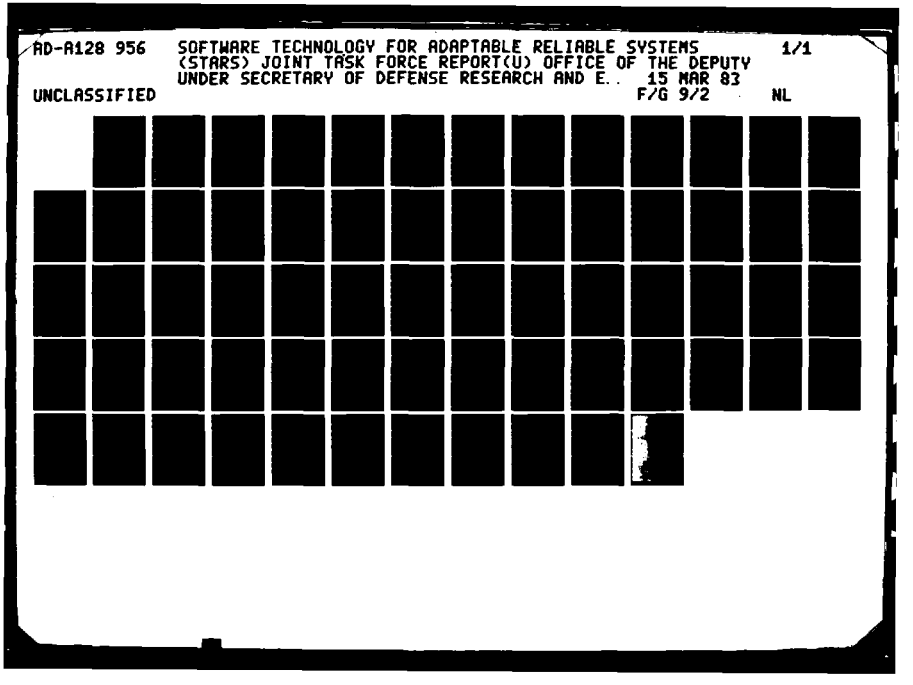
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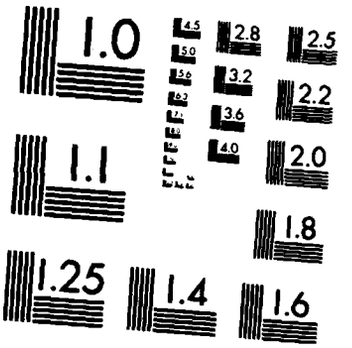

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Software, Hardware, System Interface Standards, Ada, Software Engineering Institute, Mission critical , military systems, Software Technology For Adaptable, Reliable, Systems, STARS, defense contractors, support environments, automated tools, embedded computers. Functional Task Areas.

ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report contains an overview of the functions of the Joint Task Force on the Software Technology For Adaptable Reliable Systems (STARS) Program. This report contains recommendations made by the task force regarding the technical tasks that should be undertaken, how the STARS program should be managed, and how some major tasks should be packaged for contracting pruposes. These recommendations included identifying those early tasks that are on the program's critical path(s) and must therefore be performed expeditiously.

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SOFTWARE TECHNOLOGY FOR

ADAPTABLE, RELIABLE SYSTEMS (STARS)

JOINT TASK FORCE

REPORT

Department of Defense

15 March 1983

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TABLE OF CONTENTS

		Page
1.0	INTRODUCTION	1
2.0	TASK FORCE ACTIVITIES	3
3.0	MEMBERSHIP	7
4.0	DOCUMENTS PRODUCED	10
5.0	EARLY CRITICAL PATH TASKS	12
6.0	ACKNOWLEDGEMENTS	14
APPENDIX I	DoD SOFTWARE INITIATIVE WORKSHOP	15

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1.0 INTRODUCTION

The Joint Task Force on the Software Technology for Adaptable, Reliable Systems (STARS) Program was formed at the direction of the Deputy Under Secretary of Defense for Research and Engineering (Research and Advanced Technology) (DUSD(R&AT)) with support from the Assistant Secretary of the Army (RD&A), the Assistant Secretary of the Navy (RE&S), the Assistant Secretary of the Air Force (RD&L) and the Deputy Under Secretary of Defense(C^3I) to refine the strategy for the program, to prepare for detailed planning and management of the program, and to make recommendations concerning a draft plan. In existence for the four months from 15 November 1983 until 15 March 1982, the Task Force began from the Strategy for a DoD Software Initiative[1] published 1 October 1982, and ended by producing a number of documents including this and others listed in Section 4.0.

The Task Force was composed of two or three representatives from each Service and members from the Defense Communications Agency, the National Security Agency, and the DoD Computer Security Center. The Chair was from ODUSD(R&AT). Several general consultants and a number of subject area specialist consultants supported the Task Force's efforts. The Task Force members and consultants are listed in Section 3.0.

The Task Force arrived at recommendations covering the technical tasks that should be undertaken, how the STARS program should be managed, and how some major tasks should be packaged for contracting purposes. These recommendations included identifying those early tasks that are on the program's critical path(s) and must therefore be performed expeditiously.

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[1]Department of Defense, Strategy for DoD Software Initiative, in two Volumes, ODUSD (R&AT), 1 October 1982.

The next section reviews the Task Forces activities. Section 3.0 describes the membership of the Task Force and identifies the consultants involved. Section 4.0 lists the documents produced, and Section 5.0 lists recommendations for early tasks to be expedited. Finally, Section 6.0 acknowledges the many persons who have assisted the Task Force's efforts.

2.0 TASK FORCE ACTIVITIES

The Task Force began on 15 November 1982 by receiving two days of briefings covering both volumes of the October 1 Strategy for a DoD Software Initiative, the Ada Program, a preliminary survey of DoD software R&D, and the Report of the DoD Joint Service Task Force on Software Problems. [2] In November and early December, the Task Force concentrated on three items:

- Revising the 1 October strategy document based on comments from the Services.
- Improving the preliminary survey of existing or already planned software R&D in DoD.
- Producing a first draft of a Program Management Plan to cover many of the DoD management issues that had been treated only lightly in the 1 October document or had received comment from the Services.

In mid-December, subject matter consultants for each of the major functional task areas identified in the 1 October strategy document, plus the Software Engineering Institute, briefed the Task Force on their outlines for more detailed strategies. From each half day discussion the consultant for the functional task area gained guidance for producing a draft strategy in his/her area. These detailed discussions, plus the prior efforts, resulted in the Task Force members rapidly becoming thoroughly familiar with the issues and involved in their resolution.

The Task Force dispersed during the holidays to give members an opportunity to discuss progress and issues with their home organizations. In January, the Task Force reassembled to receive a number of briefings from interested parties inside and outside DoD and to prepare for a DoD Software Initiative Workshop to be held February

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[2] Department of Defense, Report of the DoD Joint Service Task Force on Software Problems, ODUSD (R&AT), 30 July 1982.

7-9 in Raleigh, N.C. Briefings were received on selected topics from several DoD organizations such as the Ballistic Missile Defense Advanced Technology Center (Army), the Naval Research Laboratory (Navy), and--after the workshop--the Rome Air Development Center (Air Force). From outside DoD there was a briefing from the National Aeronautics and Space Administration (NASA) as well as a number of unsolicted briefings from Defense contractors. A memorandum of agreement with NASA was drafted.

Also during January, draft strategies for each of the task areas were prepared by the consultants, reviewed by the Task Force and revised. Preparations were made for the initial presentations at the workshop.

To aid in coordination within DoD, a Task Force member briefed the STARS program to the DoD Software Test and Evaluation Project (STEP) conference February 1-3 in Washington, D.C. sponsored by the National Security Industrial Association (NSIA) in cooperation with DoD. Several additional members of the Task Force attended this conference.

A Workshop on the DoD Software Initiative was held in Raleigh, North Carolina, February 7-9. The purpose of the workshop was to expose the draft Functional Task Area Strategies widely across the Defense community and revise them as appropriate. Approximately 500 persons attended the workshop. Of these, roughly 300 were Defense contractors, 150 DoD personnel, and 50 academic. The workshop used parallel panels of from 8 to 18 persons for each functional task area, meeting in alternating open and closed sessions to review and decide on revisions. During the open sessions, the Strategies were presented and persons not on panels had a chance to comment. In addition, many persons used forms provided to make written comments.

The workshop resulted in improvements to all the Strategies. Most changed in minor or moderate ways but one, Systems, received sweeping revision and another, the Software Engineering Institute, revealed a broad range of diverse opinions on its functions and proposed organization.

In the workshop's final session, reports were also made by two special panels:

- A group of senior members of the computing community who among them attended all the open sessions, reported on their impressions of the workshop and the STARS program. Copies of the panel's slides are shown in Appendix I.3.

- A group of senior industry attendees, who met in closed session throughout the workshop, addressed the entire program but particularly how it might best be implemented. A copy of the panel's report is in Appendix I.4.

The suggestions of these panels provided input particularly to the preparation of the STARS Implementation Approach.

The following conclusions were drawn from the workshop and presented to the attendees of the closing session.

- We need the initiative - DoD lead is proper
- Goal is appropriate - may need clarification
- Objectives are appropriate
- Attendees liked 1 October document as foundation for STARS
- Right technology issues were identified
- Estimates of effort were low
- Some panels got lost in detail - top level plan not visible
- Structure of program did not yet provide incentive to industry to give DoD leverage

- o Need to achieve goals through integrated projects
- o Need to rethink security and proprietary software.

Following the workshop, the Task Force concentrated on producing the final set of documents (see Section 4.0 for a complete list). Revisions were made to the Functional Task Area Strategies, reviewed by the Task Force and the workshop panels in each area, and edited to final form. The overall strategy and program management documents received revisions and an implementation approach was prepared.

During this period many discussions were held, including all day briefings for, and discussions with the Computer Science and Technology Board of the National Research Council, National Academy of Sciences and the combined Joint Policy Coordinating Group for Computer Resources Management of the Joint Logistical Commanders and the Computer Sciences Subgroup of Joint Directors of Laboratories. One result of these discussions was a recommendation for the establishment of a panel of senior people to further investigate and recommend the form and functions for the Software Engineering Institute.

The Task Force members attempted to establish a complete baseline of current and planned DoD R&D activity in the functional task areas. While the information achieved was very useful and generally sufficient for the Task Forces purposes, it became clear that the results would require more resources than were available to ensure the completeness and accuracy required for publication.

3.0 MEMBERSHIP

The DoD representatives on the Task Force were:

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4.0 DOCUMENTS PRODUCED

The following documents are products of the Task Force:

- STARS Joint Task Force Report contains a brief history of the Task Force, references to the other documents produced by the Task Force, and an appendix on the Raleigh workshop (this document).

- STARS Program Strategy gives the rationale for the program and outlines its implementation and organization.

- STARS Program Management Plan is intended to become the formal agreement among DoD Components covering how they will work together to plan and execute the program.

- STARS Implementation Approach describes the approach to composing implementation tasks and the acquisition approach for constructing automated support environments.

- STARS Functional Task Area Strategies are eight documents one for each of the functional task areas. They state overviews, objectives, strategy, and tasks for each area. They are:

  - STARS Functional Task Area Strategy for Measurement
  - STARS Functional Task Area Strategy for Human Resources
  - STARS Functional Task Area Strategy for Project Management
  - STARS Functional Task Area Strategy for Systems
  - STARS Functional Task Area Strategy for Application Specific
  - STARS Functional Task Area Strategy for Acquisition
  - STARS Functional Task Area Strategy for Human Engineering
  - STARS Functional Task Area Strategy for Support Systems.

- A Candidate Strategy for the Software Engineering Institute describes a possible plan and organization for the Software Engineering Institute. The options for the Software

Engineering Institute will be further considered during the Spring and Summer of 1983.

5.0 EARLY CRITICAL PATH TASKS

The Task Force has identified the following tasks as being early tasks on critical paths. These are foundation tasks which the Task Force recommends be initiated expeditiously. These are detailed further and their rationale discussed in the STARS Implementation Approach and the Functional Task Area Strategies.

- Construction of Support Environments (STARS Implementation Approach)
- Establish baseline(s) (Measurement Task Area)
- Determine program-success measures (Measurement)
- Establish measurement criteria, metrics, and experimental techniques for each task (Measurement)
- Develop tools and techniques for instrumentation and data analysis (Measurement)
- Perform human resource technical and managerial skill assessment (Human Resources)
- Identify important application areas (Application Specific)
- Form user groups taking advantage of existing groups
  - end-user groups (Application Specific)
  - development/support groups (Support Systems)
- Develop evaluation criteria for Ada and computer systems architectures (Systems)
- Provide Ada access to target run-time system (Systems)
- Develop system reliability enhancement techniques and tools (Systems)
- Review impediments in current acquisition practices (Acquisition)
- Establish Acquisition Panel (Acquisition)

- Establish approach to protection of software including proprietary, classification, and foreign export issues (Acquisition)

- Establish mechanism to evaluate and prioritize human engineering research, methodology, and tools (Human Engineering)

- Conduct Methodman[3] experiment (Support Systems)

- Prepare to evaluate tools, environments, and methods, particularly environment definition and design evaluation criteria for use at decision points (Support Systems, STARS Implementation Plan)

- Develop tool integration concepts, techniques, and tools (Support Systems)

- Perform functional analysis of project management (Project Management)

- Perform R&D on alternative paradigms or revolutionary approaches (Support Systems, Systems, and potentially elsewhere).

---

[3]P. Freeman and A. I. Wasserman, Comparing Software Design Methods for Ada: A Study Plan, Ada Joint Program Office, November 1982.

6.0 ACKNOWLEDGEMENTS

Many people have influenced the STARS planning in a variety of ways since the last formal statement of acknowledgements on 1 October 1982. Panel members at the February 1983 workshop worked long hours under short deadlines to help improve the strategies; attendees at the workshop also contributed generously from their expertise. Members of the Computer Science Technology Board of the National Research Council provided the benefit of their varied expertise and experience in offering suggestions to the Task Force. Also, a number of briefings and suggestions were received from both inside and outside DoD. Acknowledging the many specific contributions is impossible. While no clean way exists to acknowledge these contributions specifically, a serious debt exists to those who have given freely of their considerable talents and expertise.

APPENDIX I

DoD SOFTWARE INITIATIVE WORKSHOP

Raleigh, N.C. 7-9 February 1983

I.1 Workshop Program

I.2 Summary of Issues Raised at Workshop

I.3 Bate Panel Charts

I.4 Manley Panel Findings

APPENDIX I.1

Workshop Program

DoD SOFTWARE INITIATIVE WORKSHOP

Raleigh Marriott
Raleigh, North Carolina

7-9 February 1983

General Chairperson	-Larry E. Druffel, Lt. Colonel, USAF ODUSDRE (R&AT)
Program Co-Chairpersons	-Samuel T. Redwine, Jr. Mitre Corporation and William E. Riddle software design & analysis, inc.
Local Arrangements Chairperson	-James B. Clary Research Triangle Institute

A G E N D A

MONDAY - 7 February 1983:

10:00 a.m. - 12:15 p.m.	General Session -Opening Remarks L. Druffel -Welcome to the Research Triangle Area George R. Herbert, President of RTI -The Software Initiative Effort in the DoD Research and Advanced Technology Context H. Mark Grove, Assistant Deputy Under Secretary Defense for Research and Engineering (Research and Advanced Technology) -Software Initiative Background and Objectives L. Druffel -Overview of the Software Initiative Technical Plan S. Redwine, W. Riddle,
12:30 p.m. - 1:30 p.m.	-LUNCH

Parallel Sessions

1:30 pm. - 5:30 p.m.

-1) Support Systems Panel
Co-Chairpersons: George Sumrall
Ann Marmor-Squires
Vice-Chairperson: Jack Wileden

2) Human Resources Panel
Chairperson: Charles Oglesby
Vice-Chairperson: Joseph Urban

3) Acquisition Panel
Co-Chairpersons: D. Burton Newlin
Bernie Zampolich
Vice-Chairperson: Joseph Beardwood, III

3:00 p.m - 3:30 p.m. - BREAK

6:30 p.m. - 8:00 p.m. -Reception with Cash Bar

TUESDAY - 8 February 1983:

Parallel Sessions

8:00 a.m. - 11:00 p.m.

-1) Systems Panel
Chairperson: Stephen Squires
Vice-Chairperson: Geoffrey Frank

2) Human Engineering Panel
Chairperson: Carol Morgan
Vice-Chairperson: Elizabeth Kruesi

3) Project Management Panel
Chairperson: H. O. Lubbes
Vice-Chairperson: Donald Reifer

9:15 a.m. - 9:45 a.m. -BREAK

11:15 a.m. - 12:15 p.m. -LUNCH

12:30 p.m. - 1:30 p.m. Continuation of Morning Sessions

1:45 p.m. - 5:45 p.m.

-1) Application Specific Panel
Chairperson: Paul Cohen
Vice-Chairperson: John R. Rice

2) Technology Insertion Panel
Chairperson: Harold Falk
Vice-Chairperson: Joe Fox

3) Measurement Panel
Chairperson: Samual DiNitto
Vice-Chairperson: Janet Dunham

3:45 p.m. - 4:15 p.m. -BREAK

WEDNESDAY 9 February 1983:

Parallel Sessions

8:30 a.m. - 9:30 a.m.	-1) Support Systems Panel 2) Human Resources Panel 3) Acquisition Panel
10:00 a.m. - 11:00 a.m.	-1) Systems Panel 2) Human Engineering Panel 3) Project Management Panel
11:15 a.m. - 12:15 p.m.	-1) Application Specific Panel 2) Technology Insertion Panel 3) Measurement Panel
9:30 a.m. - 10:00 a.m.	-BREAK
12:30 p.m. - 1:30 p.m.	-LUNCH

General Session

1:30 p.m. - 4:30 p.m.	-Summary of Task Area Plans and Closing Remarks L. Druffel, S. Redwine, W. Riddle

APPENDIX I.2

Summary of Issues Raised at Workshop

APPENDIX I.2

SUMMARY OF ISSUES RAISED AT WORKSHOP

1.0 INTRODUCTION

Each functional task area panel compiled its own list of issues raised at the workshop. They vary among the panels in style and format, but all are presented here exactly as they were prepared.

2.0 MEASUREMENT ISSUES

1. Emphasis on measurement is needed throughout the whole life cycle. Requirements and design measures can locate serious problems while they are still inexpensive to fix. Measurements for and in the testing phase can help insure reliability, simplify testing, and provide an indication of when testing is complete. Metrics and measurements related to the maintainability of software products and the measurement of the maintenance process itself have a very high leverage toward holding down costs because that phase can be 70% of the total costs. Finally, user-oriented measures and measures of user performance should be included.

The panel concurred, and all of the above will be included in the measurement task.

2. Several issues and concerns were raised with regard to data collection:

(a) How much data is adequate to validate/calibrate the metrics, and establish the baselines?

(b) How does one inforce the anonymity of the data?

(c) How does one collect a superset of data to support future measures, metrics, and baselines?

(d) How does one insure generality of the data so that it will have wide application but not be too burdensome and costly to collect?

(e) How does one insure the integrity of the data?

(f) The number of environments automatically instrumented should be larger than that supported (developed) by the STARS Program.

Issue (a), was not completely resolved, but a representative set of embedded systems modules will be sought to provide a well rounded data base. At a cost of between 5 and 12% overhead in systems under development or maintenance, the data collection to support the activities must be limited.

Issue (b), had no resolution since some of the data necessary would leave little doubt as to the source.

Issue (c), had no resolution, although some of the members of the audience felt it was possible. The panel generally disagreed with the supposition.

Issue (d), had no immediate resolution, but will be given emphasis in the initiative. The panel felt it was resolvable.

On issue (e), proposals were made to use IV&V and/or the contractors own Q/A to insure the integrity of the data. The panel felt that relying on IV&V would not help to integrate measurement into the development process. The panel and audience agreed that the program manager and developer teams must recognize the value of the data and use it themselves if its integrity was to be valid.

On issue (f), the panel did not think resources were available to support instrumentation of more than one environment to automatically collect and analyze the detailed data needed. It is intended to provide a stand-alone system to work with uninstrumented environments, but these would not be able to collect all the data needed. It was strongly emphasized that there would be two levels of data collected, one at the very detailed level, and one at the higher level, which is already collected on most projects (costs, lines of code, etc.). The latter would generally be available for free if anonymity could be insured.

3. A recurring theme concerned the problems associated with the lack of commonality of definitions for terms like "line of code" and "error." While recognizing this as a problem that would be solved by the measurement task, no solutions were proposed by the panel or from the floor.

4. An issue was raised on how to get the data collection and metrics implemented as an integral part of a contract. Several good suggestions were made: the metrics and their collection should be tied to the Work Breakdown Structure of a contract. A menu of metrics should be proposed for a user, rather than a dictated set. Strong educational support should be provided. Circulate a list, of metrics and data this task area will collect, to a wide audience for comment and refinement.

2.0 HUMAN RESOURCES ISSUES

1. Coordination between tasks is needed.

2. Focus should also include training the emerging personal computer population and secondary schools to utilize proper techniques.

3. Develop other necessary skills along with the professional develop activities.

4. Use learning aids to help transfer Ada computer/software education and training to non-ADP types.

5. Current exchange programs not fully utilized.

6. Standard curriculum for software engineering.

7. Starting salary structures fo S.E.'s need revision.

8.* Who should oversee the Human Resources and STARS tasks?

9. Emphasis should also be placed on retraining efforts.

* No. 8 unresolved. Other 7 have been addressed or can be specifically incorporated into a detailed plan later.

3.0 PROJECT MANAGEMENT ISSUES AND DISPOSITIONS

1. ISSUE: Excessive focus on tools.

   DISPOSITION: Tools will be supportive of management concepts.

2. ISSUE: Early user involvement.

   DISPOSITION: A users group will be formed to guide tool development.

3. ISSUE: Definition of Acquisition Manager, Project Manager, etc.

   DISPOSITION: The problem of titles for people who perform the project management function has been dealt with in the plan.

4. ISSUE: Application to software maintenance.

   DISPOSITION: The plan has been written to specifically include the maintenance, support, or redevelopment issues.

5. ISSUE: Needs clear statement of problem and who will be helped.

   DISPOSITION: The plan has a clear statement of the problem and a discussion of who is to be helped.

6. ISSUE: Need close coupling to acquisition, measurement, and other areas.

   DISPOSITION: The differences between the Project Management and Acquisition task areas have been defined and section 3 of the plan identifies the interfaces with the other task areas.

7. ISSUE: Prioritize tasks.

DISPOSITION: To be accomplished.

8. ISSUE: JLC interface.

DISPOSITION: To be identified.

9. ISSUE: Measurement and validation.

DISPOSITION: The plan identifies validation as part of the tasks. Measures of effectiveness will be developed as part of the Measurement Task Area.

10. ISSUE: Out-year research.

DISPOSITION: Out-year research has been identified and clarified by the plan.

11. ISSUE: Elimination of the IPMTS.

DISPOSITION: The IPMTS has been retained as a necessary part of the tool evaluation and as a means of refining and validating the Project Management Functional Analysis.

12. ISSUE: Original plan identified an intelligent work station as a possible implementation of an IPMTS. This view was questioned as being too limited.

DISPOSITION: The physical implementation strategy has been eliminated from the plan.

13. ISSUE: Hosting/portability problems with the IPMTS.

DISPOSITION: The IPMTS is considered to be a prototype and is useful as a means of identifying useful tools, validating concepts and as a baseline for the Advanced Tool Set. Acquisition strategies for two IPMTSs have been identified which minimize the hosting and probability issues.

14. ISSUE: Tool distribution, maintenance support.

DISPOSITION: Results from the tool set efforts will be fed to the the Support Systems Task Area for integration/interface with the support environment. Distribution and maintenance will be handled by the Software Engineering Institute.

15. ISSUES: Leasing, liability and proprietary rights.

DISPOSITION: These problems have been identified as issues which need to be addressed by the Acquisition Panel.

16. ISSUE: Forecast next generation problems.

DISPOSITION: The strategy of the plan is such that it can adapt to the next generation problems.

17. ISSUE: Create a generic work breakdown structure (WBS) model.

DISPOSITION: The capability for a generic WBS model is incorporated in the notion of acquisition models and policies and procedures.

18. ISSUE: Impact on project management of software engineering technology.

DISPOSITION: The plan identifies a strong relationship of software engineering to project management.

19. ISSUE: Explore Government/contractor relationship.

DISPOSITION: The plan explores this relationship and identifies issues to be addressed by the Acquisition Panel.

20. ISSUE: Employ case study analysis.

DISPOSITION: The plan employs case studies to validate the results of the Project Management Functional Analysis Task.

21. ISSUE: Ada transition strategy.

DISPOSITION: The plan identifies the requirement for the tools to be integrated or interfaced with an APSE-like environment.

22. ISSUE: Implementation decision point for tool set.

DISPOSITION: Implementation of deliverable tool sets is covered in the support systems and software engineering institute plans.

23. ISSUE: Advisory council participation.

DISPOSITION: Same as #2.

24. ISSUE: Expert system/management synergy.

DISPOSITION: The use of knowledge base and artificial intelligence concepts are embedded in the planning for an Advanced Project Management Tool Set.

25. ISSUE: Plan should include leadership training.

DISPOSITION: Included in the plan.

26. ISSUE: Question of efficacy of a management simulator as a training aid.

DISPOSITION: The management simulator has been included in the plan based on the success that the Naval War College has had using digital simulations and gaming techniques to emphasize tactical decision making and planning.

4.0 SYSTEMS ISSUES

Issues

- Starting with Ada does not help people with existing systems
- Need more comprehensive target system support as early as possible including use of special devices and connection to VHSIC and VLSI
- Need to bring VHSIC and VLSI design to point where it may be more easily used as part of system development effort as needed
- Need more support for cross development
- Need more support for existing target systems
- Should target system software be in systems or support systems area?
- Suggestions received for tasks and ongoing or planned activities to support

Responses by Systems Panel

- Focused on scope, strategy, relation to other areas
- Recognized enormous size and complexity of the systems space
- Identified system properties of interest
- Recognized the need for a market interface as model, constraints, evaluation
- Recognized the need for limitations in state-of-art to be identified
- Recognized quantum model of properties

- Recognized need to have more integrated view of system properties
- Recognized scale of problem and need for scalable results
- Formulated high leverage market model with technology constraints

5.0 APPLICATION-SPECIFIC ISSUES

1. PROPRIETARY SOFTWARE RIGHTS ISSUE — What mechanisms and/or strategies are needed to protect the proprietary interests of contractors? Will contractors be willing to divest themselves of proprietary rights? Is there a danger that after donating software to the Government or putting such software in the public domain that the developer will be barred from commercially marketing this software because of it becoming classified?

2. USER GROUP ISSUE — How do we promote the formation of user groups? What should be the Government role? Should industry organizations be encouraged to take the lead? Can existing groups be used for the nuclei?

3. CATEGORIZATION OF APPLICATION AREAS — What scheme should we use to categorize application areas?

4. CHOICE OF APPLICATION AREAS — What application areas are ripe for immediate infusion of funds? What are the areas to consider for the more advanced technologies (VHLL, etc.)? Should we aim for any short term goals?

5. FUNDING ISSUE — How do we promote leverage from existing DoD programs? Should there be a policy for joint STARS/Component funding of projects in the Application-Specific Task area?

6.0 ACQUISITION ISSUES

1. ISSUE: In general we acquire systems not software.

   RESOLUTION: Incorporated in plan.

2. ISSUE: Taking software out of a system (5000.29) frequently makes it impossible to reinsert it.

   RESOLUTION: Really a Project Management issue - dismissed.

3. ISSUE: Problems often begin with unrealistic development schedules.

   RESOLUTION: Input data for Task 1. Also a Project Management issue.

4. ISSUE: Problems also begin with a poor hardware/software mix.

   RESOLUTION: Input data for Task 1. Also a Project Management issue.

5. ISSUE: Contracting vehicles have been developed on the basis of hardware, and need modification to properly address software issues.

   RESOLUTION: Input Data for Task 1.

6. ISSUE: Much more dollars and time must be spent at the front end of programs to prevent downstream problems.

RESOLUTION: Noted in Plan but really a Project Management issue.

7. ISSUE: Additionally, life cycle issues must be addressed in this front end process.

RESOLUTION: Incorporated in Plan.

8. ISSUE: It must be recognized that software, from development through O&M, is an evolving process with both incremental (ECPs) and revolutionary changes brought about by rapidly changing technology.

RESOLUTION: Incorporated in Plan.

9. ISSUE: The ECPs above often lead to an adversary relationship between government program managers and contracting officers.

RESOLUTION: Incorporated in Plan. Also a Human Resources Issue.

10. ISSUE: Firm Fixed Price contracts become viable only when the product is testable, and will not change.

RESOLUTION: Input data for Task 1.

11. ISSUE: Problem with software testing vice system testing.

RESOLUTION: Input data for Task 1.

12. ISSUE: Software should be considered in the DSARC/ASARC process.

RESOLUTION: Really a Project Management issue.

13. ISSUE: There must be a great deal more interaction between government and industry to streamline acquisition, increase productivity, reliability and reusability of software products.

RESOLUTION: Incorporated in Plan.

14. ISSUE: This leads naturally to discussion of government and industry rights in data, a very difficult problem.

RESOLUTION: Incorporated in Plan.

15. ISSUE: There is a need for a standard work breakdown structure for software development.

RESOLUTION: Incorporated in Plan.

16. ISSUE: There is a need for better DIDs.

RESOLUTION: Input data for Task 1.

17. ISSUE: There is a great need for uniformity in application of Policies and Regulations (even within a single service).

RESOLUTION: Incorporated in Plan.

18. ISSUE: Unless we get compatibility between AIE and ALS we will have lower productivity, and delay IR&D leverage from industry.

RESOLUTION: Input data for Task 1. Also a PM issue.

19. ISSUE: There is great concern over testing.

RESOLUTION: Noted.

20. ISSUE: At the same time, we have to protect the dollars for testing and quality assurance.

RESOLUTION: Really a Project Management issue.

21. ISSUE: IV&V, is it worth it, and how to do it incrementally?

RESOLUTION: Incorporated in Plan.

22. ISSUE: Need a risk sharing (Industry/DoD) mechanism.

RESOLUTION: Incorporated in Plan.

23. ISSUE: Can we use weighted guidelines to encourage both productivity and the use of IR&D funds for software related developments.

RESOLUTION: Incorporated in Plan.

24. ISSUE: We should make use of fast prototypes (recognized as throw aways) for competitive flyoffs, between competing vendors, to speed the development process.

RESOLUTION: Incorporated in Plan.

25. ISSUE: We should concentrate more on immediate problems as opposed to long term issues.

RESOLUTION: Both issues are addressed in the Plan.

26. ISSUE: More than 50% of software acquired by DoD are major system updates. Too often these updates are acquired through an attenuated process which eliminates many of the ssfeguards applied to initial system acquisitions. This often leads to big problems.

RESOLUTION: Incorporated in Plan.

27. ISSUE: A great deal more could be done within the existing policies and regulations than is generally done today. This is because of a lack of understanding of these

policies and regulations.

RESOLUTION: Incorporated in Plan. Also is a Human Resources issue.

7.0 HUMAN ENGINEERING ISSUES

1. Several people pointed out that the plan was entirely concerned with the human-computer interface instead of with the human engineering of the entire process of software development and support. This widening of the scope of human engineering has been incorporated into the latest revision of the plan.

2. One person suggested that we consider the user's conceptual model of the system. This was considered a worthy research topic with a longer-term payoff.

3. One person pointed to the problem of the long time-lag in applying research results. This problem cuts across the entire Initiative. We believe that this problem can be lessened by initiating a focused research program that is directed at solving the specific set of problems falling within the realm of the Initiative.

4. Several people reminded us that most embedded systems do not have a CRT interface yet the plan seemed to be directed towards a terminal interface. It was suggested that we focus on other types of I/O such as voice, tactile, and analog displays. It was agreed that this was under-emphasized in the original plan. The focus of the plan has now shifted to included the end-user of embedded systems.

5. One person commented on the importance of measurement to the goals of the Human Engineering Task Area. We need ways of obtaining feedback from the field use of end products. The support environment will be instrumented as part of the Measurement Task Area. The problems involved in obtaining feedback about the use of embedded systems will be addressed by Subtask 4 of the current plan.

6. We were reminded of the severity of the consequences of poor human engineering of tactical embedded systems. This has been mentioned in the current revision.

7. We received one comment about the need for validating the human engineering methodology. We interpreted this in two ways, both of which we agree are important and necessary. We need to apply the methodology and then collect data to show that the system is actually better as a result of having been developed under such a methodology. We also need to work out mechanisms

either through acquisition, management, or the use of tools to ensure adherence to the methodology. Subtask 4 of the current plan is directly concerned with the need to collect data. The necessary linkages must be set up with the Management, Acquisition, and Support Systems Task Area to ensure adherence to the methodology.

8. One person commented on the lack of a clear responsibility for the measurement aspect of Human Engineering. It was unclear whether it should lie with the Measurement Task Area or with Human Engineering. These responsibilities were clarified in the current plan by assigning that responsibility to Human Engineering with support from the Measurement Task.

9. The point was made that prototypes can be very useful in determining system requirements. It is assumed that the use of prototypes belongs under Subtask 1 of this plan. It also seems to overlap with the Support Systems Task Area.

10. One person suggested that Human Engineering should export its expertise in evaluation and experimentation into the other task areas. We recognize that many of the people involved in human factors activities are trained in experimental design and statistical analysis. This is, however, the responsibility of the Measurement Task Area although a synergistic link between the two areas is certainly expected.

11. The panel felt that there is a clear need for a steering group to be responsible for the focus of the methodological activities. This includes assessing the currently available techniques and guiding the selection of further activities. In the current revision, these functions have been incorporated into the previously planned Research Advisory Panel. The establishment of this panel is now a part of Subtask 1 (Methodology Development).

12. There were several issues concerning the human engineering of the support environment. The panel noted that there is essentially no work on the human engineering of automated environments for software development. There is much talk about human engineering which focuses on discussions of the use of graphics, mice, and other devices. No one appears to address the basic principles of interface design or systematic experimentation, both of which fall within the domain of a true human engineering discipline. Automated support environments present special problems for human engineering. The plan has been revised to include a discussion of the need to address the issue of maintaining a consistent user interface across tools while allowing for portability of tools across environments.

8.0 SUPPORT SYSTEMS ISSUES: SUMMARY OF WORKSHOP SESSIONS

The Support Systems panel first met in open session on Monday afternoon, 7 February 1983. Over 300 people attended this session. After brief introductory remarks and introduction of the panel members, a 20-minute overview of the task area was given. Questions from the audience were encouraged at this point. Further details of the Support Systems technical activities plan including milestone charts and manpower estimates were then presented in approximately two hours. Numerous issues were raised by the audience during this latter presentation; individuals were asked by the panel chairpersons to write down their questions and comments.

This first open session resulted in 57 verbal responses and 110 written responses from the audience. Some of the written responses recorded the verbal questions raised during the session. During a closed panel session on Tuesday, the responses were read by the panel members and condensed into approximately 31 issues. These 31 issues fell into six major areas of concern which will be discussed in the next paragraphs. The panel also received written comments about additional on-going or planned projects that were supportive of the Initiative's goals, particularly in the Support Systems task area.

In addition to specific issues raised about the Support Systems task area, several global issues were raised by the audience. These questions addressed the relationship of this task area to the others in the Initiative, the role of public review and comment in the Initiative, the relationship of the Initiative to Ada and its associated activities, the assumptions made about other research and development activities and other major initiatives/programs that are underway or planned, the impact of the proprietary vs. public domain issues, and the role of the marketplace. Some of the issues were addressed in later open sessions; others will be addressed in revisions of the plan.

The audience raised several questions about the apparent lack of explicit goals and objectives in the Support Systems task area plan as presented in the open session. Although there were goals and objectives presented and a rationale for the tasks, the presentation did not explicitly state them at the outset. This issue was resolved in the second open session; the overall goal of the task area was presented and specific objectives were stated explicitly. This is also being incorporated into the current revision of the plan.

Several questions indicated that the plan seemed to not be encouraging innovation and not advancing technology. There were related questions on the impact of the Support Systems task area on more innovative ways for DoD to develop systems and a need for an early identification of key research issues to be addressed. This issue was addressed in the second open session. Research is an on-going activity in the plan but was not made visible; there will be R&D pursued along both evolutionary and revolutionary paths. The research aspects of the plan will be more visible in the current revision of the plan.

There were several questions regarding the role of knowledge-based systems technology in the task area plan. Some questioners felt that there was inadequate emphasis on that technology. This issue was resolved. One of the revolutionary thrusts of the R&d in this task area will focus on a knowledge-based systems paradigm. This will be incorporated into the current revision of the plan.

There were numerous questions about environments and methodologies. The environment questions focused on: (1) was the plan to develop single or multiple environments; (2) the characteristics of the environments and the categories of users that would be supported; (3) a generic environment or application-specific environments; (4) a "model" environment; (5) the role of the environment to enforce or support the methodology; (6) how to evolve the environment and re-

engineer and integrate tools into it; (7) how to deal with existing tools and existing software. The methodology questions focused on: (1) was the plan to develop single or multiple methodologies; (2) support of the entire life-cycle; (3) methodology for building environments and integrating tools. Some of the issues raised were addressed during the second open session. There was also significant discussion related to these issues during the closed panel sessions. The current revision of the plan will incorporate the results of these comments and discussions. These issues could not all be resolved in the short time at the Workshop.

Several questions were raised about the levels of effort proposed for the tasks. It was unclear to the audience whether the manpower estimates referred to management of the tasks or actually carrying out the tasks on contract. Some of the audience felt that the levels of effort were extremely low. There was concern that without leveraging on industry and the marketplace it would be extremely difficult to carry out the Support Systems task area with the manpower estimates presented. In the technology experimentation and demonstration tasks, there was particular concern that the magnitude of the problem was extremely underestimated. There were also several related questions about the assumptions being made about activities outside the Initiative and whether that influenced the manpower estimates. This issue still needs further work.

Several questions were raised about the specific sequencing and choice of tasks to be carried out. There was concern that the parallelism of the tasks as presented was not realistic. Other comments indicated that certain tasks that need to be carried out appeared to be missing from the plan. Some of the comments were resolved quickly; however, this issue still needs further work.

9.0 SOFTWARE ENGINEERING INSTITUTE ISSUES AND ALTERNATIVES

The following 12 areas received considerable attention by Panel members and were addressed in open session comments at the Workshop. A brief description of the issue and alternatives is given and a rationale provided for the Panel consensus.

- Should the Software Engineering Institute (SEI) focus its software engineering efforts on the embedded computer applications area to a broader scope of software development areas?

  Consensus: Embedded computer systems.

  Rationale: DoD embedded computer systems (ECS) are critical to our National defense posture. They stress the extremes of such system characteristics. Unlike the ADP application environment, where industries focus their R&D efforts, little industry effort is put on defense unique ECS applications. The DoD must focus its attention on this area. Industry R&D will satisfy most Defense ADP needs.

- Should the SEI provide products and services and focus its attention the Defense community or to all areas of users of ECS?

  Consensus: The Defense community.

  Rationale: This question is related to the first. Because DoD resources are limited, the SEI should focus on defense needs. Non-sensitive spinoff technology will have commercial application and will be made available.

  The scope of the SEI mission and focus could be broadened, perhaps, with a larger basis of support from outside the DoD. This is discussed in #8 below.

- Should the SEI's primary mission be limited to engineering and integration of software development technology or should it support and accomplish software research as well?

  Consensus: The consensus favored including research in the SEI mission.

  Rationale: A significant portion of the SEI staff is to be

made up of visiting researchers who will bring software research products to the Institute for engineering and integration into the Institute's software development environment. A strong research program will encourage this infusion of quality people.

In addition, the Institute should do research on software development environment measurements and technology transition.

- Should the Institute be responsible for maintaining the DoD "standard" software development environment for all service to use?

  Consensus: No.

  Rationale: Current Service policies separately address the standardization of computer resources including development systems. As the Ada language and programming support environments are developed, there will be a convergence towards commonality.

  The SEI will develop and maintain an advanced environment compatible with the Ada programming environments developed by the Services. This will assure the efficient transition of new tools from the Institute to the Services and their contractors.

- Should the Institute provide software engineering education and training? A possible extension of the mission might be an extensive academic program, to the possible extent of a degree granting institution.

  Consensus: Education and training to support tool and practice transition should be accomplished. Additional education in general software development involving the SEI environment should be carried on. The training should be provided to key Service and contractor personnel who would then provide the education to larger groups of environment users.

  Rationale: Broadening the scope of education would require greater SEI resources than available. The Services have their undergraduate and graduate programs as well as other training programs which should provide for general needs.

- Should the SEI provide facilities and offer computer processing (including software tools) resources and services for fee?

  Consensus: It seemed appropriate that, at the beginning, only limited services-for-fee should be provided. Such services involving the use of new tools could be provided as a way of introducing these tools as well as evaluating their effectiveness in real applications.

  Rationale: A larger operation to provide complete environment and remote computer service capability for the DoD community seemed very ambitious. It could be an SEI growth possibility if its effectiveness and feasibility is demonstrated by initial, smaller scale experiments.

- Are the scope, size, and budget, as proposed, compatible?

  Consensus: The size and scope are compatible. The budget as proposed was not adequate.

  Rationale: The budgeted amounts for personnel were too small. (These amounts have been increased in the current plan.)

- Should the management and the support for the SEI be DoD based or broader based? Should other government agencies, i.e., NASA, FAA, etc., be included? Should organizations outside Government be involved in support and management of the SEI?

  Consensus: Although strong suggestions for a "National" SEI were heard, the Panel recommended limiting management to the DoD. Support grants can be accepted from outsiders but not direction.

  Rationale: The focus should be maintained to support the Defense community embedded computer software engineering area. Thus, management should be limited to the DoD.

- How should the SEI be managed within the DoD — by OSD, by the Services jointly, or by a single Service?

  Consensus: The SEI is a part of the STARS Program and probably remain part of this program as long as it exists. The STARS Program is currently planned as a tri-service managed program, the management to be composed of Service represen-

tatives.

Rationale: The above was not thoroughly worked out. Strong Service views exist that the SEI, and possible the STARS program as well, should be Service managed.

- What vehicle or host institution should be used to organize and establish the SEI — a university or university consortium, a not-for-profit company, a for-profit corporation, or a Service or Agency?

  Consensus: The university, university consortium, or not-for-profit corporation were favored.

  Rationale: The DoD is personnel resource limited. Establishing the SEI within the DoD would cause a personnel resource redistribution which would adversely effect other functions. DoD salary structure would limit the effectiveness in obtaining quality personnel.

  The motivation of for-profit industry appears incompatible with the free interchange of ideas necessary for the SEI.

  Some expressed the belief that researchers would be better attracted to a university environment.

- Orientation of the Institute -- user needs or technology push?

  Consensus: User needs.

  Rationale: The requirements of software developers in industry and in Service centers must be the driver for the SEI activities.

- Type of personnel required for the SEI mission — world-class researchers or other types?

  Consensus: A variety of personnel will be required to staff a successful SEI, both engineering and research.

  Rationale: A specific type of engineering resource is required to transition, engineer, and integrate software engineering tools and develop advanced environments. A thorough understanding of the application — software engineering of real systems — is needed. "World-class"

researchers probably are not the best resource; however, these people must still be attracted to the Institute to bring in new ideas.

APPENDIX I.3

Bate Panel Charts

SPECIAL PANEL 1 MEMBERS

ROGER R. BATE, CHAIRMAN	TEXAS INSTRUMENTS
BERNARD A. GALLER	UNIVERSITY OF MICHIGAN
MARK GROVE	ODUSD (R&T)
HERBERT HECHT	SOHAR, INC.
JOHN B. MUNSON	SYSTEM DEVELOPMENT CORP.
PERRY R. NUHN	ITT
EDWIN B. STEAR	UNIVERSITY OF WASHINGTON
PETER WEGNER	BROWN UNIVERSITY
STEPHEN S. YAU	NORTHWESTERN UNIVERSITY

SOFTWARE TECHNOLOGY INITIATIVE PLAN

FUNDING LEVEL

- $225 MILLION
- 9 TASK AREAS
- 7 YEARS
- IMPRESSION OF UNDERFUNDING

LEVERAGE

- BUILD ON EXISTING ACTIVITIES
- TRIGGER MARKET PLACE DEVELOPMENTS
- ATTRACT SUPPORTED PROJECTS

SCOPE

- ALL TASK AREAS ARE NECESSARY
- SOME REAPPORTIONMENT MAY BE POSSIBLE

PHASING

- TASKS NEED NOT ALL PROCEDE IN PARALLEL
- DEPENDENCIES
- NEED FOR EARLY SUCCESSES

MORE EMPHASIS NEEDED

INTER TASK COORDINATION

- TASK AREAS ARE FOR PLANNING
- PROJECTS SHOULD EMBODY SEVERAL TASKS

SOFTWARE FIELDS

- SOFTWARE MODIFICATION
- CONFIGURATION CONTROL
- INTEGRATION
- TESTING

SOFTWARE ENGINEERING INSTITUTE

- SUCCESS WILL REQUIRE GOOD PEOPLE
- GOOD PEOPLE WILL REQUIRE SIGNIFICANT WORK
- EXPANDED ROLE
  - RESEARCH ACTIVITIES
  - FOCUS FOR THE INITIATIVE
- JOINT VENTURE OF DoD, UNIVERSITIES AND INDUSTRY

SUMMARY

- EVOLUTIONARY APPROACH DOMINANT
- A BOLDER APPROACH IS NEEDED TO MAINTAIN WORLD LEADERSHIP

APPENDIX I.4

Manley Panel Findings

FINDINGS

OF THE

STARS REVIEW PANEL

(SPECIAL PANEL 2)

Dr. John H. Manley, ITT, Chairman

Dr. Barry W. Boehm, TRW

Mr. Neil S. Eastman, IBM

Mr. Donn Philpot, GE

Dr. Terry A. Straeter, GD

Mr. G. Allan Whittaker, Honeywell

Dr. William A. Wulf, Tartan Laboratories

DOD SOFTWARE INITIATIVE WORKSHOP
RALEIGH MARRIOTT
RALEIGH, NORTH CAROLINA
FEBRUARY 6 - 9, 1983

CONTENTS

1.0 Introduction 2
1.1 Purpose and Scope 2

2.0 Executive Summary 4

3.0 Findings and Recommendations Discussion 6
3.1 STARS Goal: Restatement and Rationale 6
3.2 STARS Plan Documentation: Reorganization and Rationale 7
3.3 Acquisition Strategy for Major Deliverables . . . 8
3.3.1 Deliverables strategy rationale 8
3.3.2 Evolutionary products 9
3.3.3 Revolutionary products 9
3.4 Software Engineering Institute 9
3.4.1 STARS Implementation Plan 10
3.4.2 Implementation Support Activities 11
3.4.3 Technology Insertion 12

STARS

SOFTWARE TECHNOLOGY FOR ADAPTABLE, RELIABLE SYSTEMS

Contents

1.0 INTRODUCTION

Faced with a serious threat of being overtaken by massive, nationally-sponsored software technology initiatives in other countries and a consequent erosion of U.S. superiority in mission-critical, software-dependent defense systems, the DoD is establishing a Software Intiative, Software Technology for Adaptable, Reliable Systems (STARS), to ensure that the present U.S. lead is maintained.

In October 1982 a draft of the Initiative's program plan was issued. In February 1983 this plan, augmented by work to date, was publicly reviewed at the DoD Software Initiative Workshop in Raleigh, NC, under the chairmanship of LtC Larry Druffel. "Special Panel 2," the STARS program review panel, was convened to evaluate the draft plan independently of the other Workshop panels. This report documents the findings and recommendations of Special Panel 2.

Membership included: John Manley (ITT), Chairman, Barry Boehm (TRW), Neil Eastmar (IBM), Donn Philpot (GE), Terry Straeter (GD), Al Whittaker (Honeywell) and Bill Wulf (Tartan Labs).

The Panel members concur unanimously with this report. There are no minority or dissenting opinions.

1.1 PURPOSE AND SCOPE

Special Panel 2 was convened by the Workshop chairman, LtC Larry Druffel, to evaluate the STARS program strategy documentation with particular emphasis on the following areas:

- purpose of STARS
- potential benefits to DoD mission-critical systems
- program deliverables
- advocacy and implementation strategies
- economic issues and the composition of industry involvement
- continuation of results
- leveraging by industry of Initiative-generated advances

The STARS strategic plan as represented by current documentation was reviewed. Panel members minimized interaction with

other Workshop participants to ensure a concentrated, uninterrupted review and to ensure that the plan itself, not participants' interpretations, was the subject of discussion.

2.0 EXECUTIVE SUMMARY

The Panel strongly concurs that a Software Initiative is essential to maintaining leadership in DoD mission-critical systems. The specific needs for improvement identified in the Initiative documentation appear to be complete.

However, as presently structured the STARS plan will fall short of its goals. The paragraphs below summarize recommendations to realign the plan towards successful attainment of its goals.

The Panel recommends that a results-based goals statement be formulated and that plan elements be revised to concentrate upon problems whose solutions lead to results. The attendant objectives should give prominent priority to the need for drastically shortened elapsed times between software concept definition and operational deployment. Goals statements in the October draft document are broad and essentially technology-oriented; all technology areas germane to the software life cycle are addressed at roughly equal levels of emphasis. Results-based goals and problem-based plans are necessary to ensure timely, continuing and coordinated progress towards needed capabilities rather than just increased technology potential.

The Panel recommends that the revised STARS plan assure strong industry participation and complementary industry investment. As a stand-alone program, presently proposed funding levels are inadequate by several factors. Without energetic industry participation, effective technology insertion and reduction to practice are not achievable within time objectives.

The Panel recommends that a STARS acquisition strategy be established to:

- Facilitate rapid evolutionary insertion of technology into operational mission-critical systems
- Allow identification and funding of very high potential technologies
- Secure the program elements necessary for successful implementation support

The acquisition strategy should call for both "evolutionary" and "revolutionary" deliverables. Evolutionary deliverables are "showcase" operational software elements that have been produced on shorter schedules and with greater functionality, quality and maintainability than previously achieved, together with the improved techniques, tools, environments and components that make the showcase achievements routine. Revolutionary deliverables are high-payoff, high-risk prototype and brassboard software elements.

The Panel recommends that the role of the Software Engineering Institute be re-evaluated. Its mission and responsibilities should be sufficient to attract top-caliber software business management and technical management talent. The role and composition of the Software Engineering Institute in providing essential STARS implementation support are discussed in the body of this report.

3.0 FINDINGS AND RECOMMENDATIONS DISCUSSION

3.1 STARS GOAL: RESTATEMENT AND RATIONALE

The STARS goal should be restated as follows:

- "The STARS goal is to increase the current U.S. DoD lead in operational software: to build and support more complex, higher quality mission-critical systems on shorter schedules and to assure that leadership is maintained throughout the 1990's."

The restatement shifts the emphasis of the program from reducing software people and dollar requirements to accelerating the deployment of increasingly complex systems. That is, we agree that cost reduction and productivity in general are necessary to the future of the United States but believe that system functionality and timeliness, and therefore quality software, should be the primary drivers of the defense software technology base. Accepting this restated goal helps to preclude the many productivity solutions available through combining program resources and extending schedules. It recognizes that overcoming the significant barriers to compressing schedules which exist today while simultaneously increasing delivered system function will give the United State clear and continued leadership in software.

From the restated goal it follows that the plan should be restructured to assure strong industry participation, not only in the sense of contract opportunities but just as importantly in the sense of attracting industry investment. Without such investment the proposed DoD funding would need to be increased by several factors for the Initiative to meet its stated goals. Even if sufficient funds were available such an approach would be undesirable, since those for whom technology transition is intended (industry) would tend to resist and lag if they were not spontaneous participants.

In order to engage industry there must be economic considerations given to major prime contractors, subcontractors and entrepreneurial firms. Technology targets must be of common concern across DoD and where possible to the commercial sector. The software acquisition process must complement profitability and protect trade secrets.

3.2 STARS PLAN DOCUMENTATION: REORGANIZATION AND RATIONALE

The Panel finds the organization and structure of the present STARS plan to give cause for concern. The plan is primarily organized by a categorization of technologies applicable across the software life cycle. Each technology category is and will be a necessary part of the STARS approach, but a technology-based organization does not provide a framework for problems, priorities or results. A fragmented approach appears to be probable since there is no consistent thread of purpose to bind the task areas. A technology-based approach as contrasted with a problem-based approach will cause problems in four key aspects:

- Advocacy

  Should the STARS plan fail to clearly delineate problem areas and objectives, the Services will not be able to evaluate program elements in light of anticipated capabilities, threats and missions, and Congress will be hindered in their policy and funding deliberations. STARS may appear as a large expenditure with an uncertain return.

- Industry support

  A "shopping list" of potential technology capabilities is unlikely by itself to draw active industry interest. Reduction to practice and integration into existing practices are frequently expensive obstacles; clear customer (DoD) goals and plans are prerequisite for industry motivation.

- Implementation

  Without a problem- and solution-based organization, an understanding of requirements leading to complementary and synergistic task definitions is unlikely to occur.

- Management

  A fragmented, non-prioritized program does not set a base for effective or efficient management of scarce resources, nor for optimal decisions in the case of alternative opportunities or discretionary resource allocations.

The Panel recommends that the STARS document be repackaged into a plan that is based upon Application problem areas (discussed in the deliverables strategy rationale) to assure linkage and integration of the necessarily wide range of technology elements.

3.3 ACQUISITION STRATEGY FOR MAJOR DELIVERABLES

The Panel recommends an acquisition strategy calling for STARS major deliverables in three categories:

- Implementation support
- "Evolutionary" products
- "Revolutionary" products

Implementation support deliverables span the wide range of process, practice, standards, data and measurement areas essential to support the developing state-of-the-art software engineering environment. These are seen as a principal concern of a Software Engineering Institute, discussed in a later section of this report. An evolutionary product marks the successful reduction to standard practice of an improved capability; a revolutionary product is a prot type or brassboard demonstration of high-payoff but high-risk advanced capability. In both cases, the products should represent solutions of specific problems or attainment of specific objectives.

3.3.1 Deliverables strategy rationale

DoD operational software should be categorized by Application Areas within which common algorithms, techniques, components and tools may reasonably be expected to apply. Examples of Application Areas are C3, avionics, flight control, fire control, electronic warfare, trainers and simulators and the like. Each Application Area should then be analyzed to identify, for each phase of the software life cycle, the development, support and operational elements which are Application-specific and those which are common to all Applications. Contractors may then propose the use of improved capabilities in operational software development contracts, or the procuring agent may solicit such use. Upon demonstration in a successful deliverable the improved capability is added to growing repertoires of 'standard' Application or cross-Application capabilities.

The first use and demonstration of new or improved capabilities in operational software procurements under the funding sponsorship of STARS will significantly accelerate effective reduction to practice. An environment in which all the expense and risk of novelty is born by the contractor carries powerful incentives for each contractor to seek to be second - and <u>never</u> first.

3.3.2 Evolutionary products

Evolutionary products should be in the form of operational software which is produced on shorter schedules, with higher quality (including maintainability) and providing greater functionality than previously achieved. These improvements will be the demonstrated benefits of improved or new software techniques, components, environments and tools. Integration, adaptation and first application of these elements to the production of evolutionary deliverables should be underwritten by STARS contract funds, and they should in turn be deliverables as their capabilities are proved.

Evolutionary products should be procured via RFP's whose Statements of Work identify candidate capabilities and request bidders to include plans to use, demonstrate and deliver improved capabilities. Award determinations would include evaluations of evolutionary-related bid response parts. As in the VHSIC program, each Service should sponsor a number of evolutionary products.

3.3.3 Revolutionary products

Revolutionary products may occasionally be in the form of operational software but will usually be prototype or brassboard components built to demonstrate novel capabilities. The source of these capabilities may be advanced research or technology development projects; the revolutionary deliverable will be the vehicle for scaling-up to pre-production levels and experience in a production-equivalent environment. Capabilities successfully used in revolutionary deliverables become candidates for validation in evolutionary deliverables.

3.4 SOFTWARE ENGINEERING INSTITUTE

The October draft strategy assumes that other DoD organizations will be responsible to see that DoD expertise is maintained in their áreas and that the Initiative will provide funds to selected DoD organizations to execute and manage contracts to support the Initiative. The draft views a Software Engineering Istitute as being the principal engineering organization for creating a state-of-the-art software environment, and consequently as the main point of supply for newly engineered and integrated capabilities, documentation, training and user assistance. Its suggested role is to bridge the "gap between R&D activities that demostrate new techniques in a con-

strained domain and the exploitation of those techniques on real systems."

The Panel is concerned by the suggested Software Engineering Institute focus for several reasons:

- Staff and funding would need to be greater by several factors than proposed levels to undertake such activities.
- DoD assumption of a principal implementation and supplier role would severely limit industry incentives to actively participate.
- Responsibilities for planning, coordination and management of activities distributed across academia, the Government and industry are not sufficiently considered.

The Panel recommends that the role of the Software Engineering Institute be re-evaluated. STARS program planning, coordination and management from both a business management and a technical management point of view could be principal responsibilities of an Institute.

The Software Engineering Institute could be assigned specific near-term responsibility for a STARS implementation plan, a deliverables acquisition plan and a technology insertion plan. The Panel's recommended acquisition strategy for evolutionary and revolutionary deliverables (discussed in paragraphs above) establishes the major framework within which program activities should be developed.

Technology development scopes are well covered in the present Initiative draft document. As the plans outlined above develop and are implemented the Software Engineering Institute could ensure that appropriate linkage and transition activities are identified and put in place.

3.4.1 STARS Implementation Plan

Implementing a revised STARS plan requires two major steps:

- Step 1
  - Repackage the STARS documentation
  - Establish a STARS acquisition strategy
  - Develop an implementation plan that includes a clear definition of essential roles and missions, to include those assigned to the Software Engineering Institute.

- Step 2

  - Implement the repackaged plan, using the acquisition strategy established in Step 1. This will involve implementing the major portions of the repackaged plan in parallel.

The STARS acquisition strategy task needs to define STARS acquisition roles and responsibilities within DoD and the Services, to establish criteria for the awards and deliverables to be pursued in Step 2, and to define an appropriate set of candidate mission-critical areas (C3, flight control, fire control, EW, etc.) for implementation as evolutionary operational products and revolutionary prototype products.

3.4.2 Implementation Support Activities

The STARS program will create a large number of powerful methods, tools and components which must be assimilated into a unified, APSE-based structure and infused throughout all portions of DoD and industry. This will probably require major involvement of the Software Engineering Institute function. Implementation support tasks include:

- measurement (as a technology and to show STARS progress)
- acquisition (of technologies)
- Software engineering processes and business practices
- software engineering standards and controls
- technology interface management (cataloging, tracking)
- information transfer
- tools, methods and components repository
- data base administration
- linkages

These tasks would probably be best carried out within or under the close direction of the Software Engineering Institute. Once the expanded scope of Institute responsibilities is determined, including interfaces with other important agents such as the JLC, an integrated plan for effecting the STARS implementation support functions must be developed and put into action.

3.4.3 Technology Insertion

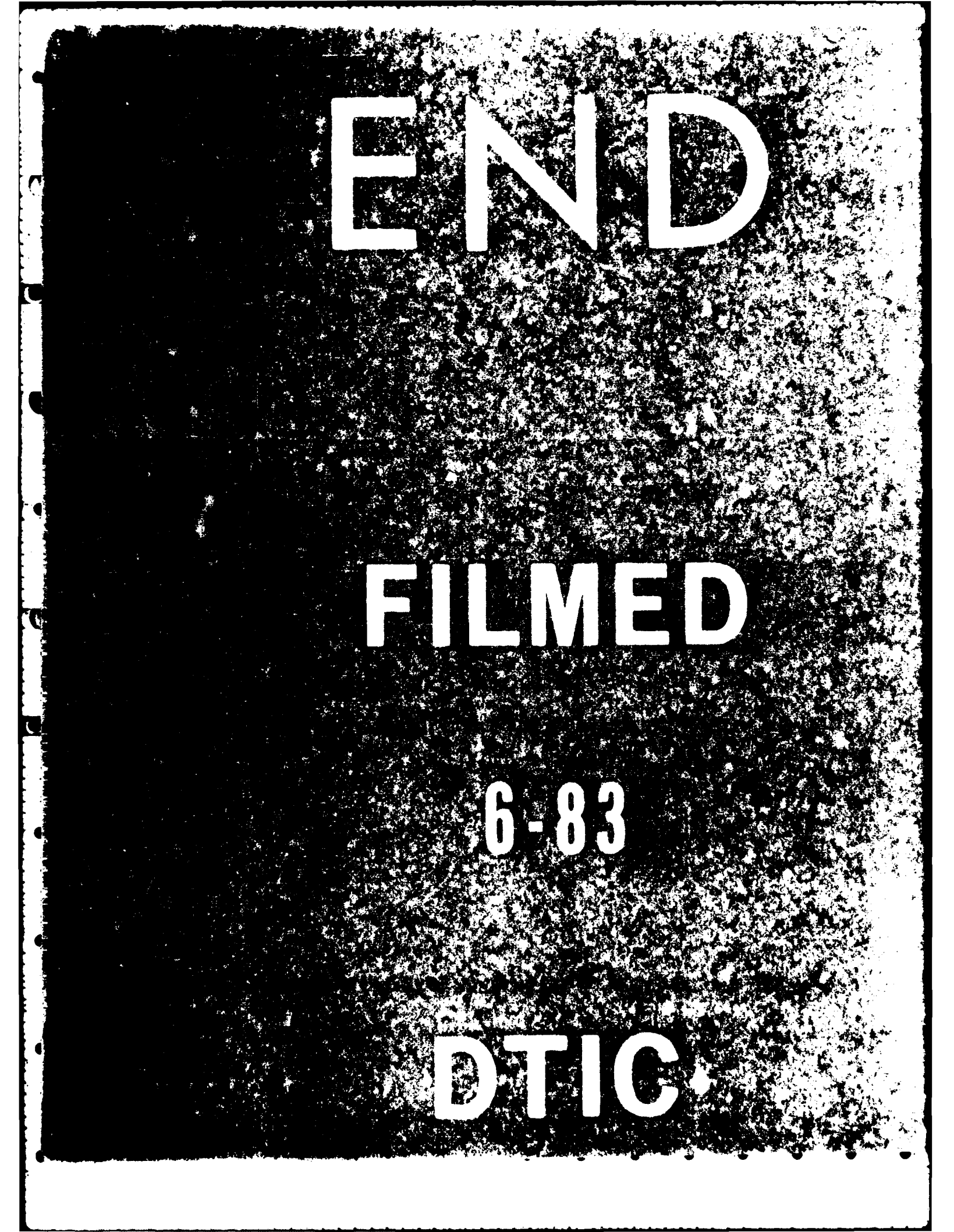
The essential functions of implementation support and technology insertion must be provided by an organization that is independent of factional biases. Technology insertion (not just technology development) should be the primary goal of the Software Engineering Institute. In this regard, the Panel agrees with the present plan's strategy of rotating academic, Government and industry personnel through the Institute since technology is most effectively transferred through people. The Institute should not be exclusively a research organization but, to be effective, must have mission and scope that attract world-class talent in each of its areas of responsibility, including as a top priority software business management and technology management as well as the best technical experts available.

Given that sets of advanced methods, tools and components are delivered by contractors as outlined in the deliverables acquisition strategy in paragraphs above, the technically difficult work that remains is:

- smooth integration of the parts across contractor packages
- achieving wide and uniform usage

The first task is a major effort which is seen by the Panel as a possible function of a redefined Software Engineering Institute. The second task will be accomplished partly by strongly encouraging use in the RFP provisions for large-scale DoD system acquisitions and partly by technology insertion activities recommended by the Institute.

The technology insertion challenge is key to the entire DoD Software Initiative. Reuse of the developed state-of-the-art technologies must not be left to chance -- it must be made to happen!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