AdaNET highly responsive to user needs.

In order to attract the professional markets previously identified, the AdaNET system must be established as a highly professional, "cutting-edge" technology service. To achieve this, AdaNET will demonstrate easily accessible information that is truly of value to computer professionals. Presentation of the DSI will emphasize the wealth of software available, as well as the inherent value of the AIS to the software development process. Presentation of AdaNET services will be of high quality and will set AdaNET apart from current information services.

MountainNet will promote AdaNET services through:

- Attendance at related major trade shows and conferences.
- Direct marketing to:
  - corporate organizations;
  - professional organizations;
  - consortia, such as the Software Productivity Consortium (SPC).

- Expanded technology transfer activities with additional government organizations.
- Survey and advertising materials in professional and trade publications.
- Utilization of existing distribution channels for the types of media provided by MountainNet through AdaNET.

2.5 Products

2.5.1 Description

Implementation of AdaNET services will continue over a two year period, with new services being phased in as other services are under development. The following is a listing and description of services currently planned.

Description	Target Service Date			
	Low Level	Prototype	Standard	High-End
Dynamic Software Inventory		01/90	01/91	01/92
Reusable Ada Software				
Other Life Cycle Objects				
Documentation				
Metrics				
Profile Information				
Reuse Database/Taxonomy				
Tutorials				
AdaNET Information Services	01/88	10/88	01/90	01/91
User Forums				
AdaNET Bibliographic System				
Educational Materials				
Electronic Communications				
Full Text				
Directories/Publications				
Other Repositories & Services				
Professional Support				
Consultant services			02/89	
Seminars and Workshops			07/89	

2.5.2 Dynamic Software Inventory (DSI)

The Dynamic Software Inventory (DSI) will provide access to both software and associated life cycle products, along with value-added services relevant to that software. Its design will allow users to view these objects across and within the phases of the life cycle. MountainNet uses the term Dynamic Software Inventory to distinguish this

service from that of a "repository". Like a repository, the DSI will store reusable components. However, unlike other repositories, The DSI will also store other life cycle products associated with the reusable components, such as requirements documents, design documents, and test plans. Also, the contents of the DSI will undergo constant improvement through the application of value-added services that include quality and performance testing, portability reports, and extended profile information. Furthermore, the DSI will contain built-in mechanisms by which users of the reusable components will be encouraged to make refinements to the components and resubmit them to the inventory.

Reuseable Ada Software: An inventory of public domain Ada software from NASA, DoD, other government organizations, and private sector sources will be evaluated for inclusion in the DSI. Wherever possible, associated life cycle products will also be incorporated in the DSI.

Other Life Cycle Objects: In later phases of the project, the inventory of reusable components will be expanded to include other objects from the software life cycle, such as requirements documents, test plans, and software specifications.

Documentation: Standard documentation accompanying software components and related life cycle products will be stored in the DSI. Standards or guidelines under evaluation for possible adoption include NASA's DID's (Ada version) and MIL-STD-2167A. For standard life cycle and AdaNET specific documents, AdaNET developers are considering the adoption of the SGML ISO standard to develop Document Type Descriptions (DTD) representational markup.

Profile Information: Each inventoried software object will have an associated profile. Current profile attributes include abstract, author, hardware/OS requirements, size, documentation status, portability report, etc.

Reuse Database/Taxonomy: Objects in the DSI will be stored in the reuse database using a faceted classification scheme, which will allow for a flexible design. The design of this database will be independent of the data model used to ensure that it will not be constrained by the current "state of the practice".

Tutorials: This consists of instructional information on the use of the DSI, and on the use of inventoried components.

2.5.3 AdaNET Information Services (AIS)

User Forums: A variety of bulletin board services, each relating to a general topic area will be developed. Current events, Special Interest Groups (SIGs), discussion forums, news, and product information will be offered.

AdaNET Bibliographic System: A bibliographic retrieval system for texts of interest to the software engineering/Ada community will be available. Information will be accessed by key field/key word search categories, including article and periodical/publication references and abstracts.

Educational Materials: Access to or information about educational books, video courses, overhead slide presentations and CAI tutorials and other types of educational materials about software engineering and Ada will be provided.

Electronic Communications: Standard electronic mail and document transfer services are available.

Full Text Information: Full text information relevant to software engineering, Ada and related technologies in the AdaNET library, that MountainNet is authorized to make available to AdaNET users, will be provided.

Directories/Publications: Printed information about software objects in the DSI, and regular user updates concerning new and/or improved AdaNET services and activities will be available.

Other Repositories and Services: Information about known public and private software repository activities throughout the country for both Ada and non Ada software will be provided. Such repositories include the ASR, and NASA's COSMIC.

Consultant Services: MountainNet's staff and those companies comprising the AdaNET support infrastructure will be available via AdaNET for specialized software engineering/Ada technology consultant services.

Seminars and Workshops: MountainNet will sponsor workshops, working groups, and conferences.

2.5.4 Spinoffs

As the AdaNET system evolves, other spinoff services will be pursued. Such services include:

- Consultant services to aid manufacturers in their transition from traditional technologies to Ada based CIM/FCIM technologies.
- Consultant services to private sector organizations in their development of reusable software components inventories.
- Expansion to the international Ada technology market; AdaNET may be able to serve as a technology transfer medium for software engineering and Ada technology developed overseas to the United States market.

2.5.5 Revenue Classes

Three revenue classes are being examined. Some services will be offered on a subscription basis, where levels of services are available for fixed rate fees; these services are denoted by an "S" in the following table. Other services are offered for incremental fees, denoted by an "I", allowing users to "pay as they go" for services not standard to their regular subscriptions. A third potential structure is full purchase of product, denoted by a "P", in which users buy a working application or other specific AdaNET product. The revenue classes listed below are for discussion purposes only at this time; final recommended revenue structures will be provided in the final report on Revenue Structures, which will be reflected in the final draft of this business plan. Services will be provided across a variety of media, which include: on-line computer access; CD-ROM distribution; magnetic tape; diskette; hardcopy; misc (including Teleconference and video media); and live support.

Revenue Classes for AdaNET Services

Description	Distribution Medium						
	On-Line	CD-ROM	Tape	Diskette	Hardcopy	Misc.	Live
Dynamic Software Inventory	ISP	SP					
Ada Software Components	IS	SP	P	PS			
Documentation	IS	SP	P	PS	P		
Metrics	IS	SP	P	PS			
Profile Information	IS	SP			P		
Reuse Database/Taxonomy	IS	SP					
Tutorials	IS	SP	P	P	P		
Information Services							
User Forums	IS				S		
Bibliographic System	IS	PS			PS		
Educational Materials	IS	PS	P	PS	PS		
Electronic Communications	S						
Full Text	I	PS	P	P	PS		
Directories/Publications					PS		
Outside Services	S						
Professional Support							
Consultant services							P
Seminars and Workshops							P

I = Incremental S = Subscription P = Purchased

2.6 Management

MountainNet's management team for the AdaNET project includes:

James W. Rautner	Project Director
Donn Philpot	Technical Director
Kevin J. Dyer	Strategic Planning
Linda K. Braun	Contract Administrator

2.7 Financial

The following pages detail MountainNet's projections for the first five years of the development of AdaNET. As can be seen, support for development of AdaNET services is provided by Univeristy of Houston - Clear Lake. Revenue generating services are phased in early in the second year of development. By year three, a strong base of services will be available and generating approximately 30 percent of the total operating costs. By year four, UHCL funding will account for less than 30 percent of the total AdaNET operating budget. By the fifth year, UHCL funding will account for less than 10 percent of AdaNET's total operating expenses. Major cost items, as MountainNet moves into prototype development,

Chapter 3

Technical Plan

3.1 Scope

This chapter is the Technical Plan for AdaNET Project Services implementation. The intent of the Technical Plan is to describe how MountainNet, Inc. will establish a software engineering and Ada technology transfer network. Further, it takes into account that the University of Houston – Clear Lake (UHCL), Research Institute for Computing and Information Systems (RICIS) has an in-place network of computing facilities. Additionally, this plan accounts for other networks which may be instrumental in the formation of this network. The network is called: "AdaNET: The Advanced Software Engineering Network for Ada Applications" to inform potential users of the general-purpose nature of the network.

This document first discusses AdaNET, including it's current configuration. Next, the functional requirements are detailed, followed by a statement of the tasks and deliverables MountainNet expects to produce. Additionally, quality and standards assurance are specified as part of this plan. Finally, the plan details the additional resources required to successfully implement this important technology transfer mechanism, including an organizational structure and a milestone and deliverable schedule.

3.1.1 Goal

The goal of AdaNET is to act as a change agent by transferring existing and emerging software engineering and Ada technology from the federal government to the private sector.

Attainment of this goal is based upon accomplishment of three primary objectives:

1. Develop a service center offering a wide spectrum of software engineering and Ada technological information services.
2. Achieve long term commercial independence through cost recovery measures.
3. Create a broad-based intergovernmental and private sector infrastructure to ensure continuing AdaNET services.

This plan concentrates on specifying implementation of the first of these objectives. Other documents generated during the first and second phases of this project will address remaining objectives.

3.1.2 AdaNET System Overview

AdaNET is divided into two main categories:

1. *AdaNET Information Services (AIS)*, which will incorporate user forums, bibliographic and full text information, educational materials, electronic communications, directories and publications, and information about other Ada repositories and libraries.

2. *Dynamic Software Inventory (DSI)*, which will be comprised of libraries of public domain Ada software components and their associated life cycle objects. Accompanying value-added services, such as the tracking and classification of these objects across and within the life cycle, will encourage and aid in the reuse of these objects.

These services will be provided on a wide spectrum of distribution media that include:

- CD-ROM
- Diskette
- Magnetic Tape
- On-line Access
- Printed Media

Figure 3.1 depicts the AdaNET Gateway/Clearinghouse Functional Overview

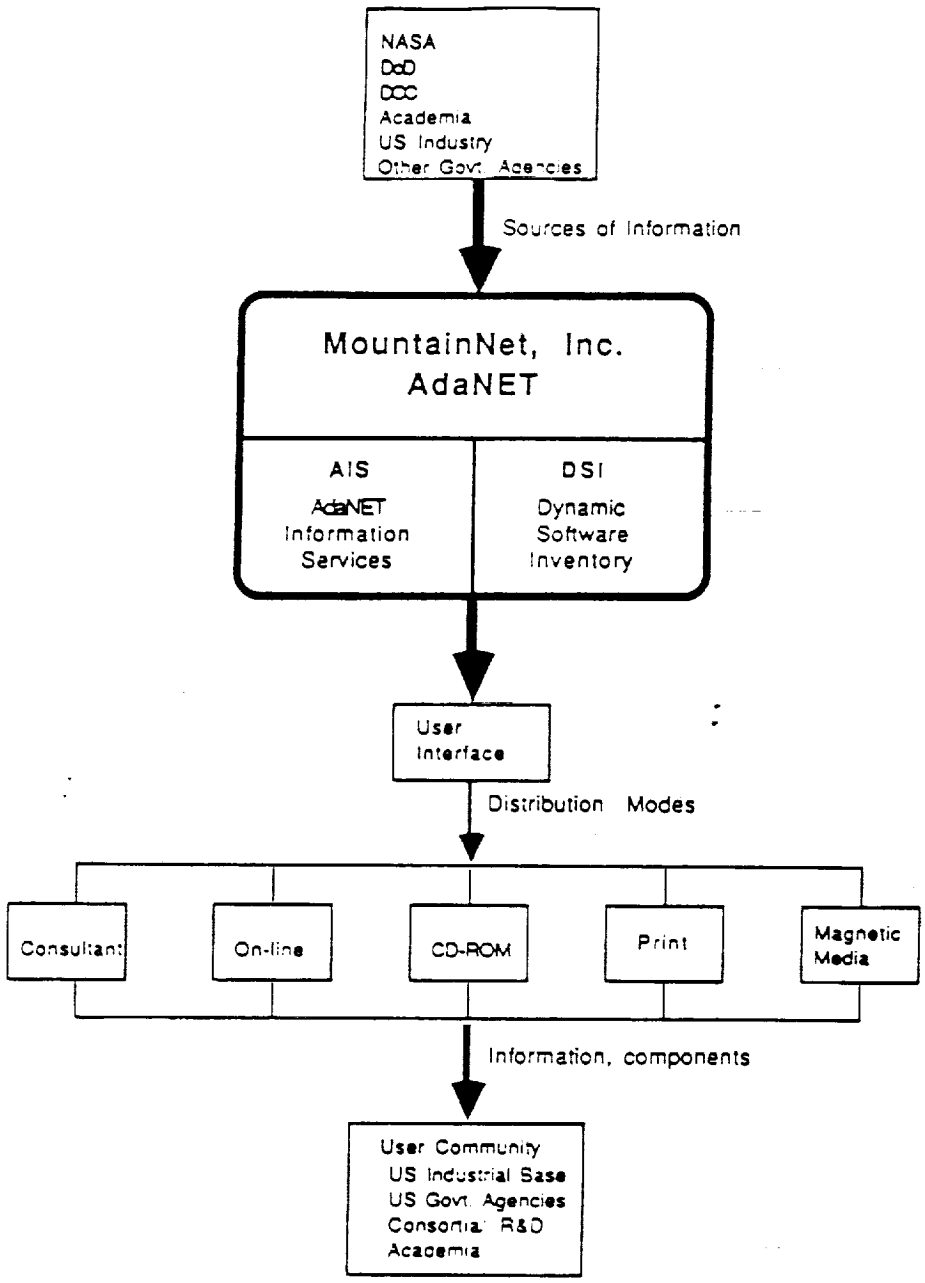


Figure 3.1: AdaNET Gateway/Clearinghouse Functional Overview

Participating Organizations Views

One of the earlier deliverables for this project was a report describing the views of several key organizations involved in the AdaNET program. These organizations were interviewed and their comments incorporated into that document. The organizations are:

- National Aeronautics and Space Administration (NASA) Technology Utilization Division (TU)
    1. Computer Software Management and Information Center (COSMIC)
    2. NASA Industrial Applications Center
    3. NASA Technical Applications Team
- University of Houston – Clear Lake, Research Institute for Computing and Information Systems
- Department of Defense Ada Joint Program Office (DoD AJPO)
- Department of Commerce, Office of Productivity, Technology and Innovation (DOC OPTI)
- Beckley College
- Software Valley Corporation (SVC)
- West Virginia University/WVU Research Corporation

To sum up the results of the meetings and information exchange, three federal government organizations funded the AdaNET project to:

> "increase U.S. competitiveness through the transfer of software engineering technology and government developed Ada software, to benefit the manufacturing, industrial, educational and other private sector communities"

These three organizations are the NASA TU, DoD AJPO, and DOC OPTI.

Applicable documents

The following list of documents have been previously delivered under the subject contract. This list is included for reference, and individual documents will be referred to by name in the body of this report.

- Subcontract No. 002, UHCL to MountainNet
- AdaNET Electronic Mail Service, Draft Users Guide
- AdaNET Organizational Structure and Report of Project Activity
- AdaNET Organizational Documents
- AdaNET Business Plan

3.1.3 Schedule Constraints

This section provides an overview of potential obstacles to the proposed schedule (See Section ??). This does not mean the schedule will change, only that MountainNet is aware of these possible disruptions and is taking management action to ensure schedule adherence.

Potential constraints that would serve to alter and extend the schedule of deliverables include:

- Interruptions in funding;
- Expansion or addition of elements in the statement of work (SOW);
- Delays in coordination and direction from government/private sector participants, where such interaction is necessary for deliverable development;
- Deferred developmental schedules in other federally funded projects whose deliverables support technical development of AdaNET services.

3.2 AdaNET Functional Requirements

This section describes the functional requirements for the AdaNET system. These derived requirements are based on input from the principal organizations supporting the project. (Section 3.1.2 delineated those organizations.) Requirements are discussed for:

- Networking and Communications;
- Hardware;
- Software;

- Data and Information Sources;
- Operational considerations;
- The Dynamic Software Inventory (DSI);
- The Reuse Database;
- The AdaNET Information Services (AIS).

3.2.1 Networking and Communications

This subsection addresses the need AdaNET has to establish and operate a network system in order to communicate with a potentially large population. It considers that in some instances, AdaNET will act as a stand-alone network with it's own dial-in capability. In other circumstances, AdaNET will be required to be a part of a larger, heterogeneous network. The latter will be discussed in subsection 3.2.1 and in section 3.3.7, "Growth Plan for Additional Services".

Existing Elements

MountainNet's current telecommunications configuration provides on-line computer access to host systems available within the MountainNet telecommunications network, as well as host systems located in state supported telecommunications networks. Access is provided through remote user node sites connected directly into the MountainNet network with dedicated data circuits, and through local dial-in telephone lines located throughout West Virginia.

Access to MountainNet host systems, such as those forming the AdaNET host configuration, is currently available through MountainNet's own dial-in lines, through all state educational network (West Virginia Network for Educational Telecomputing (WVNET)) dial-in lines, and by cooperative agreement, through a Telenet connection currently providing direct access to the WVNET DCA network server. Current volume capabilities for the Telenet link are 15 simultaneous users; this number will be increased as usage justifies further expansion.

Planned Expansion

Systems Interconnectivity: Plans are being finalized for internal network interconnection of all host systems used to develop AdaNET. A configuration which allows a high level of interconnectivity includes use of a commercial off-the-

shelf star network controller. This controller supports Ethernet and TCP/IP (Transmission Control Protocol/Internet Protocol) communications. Additionally, layered communications software, supporting electronic mail transfer between many vendors hardware products and operating systems is also included. Specialized software is under development to support electronic mail transfer between Digital Equipment Corporation (DEC) Virtual Memory System (VMS) and Data General (DG) Advanced Operating System/Virtual System (AOS/VS) host systems currently in the configuration. For full support of direct intersystem disk access and data transfer, an additional package would be layered on top of the star controller, providing complete DEC/DG compatibility. This controller may be connected directly into the MountainNet network, to provide network level single point access to AdaNET users for all on-line services.

Direct Telenet Connection: This service provides direct connection to MountainNet's network at the Telenet prompt level for AdaNET users. A final step is to route users directly to AdaNET specific front-end network controllers. The user is then prompted for specific AdaNET systems.

MountainNet Network Expansion: For those areas where a substantial base of AdaNET users exist, MountainNet will establish dedicated lines to support them with a higher level of telecommunications service than that provided by Telenet. Direct connections are currently being discussed for:

Washington, D.C.: For Government Access
Clear Lake, TX : For UHCL and Johnson Space Center (JSC)

Other potential areas of high level usage during subsequent phases of implementation include:

Huntsville, AL : For Marshall Space Flight Center (SFC)
Boston, MA : To provide computer vendor coverage
Pittsburgh, PA : For the Software Engineering Institute (SEI)

NASA Networks Interconnection: AdaNET is serving the diverse Ada community which includes NASA, DoD, academia and the private sector. However, the majority of AdaNET users already communicate on one or more electronic mail systems. The users of AdaNET include key individuals from diverse (and unconnected) telecommunications systems. Introduction of another autonomous mail system presents an obstacle to the community already using these other networks. Therefore, in addition to building its own internal base of AdaNET user accounts, MountainNet is studying how inter-network connections can be established to provide electronic mail transfer as a minimum level of service, without compromising system security.

The volume of development activities using Ada technology at various field centers is radically increasing. The inter-network connection would facilitate communications with these centers and heighten the availability of Ada technology developments to AdaNET users.

MountainNet is currently studying the NASA network structures in place at various field centers and the network architectures which currently link those centers together. MountainNet will determine the feasibility of this network connection.

The NASA Scientific Network, which is also supported in part by the National Science Foundation (NSF), is an example of a gateway which will be pursued because it is intended to provide a mechanism for public/private sector technology exchange. This network is TCP/IP based, and so connection will be supported by the equipment currently being integrated into the configuration. Administrative and policy issues regarding approval for connection is also being pursued.

Internet/DDN Connection: A connection to the DoD Defense Data Network (DDN) is essential to maintain and enhance the base of support being provided by various DoD organizations. The majority of the national Ada community is affiliated with the DoD, either as military, government, or contractor/subcontractor personnel. With ongoing and proposed expansions in DoD based Ada programs, this linkage will facilitate a higher level of activity and cooperation between AdaNET and the Ada community. SIGAda, whose executive council is trying out the AdaNET as their major communications source, has indicated that such a connection is essential for continued use, since a large

percentage of their membership currently use the Internet. Discussions with the U.S. Army Office of the Directorate for Information Systems for Command, Control, Communications and Computers (ODISC4) led to the recent signing of a Memorandum of Understanding (MOU) between NASA and the Army to support AdaNET development. A key objective of this MOU is to expand the base of support for AdaNET's connection to the Internet with other Army activities such as the Information Systems Engineering Command (ISEC). MountainNet is currently evaluating the telecommunications and software requirements necessary for this connection.

USENET Communications: USENET information transfer occurs through a WVU DEC/VAX system. As the AdaNET Information Services (AIS) system is developed, MountainNet will task one individual to conduct regular checks of the USENET information. Information which is relevant to the AdaNET user community will be transferred to the AIS. An expansion of the AdaNET level of service includes direct connection of USENET into the MountainNet network. This will provide regular access to this resource.

SEAD Connection: By establishing a data line with local dial-in in the Houston area, MountainNet will be able to provide a direct link for interconnection of the SEAD (Software Engineering and Ada Database) system operated by UHCL. This connection will make SEAD available to any AdaNET user at the network prompt level as another available host node and service. Building this distributed network of host services enhances the direction of growth and increases the value of AdaNET as a single point of access to a multitude of diverse services.

OSI Integration: As the Open Systems Interconnect (OSI) protocol is implemented at all levels, we will study the feasibility of integration of that protocol into AdaNET. An applications gateway between the mail layer and the file transfer layer of the TCP/IP and OSI protocols is being developed for the DoD. DoD

plans to require that all future procurements be based on OSI protocols. Integration of an OSI implementation for AdaNET would most likely occur sometime after such requirements became mandatory.

Figure 3.2 depicts AdaNET Network Connectivity.

3.2.2 Hardware

This subsection describes the current hardware configuration for AdaNET. It describes each element and details future hardware requirements to ensure continuing viability.

Present Configuration

MountainNet utilizes a multi-vendor systems environment for services implementation. The following resources for early prototyping and implementation are planned:

- (1) Digital Equipment Corporation VAX 11/780 (VMS).
- (1) Digital Equipment Corporation VAX 11/750 (VMS/UNIX)
- (1) Data General MV8000 (AOS/VS)
- Various micro-computers (Apple & IBM PC compatibles)

The systems are being used in the following capacities:

DEC VAX 11/780 (VMS): This resource is MPL Corporation's VAX time-share service. The system is configured on-line into the MountainNet network. It is initially being used to provide access to the AIS Prototype. However, the addition of AdaNET services on this resource intensive service will tax the system beyond manageable limits. Although AdaNET's internal administrative computing will continue to be performed on this system, additional resource requirements are expected.

DEC VAX 11/750 (VMS): A DEC VAX 11/750 may be merged into the AdaNET configuration for dedicated AdaNET use. This system will initially provide a migration point from the VAX currently in use, and will offer services for prototyping and development.

DEC VAX 11/750 (UNIX): Use of a DEC VAX 11/750 UNIX is being provided as part of the WVU Statistics and Computer Science in-kind contribution to AdaNET development. This system will be used to develop initial software testing and analysis for the Dynamic Software Inventory (DSI) components. The system will be available through AdaNET.

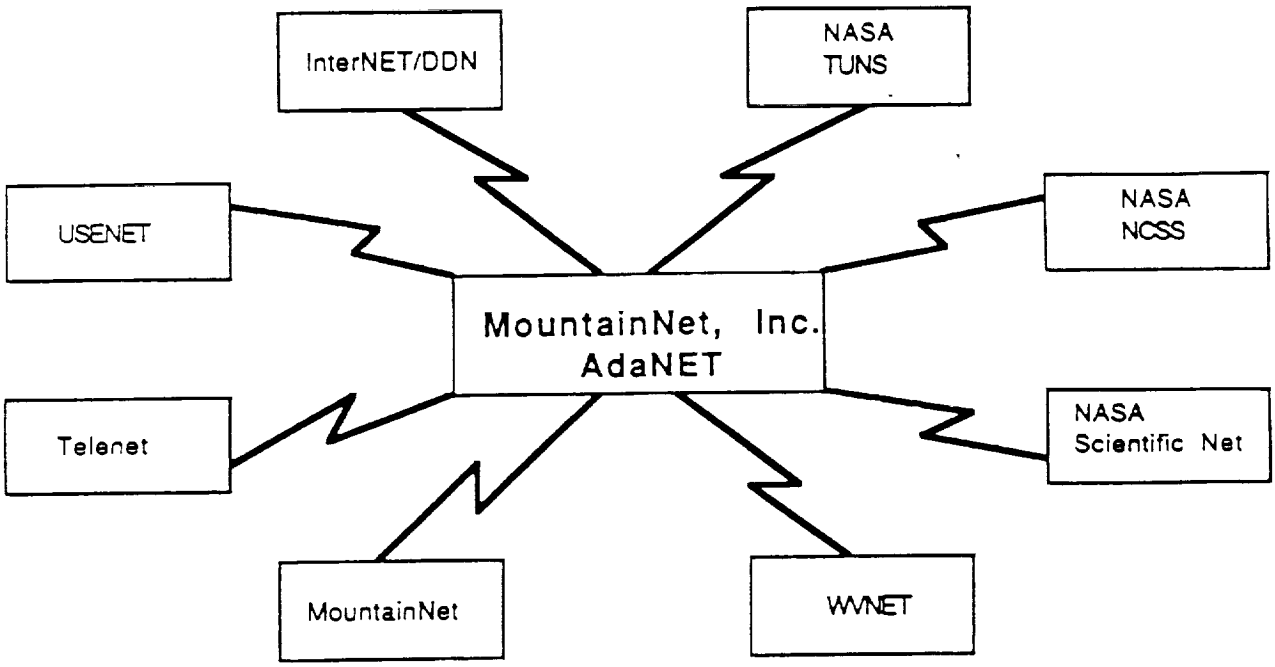


Figure 3.2: AdaNET Network Connectivity

Data General MV8000 (AOS/VS): MountainNet's system, equipped with multiple disk controllers, high volume storage and DG's Ada Development Environment (ADE) is being used for storage, compilation and evaluation of Ada Software Repository (ASR) components. Through planned network expansion, this system will serve as the main resource for implementation of the object retrieval system of the DSI.The systems interconnection allows development of applications to support data transfer between the DG storage system and the DEC VAX/VMS system, with complete transparency to DSI users. Low level access to components is being established so that users can obtain copies of repository software which have not been entered into the DSI.

Future Expansion

Service expansion will require continuing system enhancement and development. MountainNet's long term systems strategy is to study the possibility of utilization of a combination of the following hardware resources:

DEC VAX 8500 (VMS): As the first tier of services are developed and made commercially available, volume usage is expected to exceed the capacity of the VAX 11/750. It will either continue to serve as an internal development machine, or be networked with other AdaNET host systems and provide continuing services support. The main user interface system(s) used to access the Dynamic Software Inventory (DSI) and AdaNET Information Services (AIS) will require the level of resources provided by a machine of this class. After analysis of the mix of users of various services, an alternate strategy may be to establish multiple host systems providing one or more related services and to segregate those services which require competing types of resources.

Harris HCX9 (UNIX): Network access is being expanded for this system in the WVU configuration. Resources will be utilized on this system to support AdaNET as part of WVU's in-kind support. This machine may also be utilized for development of automated code testing and evaluation processes.

Terradata DBC/1012: MountainNet expects growing storage requirements within the next two years of development. We are looking at various mass storage and database machine technologies to support the DSI software library. Currently, both the relational and object oriented database models are being researched. If the relational model is chosen, the Terradata machine will be considered.

Terradata represents one of only two major producers of database machines (the other being Britton-Lee). Use of this type of machine architecture is preferable to use of other mass storage technologies, such as Optical Disk/WORM (Write Once/Read Many) Storage and Retrieval systems, which are not designed for dynamic use. Terradata's Shared Information Architecture system provides connectivity to a variety of processing environments and information tools. The DBC/1012 can be connected to multiple host mainframes at the same time.

Figure 3.3 depicts the proposed AdaNET configuration.

3.2.3 Software

This subsection describes software acquisition and development activities for AdaNET. It includes software which may be available in the public domain.

Off-the Shelf

The following Commerical Off-the Shelf software is either required or being evaluated to support services delivery:

Digital Equipment Corporation DECnet network software: This software will be supported on all MountainNet VAX systems in its configuration, which will provide DECnet-level connectivity between VAX and Data General system resources, allowing disk to disk information access.

Ki Research DEKnet network software: This software, layered on top of an Ethernet carrier, will integrate with DEC DECnet software, providing systems interconnectivity between AdaNET host DEC and DG systems. It will be supported on MountainNet's Data General MV8000 (AOS/VS) system.

Relational Database Management System: Commercially available relational database management systems (RDBMS) are being evaluated for supporting the design and implementation of the reuse database, which provides the object inquiry facility of the DSI. Should a database machine become available, the design of the

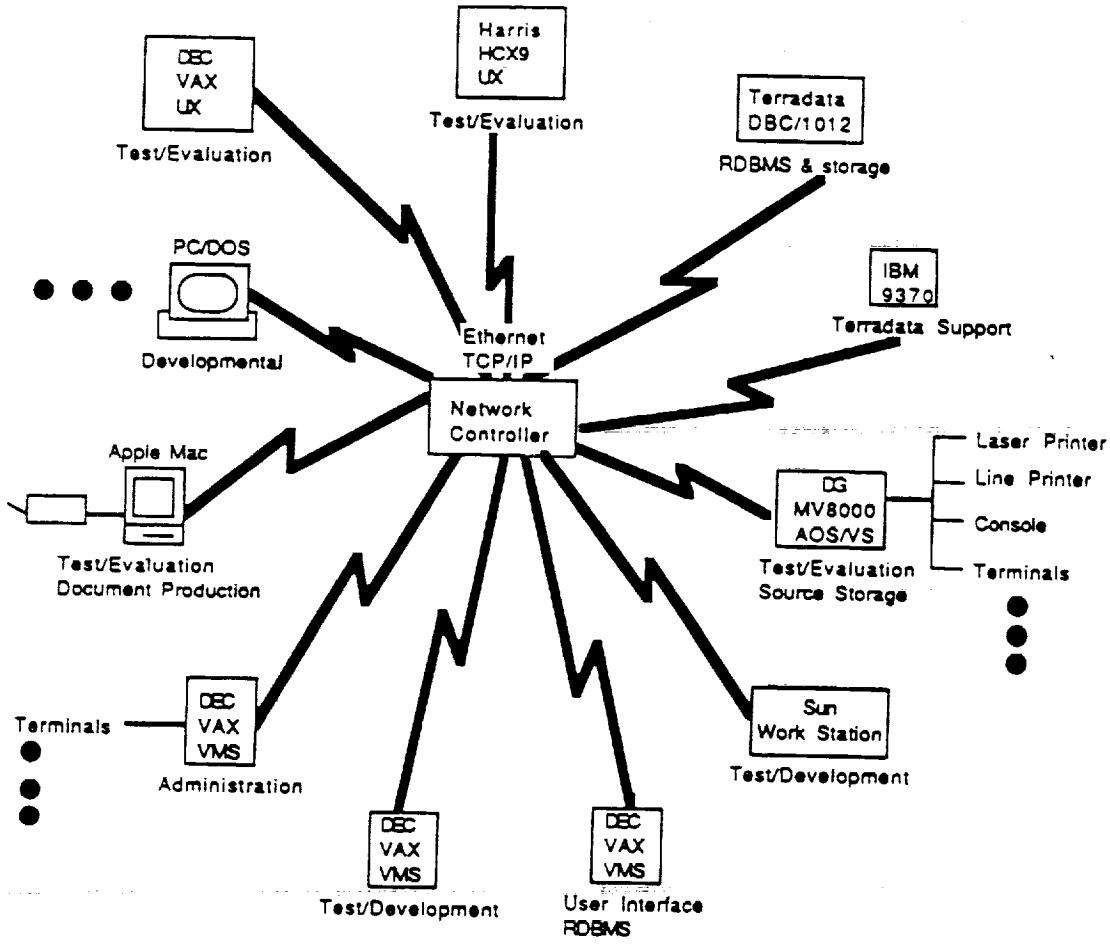


Figure 3.3: AdaNET Proposed Systems Configuration

database would be easily transferrable to that machine. Should the relational model be chosen, only RDBMS' that support Structured Query Language (SQL) will be considered. As part of the evaluation, RDBMS' implemented in Ada will be examined, such as CRI's Relate 3000.

Ada/SQL Binding: The development of satisfactory Ada/SQL bindings has become a major topic in the Ada marketplace. Should they become available, AdaNET will utilize Ada/SQL bindings that are being developed as part of the Software Technologies for Adaptable, Reliable Systems (STARS) tools development programs.

Configuration/Library Management: The AdaNET staff will utilize, wherever possible, tools developed in other government supported programs for configuration and library management. Programs sponsored by STARS, such as the Army Institute for Research in Management Information, Communications, and Computer Science program (AIRMICS), may yield valuable toolsets.

Text Retrieval System: To support the provision of specific areas of the AdaNET Information Services (AIS), evaluation of various text retrieval database systems are being conducted. One package that is being closely evaluated is the INMAGIC package, developed by INMAGIC, INC.

DCDS/Ada: Members of the AdaNET staff are currently beginning evaluation of the DCDS/Ada (Distributed Computing Design System) distributed Ada development environment, whose development is being supported by the Army STARS initiative.

SGML Implementation: A commercially available copy of Standard Generalized Markup Language (SGML) will be obtained.

Development Tools and Environments: AdaNET is also evaluating other support tools and environments that may support internal software development activities. Such products will include EVB Software Engineering's Ada MacHost product,

Iconix Software Engineering's Powertools system, and the Distributed Ada Programming Support Environment (DAPSE) project software under development by the Army STARS initiative.

Developmental Activities

Software to be developed for AdaNET includes:

- User interfaces
- Automated Software Testing Tools
- Software Retrieval System Applications Software
- Configuration/Library Management Tools

3.2.4 Data and Information Sources

This subsection details the sources of life cycle products which will become part of the Dynamic Software Inventory (DSI), specified in subsection 3.2.6. It describes the known repositories to which MountainNet has access and permission to include.

Life cycle products are being solicited from a variety of sources that include public domain libraries, software projects which are obtained directly from developers as they evolve, and proprietary sources.

Current sources of non-classified components include:

NASA sources:

- Space station software (Software Support Environment (SSE), etc.)
- Products of Software Reuse Environment
- COSMIC
- Other major NASA development activities

DoD – STARS

- Foundations
- Competing Primes

- Shadows
- Future repositories established by STARS Army
- SIMTEL-20 Ada Software Repository (ex., Worldwide Military Command and Control System (WWMCCS))
- Reusable Ada Packages for Information Systems Development (RAPID)
- Specific software development programs (ex., MAFIS) Air Force
- Naval Ocean Systems Command (NOSC) library (primarily included in the ASR)
- Naval Research Laboratory (NRL) STARS Foundations software
- Specific software development programs (ex., AWHMS)

DOC

- National Bureau of Standards (NBS): automation primitives and tools taxonomies, CIM/FCIM (Computerized Integrated Manufacturing/Flexible Computerized Integrated Manufacturing) Ada systems development

Department of Transportation

- Federal Aviation Administration (FAA): All new systems will be developed using Ada

Private sector sources with whom MountainNet is establishing operational agreements.

AdaNET is continually working to increase new sources of Ada components and repositories.

Figure 3.4 depicts the initial sources of life cycle products.

3.2.5 Operational Considerations

In addition to the purely technical considerations for requirements, the AdaNET project must also address the boundaries of day-to-day operations. This is due to the outreach nature of AdaNET. In order to implement the service, items must be addressed which are not necessarily germane to the successful operation of a networked database systems.

This section addresses eight important operational considerations and their impact on AdaNET. These are:

- the expected volume of data and usage;
- distribution of information beyond on-line computing;
- a user-assistance function;

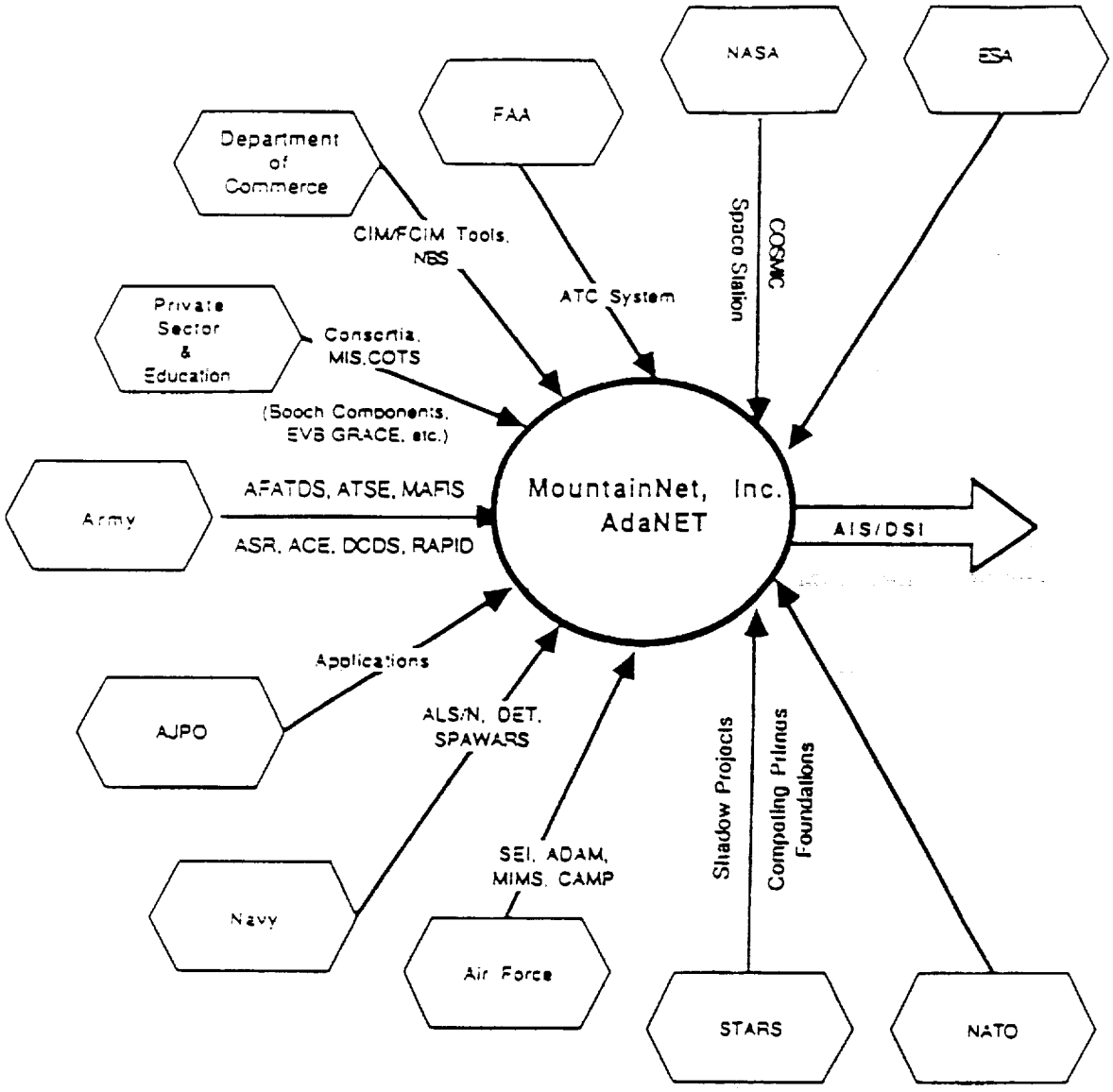


Figure 3.4: Sources of Software Engineering and Ada Technology

C-2

- user billing;
- telephone support for user questions;
- user documentation;
- on-line access methods;
- microcomputer access.

Expected Volume

MountainNet expects a user base of 250 usernames by 12/88. Based on statistical samples of current accounts/users, we can expect approximately 20 simultaneous users on AdaNET.

AdaNET will track usage profiles over time in order to determine the optimum mix of resources for future expansion.

Distribution Media

Users of AdaNET will not only be able to access information on-line, they will also be able to receive information through other media, in a variety of formats. Media currently planned are:

- CD-ROM
- Diskette
- Magnetic Tape
- Printed matter

Additional media will be made available as the desire for them is expressed. The information will be made available on CD-ROM/Magnetic tape to interested parties, thus allowing users to reduce on-line access and connect time charges. As preferences for formats shift over time, MountainNet will modify its support accordingly. In this way, the value-added nature of AdaNET will be free to expand the boundaries of service in response to user needs.

User Assistance

Due to the service-oriented nature of AdaNET, we can expect a high level of client interaction. This means that MountainNet plans to establish administrative and operational procedures to ensure that each AdaNET client receives the service necessary to promote usage, goodwill and expanded knowledge of AdaNET environment.

From a revenue perspective, user support must be included as a key element in billing algorithms. Most likely, AdaNET will spread the cost of user support among all clients, as a percentage of system access usage. In this way, we can be sure that full service will be provided to each client and that no client will suffer from a lack of human resources.

Service Revenue Structures

The AdaNET project will gather usage information whenever clients log onto the system. This data will account for:

- Log-on time;
- Log-off time;
- Number of disk accesses;
- Amount of data down-loaded to users' systems;
- Different types of information retrieved.

MountainNet will use this information to examine different pricing algorithms.

Whenever possible, revenue structures will be established that will allow simple and affordable low-level access charges using combinations of subscription, purchase, and incremental charges. For a more complete discussion of revenue structures, please refer to the AdaNET Revenue Support Structure report prepared as another deliverable item to UHCL.

Telephone Support

On-line telephone support will be provided as needed to AdaNET users, giving help in the use of system services, with more detailed help available for use of specific services (such as the DSI and other library services). This support is available now, and is being provided for the services currently available. As new services are made available, support requirements are expected to increase.

User Documentation

User documentation is one of the most important requirements for AdaNET. Primarily, it is the means by which each user will be able to access and utilize the AdaNET resource.

On-Line Access

The AdaNET system user interface being developed satisfies several major requirements [Shneiderman]:

- proper functionality
- reliability
- availability
- security
- integrity
- schedules
- budgets

The development team is determining the tasks and subtasks the interface needs to perform. Functionality of this interface includes those tasks needed to tie users to applications and/or databases. Compatibility of the interface with different vendor machines that may be used to access AdaNET services will be a major consideration during interface design.

Human factors determined through MountainNet's experience in analysis of behavioral patterns and responses of the many diverse interactive user groups in its user base, as well as current research, form the foundation for design of the AdaNET interface. These factors include:

- time to learn
- speed of performance
- rate of errors by users
- subjective satisfaction
- retention over time

The AdaNET interface will be designed for both ease of learning in a short period of time and full functionality for the experienced user. Rules governing this interface design are:

- Consistency: Response conventions will be the same throughout the system.
- Shortcuts: Frequent users will be able to use shortcuts to more rapidly traverse the system.
- Offer informative feedback: Respond to all the user actions.

- Design dialogs to yield closure: Each group of actions has a beginning, middle, and an end. Users receive proper feedback at the close of the group of actions.
- Simple error handling: The system will be designed to avoid serious errors by users. If errors are made, easy error handling mechanisms will be provided.
- Easy reversal of actions: Actions will be reversible wherever possible.
- Internal locus of control: Give users a feeling of control over the system, making them initiators of actions rather than responders.
- Reduce short-term memory load: Users should not have to remember more than seven plus/minus two items at any given time. Help will always be available to assist users with code mnemonics and sequences of actions.

AdaNET's standard interface environment will use elements of most of the major current interaction styles at various levels of the system. Current interaction styles include:

- Menu selection: Allow users to choose among several options.
- Form fill in: Users fill in blanks and the cursor is automatically moved using predefined keys.
- Natural language: Users construct queries in their natural language, which are then interpreted by the system.
- Direct manipulation: Users are allowed to manipulate objects on the screen directly using a pointing device.

Microcomputer Access

In addition to providing on-line access to repository components, the AdaNET development team plans to implement a stand-alone microcomputer version of the Dynamic Software Inventory (DSI), utilizing graphic, windowing, and mouse interface capabilities.

This interface will initially be developed for the Apple MacIntosh, using the Toolbox provided by Apple. The Toolbox supports design of windows, dialog boxes, drop

down menus and some direct manipulation techniques. The Telegen2 system, developed by Telesoft, is being considered as a way to develop this interface. The Ada Compiler and related tools developed by Meridian Software Systems, Inc. and Alsys, Inc. are also being investigated. Telesoft and Meridian are developing an interface to the Macintosh Toolbox, and have developed a compiler for the Macintosh II system.

3.2.6 Dynamic Software Inventory (DSI)

This subsection describes design parameters for a Dynamic Software Inventory (DSI). It discusses the background and rationale for the DSI.

Background

The DSI will provide access to both life cycle objects and value-added services relevant to those objects. Its design will allow users to view objects across and within the phases of the life cycle. Furthermore, mechanisms will be developed within the DSI to encourage users to submit their own life cycle objects for inclusion in the DSI.

Reuseable Ada Software

An inventory of public domain Ada software from NASA, DoD, other governmental organizations and private sector sources will be evaluated for inclusion in the DSI. Wherever possible, associated life cycle products will also be incorporated in the DSI.

Other Life Cycle Objects

In the process of software development, various life cycle products are generated, such as requirements documents, design documents, and test plans. In later phases of the project, the inventory of reusable objects will be extended to include these products.

Documentation

Standard documentation accompanying software components and life cycle products will be stored in the DSI. Standards or guidelines under evaluation for possible adoption include NASA SMAP DID's (Ada version) and MIL-STD-2167A. For standard life cycle and AdaNET specific documents, AdaNET developers are considering the

adoption of the SGML ISO standard to develop Document Type Descriptions (DTD) representational markup.

Metrics

As objects pass through quality and performance tests, metrics will be collected to yield relative values in specific areas tested. Such information will be provided to users searching for objects in the reuse database as part of the extended profile information for objects in the DSI. Such information may help users to restrict their selection prior to making requests for object retrieval.

Profile Information

Each inventoried software object will have an associated profile. Current profile attributes being examined are:

- Identification Code
- Abstract
- Author
- Developing Organization
- Point of Contact
- Hardware/OS Requirements
- host
- target
- integration
- Compiler/Version
- Size
- Documentation Status
- Portability Report
- pragma usage
- dependencies on vendor supplied systems
- usage of low level I/O, memory addressing, etc.
- Problem Report

Reuse Database/Taxonomy

Objects in the DSI will be stored in the reuse database using a faceted classification scheme. This scheme will allow for a flexible database design. The design of the database will be independent of the data model used to ensure that it will not be constrained by the current "state of the practice". Guidelines for design will closely follow the EA/RA model and IRDS.

Retrieval/Duplication

Objects inventoried in the DSI may be retrieved through either on-line access or distribution media such as magnetic tape, diskette, or CD-ROM. For objects not available on-line in the DSI, on-line order processing will be provided.

Tutorials

This consists of instructional information on the use of the DSI, and on the use of inventoried components.

3.2.7 AdaNET Information Services (AIS)

This subsection describes the requirements for the AdaNET Information Services. Each of the separate databases will be structured according to the information contained in them. A common command structure will provide the powerful text retrieval access necessary and will function at the level of expertise desired by the user.

User Forums

A variety of bulletin board services, each relating to a general topic area will be developed. Current events, Special Interest Groups (SIGs), discussion forums, news and product information will be offered.

AdaNET Bibliographic System

A bibliographic retrieval system will be available for texts identified as related to Ada and software engineering technologies. Some of the covered topics will comprise

technical subject areas, costing and market information, and information available on related subject areas such as CIM/FCIM. Information will be accessed by key field/key word search categories, including article and periodical/publication references and abstracts.

Educational Materials

Access to or information about educational books, papers, video courses, overhead slide presentations, CAI tutorials and other types of educational materials about software engineering and Ada will be provided.

Electronic Communications

Electronic mail and document transfer services are available.

Full Text Information

Full text information relevant to software engineering, Ada and related technologies in the AdaNET library, that MountainNet is authorized to make available to AdaNET users will be provided. News and current events information will be included here.

Directories/Publications

Printed information about software objects in the DSI, and regular user updates concerning new and/or improved AdaNET services and activities will be available.

Other Repositories and Services

Information about public and private software repository and information activities throughout the country for both Ada and non Ada software will be provided. Such repositories include the SIMTEL-20 ASR, NRL STARS repository, and NASA's COSMIC. Such information will include general information about the services provided by each of these facilities. Information regarding access and/or ordering, and in some cases, on-line or distribution access to software obtained from these sources (such as the ASR) will be supplied. However, software provided at this level of service will be virtually in an "as-is, buyer beware" format, and should not be confused with services

provided through the DSI. This service is being made available to provide early access to Ada software currently in demand by the private sector, in the interim period during implementation of the DSI. Other information services may include access to SEAD and the Ada Information Clearinghouse (AdaIC).

3.2.8 Access Security

All systems now available on the MountainNet network have implemented tight systems security measures to insure the integrity and reliability of user data and applications. Security measures currently in place provide satisfactory protection; no breach of security has ever been experienced. However, as systems in the AdaNET configuration establish increasing visibility in the computing world, the highest level security possible must be implemented. As was stated earlier, the information on host systems available on the MountainNet network is unclassified. There are no plans to incorporate systems carrying classified information. Systems security measures are in place to insure privacy, integrity, and safety of user information stored on host systems, and in protecting host systems from the introduction of "worms" and "viruses" into the systems. Prior to making AdaNET services commercially available, it is anticipated that a security audit, conducted by an outside consulting firm, will be run, to reinforce current measures.

Current systems security for systems in the AdaNET configuration include:

- Regular mandatory password changes
- Multiple passwords for privileged accounts, or accounts where requested.
- Restricted system privileges to a very few users in administrative positions and with a need for such privileges; on all systems currently in the configuration, only three users have such privileges for each system.
- Tightly controlled public accounts: accounts that are "public" (that have no password required for entry) give tightly controlled access to specific applications. Defensive measures are in place to ensure that users cannot "crash" these applications and obtain system entry. For planning of AdaNET systems services, public accounts (for applications for information or market survey collection), may be established on stand-alone systems (such as microcomputers) to insure main host systems security and internetwork systems security.

- Tightly controlled user accounts: as with public accounts, defensive measures are in place to provide secure user interactions.
- Archiving and backup that includes:
    1. Daily incremental backups of all systems
    2. Weekly system wide backups of all systems
    3. Off-site storage of backup tapes in secure environments
    4. Off-site storage of copies of archived information
    5. Contingency plans for backup systems to support the critical users, in case of disaster.

Continuing study and implementation of enhanced security measures should be performed.

3.3 Tasks and Deliverables

This section describes the tasks to be performed and the deliverables to be generated for this Technical Plan. It details the work to be performed and MountainNet's approach to its completion, which is in the form of specific deliverable items. These are:

- AdaNET System Design
- Data Gathering
- System Documentation
- AdaNET Information Services (AIS)
- Dynamic Software Inventory (DSI)
- Initial Network Introduction
- Growth Plan for Additional Services
- Spinoffs

3.3.1 AdaNET System Design

MountainNet views the design objectives of the AdaNET system as; 1) the storage of data and information in the most efficient manner for retrieval, and 2) the enhancement of interface functions to allow users to perform inquiries in the most effective

manner. The AdaNET system is comprised of two main functional areas; the AdaNET Information Services (AIS) and the Dynamic Software Inventory (DSI). Each of these are dealt with in subsequent portions of this document.

3.3.2 Data Gathering

Data gathering will be an ongoing, dynamic process for AdaNET. Initial efforts will be important to the successful introduction of the service. To that end, MountainNet expects to perform a marketplace survey to determine the optimum mix of information for inclusion. In this way, early efforts can be expected to provide useful data to the user community and ensure AdaNET's early acceptance. This marketplace survey will be conducted among the most likely current users of software engineering and Ada technology. Specifically, MountainNet expects to survey and interview key individuals and organizations involved in SIGAda, AdaJUG, and academic institutions with ties to Ada and software engineering such as UHCL, Carnegie Mellon University, WVU, the University of Georgia, and the University of Maryland.

Interviews will be conducted with NASA TU and field center programs developing Ada technology applications, AJPO, STARS program and other DoD organizations including service labs and operational programs. Finally, MountainNet will contact it's largest potential constituency, aerospace and defense contractors. In order to ensure future potential growth, we will also interview the commercial divisions of these same companies. This will help determine the potential for commercial applications such as industrial and manufacturing automation.

3.3.3 System Documentation

System documentation for AdaNET will take the form of descriptive, operational and maintenance information.

Descriptive information will include all organizational, business and technical plans called for under Subcontract No. 002 for RICIS project No. SE 18. These documents also include a schedule of user fees, and the agreement documents required to conduct AdaNET business activities.

Operational documentation will include the users guide; preliminary and detailed database design documentation; operational manuals for communications, data entry and update; and hardware/software Configuration and operational instructions. Maintenance information includes those items necessary to correct, enhance, or adapt

the system. In addition to design documentation, detailed design requirements will be supplied. This documentation will be delivered as AdaNET is funded and the development program is underway. These documents will form an early deliverable on future program phases.

3.3.4 AdaNET Information Services (AIS)

This section discusses the design of the AdaNET Information Services. The AIS is the cornerstone of the AdaNET system. It represents that portion of AdaNET that we believe will yield immediate benefits as a technology transition and cost recovery mechanism. Further, AIS will provide a gateway function into the Dynamic Software Inventory (DSI) and other AdaNET services.

Clearinghouse functions are primarily dependent on the information and data provided by the clearinghouse itself. Therefore, a key element in design of the AIS is the data gathering and database design functions discussed in section 3.3.2 and in section 3.2.6. Planning these functions is tantamount to the preliminary design. The following paragraphs describe the minimal design frameworks for the AIS.
The following services have been defined:

- Bibliographic Information
- Electronic Communications/Document Transfer
- User Forums
- News & Current Events
- Other Repositories and Services
- Special Interest Groups
- Full Text Information
- Educational Materials
- Directories/Publications

The AdaNET Information Service (AIS) will provide a wide spectrum of information services to its user community. These services will be provided through on-line access and a mix of printed, CD-ROM, diskette and magnetic tape media.

The following paragraphs describe each service category and the projected first stage service offerings.

Bibliographic Information: This need will be met through a combination of AdaNET's library references and with existing library catalogues such as the SEI's library and publication lists from user forums and workshops. This feature will allow the user to glean information specifically regarding Ada, software engineering and related subjects and applications.

Electronic Communications/Document Transfer: Systems mail utilities will form the core service mechanism, linked to the applications user interface. When internetwork gateways are established, internetwork mail transfer will be established through use of standardized mail server protocols.

User Forums: AdaNET will keep an updated list, with accompanying information, of user forums available on the system. This list is intended to be a quick reference as well as an announcement medium. Software to support the actual forums is currently in place.

News & Current Events: This service will provide the user with excerpts from the press and highlight special events such as the International Conference on Software Engineering, Ada Expo, National Conference on Ada Technology, Ada contracts awards, and significant technology developments. This service will be designed using a text retrieval database system.

Other Repositories and Services: This information will guide the user toward existing repositories of reusable software systems and components. It will extend beyond Ada per se in that repositories of a more general nature such as NASA's COSMIC system of components will be referenced. Initially, only Ada software will be provided for distribution through AdaNET. Due to market demand, some software will be made available through AdaNET in "as is" form, taken from other public domain repository sources such as the ASR and NRL.

Special Interest Groups: Special interest groups abound in the Ada world, the most visible of these being SIGAda. However, groups are formed based on "birds of a feather" sessions at conferences and workshops. Other non Ada specific groups require information about the current status of Ada. The Electronic Industries Association and the National Security Industrial Association each have software subcommittees

concerned with Ada and software engineering. Further, Ada may become a significant factor in the DoD's Computer-aided Aquisition and Logistics System (CALS) initiative. Each of these special interest groups will most likely be willing to share data and become users of AdaNET.

Full Text Information: This is one of the most significant services AdaNET will offer. It will provide information on Ada projects throughout the industry and act as the host for abstracting certain items of documentation from those projects. For example, if a management overview of the Space Station SSE were to be available through AdaNET, its dissemination to the marketplace would be enhanced. In addition to project information, public domain documents basic to Ada, such as standards, will be made available as is possible.

Educational Materials: Because use of software engineering and Ada technology requires an extensive re-education effort, educational information will be provided. Actual course description and curriculum designs, as well as references to a whole range of educational materials including Computer Based Training (CBT), video tapes, films, etc., will be available.

Directories/Publications: In order to make the AdaNET system as easy to use and widely familiar as possible, a set of printed information is being developed. These publications will include a catalog of services available, user reference guides, and brochures describing AdaNET.

3.3.5 Dynamic Software Inventory (DSI) Design

The design of the DSI has been divided into the four functional areas:

- Object Evaluation
- Object Inquiry
- Object Retrieval
- Library/Systems Configuration Management

During first stage of DSI design the majority of work will concentrate on implementation of the first three categories, with development of a Configuration Management Plan. The following sections describe planned design implementation for each of these component areas.

Object Evaluation

Each candidate object must undergo testing and evaluation as part of its incorporation into the DSI library. Software objects will be evaluated for:

- *Completeness:* Determine if all necessary components have been provided to allow successful compilation and execution of the software object;
- *Portability:* Check for features that compromise portability;
- *Errors/Constraints:* Determine constraints placed on variables and types; test robustness of error handling;
- *Complexity:* Determine the component's relative code complexity;
- *Performance:* Run benchmarks against software components;
- *Classification:* Assign facet terms;

Results of each phase of the evaluation will yield the unit's profile, which is entered into the reuse database for user retrieval and evaluation.

The following steps will be taken to develop the software evaluation process:

- Identify initial parameters/procedures for evaluation;
- Document such parameters in an AdaNET Reuse Policy and Guidelines manual;
- Develop procedures for completeness testing;
- Identify features to test for portability analysis;
- Develop procedures for object portability analysis;
- Develop automated portability analysis procedures;
- Identify complexity analysis tool(s) to be used;
- Develop method for applying tool(s) to software objects;
- Develop automated methods to generate the object testing framework;
- Develop method for facet terms assignment;
- Develop procedures for object classification.

Object Inquiry

Access to objects available or inventoried by AdaNET will be provided through a reuse database. The database will contain results of evaluation testing to provide potential reusers with a profile of the software object. Information such as object type, function, functional area, algorithm and system information will be provided as terms defined for the various facets that make up an object descriptor. Key design activities include:

1. Domain analysis of objects;

2. Facet definition;

3. Assignment of initial facet terms;

4. Classification of a representative sample of programs;

5. Design database.

Object Retrieval

To form an object descriptor, the user chooses facet terms under each facet. In order to examine specific objects resident in AdaNET libraries, one of two actions, depending on object size and other criteria, is taken:

1. On-line object retrieval initiated

2. On-line ordering request initiated

For objects that can be provided on-line, the files referenced by the object descriptor will be returned to the user. The user may then select which specific objects are desired. The associated files are then transferred to the retrieval system to be downloaded. Items that must be ordered become open orders and are entered into AdaNET's distribution center. Accounting information provided by users will allow direct billing for all distribution requests.

Development of the retrieval system will consist of:

- System requirements definition;
- Top level design of object retrieval system;
- Systems communications design;
- Database/retrieval system interface design;
- Retrieval system/distribution system integration design;
- Retrieval system implementation.

Library/System Configuration

A Configuration Management Plan defining policies and procedures for DSI management will be developed. Issues to be addressed in this document include such areas as:

- Object insertion into reuse database;
- Object modification/revision;
- Multiple version tracking;
- Life cycle object collection management;
- Maintenance history;
- User problem report notification.

3.3.6 Initial Network Introduction

The initial introduction of AdaNET will be based on one overriding principal: only that which is available and operational will be included. In this way, AdaNET can ensure that user expectations don't exceed the systems capabilities prior to feature availability. Clearly one of the most important aspects of the introduction process is the public announcements about the service. In order to clearly specify the overall plan, we will state the shorter range goals and follow that with longer term commitments.

The primary goal for the short term (through 12/88) is the implementation of services to be offered on a prototype basis beginning with the TRI-Ada '88 meeting. The TRI-Ada '88 meeting will be held in Charleston, West Virginia, October 24-28. Services to be announced at the meeting are:

- The existing Ada Software Repository currently on the SIMTEL20 system at White Sands Missile Range with some value-added services and other software inventoried at that time;
- Electronic mail linking members of the Ada community;
- User forums and information services.

Activities Activities during this period will be in the following areas:

- Implementation of commercially available AdaNET Information Services (AIS);
- Preparation for TRI-Ada '88 marketing effort;
- Planning for additional services to be made available in future phases of implementation;
- Identify other repositories to be referenced through AdaNET;
- Identify software tools useful in performing software evaluation and configuration management functions for AdaNET;
- Build a list of potential additional services to be offered by AdaNET;
- Attend relevant conferences and trade shows.

3.3.7 Growth Plan for Additional Services

This section specifies the plans for AdaNET's growth and the additional services that will be incorporated. It includes medium and long term goals for spinoffs, additional repositories, software and communications.

Spinoffs

As AdaNET evolves, other spinoff services will be pursued. Such services include:

- Consultant services to aid manufacturers in their transition from traditional technologies to Ada based CIM/FCIM technologies.
- Consultant services to private sector organizations in their development of reusable software components inventories.
- Expansion to the international Ada technology market; AdaNET may be able to serve as a technology transfer medium for software engineering and Ada technology developed overseas to the United States market.

During first stage implementation of the DSI, inventoried objects will be exclusively from the coding and unit testing stages of the software life cycle. This limitation is a consequence of the fact that we will be first evaluating existing Ada source code components obtained from public domain sources such as the ASR, NOSC Ada tapes, and other identified existing Ada repositories. Initial minimal evaluation criteria are being developed, and will form the basis for quality evaluation for potential reusability at this components/subcomponents level. These requirements will be detailed in the document AdaNET Reuse Policy and Guidelines during this first stage of implementation. It is anticipated that this document will be expanded to include all life cycle products incorporated into the AdaNET inventory during future phases of DSI implementation. From these guidelines, standard procedures for component evaluation will be developed to analyze quality.

MountainNet's long term goal for implementation of the DSI is to develop a system that will implement the life-wide object representation model proposed by Dr. Charles McKay, Director of the Software Engineering Resources Center (SERC) at the University of Houston at Clear Lake City. MountainNet's development team recognizes that the benefits of reusability will come only when life wide information about available software components can be offered to AdaNET users.

MountainNet is balancing the longer term development of this model against the current need to provide access to reusable software in a fairly short time. For this reason, we emphasize in the current document the planning for a DSI of reusable software designed to provide growth and expansion that will allow later evolution to Dr. McKay's proposed taxonomy of taxonomies, but that can be realistically implemented within the time frames described herein.

Medium Term

The following subsection describes medium term (1-2 yrs) goals for AdaNET services. The primary goals over the medium period (November 1988 - December 1989) include:

- Provide additional value-added services for the AIS;
- Identify and/or develop tools for decomposition and recomposition of total software systems into reusable components and modules;
- Incorporate other repositories within the AdaNET taxonomy;
- Identify existing Ada software that can be used for CIM/FCIM applications.

The following list of planned activities is grouped according to the four goals listed above.

Additional Value-Added Services: Activities related to the provision of additional value-added services to the repository include:

- Testing for correct behavior
- Classifying according to Booch's taxonomy
- Improving user documentation and tutorials
- Widening the range of evaluation applied to units

Tools for Decomposition and Recomposition: It is anticipated that large systems of Ada software developed for the federal government will eventually be delivered to the AdaNET project for evaluation, decomposition into reusable units, and inclusion in the DSI. To assist in this activity, the technical team will need access to software tools for detecting reusable portions of code and for decomposing large systems into smaller ones. Initially, tools for measuring cohesion and coupling would be useful. The necessary procedures are:

1. Identify candidate tools and metrics;
2. Learn to use these tools;
3. Determine their utility in assisting with the decomposition of systems;
4. Construct other needed tools.

Other Repositories: Several collections of reusable Ada code are well-known in the Ada community. These include the ASR, CAMP, STARS Foundations, the Booch Components, and GRACE components. Each of these collections has its own organization. AdaNET will provide references to units in other repositories. AdaNET will attempt to provide a thesaurus to support context dependent specifications used by each affiliated repository and add unit references to the reuse database.

Existing Ada Software: The DOC OPTI support of AdaNET is provided to stimulate leadership in development of CIM/FCIM Ada technology applications. AdaNET will attempt to work with mature leaders in CIM/FCIM applications, to build a base of Ada technology in support of this technology.

Long Term Goals

The goals over the long term period (through 1993) are:

- Link services provided directly by AdaNET with those provided by other systems such as the AdaIC bulletin board and SEAD;
- Develop and provide support and expertise for companies making transition to the use of automation technologies;
- Develop expertise to provide help in selection of computer hardware and software development tools best suited for specific applications development.

3.4 Quality and Standards Assurance

This section of the technical plan states AdaNET's verification requirements and details a validation demonstration to meet those requirements. MountainNet plans to follow basic software engineering principles in the evolution of AdaNET. To this end, a section on "Process Standards Compliance" is included.

3.4.1 Verification Requirements

This subsection addresses the way in which AdaNET requirements will be verified as complete. Since AdaNET is more than the software which drives it, this subsection also deals with those items which are important to the overall implementation of AdaNET, but not necessarily software. For example, AdaNET's requirement to distribute information in printed, CD/ROM and diskette format will be proven to be complete through the creation of information using these formats, which will then be forwarded to UHCL.

This subsection first lists each requirement as stated in section 3.2 of this document, then follows that with the plan for proof the requirement has been met. Please

note that an overall system demonstration is planned and is covered in section 3.4.2 "Validation Demonstration ".

Networking and Communications

This requirement will be verified through remote login to AdaNET through the existing network schema. The logins will take place at the UHCL facility and will be performed in the following manner:

- Login through the Telenet access to AdaNET;
- Login to MountainNet directly;
- Login to AdaNET directly.

In each case, the record of the login sequence will be saved and printed to show proof of performance.

Hardware

Verification of existing hardware cannot be accomplished in the traditional sense, nor does it need to be. Since AdaNET is using existing services, MountainNet plans to provide initial signature pages for the agreements between MountainNet and the vendors of those services.

Software

There are two types of software verification for AdaNET. One is the testing of software which is to be included in the Dynamic Software Inventory (DSI). Since this is a separate subject, it will be dealt with in subsequent deliverables. The second is verification of the software developed for AdaNET. MountainNet will follow standard testing procedures for software. Standard testing procedures include:

- Unit test all code during development. These tests will be conducted by the software engineer responsible for that piece of code;
- Build tests that will be conducted using stems and stubs, as appropriate;
- Sub-system testing will be conducted as supersets of each build test;
- In all cases, software engineers will follow internal MountainNet Software Test Plan.

Data and Information Sources

Verification of Data and Information sources will be verified by supplying UHCL with duplicate copies of the agreements signed by the supplier with AdaNET.

Operational Considerations

Operational aspects of AdaNET will be confirmed through copies of required deliverables from this subcontract.

Dynamic Software Inventory (DSI)

The DSI will be a constantly changing entity. However, verification of it's robustness will be accomplished through publication of the contents and internal monthly reports detailing problem areas, new additions and deletions and planned activities for expansion. In this way, a running record of the DSI will be kept, allowing an historical perspective for future changes.

Database

Database access and security will be tested and proven through the Validation Demonstration. Although MountainNet has not chosen a specific database management system vendor, it is anticipated that a key element in vendor selection will be the access, security and record/element administration functions available.

AdaNET Information Services (AIS)

Beyond the testing for software discussed in section 3.4.1, the AIS will be tested for clarity and ease of use. Most of this testing will take place in preparation for the Validation Demonstration discussed in the next subsection.

3.4.2 Validation Demonstration

The ultimate test of any service-oriented endeavor is the application itself. Since fielding a new system will always uncover unanticipated problems, the most valid test

for such a system is a validation demonstration. MountainNet plans a two-phased approach to this demonstration. These are:

1. Demonstration to UHCL/RICIS and;
2. Demonstration to NASA headquarters and the liason office for Sen. Robert Byrd.

Primarily, the demonstration will take the form of accessing AdaNET then allowing the user to browse through the services offered. In this way two key elements will be addressed; one, access and availability and; two, ease of use. MountainNet will perform these tests internally with non computer-literate personnel prior to the live demonstration.

3.4.3 Process Standards Compliance

Processes have helped most engineering disciplines overcome the problems associated with the design and implementation of a given system. Although the term "software engineering" was coined more than twenty-five years ago, the process of software engineering is just beginning to become a practiced method of development. MountainNet plans to comply with NASA's SMAP methodology in development of AdaNET. Although not entirely a software subsystem, AdaNET can benefit now and in the future by compliance with this disciplined approach to development.

Quality Assurance practices will take into account each phase and step of SMAP, and ensure that each is measurable and accurate. Additionally, MountainNet will employ the practices espoused by Dr. Roger Pressman in his book, *Software Engineering - A Practitioners Approach.*

Process standards compliance will be measured based on the stated goals in Dr. Pressman's volume. Finally, MountainNet recognizes the need to track this measurement, and will do so with modified versions of a "module development folder". Each functional area will receive it's own folder which will be kept by the chief programmer or administrator for the team charged with accomplishing the goals of that functional entity.

3.5 Additional Resource Requirements

This section of the technical plan delineates additional resources needed in order to meet the objectives surrounding a viable AdaNET service. It specifies the needs associated with hardware, software, networking and communications and personnel and administration.

At this point in time, it's understood that additional resources are contingent upon additional contracting dollars not yet allocated. MountainNet is also pursuing further corporate partnering agreements with an eye toward baseline funding for expansion.

3.5.1 Hardware

Specific hardware additions are:

- VAX 8500 and/or other VAX systems to support a greater number of users and distribution of services requiring competing resources;
- Harris HCX9 to expand the in-kind services currently being supplied by WVU;
- Terradata DBC/1012 to serve as a standalone Reuse Database system;
- IBM 9370 (MVS) to support the Terradata.

3.5.2 Software

Software required to expand AdaNET is:

- COTS software for to provide compatibility between DEC and DG computers;
- COTS implementation of SGML;
- COTS implementation of IRDS;
- COTS development tools and environments;
- Relational Data Base Management software (prior to incorporation of dedicated database machines.

3.5.3 Networking and Communications

Networking and Communications needs are:

- A star network controller;
- Direct connection between AdaNET and Telenet for ease of access;
- Direct lines to the RICIS at UHCL, Washington, D.C., Huntsville,Boston and Pittsburgh;
- A link into the NASA network;
- A link into the DoD's DDN.
- A direct connection between AdaNET and SEAD.

3.5.4 Personnel

Development team personnel required for first stage implementation of the DSI are 10 FTE staff members plus senior level software engineering consultants. These staff positions will be divided among:

- 6 Software Engineers
- 1 Library Information Systems Specialist
- 1 Systems Analyst
- 2 Programmers

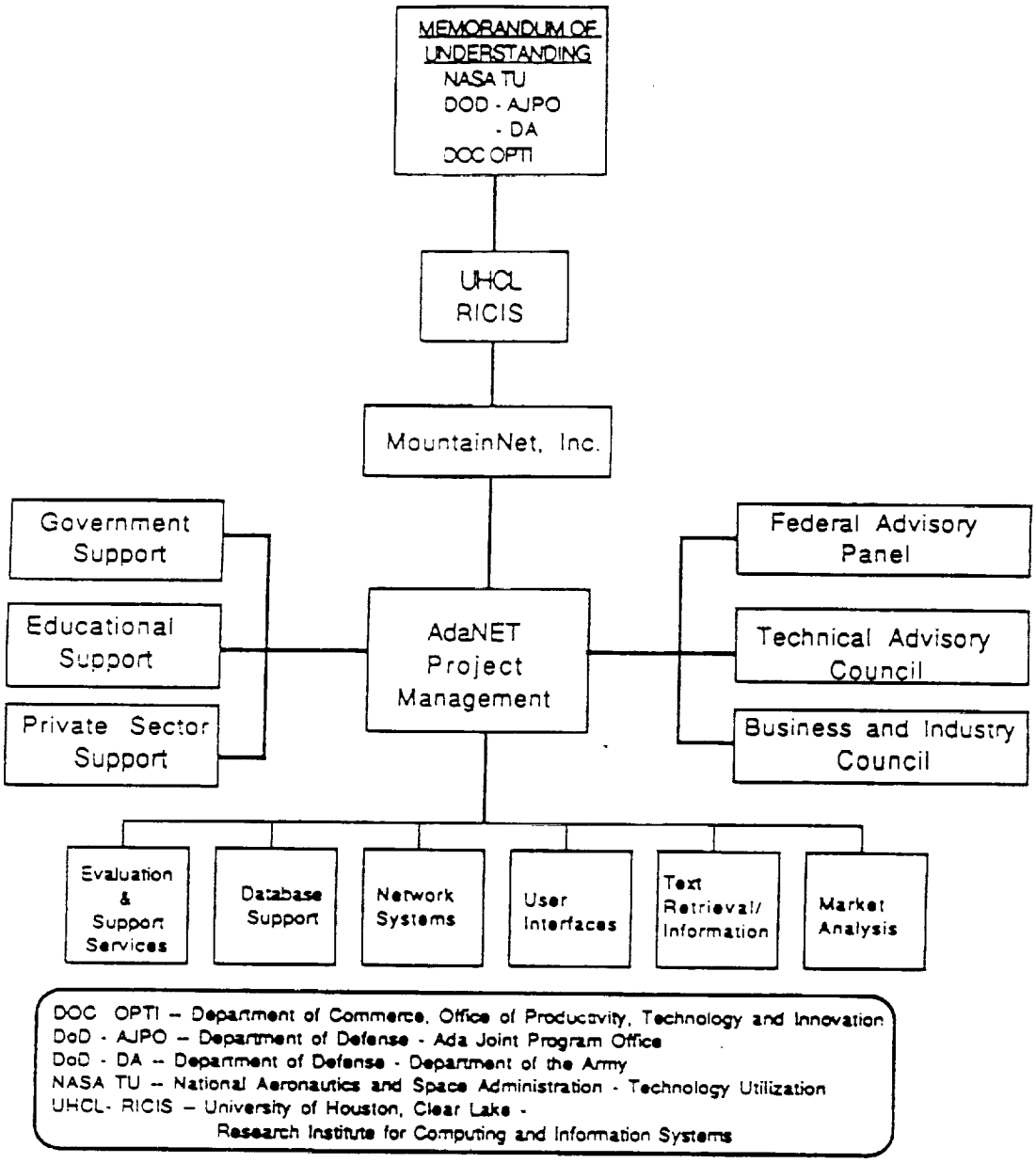


Figure 3.5: AdaNET Organizational Structure

ORIGINAL PAGE IS
OF POOR QUALITY

Chapter 4

Revenue Plan

4.1 Overview

This chapter describes the Revenue Plan for implementation of MountainNet's AdaNET project.

The information available through AdaNET will be offered with accompanying value-added services, making it a gateway and clearinghouse for software engineering and Ada technology that is unique. These services will be offered through a cost recovery structure that provides for migration to full commercial viability.

This chapter describes what is to be offered to defined market segments, sources of Ada software and technology, revenue structures, reimbursement of direct contribution and comparative pricing.

4.2 Products and Services

Services to be offered are defined as one of two specific services categories:

- Dynamic Software Inventory
- AdaNET Information Services

The following subsections provide descriptions of specific services to be offered under each of these categories:

4.2.1 Dynamic Software Inventory (DSI)

The Dynamic Software Inventory consists of software (and other life cycle objects) within an environment developed to support ease of definition and access to information about objects for reuse.

Reusable Ada Software

An inventory of public domain Ada software from NASA, DoD, other government agencies and private sector sources will be evaluated for inclusion in the DSI. Wherever possible, associated life cycle products will also be incorporated in the DSI.

Other Life Cycle Objects

In the process of software development, various life cycle products are generated, such as requirements documents, design documents and test plans. In later phases of the project, the inventory of reusable objects will be extended to include these products.

Documentation

Standard documentation accompanying software components and life cycle products will be stored in DSI. Standards or guidelines under evaluation for possible adoption include NASA SMAP DID's (Ada version) and MIL-STD-2167A. For standard life cycle and AdaNET specific documents, AdaNET developers are considering the adoption of the SGML ISO standard to develop Document Type Descriptions (DTD) representational markup.

Metrics

As objects pass through quality and performance tests, metrics will be collected to yield relative values in specific areas tested. Such information will be provided to users searching for objects in the reuse database as part of the extended profile information for objects in the DSI. This information may help users to restrict their selection prior to making requests for object retrieval.

Profile Information

Each inventoried software object will have an associated profile. Current profile attributes being examined are:

- Identification Code
- Abstract
- Author
- Developing Organizations
- Point of Contact
- Hardware/OS Requirements
    - host
    - target
    - integration
- Compiler/Version
- Size
- Documentation Status
- Portability Report
    - pragma usage
    - dependencies on vendor supplied systems
    - usage of low level I/O, memory addressing, etc.
- Problem Report

Retrieval/Duplication

Objects inventoried in the DSI may be retrieved through either on-line access or distribution media such as magnetic tape, diskette or CD-ROM. For objects not available on-line in the DSI, on-line order processing will be provided.

Reuse Database/Taxonomy

Objects in the DSI will be stored in the reuse database using a faceted classification scheme. This scheme will allow for a flexible database design. The design of the database will be independent of the data model used to ensure that it will not be constrained by the current "state of the practice". Guidelines for design will closely follow the EA/RA model and IRDS.

Tutorials

This consists of instructional information on the use of the DSI, and on the use of some specific inventory components (such as tools, training systems or complete operational systems).

4.2.2 AdaNET Information Services (AIS)

This subsection describes the requirements for the AdaNET Information Services. Each of the separate databases will be structured according to the information contained in them. A common command structure will provide the powerful text retrieval access necessary and will function at the level of expertise desired by the user.

User Forums

This service consists of a variety of bulletin board services including current events, Special Interest Groups (SIG's), forum discussions, news and product information.

AdaNET Bibliographic System

A bibliographic retrieval system will be available for texts identified as related to Ada and software engineering technologies. Some of the covered topics will comprise technical subject areas, cost and market information, and information available on related subject areas such as CIM/FCIM. Information will be accessed by key field/key word search categories, including article, periodical and publication references, and abstracts.

Educational Materials

Access to or information about educational books, papers, video courses, overhead slide presentations, CAI tutorials and other types of educational materials about software engineering and Ada will be provided.

Electronic Communications

Internetwork electronic mail and document transfer services will be provided to support communication with other Ada software engineering professionals.

Full Text Information

Full text information relevant to Ada software engineering and related technologies in the library, that MountainNet is authorized to make available to users of AdaNET. News and current events information will be included here.

Directories/Publications

Printed information about software objects in the DSI and regular user updates concerning new and/or improved AdaNET services and activities will be made available.

Other Repositories and Services

Information about known public and private software repository and information activities throughout the country for both Ada and non-Ada software will be provided. Such repositories include the SIMTEL-20 ASR, NRL STARS repository and NASA's COSMIC. Such information will include general information about the services provided by each of these facilities. Information regarding access and/or ordering, and in some cases, on-line or distribution access to software obtained from these sources (such as the ASR) will be supplied. However, software provided at this level of service will be virtually in an "as is, buyer beware" market composition format, and should not be confused with services provided through the DSI. This service is being made available to provide early access to Ada software currently in demand by the private sector, in the interim period during implementation of the DSI. Other information services may include access to SEAD and the Ada Information Clearinghouse (AIC).

Consultant Services

MountainNet's staff and companies comprising the project support infrastructure will be available for specialized software engineering and Ada technology consultant services. This service will be key to successful use of the AdaNET services, and will be essential to the catalyst role of encouraging transition to use of Ada technology in private sector initiatives.

Seminars and Workshops

Seminars and workshops will be provided to educate and train the user base.

4.3 Target Market

The following sections define target markets identified as potential users of the AdaNET services:

4.3.1 Market Segments

The target market can be divided into the following categories:

- Current Ada users
- New entrants into the Ada market
- Industrial and manufacturing organizations
- Government agencies
- Educational institutions

The current Ada users market represents the most immediate market for AdaNET. Based on preliminary data, the professional Ada community has specific interest in baseline services planned. Of particular interest is reusable software components, supporting value-added services, professional papers and general information services such as, market trends and information about contract opportunities. Major users in this area are currently the aerospace industry and defense contractors.

Market entry into the industrial and manufacturing areas will require a more prolonged effort. Significant pre-market education will probably be required for industry segments to see the direct advantages of applying Ada technology to their unique applications. Specific component taxonomies relative to manufacturing primitives, will be adopted, similar to the approach used in presentation of the Common Ada Missile Packages (CAMP) software to inventory software parts primitives. Educational and consultant support for successful long-term Ada technology migration in such areas as Paperless Order Processing (POP), Just-In-Time Inventory (JIT), Computer Integrated Manufacturing (CIM), Flexible Computerized Manufacturing technologies (FCM) and other real time control systems will also be provided.

The government market represents a stable, proactive environment for AdaNET use. Although AdaNET's purpose is the transfer of government developed Ada technology to the private sector, available technology and applications within various government agencies and even within various divisions of the same agency will also be inventoried where appropriate. For educational institutions interested in gaining Ada technology expertise in order to introduce strong Ada and software engineering curriculums, high quality information will be available from AdaNET.

4.3.2 Market Composition

Several major professional areas within each market segment have been identified:

- Software Engineers/Developers currently working with software engineering and Ada technology have expressed interest in Ada and software engineering, methodologies, Ada specific metrics, reusable software and faceted classifications.

- Managers/Administrators within commercial and government organizations have shown interest in services that provide contracting and subcontracting information, current events, market trends, governmental activities with respect to the use of Ada and information about companies and products in the Ada market.

- Educators indicated interest in educational and technically oriented information such as, faceted classifications for reuse and Ada tutorials.

- Members of manufacturing and industrial communities are interested in the place of Ada technology as part of the overall advanced technology solutions to increase productivity, competitiveness and reliability. Areas of interest include

information about educational and professional information, current industrial applications and information about companies that possess specific areas of Ada technology expertise.

4.3.3 Initial Market Survey

An initial survey for AdaNET was conducted at the Ada Expo '87 held in Boston in December 1987. The survey, while a small sampling of those in attendance, yielded information about the Ada community's current interests. The survey gathered the following types of information:

- General demographic information
- Ada application areas represented at the conference
- Levels of interest in potential service offerings
- Current hardware and telecommunications utilization

Following are charts which summarize the data collected in the initial market survey.

Survey of Ada Expo '87 Attendees
Areas of Ada Software Development

AREA	FREQUENCY	PERCENT
Weapons/C31	39	16.9
Engineering	35	15.2
Tools	28	12.1
Scientific	21	9.1
Telecommunications	20	8.7
Education	18	7.8
Databases	18	7.8
Business/MIS	17	7.4
Compilers	14	6.1
Process Control	8	3.5
Financial Applications	6	2.6
Consumer	6	2.6
Chemicals/Petroleum	1	0.4

Survey of Ada Expo '87 Attendees
Networks Utilized

NETWORK	FREQUENCY	PERCENT
ARPANET	32	33.3
DDN	20	20.8
Telenet Mail	15	15.6
Compuserve	12	12.5
BITnet/Mailnet	9	9.4
The Source	4	4.2
Dialcom	2	2.1
NASA Mail	2	2.1

Survey of Ada Expo '87 Attendees
Usefulness of Service Categories

USAGE	SUM OF RATINGS
SW Eng. Methodology	130
Ada-Specific Metrics	112
Reuse Classifications	100
Topical Search	97
Documentation	93
Project Management	91
Commercial	77
User Communications	69
Contracting	67
On-Line Tutorial	57
Telephone Help Line	51
CBT	50

0 = Not Useful; 1 = Useful; 2 = Very Useful

4.4 Sources of Ada Software and Technology

4.5 Revenue Structures

Careful consideration is being given to the approach taken in planning for services cost recovery (or revenue) structures. Current thoughts and approaches being taken in development of this structure are discussed below. This document does not attempt to define specific dollar amounts for services structures. Such activity is premature, due to a lack of information about total investment in development of services; specific operational costs of supporting services delivery; resource requirements and allocations necessary for delivery of various services and specific information about potential market demand for individual or group services. Such information will become available and realistic projections possible in future phases of the project, as it moves from planning, research and early prototyping into full scale services implementation. Criteria that must be met by the revenue structure include:

- Defraying costs of operation
- Maintaining commercial competitiveness
- Standardizing revenue structures
- Implementing incentive programs
- Providing economically disadvantaged discounts
- Reimbursing of direct contributions

The revenue structure will utilize standard subscriptions, incremental charges, purchase fees and a differential fee structure as described below. These structures will be based on high volume usage, rather than charging individual users premium prices as the service goal is to provide reliable information services at cost effective rates. The most common structures to be used will be:

Subscription Rate

An annual, quarterly or monthly base rate allowing access to services (or groups of services) through on-line connect, CD-ROM, diskette and printed media.

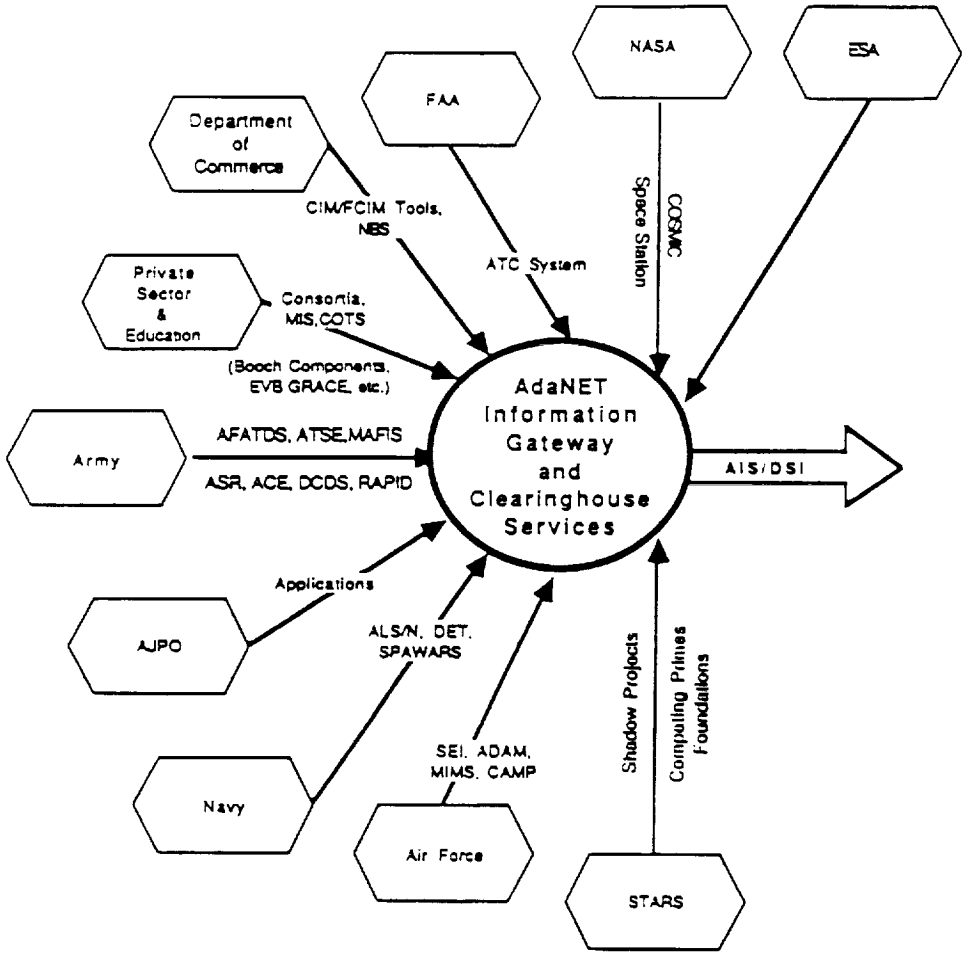


Figure 4.1: Source of Ada Software and Technology

Incremental Rate

Users "pay as they go" for on-line services not standard to their regular services subscriptions.

Purchase Price

Users purchase products on an individual unit basis.

Differential Fee Structure

Usage information will be collected as clients log onto the system. This data will include:

- Log-on time
- Log-off time
- Number of disk accesses
- Amount and kind of data down-loaded to user's system
- Types of information retrieved

In all cases, MountainNet understands that the difference between data and information will make a difference in billing for a given session. For example, if a client retrieves data which points him toward another resource for information, he will be billed less than if the retrieval nets information which is unavailable elsewhere. This logic follows an automated path for traditional information and data services; i.e., the Auerbach Report. Although not automated, a substantial fee is charged. The difference with this service is that the user will be billed for only the information retrieved and not for all of the information in the database.

Revenue Classes for AdaNET Services

Description	Distribution Medium						
	On-Line	CD-ROM	Tape	Diskette	Hardcopy	Misc.	Live
Dynamic Software Inventory	ISP	SP					
Ada Software Components	IS	SP	P	PS			
Documentation	IS	SP	P	PS	P		
Metrics	IS	SP	P	PS			
Profile Information	IS	SP			P		
Reuse Database/Taxonomy	IS	SP					
Tutorials	IS	SP	P	P	P		
Information Services							
User Forums	IS				S		
Bibliographic System	IS	PS			PS		
Educational Materials	IS	PS	P	PS	PS		
Electronic Communications	S						
Full Text	I	PS	P	P	PS		
Directories/Publications					PS		
Outside Services	S						
Professional Support							
Consultant services							P
Seminars and Workshops							P

I = Incremental S = Subscription P = Purchased

4.5.1 Defraying Costs of Operation

As a minimum requirement, revenue structures established for services must provide a realistic basis for cost recovery for a given target number of users. Below are estimated resource requirements at full staffing. Costs for these resources do not include variable costs associated with specific services delivery.

Human Resources

Type of support	Number of FTE*
General information services	4
Library information services	1 1/2
Software evaluation	5
Configuration management	2
Database	2
Distribution personnel	3
Marketing/Advertising	2
Network and systems	3
Infrastructure support services	4

*FTE = Full Time Equivalent

Hardware/Software

- Six (6) Large scale computer systems
- Network support
- New acquisition and maintenance of software
- Administrative and travel expenses

Notes:

The estimated number of FTE's in various activity centers are based on current knowledge of staffing needs, as well as comparative staffing requirements in similar programs, such as the USAISEC SDC-W RAPID program. Estimates on other expense areas are projected for current operational costs.

4.5.2 Maintaining Commercial Competitiveness

AdaNET must be competitive (as a minimum) with comparative commercially available services. The difference between minimum charge scales necessary for cost recovery and current market rate structures for similar services establishes a margin within which there is flexibility for determination of revenue structures (see Section 6 for comparative pricing rates).

4.5.3 Standardizing Revenue Structures

Revenue structures must be standardized with few "add-on" charges for specific services usage (see Section 6 for comparative pricing structures). For most on-line services, standardized subscription services will be introduced, at levels that will allow cost recovery of resources expended for services delivered at average usage levels. Services would be "packaged" in incremental subscription levels. This will allow delivery of highly affordable general services (hence removing economic barriers). It will also allow alternate cost recovery structures (such as those listed in Section 6) for services delivering strategically valuable or resource intensive information.

4.5.4 Implementing Incentive Programs

Attractive pricing and/or special incentives to induce use of services and reinsertion of information by U.S. and foreign businesses and government organizations will be provided. Such programs may include introductory service "credits" to organizations providing valuable technology reinsertion, hence providing an additional incentive to encourage continued use of the services.

4.5.5 Providing Economically Disadvantaged Discounts

Special pricing discounts to remove economic barriers to access of information by qualifying educational or small business users will be provided. These market segments generate potentially less expendable revenue that can be used for investment in new technology areas, this may present an economic barrier to entry in new technological markets. Use of software engineering and Ada technology by these market segments will be encouraged. Specific qualifications for such discounts remain to be determined; criteria used must be easily obtainable and verifiable, and not represent high resource

requirements in supporting such verification. By establishing such a pricing structure in the form of a discount, the established standard pricing structure is not eroded by non-standard fee structures available to special groups of users. Not all small businesses and educational institutions will meet criteria established for these discounts, and should legitimately be charged standard rates.

4.5.6 Reimbursing of Direct Contributions

Reimbursement of direct contributions of sponsoring governmental agencies will be made. This reimbursement will be realized through the value of technology transferred for reuse by public and private sector users of AdaNET. Methods are currently being developed to analyze the relative value of various information components distributed so that a reuse value of that information can be established. Within ten years, the total value of that information should be greater than or equal to the original governmental investment.

4.6 Comparative Pricing

Below is a description of pricing strategies used by various companies that offer similar types of information services and products. These do not reflect the proposed fee structure for the AdaNET services, but rather are indicative of existing market pricing strategies. These services include on-line information services, information provided through alternate distribution media, and consultant and educational services.

4.6.1 On-Line Services Delivery

The following revenue categories are related to delivery of on-line communications networks, provided through telecommunications network access.

Communications Fees

Fees associated with communications networks access, such as TYMNET and TELENET. These fees vary based on geographic location, data transmission speed and the availability of a local dial-in number to access services. Fees generally range from

a few dollars per hour to over $30.00 per hour depending on data transmission speed and which subservice is accessed.

Connect Time Charges

Connect time charges are based on the amount of time the user is actually connected to the system. Rates are quoted on a per hour basis and are dependent upon the type of information and subject matter required. Business and technical information are available at higher rates than citations and abstracts. Databases that provide citations and abstracts to publications usually cost less than those that provide information such as, a company's name or address or a history of stock quotations for a particular industry. Connect time fees can range from $15.00 for access to subsets of several files for teaching purposes to $300.00 for access to citations for chemical patents.

Print or Display Charges

Print or display charges are assessed for each record displayed on the screen or printed offline. The fee varies as a function of the amount of information provided. Little or no charge is associated with viewing the title and subject headings for a record. Fees ranging from $.10 to $4.00 can be associated with viewing enough information to allow user to obtain the item which is being searched or for actually displaying the information. Files that allow the user to create reports are charged per item, per record listed.

Per Search Term Charges

This is a new approach introduced by database producers. This option is not yet available to users. Use of search terms as a charge base has many implications for vendors and users. Searchers always attempt to minimize on-line search costs. To minimize costs which are based on the number of keywords used to conduct the search has different implications than minimizing costs based on the amount of time the user is actually on line and the number of items retrieved.

Flat Rates

This can be set up as a monthly minimum fee to be paid, regardless of whether searches are actually performed.

Annual "Password" Fees

"Password" fees are designed to cover the cost of maintaining the account and costs involved in the billing process. Fees are usually between $25.00 and $100.00 per year.

Deposit Account Charges

A deposit account (or pre-paid account) often offers discounts, usually "stepped" according to the amount of the deposit. Sometimes fees, other than connect time charges, are deducted from the deposit account.

Credits

Some systems issue credits for certain transactions on the system. An example is OCLC, an interlibrary loan system. A fee is incurred for use of a record. A credit equal to the fee incurred for such a use is given for input of a catalog record not already in the system or for lending an item.

4.6.2 Alternate Distribution Media

CD-ROM Products

Products associated with on-line search services are usually licensed on an annual basis with updates on a quarterly basis. Annual subscription fees cover updates to the search software necessary to access the information on the CD. Discs with older information on them are sometimes made available for purchase. Prices vary widely in products marketed to the general public or to libraries. These prices range from $300.00 for an outright purchase to $18,000.00 for a yearly licensing fee.

Floppy Disk Products

Floppy disks are produced on a one time basis and are not normally updated. The distribution is usually an ASCII file to be used with a word processor and generally sells for less than $100.00.

Magnetic Tape

As with floppy disk products, magnetic tape products are usually produced on a one time basis and are not normally updated. Formats available generally include Unix TAR and ANSI labeled, in densities ranging from 800 bpi to 6250 bpi. Comparable services include: ASR (Ada Software Repository) ANSI labeled duplications for $200 (user supplied tapes); COSMIC software duplications, where prices range from $50 to $10,000 per individual software system (tapes and documentation supplied).

Printed Media

Printed media include directories of available software and services, news and information newsletters and full text information. COSMIC's charges for its software directory runs from $25.00 for printed media to $50.00 for magnetic tape version of that directory.

Workshops, Seminars and Consultants

Costs for technical workshops and seminars can range from free to $4,000 per day plus cost of course materials and travel expenses for the instructor. Technical workshops are usually limited in size (15 to 20) people. Business oriented courses are normally unlimited in size and can cost $4,000 depending on the nature of the lecture. Seminars open to the public are generally on a per person cost scale and range from $1,200 to $1,500. Consultant fees can be as much as $500.00 per hour for highly technical information.

Chapter 5

Acronyms

5.1 List of Acronyms

A list of acronyms used by the AdaNET project:

ABS	AdaNET Bibliographic System
ACE	Ada Center of Excellence
ACM	Association for Computing Machinery
ADAM	Automated Data Manipulation
ADE	Ada Development Environment
AFATDS	Advanced Field Artillery Data System
AdaIC	Ada Information Clearinghouse
AIRMICS	Army Institute for Research in Management Information, Communication and Computer Science
AIS	AdaNET Information Services
AJPO	Ada Joint Program Office
ALS/N	Ada Language System/Navy
AOS/VS	Advanced Operating System/ Virtual System
ANSI	American National Standards Institute
ASR	SIMTEL-20 Ada Software Repository
ATC	Air Traffic Control
ATSE	Army Test Program Set Support Environment
AWHMS	Aircraft Wire Harness Manufacturing System
CALS	Computer-aided Acquisition and Logistics System

CAMP	Common Ada Missile Packages
CBT	Computer Based Training
CD-ROM	Compact Disk - Read Only Memory
CIM	Computerized Integrated Manufacturing
COSMIC	Computer Software Management Information Center
COTS	Commercial-off-the-shelf
DA	Department of the Army
DAPSE	Distributed Ada Programming Support Environment
DASD	Direct Access Storage Device
DBMS	Database Management System
DCDS/Ada	Distributed Computing Design System/Ada version
DDN	Defense Data Network
DEC	Digital Equipment Corporation
DET	Design Evaluation Tool
DG	Data General
DID	Data Item Description
DOC	Department of Commerce
DOC OPTI	Department of Commerce Office of Productivity, Technology and Innovation
DoD	Department of Defense
DSI	Dynamic Software Inventory
DTD	Document Type Description
EA/RA	Entity Attribute/ Relation Attribute
ESA	European Space Agency
FAA	Federal Aviation Administration
FCIM	Flexible Computerized Integrated Manufacturing
FTE	Full Time Equivalent
GRACE	Generic Reusable Ada Components for Engineering
IRD	International Resource Development, Incorporated
IRDS	Information Resource Dictionary System
ISEC	Information Systems Engineering Command
ISF	Industrial Space Facility
JSC	Johnson Space Center
MAFIS	Mobile Automated Field Instrumentation System
MIMS	Mobile Information Management System
MIS	Management Information Systems
MOU	Memorandum of Understanding

NASA	National Aeronautics and Space Administration
NASA TU	National Aeronautics and Space Administration Technology Utilization
NASA TUNS	National Aeronautics and Space Administration Technology Utilization Network System
NATO	National Atlantic Treaty Organization
NBS	National Bureau of Standards
NIAC	NASA Industrial Applications Center
NOSC	Naval Ocean Systems Command
NRL	Naval Research Lab
NSF	National Science Foundation
NTT	Nippon Telegraph-Telephone
ODISC4	Office of the Directorate for Information Systems for Command, Control, Communications and Computers
OSI	Open Systems Interconnect
OPTI	Office of Productivity, Technology and Innovation
RAPID	Reusable Ada Packages for Information Systems Development
RDBMS	Relational Database Management System
RICIS	Research Institute for Computing and Information Systems
SDI	Strategic Defense Initiative
SE	Software Engineering
SEAD	Software Engineering and Ada Database
SEI	Software Engineering Institute
SERC@UHCL	Software Engineering Research Center at University of Houston Clear Lake City
SFC	Space Flight Center
SGML	Standard Generalized Markup Language
SIG	Special Interest Group
SIGAda	ACM Special Interest Group on Ada
SMAP	Software Management Assurance Program
SPAWAR	Space and Naval Warfare Systems Command
SPC	Software Productivity Consortium
SOW	Statement of Work
SQL	Structured Query Language
SSE	Software Support Environment
STARS	Software Technologies for Adaptable, Reliable Systems
SVC	Software Valley Corporation

TCP/IP	Transmission Control Protocol/ Internet Protocol
TCSEC	Trusted Computer System Evaluation Criteria
TU	See NASA TU
UHCL	University of Houston at Clear Lake City
VMS	Virtual Memory System
WIS	WWMCCS Information System
WORM	Write Once/ Read Many
WVNET	West Virginia Network for Educational Telecomputing
WWMCCS	Worldwide Military Command & Control System

5.2 Appendix A: Initial Marketing Survey Results for the AdaEXPO–Boston, MA, December, 1987

This document represents the results of a survey of participants at the Ada Expo '87, held in Boston,MA during December of that year. MountainNet recognizes that two key elements exist regarding the participants and respondents:

1. The largest majority (45%) of survey respondents were from the Aerospace and Defense contractor community. This represents a bias which cannot be ignored.

2. Although this bias exists, the results of this survey are significant because the Aerospace and Defense contractor community represent the baseline constituency for the AdaNET service.

Each form receives it's own page and accompanying analysis in order to make the results readable and the analysis more understandable. Finally, conclusions are drawn from this survey which explain the view espoused in the business plan.

Respondent Profile

Affiliation	Count
Aerospace and Defense	44
Software Companies	12
Government	12
No Affiliation Listed/ Other	12
Educational Institutions	9
Hardware Manufacturers	9
TOTAL	98

Affiliation With Professional Organizations

Affiliation	Count
SIGAda	68
IEEE	36
None or No Response	17
AdaJUG	15
Other*	9
TOTAL	145

* "Other" = one response only. Represented were: SIGPLAN, AIAA NSIA, etc.

Survey Data

Raw Results

Questions Asked by Order

* Note: Responses to each question were: Very Useful, Useful, Not Useful. In some cases, no response was given. All Responses were ordered by % of responses without regard for no response.

	Response			Rank		
Question	Very Use	Use	Not Use	Very Use	Use	Not Use
Commercial Products and Services	24	41	13	8	2	4
Contracting Opportunities	29	19	26	6	10	3
Ada Faceted–Classifications for Reuse	40	25	9	4	9	6
Topical Search Categories for Reuse	45	25	10	2	9	5
Documentation and Information	32	40	6	5	3	7
User Communications	21	39	13	9	4	4
Ada–Specific Metrics	44	35	3	3	5	8
On–Line Tutorials	15	34	26	10	6	3
Computer Based Training	15	30	26	10	6	3
Telephone Help–line	15	30	29	10	8	2
Project Management Software	25	53	9	7	1	6
Software Engineering Methodology	54	33	3	1	7	8
Total Responses	359	404	178			

Based on Percentage of Response

Question	% Response
1. Software Engineering Methodology	91.83
2. Project Management Software	88.77
3. Ada Specific Metrics	83.67
4. Topical Search Categories for Reuse	81.60
5. Documentation and Information and Commercial Products and Services	79.59
6. Computer-Based Training	77.55
7. On-Line Tutorials	76.53
8. Contracting Opportunities and Ada Faceted Classification for Reuse and Telephone Help-Line	75.50
9. User Communications	74.48

Ranking of Importance

Topic	Rank
1. Software Engineering and Methodology	256
2. Ada Specific Metrics	228
3. Topical Search Categories for Reuse	200
4. Ada Faceted Classifications for Reuse	180
5. Documentation and Information	150
6. Project Management Software	94
7. Commercial Products and Services	61
8. User Communications	49
9. Contracting Opportunities	17
10. On-Line Tutorials	-33
11. Telephone Help-Line	-47
12. Computer Based Training	-67

* Note: Ranking Methodology. Very Useful=+10; Useful=+1; Not Useful=-1.

- Highest possible score = 275
- Lowest Possible score = -239

Appendix B

Project Participants

National Aeronautics and Space Administration (NASA)
Technology Utilization Division

- *NASA Industrial Applications Center (NIAC)*
  University of Pittsburgh, PA
- *NASA Technology Application Team*
  Research Triangle Institute, NC
- *Computer Software Management and Information Center (COSMIC)*
  University of Georgia, GA

University of Houston–Clear Lake (RICIS)
Research Institute for Computer and Information Systems

- *Space Business Information Center*
- *High Technologies Laboratory*

Department of Commerce (DOC)

- *Office of Productivity, Technology and Innovation (OPTI)*

Department of Defense (DOD)

- *Ada Joint Program Office*

Department of the Army (ODISC4)

- *Office of the Secretary of the Army, Directorate of Information Systems for Command, Control, Communications and Computers*

West Virginia University/WVU Research Corporation
Morgantown, WV

Beckley College
Beckley, WV

Appendix C
Project Deliverables

Report on participant organizational views	November 30, 1987
Draft organizational plan	December 21, 1987
Final organizational plan	January 25, 1988
Draft business plan	February 22, 1988
Draft organizational documents and agreements	February 22, 1988
Draft technical plan	March 7, 1988
Draft schedule of user fees and charges and associated analysis	March 14, 1988
Final organizational documents and agreements	April 25, 1988
Final technical plan	April 25, 1988
Final schedule of user fees and charges and associated analysis	April 25, 1988
Final Business Plan	May 30, 1988
Final Report on Phases I and II	May 30, 1988

AdaNET
Ada Market survey

The accompanying packet of materials describes AdaNET-The Advanced Development Network for Ada Software Applications. The few minutes you spend answering the questions below will provide information to be used in the planning and implementation of AdaNET. services. If you wish to receive more information about AdaNET. please attach your business card or provide your name. address. and telephone number at the bottom of this survey form. Unless you indicate otherwise. all information you provide will remain confidential and will be reported in summary form.

By taking the time to answer the questions below. you identify yourself as candidate for participation in onsite user tests of AdaNET services.

1. With which Ada-related professional organizations are you affiliated?
___SIGAda ___AdaJUG ___IEEE Other_____

2. Is your organization involved in Ada software development?
___No ___Yes. please check all types that apply:
___Consumer ___Scientific ___Engineering
___Business/ ___Data Bases ___Telecommunications
___MIS Functions

___Education ___Financial Applications ___Weapons/C3I
___Process Control ___Chemicals/Petroleum ___Compilers
___Tools

3. Which AdaNET services or information would you find useful?

	Not Useful	(Circle One) Useful	Very useful
Commercial Product and Services	0	1	2
Contracting Opportunities	0	1	2
Ada Faceted Classifications for Reuse	0	1	2
Topical Search Categories for Reuse	0	1	2
Documentation and Information	0	1	2
User Communications	0	1	2
Ada-Specific Metrics	0	1	2
On-Line Tutorials	0	1	2
Computer-Based Training	0	1	2
Telephone Help Line	0	1	2
Project Management Software	0	1	2
Software Engineering Methodology	0	1	2

4(a). To which data/telecommunications networks do you have access?
___DDN ___ARPANET ___Nasa Mail ___BITNET/Mailnet ___Telenet Mail
___MCI Mail ___Compuserve ___Dialcom ___Source Other _____

(b) What computer hardware do you use to access the resources you checked in 4(a)?
___Microcomputer-please identify the manufacturer and model: _____

___Video terminal-please identify the manufacturer and model: _____

Please attach your business card here or provide your name, address, and telephone number:

Your Name: _____

Organization: _____

Position or Title: _____

Mailing Address: _____

_____

City, State, Zip _____

Thank you for taking the time to provide the information requested.

AdaNET Management Team
December 1987

AdaNET
Electronic Mail Service and Document Transfer
User Registration Form

Please type your information at the "--->"

1. Name, address, telephone:

Person's Name: --->

Organization: --->

Address (#1): --->

Address (#2): --->

City and State: --->

Zipcode: --->

Primary Telephone Number: --->

Alternate: --->

FAX Number: --->

(Continued on next page)

2. Network ID's (e.g.: BITNET: VM5521 @ WVNVM, DIALCOM, COMPUSERVE, etc)

Preferred AdaNET userid: --->

DDN userid: --->

NASA Mail userid: --->

BITNET userid/node: --->

DIALCOM userid: --->

COMPUSERVE userid: --->

SOURCE userid info: --->

MPL userid: --->

other (specify): --->

3. From what location will you normally be accessing AdaNET?

4. What device will you be using to access AdaNET (e.g., *IBM-PC, Televideo 924 video terminal, etc*) ? Please be specific as to the manufacturer and model number.

5. What type of telephone modem do you have connected to the device listed in #4 above? Please be specific as to the manufacturer and model number.

Thank you. Please return this questionaire to:

AdaNET

c/o MountainNet, Inc.
Attn. Mr. Michael Digman
P. O. Box 370
Dellslow, WV 26531

Appendix F

Agenda

AdaNET Project Meeting

December 10, 1987

6:00 P.M. - 7:00 P.M.

- Specific responsibilities of each of three sponsoring agencies
- Review specific objectives for the combined effort
- Define specific goals for each of three sponsoring agencies
- Coordination between three sponsoring agencies
- Direction to contractor

7:00 P.M. - 9:00 P.M.

- Discussion of current AdaNET activities
  1. Outline of status report
  2. Marketing and Imaging
  3. Marketing Survey
- Project Management
  1. Expanded discussion of deliverables
  2. Accountability of contractor & sponsoring agencies
- Role of other government agencies
  1. Methods for incorporation of additional agencies
  2. Criteria for consideration
- Federal Advisory Panel
  1. Role of Panel
  2. Criteria for Membership
- Technology Advisory Council
  1. Role of Council
  2. Criteria for membership

- New Business
    1. Next Scheduled meeting

AdaNET*

The Advanced Development Network For Ada* Software Applications

AdaNET is a cooperative effort between government, education and the private sector to create a resource that will aid in facilitating the wide-spread use of Ada technology.

AdaNET will be a gateway to Ada and advanced software technology information. It will be a resource to aid in the identification and acquisition of information needed at all levels of expertise.

AdaNET will serve as a test bed for new Ada training methodologies and will be accesible via established telecommunications linkages with existing government, educational and commercial networks.

AdaNET will provide continuous refinement of Ada software and software engineering information and technology, and will provide a system for identifying and acquiring needed information.

AdaNET will serve as a source for advice relating to specifics of the Ada language and its usage, and what tools are essential for good software development practices.

By organizing and enlarging the scope of knowledge available and the ease with which it may be obtained, AdaNet can give business, industry, government, and the individual many of the tools needed to make a transition into the Ada culture.

AdaNET® is a registered trademark of MountainNet, Inc.
Ada® is a registered trademark of the U.S. Government (AJPO)

AdaNET®

The Ada® Soft-Where-House

AdaNET is a facility providing centralized accumulation of Ada information and technology.

This free flow of information will allow advances in technology that have been made, primarily through government funded development , to be disseminated throughout all levels of the private and public sectors.

With a gateway such as AdaNET, with the various attendant services that will be offered, the road will be opened to rapid advancement in many fields.

Some of those organizations that will benefit almost immediately include:

- Traditional industries faced with the need to automate in order to re-establish a competitive position in the international marketplace
- The academic community for the education of Ada trainers and software engineers, as a tool for research and development, and for academic/industry transfer
- Commercial developers concerned with applications and "embedded" software for commercial products development
- Large and small industries exploring the transition to Flexible Computerized Manufacturing (FCM)
- NASA, the U.S. Department of Defense, and the U.S. Department of Commerce
- Contractors developing Ada systems and programs for Federal agencies

AdaNET® is a registered trademark of MountainNet, Inc.
Ada® is a registered trademark of the U.S. Government (AJPO)

AdaNET®

Value-added Services and Products

AdaNET will offer a wide array of services and products designed to enhance the application of Ada® technology at all levels of expertise.

AdaNET Information Services will include:

- On-line Repositories Access
- Taxonomic Classifications
- Repository Reproductions
- Easy to Use Topical Search Categories
- Electronic Bulletin Boards
- User Communications
- AdaNET Telephone Help Line
- Ada "Starter" Packages
- Services and Products Publications
- Validation and Verification
- Documentation and Tutorials
- Libraries of Reusable Modules
- Life Cycle Identification

Collateral and Supplemental Products and Services will include:

- Seminars and Workshops
- Development and Management Tools Needed to make Optimal Use of Ada Software
- Industry Transition
- Proprietary Software
- Special Interest Groups
- Specialized Libraries
- AdaNET Publications and Newsletters

Those interested in Ada technology and its applications will be able to acquire the information available from AdaNET through a variety of methods; telephone, telecommunications, electronic media or by hard copy.

AdaNET is an interactive partnership. AdaNET will identify new information on Ada technology, provide access to it in usable formats, and support its transfer to any interested party. This will create a wide-open forum that will provide a free flow of information in an active, rapidly expanding field.

From government agencies to private business, AdaNET will be a dynamic tool in working with Ada technology and the application of this powerful technology.

AdaNET® is a registered trademark of MountainNet, Inc.
Ada® is a registered trademark of the U.S. Government (AJPO)

MdaNET First Year Projections

Major Cost Elements	Oct.'87	Nov.'87	Dec.'87	Jan.'88	Feb.'88	March '88
Personal Services	18,072	19,352	23,426	21,601	20,613	33,860
Current Expense	24,074	22,710	33,491	30,042	33,000	33,000
Travel Subtotal	205	5,192	12,031	148	4,394	4,394
Outside Services	2,800	2,800	800	1,200	1,900	1,900
Research Equipment	0	0	0	0	0	4,500
WVU	8,667	8,667	8,667	8,667	8,667	8,667
WVU Research Corp.	0	0	0	0	0	0
Beckley College	3,333	3,333	3,333	3,333	3,333	3,333
Software Valley Corp.	7,500	2,000	2,000	2,000	3,375	3,375
Total Direct Costs:	64,651	64,054	83,747	67,790	75,281	93,029
Fee	3,233	3,203	4,187	3,390	3,764	4,651
Total Expenses:	67,883	67,256	87,935	71,180	79,045	97,680
Revenues						
NASA Contract	67,883	67,256	87,935	71,180	79,045	97,680
Software Services	0	0	0	0	0	0
Electronic Communications	0	0	0	0	0	0
Educational Services	0	0	0	0	0	0
Printing/Duplication	0	0	0	0	0	0
Consultant Services	0	0	0	0	0	0
Seminars/Workshops	0	0	0	0	0	0
Total Revenue:	67,883	67,256	87,935	71,180	79,045	97,680

ORIGINAL PAGE IS
OF POOR QUALITY

AdaNET First Year Projections (cont'd)

Major Cost Elements	Apr.'88	May'88	June'88	July'88	Aug.'88	Sept.'88	Cumulative
Personal Services	33,860	33,860	57,130	57,130	57,130	57,130	433,163
Current Expense	33,000	33,000	36,000	36,000	36,000	36,000	387,117
Travel Subtotal	4,394	4,394	6,000	6,000	6,000	6,000	59,149
Outside Services	1,900	1,900	2,267	2,267	2,267	2,267	24,268
Research Equipment	4,500	4,500	20,000	20,000	20,000	20,000	93,500
WVU	8,667	8,667	10,000	10,000	10,000	10,000	109,336
WVU Research Corp.	0	0	0	0	0	0	0
Beckley College	3,333	3,333	3,333	3,333	3,333	3,333	39,996
Software Valley Corp.	3,375	3,375	3,000	3,000	3,000	3,000	39,000
Total Direct Costs:	93,029	93,029	137,730	137,730	137,130	137,730	1,185,529
Fee	4,651	4,651	20,659	20,659	20,659	20,659	114,368
Total Expenses:	97,680	97,680	158,390	158,390	158,390	158,390	1,299,898
Revenues							
NASA Contract	97,680	97,680	158,390	158,390	158,390	158,390	1,299,898
Software Services	0	0	0	0	0	0	0
Electronic Communications	0	0	0	0	0	0	0
Educational Services	0	0	0	0	0	0	0
Printing/Duplication	0	0	0	0	0	0	0
Consultant Services	0	0	0	0	0	0	0
Seminars/Workshops	0	0	0	0	0	0	0
Total Revenue:	97,680	97,680	158,390	158,390	158,390	158,390	1,299,898

ORIGINAL PAGE IS
OF POOR QUALITY

AdaNET Second Year Projections

Major Cost Elements	Oct.'88	Nov.'88	Dec.'88	Jan.'89	Feb.'89	March '89
Personal Services	57,130	57,130	57,130	65,700	65,700	65,700
Current Expense	36,000	36,000	36,000	41,400	41,400	41,400
Travel Subtotal	6,000	6,000	6,000	6,900	6,900	6,900
Outside Services	2,267	2,267	2,267	2,607	2,607	2,607
Research Equipment	20,000	20,000	20,000	23,000	23,000	23,000
WVU	10,000	10,000	10,000	11,500	11,500	11,500
WVU Research Corp.	0	0	0	0	0	0
Beckley College	3,333	3,333	3,333	3,833	3,833	3,833
Software Valley Corp.	3,000	3,000	3,000	3,000	3,000	3,000
Total Direct Costs:	137,730	137,730	137,730	157,940	157,940	157,940
Fee	20,659	20,659	20,659	23,691	23,691	23,691
Total Expenses:	158,390	158,390	158,390	181,630	181,630	181,630
Revenues						
NASA Contract	150,140	155,640	154,140	176,230	173,580	173,630
Software Services	0	750	1,500	2,000	2,000	2,500
Electronic Communications	0	1,500	2,000	2,500	5,000	4,000
Educational Services	0	0	0	150	300	500
Printing/Duplication	250	500	750	750	750	1,000
Consultant Services	0	0	0	0	0	0
Seminars/Workshops	0	0	0	0	0	0
Total Revenue:	150,390	158,390	158,390	181,630	181,630	181,630

ORIGINAL PAGE IS
OF POOR QUALITY

AdaNET Second Year Projections (cont'd)

Major Cost Elements	April '89	May '89	June '89	July '89	Aug. '89	Sept. '89	Cumulative
Personal Services	65,700	65,700	65,700	65,700	65,700	65,700	762,686
Current Expense	41,400	41,400	41,400	41,400	41,400	41,400	480,600
Travel Subtotal	6,900	6,900	6,900	6,900	6,900	6,900	80,100
Outside Services	2,607	2,607	2,607	2,607	2,607	2,607	30,264
Research Equipment	23,000	23,000	23,000	23,000	23,000	23,000	267,000
WVU	11,500	11,500	11,500	11,500	11,500	11,500	133,500
WVU Research Corp.	0	0	0	0	0	0	0
Beckley College	3,833	3,833	3,833	3,833	3,833	3,833	44,496
Software Valley Corp.	3,000	3,000	3,000	3,000	3,000	3,000	36,000
Total Direct Costs:	157,940	157,940	157,940	157,940	157,940	157,940	1,834,646
Fee	23,691	23,691	23,691	23,691	23,691	23,691	275,197
Total Expenses:	181,630	181,630	181,630	181,630	181,630	181,630	2,109,842
Revenues							
NASA Contract	168,230	166,430	158,130	161,630	159,630	151,130	1,954,542
Software Services	5,000	5,500	6,500	7,000	8,000	8,500	49,250
Electronic Communications	6,500	7,000	7,500	8,000	8,500	10,000	64,500
Educational Services	900	1,200	1,500	1,500	1,500	1,500	9,050
Printing/Duplication	1,000	1,500	2,000	2,500	3,000	4,500	18,500
Consultant Services	0	0	1,000	1,000	1,000	1,000	4,000
Seminars/Workshops	0	0	5,000	0	0	5,000	10,000
Total Revenue:	181,630	181,630	181,630	181,630	181,630	181,630	2,109,842

ORIGINAL PAGE IS
OF POOR QUALITY

AdaNET Third Year Projections

Major Cost Elements	Oct.'89	Nov.'89	Dec.'89	Jan.'90	Feb.'90	March '90
Personal Services	65,700	65,700	65,700	75,555	75,555	75,555
Current Expense	41,400	41,400	41,400	47,610	47,610	47,610
Travel Subtotal	6,900	6,900	6,900	7,935	7,935	7,935
Outside Services	2,607	2,607	2,607	2,607	2,607	2,607
Research Equipment	23,000	23,000	23,000	26,450	26,450	26,450
WVU	11,500	11,500	11,500	11,500	11,500	11,500
WVU Research Corp.	0	0	0	0	0	0
Beckley College	3,833	3,833	3,833	4,000	4,000	4,000
Software Valley Corp.	3,000	3,000	3,000	3,000	3,000	3,000
Total Direct Costs:	157,940	157,940	157,940	178,657	178,657	178,657
Fee	23,691	23,691	23,691	26,799	26,799	26,799
Total:	181,630	181,630	181,630	205,456	205,456	205,456
Revenues						
NASA Contract	150,630	145,130	135,130	156,956	153,956	143,956
Software Services	10,000	12,000	15,000	15,000	15,000	16,000
Electronic Communications	12,000	14,000	15,000	18,000	20,000	22,000
Educational Services	2,000	2,500	3,000	5,000	5,000	5,000
Printing/Duplication	5,000	5,500	6,000	6,000	7,000	8,000
Consultant Services	1,000	1,500	1,500	2,500	2,500	2,500
Seminars/Workshops	1,000	1,000	6,000	2,000	2,000	8,000
Total Revenue:	181,630	181,630	181,630	205,456	205,456	205,456

ORIGINAL PAGE IS
OF POOR QUALITY

AdaNET Third Year Projections (cont'd)

Major Cost Elements	Apr.'90	May '89	June'90	July'90	Aug.'90	Sept.'90	Cumulative
Personal Services	75,555	75,555	75,555	75,555	75,555	75,555	877,094
Current Expense	47,610	47,610	47,610	47,610	47,610	47,610	552,690
Travel Subtotal	7,935	7,935	7,935	7,935	7,935	7,935	92,115
Outside Services	2,607	2,607	2,607	2,607	2,607	2,607	31,285
Research Equipment	26,450	26,450	26,450	26,450	26,450	26,450	307,050
WVU	11,500	11,500	11,500	11,500	11,500	11,500	138,000
WVU Research Corp.	0	0	0	0	0	0	0
Beckley College	4,000	4,000	4,000	4,000	4,000	4,000	47,499
Software Valley Cor	3,000	3,000	3,000	3,000	3,000	3,000	36,000
Total Direct Costs:	178,657	178,657	178,657	178,657	178,657	178,657	2,081,732
Fee	26,799	26,799	26,799	26,799	26,799	26,799	312,260
Total:	205,456	205,456	205,456	205,456	205,456	205,456	2,393,992
Revenues							
NASA Contract	145,456	141,456	129,956	131,456	117,956	118,456	1,670,492
Software Services	17,000	18,000	20,000	22,000	24,000	25,000	209,000
Electronic Communications	24,000	25,000	27,000	29,000	30,000	32,000	268,000
Educational Services	5,500	6,000	6,500	7,000	7,500	8,000	63,000
Printing/Duplication	8,000	8,500	9,000	10,000	11,000	12,000	96,000
Consultant Services	2,500	4,500	5,000	6,000	7,000	8,000	44,500
Seminars/Workshops	3,000	2,000	8,000	0	8,000	2,000	43,000
Total Revenue:	205,456	205,456	205,456	205,456	205,456	205,456	2,393,992

ORIGINAL PAGE IS
OF POOR QUALITY

AdaNET Fourth Year Projections
(Quarterly Distribution)

Major Cost Elements	1st QTR.	2nd QTR.	3rd QTR.	4th QTR.	Total
Personal Services	225,000	225,000	225,000	225,000	900,000
Current Expense	150,000	150,000	150,000	150,000	600,000
Travel Subtotal	20,000	20,000	20,000	20,000	80,000
Outside Services	12,500	12,500	12,500	12,500	50,000
Research Equipment	81,000	81,000	81,000	81,000	324,000
WVU	37,500	37,500	37,500	37,500	150,000
WVU Research Corp.	0	0	0	0	0
Beckley College	12,000	12,000	12,000	12,000	48,000
Software Valley Corp.	9,000	9,000	9,000	9,000	36,000
Total Direct Costs:	547,000	547,000	547,000	547,000	2,188,000
Fee:	82,050	82,050	82,050	82,050	328,200
Total Expenses:	629,050	629,050	629,050	629,050	2,516,200
Revenues					
NASA Contract	187,500	187,500	187,500	187,500	750,000
Software Services	175,000	175,000	175,000	175,000	700,000
Electronic Communications	150,000	150,000	150,000	150,000	600,000
Educational Services	22,500	22,500	22,500	22,500	90,000
Printing/Duplication	25,000	25,000	25,000	25,000	100,000
Consultant Services	75,000	75,000	75,000	75,000	300,000
Seminars/Workshops	35,000	35,000	35,000	35,000	140,000
Total Revenues:	670,000	670,000	670,000	670,000	2,680,000
Balance:	40,950	40,950	40,950	40,950	163,800

ORIGINAL PAGE IS
OF POOR QUALITY

PRECEDING PAGE BLANK NOT FILMED

ORIGINAL PAGE IS
OF POOR QUALITY

AdaNET Five Year Projection

Major Cost Elements	1988	1989	1990	1991	1992
Personal Services	433,163	762,686	877,094	900,000	975,000
Current Expense	387,117	480,600	552,690	600,000	850,000
Travel Subtotal	59,149	80,100	92,115	80,000	90,000
Outside Services	24,268	30,264	31,285	50,000	50,000
Research Equipment	93,500	267,000	307,050	324,000	750,000
WVU	109,336	133,500	138,000	150,000	175,000
WVU Research Corp.	0	0	0	0	0
Beckley College	39,996	44,496	47,499	48,000	48,000
Software Valley Corp.	39,000	36,000	36,000	36,000	36,000
Total Direct Costs:	1,185,529	1,834,646	2,081,732	2,188,000	2,974,000
Fee	114,368	275,197	312,260	328,200	446,100
Total Costs:	1,299,898	2,109,842	2,393,992	2,516,200	3,420,100
Revenues					
NASA Contract	1,298,298	1,954,542	1,670,492	750,000	350,000
Software Services	0	49,250	209,000	700,000	950,000
Electronic Communications	1600	64,500	268,000	600,000	1,200,000
Educational Services	0	9,050	63,000	90,000	100,000
Printing/Duplication	0	18,500	96,000	100,000	150,000
Consultant Services	0	4,000	44,500	300,000	750,000
Seminars/Workshops	0	10,000	43,000	140,000	150,000
Total Revenues:	1,299,898	2,109,842	2,393,992	2,680,000	3,650,000
Balance:	0	0	0	163,800	229,900

AdaNET Fifth Year Projections
(Quarterly Distribution)

Major Cost Elements	1st QTR.	2nd QTR.	3rd QTR.	4th QTR.	Total
Personal Services	243,750	243,750	243,750	243,750	975,000
Current Expense	212,500	212,500	212,500	212,500	850,000
Travel Subtotal	22,500	22,500	22,500	22,500	90,000
Outside Services	12,500	12,500	12,500	12,500	50,000
Research Equipment	187,500	187,500	187,500	187,500	750,000
WVU	43,750	43,750	43,750	43,750	175,000
WVU Research Corp.	0	0	0	0	0
Beckley College	12,000	12,000	12,000	12,000	48,000
Software Valley Corp.	9,000	9,000	9,000	9,000	36,000
Total Direct Costs:	743,500	743,500	743,500	743,500	2,974,000
Fee:	111,525	111,525	111,525	111,525	446,100
Total Expenses:	855,025	855,025	855,025	855,025	3,420,100
Revenues					
NASA Contract	87,500	87,500	87,500	87,500	350,000
Software Services	237,500	237,500	237,500	237,500	950,000
Electronic Communications	300,000	300,000	300,000	300,000	1,200,000
Educational Services	25,000	25,000	25,000	25,000	100,000
Printing/Duplication	37,500	37,500	37,500	37,500	150,000
Consultant Services	187,500	187,500	187,500	187,500	750,000
Seminars/Workshops	37,500	37,500	37,500	37,500	150,000
Total Revenues:	912,500	912,500	912,500	912,500	3,650,000
Balance:	57,475	57,475	57,475	57,475	229,900

ORIGINAL PAGE IS
OF POOR QUALITY

Bibliography

Papers and Periodicals

[1] Anderson, J.D., Perkins, J.A., *Experience using an Automated Metrics Framework in the Review of Ada Source of WIS*, Proceedings of the Sixth National Conference on Ada Technology, Arlington, VA, March 14-17, 1988, pp. 32-41.

[2] Andrews, Timothy,

[3] Bailin, S., *The CTA Object-Oriented Development Facility*, Abstract, Computer Technology Associates, Inc., Laurel, MD.

[4] Bailin, S., Moore, J., *An Object-Oriented Specification Method for Ada*, Extended Abstract, Computer Technology Associates, Inc., Laurel, MD.

[5] Bailin, S., *Informal Rigor: A Practical Approach to Software Reuse*, Computer Technology Associates, Inc., Laurel, MD.

[6] Bailin, S., Moore, J., *A Software Reuse Environment*, Computer Technology Associates, Inc., Laurel, MD.

[7] Bailin, S., *An Automated Quality Assessor For Ada Object-Oriented Designs*, Computer Technology Associates, Inc., Laurel, MD.

[8] Basili, V.R., Rombach, H.D., *TAME: Tailoring an Ada Measurement Environment*, Proceedings of the Joint Ada Conference, Washington, DC, March 1987, pp. 318-325.

[9] Brykczynski, Bill R., *Preliminary Version: Ada/SQL: A Standard, Portable Ada-DBMS Interface*, IDA Paper P-1944, IDA Log No. HQ 86-31239, Institute for Defense Analyses, April 1987.

ORIGINAL PAGE IS
OF POOR QUALITY

[10] Brykczynski, Bill R., *Methods of Binding Ada to SQL: A General Discussion*, Institute for Defense Analysis Paper.

[11] Burton, B.A., Aragon, R.W., Bailey, S.A., Koehler, K.D., Mayes, L.A., *The Reusabile Software Library*, IEEE Software, July 1987, pp. 25-32.

[12] Carney, David, *Software Methodology and the AIE Program Library*, Ada Companion Series, Ada: Managing the Transition, Proceedings of the Ada-Europe International Conference, Edinburgh , May 6-8, 1986.

[13] Chen, P.P, *The Entity-Relationship Model-Toward a Unified View of Data*, Transactions on Data Base Systems, Vol. 1, No. 1, March 1976, pp. 166-193.

[14] Conn, R., *The Ada Software Repository and Software Reusability*, Proceedings of the Joint Ada Conference, Washington, DC, March 1987, pp. 45-53.

[15] Conn, R. (Editor), *Ada Software Repository Newsletter*, Management Assistance Corporation of America, issue 103, January - February 1988.

[16] Conn, R., *The Ada Software Repository (ASR) on Simtel 20*, Ada-JUG/SigAda, March 1988.

[17] Conti, R.A., *Critical Run-Time Design Tradeoffs in an Ada Implementation*, Proceedings of the Joint Ada Conference, Washington, DC, March 1987, pp. 486-495.

[18] Crawford, R.G., Becker, H.S., *A Novice User's Interface to Information Retrieval Systems*, Application Processing and Management, vol. 22, no. 4, 1986, pp. 287-298.

[19] Dausmann, M., *Library Structures for Reusable Components*, ACM SIGAda International Conference, Boston, MA, December 1987, pp. 226-235.

[20] Delaney, R.P., Summerill, L.F., *Ada Software Metrics*, Proceedings of the Sixth National Conference on Ada Technology, Arlington, VA, March 14-17, 1988, pp. 24-31.

[21] Dobbins, G.L., Szarek, V.E., Webster, W.H., *An Ada/Prolog Database Management System for Ada Source Code*, Third Annual Conference on Artificial Intelligence & Ada, Washington Dulles Ramada Renaissance Hotel, Herndon, VA, October 1987, pp. 23-39.

ORIGINAL PAGE IS
OF POOR QUALITY

[22] El-Ghoroury, H., LaBarbera, P.R., Bollenbacher, J., *Software Portability in Embedded, Distributed Systems*, Proceedings of the Joint Ada Conference, Washington, DC, March 1987, pp. 420-431.

[23] Freeman, P., *A Perspective on Reusability*, Computer Society Press of the IEEE, Washington, D.C., December 1986, pp. 2-9.

[24] Freeman, P., *Reusable Software Engineering: Concepts and Research Directions*, ITT Proceedings of the Workshop on Reusability in Programming, 1983, pp. 2-16.

[25] Goel, A.,Wong, E., *Evaluation of Existing Benchmark Suites for Ada*, Proceedings of the Sixth National Conference on Ada Technology, Arlington, VA, March 14-17, 1988, pp. 42-48.

[26] Goguen, J., *Reusing and Interconnecting Software Components*, IEEE Computer, February, 1986, pp. 16-28.

[27] Gorzela, R.S., Perkins, J.A., *Experience Using an Automated Metrics Framework to Improve the Quality of Ada Software*, Proceedings of the Joint Ada Conference, Washington, DC, March 1987, pp. 277-284.

[28] Harrison, C., *An Automated Method of Referencing Ada Reusable Code Using LIL*, Proceedings of the Joint Ada Conference, Washington, DC, March 1987, pp. 1-7.

[29] Hendler, J.A., Wong, Y.C., *AIRS: An AI-based Ada Reuse Tool*, Third Annual Conference on Artificial Intelligence & Ada, Washington Dulles Ramada Renaissance Hotel, Herndon, VA, October 1987, pp. 1-22.

[30] Horowitz, E., Munson, J.B., *An Expansive View of Reusable Software*, IEEE Transactions on Software Engineering September 1984, pp. 477-487.

[31] Hulkkonen, T.O., *Software Component Library*, Ada Companion Series, Ada: Managing the Transition, Proceedings of the Ada-Europe International Conference, Edinburgh, May 4-6, 1986.

[32] Ichbiah, J.D., *On the Design of Ada*, Information Processing 83, Edited by R.E.A. Mason, 1983, pp. 1-10.

ORIGINAL PAGE IS
OF POOR QUALITY

[33] Jones, T.C., *Reusability in Programming: A Survey of the State of the Art*, IEEE Transactions on Software Engineering, September 1984, pp. 488-494.

[34] Lanergan, R.G., Grasso, C.A., *Software Engineering with Reusable Designs and Code*, IEEE Transactions on Software Engineering, September 1984, pp. 498-501.

[35] Leach, R.J., *Ada Software Metrics and Their Limitations*, Proceedings of the Joint Ada Conference, Washington, DC, March 1987, pp. 285-293.

[36] McKay, C.W., *A Position Paper: The Need to Advance Beyond the Relational Data Model and SQL*, 1988.

[37] McKay, C.W., *A Proposed Framework for the Tools and Rules to Support the Life Cycle of the Space Station Program*, IEEE, 1987.

[38] McKay, C.W., *Technical Issues: Software Trade-off Considerations for Run Time Risk Management in Target Environments*, NSIA Conference, 1987.

[39] Muser, D.R., Stepanov, A.A., *A Library of Generic Algorithms in Ada*, ACM SIGAda International Conference, Boston, MA, December 1987, pp. 216-225.

[40] Narfelt, K., SCHEFSTROM, D., *Extending the Scope of the Program Library*, Ada Companion Series, Ada In Use, Proceedings of the Ada International Conference, Paris, May 14-16, 1985.

[41] Olsen, R., *Manufacturing Strategies for the 1990's*, Conference Proceedings, Presented at James Madison University, 21-22 March 1988.

[42] Owen, G.S., Gagliano, R., Honkanen, P., *Functional Specifications of Reusable MIS Software in Ada*,Proceedings of the Joint Ada Conference, Washington, DC, March 1987, pp. 19-26.

[43] Parnas, D.L., Clements, P.C., Weiss, D.M., *Enhancing Reusability with Information Hiding*, ITT Proceedings of the Workshop on Reusability in Programming, 1983, pp. 72-76.

[44] Perlman, G., *User Interface Development*, SEI Curriculum Module SEI-CM-17-1.0, Carnegie Mellon University, Software Engineering Institute, Draft for Public Review, April 1988.

[45] Potosnak, K., (Editor, The Koffler Group), *Do icons make user interfaces easier to use?*, HUMAN FACTORS, May, 1988, pp. 97-

[46] Poutanen, O., *Notes on Building a Relational Database Management System in Ada*, Ada Companion Series, Ada in Use, Proceedings of the Ada International Conference, Paris, May 14-16, 1985.

[47] Preston, D., Nyberg, K. Mathis, R., *An Investigation into the Compatibility of Ada and Formal Verification Technology*, Proceedings of the Sixth National Conference on Ada Technology, Arlington, VA, March 14-17, 1988, pp. 13-23.

[48] Prieto-Diaz, R., Freeman, P., *Classifying Software for Reusability*, IEEE Software, January 1987, pp. 6-16.

[49] Prieto-Diaz, R., *Domain Analysis for Reusability*, Proceedings of the COMPSAC 87, Tokyo, Japan, October 1987.

[50] Prieto-Diaz, R., Jones, G. A., *Breathing New Life into Old Software*, GTE Journal, pp.22-31.

[51] Prieto-Diaz, R., *Faceted Classifications and Reuse Across Domains*, Abstract.

[52] Radi, T.S., *TestGen - Testing Tool for Ada Designs and Ada Code*, Proceedings of the Sixth National Conference on Ada Technology (Sponsored by: United States Army, United States Navey, United States Air Force, United States Marine Corps, Ada Joint Program Office), Arlington, VA, March 14-17, 1988, pp. 1-6.

[53] Rice, J.R., Schwetman, H.D., *Interface Issues in a Software Parts Technology*, ITT Proceedings of the Workshop on Reusability in Programming, 1983, pp. 129-137.

[54] Rogers, P., *A Taxonomy for Ada Software Components*, Master's Thesis, University of Houston at Clear Lake, December 1987.

[55] Russell, G., *Experiences Implementing a Reusable Data Structure Component Taxonomy*, Proceedings of the Joint Ada Conference, Washington, DC, March 1987, pp. 8-18.

[56] Selby, R.W., *Incorporating Metrics into a Software Environment*, Proceedings of the Joint Ada Conference, Washington, DC, March 1987, pp. 326-333.

[57] Sivley, K.E., *Experience and Lessons Learned in Transporting Ada Software*, Proceedings of the Joint Ada Conference, Washington, DC, March 1987, pp. 436-440.

[58] Slonaker, P., Prizant, S., Smith, M.S., Giles, J., *Development of Multi-Tasking Software in Ada–A Case Study*, Proceedings of the Joint Ada Conference, Washington, DC, March 1987, pp. 304-317.

[59] Smith, J. M., Chan, A., Danberg, S., Fox S., Nori A., *A Tool Kit for Database Programming in Ada*, Ada Companion Series, Ada in Use, Proceedings of the Ada International Conference, Paris, France, May 1985.

[60] Tauson-Conte, H.J., *Ada Complexity Extension (ACE) An Extension of McCabe's Cyclomatic Complexity Metric for Analysis of Ada Software*, Proceedings of the Sixth National Conference on Ada Technology, Arlington, VA, March 14-17, 1988, pp. 7-12.

[61] Tracz, W., *Ada Reusability Efforts: A Survey of the State of the Practice*, Proceedings of the Joint Ada Conference, Washington, DC, March 1987, pp. 35-44.

[62] *Vbase: Technical Overview*, a publication by Ontologic, Inc. for Vbase release version 0.8, March 6, 1987.

[63] Vizard, M., *Battle of the Network Protocols*, Digital Review, August 24, 1987, pp. 73-74.

[64] Vizard, M., *OSI Gains Momentum in Protocol Struggle*, Digital Review, August 24, 1987, pg. 75.

[65] Wagner, P., *Varieties of Reusability*, ITT Proceedings of the Workshop on Reusability in Programming, 1983, pp. 30-44.

[66] Walker, J.E., Skyles, S.D., Gilliam, P.U., *A Practical Experience with Ada Portability*, Proceedings of the Joint Ada Conference, Washington, DC, March 1987, pp. 432-435,

[67] Wolf, A.L., Clarke, L.A., Wileden, J.C., *Ada-Based Support for Programming in-the-Large*, IEEE Software, March 1985, pp. 58-71.

[68] Woodfield, S.N., Embley, D.W., *A Knowledge Structure for Reusing Abstract Data Types in Ada Software Production*, Proceedings of the Joint Ada Conference, Washington, DC, March 1987, pp. 27-34.

[69] Wu, L., Basili, V.R., Reed, K., *A Structure Coverage Tool for Ada Software Systems*, Proceedings of the Joint Ada Conference, Washington, DC, March 1987, pp. 294-303.

[70] Yoelle, S.M., Kaiser, G.E., *Using Conceptual Clustering for Classifying Reusable Ada Code*, ACM SIGAda International Conference, Boston, MA, December 1987, pp. 208-215.

Books

[71] Booch, Grady, *Software Engineering With Ada, 2nd Edition*, The Benjamin/Cummings Series in Ada and Software Engineering, Benjamin/Cummings, Menlo Park, CA, 1986.

[72] Booch, Grady, *Software Components With Ada*, The Benjamin/Cummings Series in Ada and Software Engineering, Benjamin/Cummings, Menlo Park, CA, 1987.

[73] Conn, R., *The Ada Software Repository and the Defense Data Network: A Resource Handbook*, New York Zoetrope, New York, NY, 1987.

[74] , COSMIC, The University of Georgia, Athens, GA, 1988.

[75] General Electric Company, Corporate Information Systems, *Software Engineering Handbook*, McGraw-Hill Series in Software Engineering and Technology, McGraw-Hill Book Company, 1986.

[76] Kernighan and Pike *The UNIX Programming Environment*

[77] Kiger, J.I., *The Depth/Breadth Trade-off in the Design of Menu-Driven User Interfaces.*

[78] Matsumoto, Y., *A Software Factory: An Overall Approach to Software Production*, Computer Society Press of the IEEE, Washington, D.C., December 1986, pp. 155-178.

[79] Nissen, J., Wallis, P., *Portability and Style in Ada*, Cambridge University Press, Cambridge, 1984.

[80] Shneiderman, B., *Designing the User Interface: Strategies for Effective Human-Computer Interaction*, Addison-Wesley Publishing Co., Reading, MA, 1987.

[81] *Integration and Pagination: Long Documents, Proposals, Books*, Seybold Rep. Publ. Syst., April 1987.

Standards and Government Documents

[82] , *Standard for Electronic Manuscript Preparation and Markup*, Electronic Manuscript Series, Association of American Publishers, Washington, D.C., February 1986.

[83] *Reference Manual for the Ada Programming Language*, ANSI/MIL-STD-1815A-1983, American National Standards Institute, Inc., New York, 1983.

[84] *SQL Standard* American National Standards Institute, Inc., New York, 198

[85] *Distributed Computing Design System - A Technical Overview*, CDRL B003, 25 July 1987.

[86] *Distributed Computing Design System (DCDS) Methodology Guide (Ada Version)*, CDRL A008, October 1987.

[87] *Distributed Computing Design System (DCDS) Tool User's Guide (Ada Version)*, Draft, CDRL B006, May 1987.

[88] *Distributed Computing Design System (DCDS) Tool User's Guide (Ada Version)*, CDRL B006, October 1987.

[89] *Distributed Computing Design System (DCDS) Methodology Guide (Ada Version) Appendices*, CDRL A008, October 1987.

[90] *Distributed Computing Design System (DCDS) Tools User's Guide (Ada Version) Appendices*, CDRL B006, October 1987.

[91] *Defense System Software Development*, Military Standard, DOD-STD-2167, AMSC NO. N3608, AREA MCCR, June 1985.

[92] *Version Description Document for the Missile Software Parts of the Common Ada Missile Packages (CAMP)*, October 1987.