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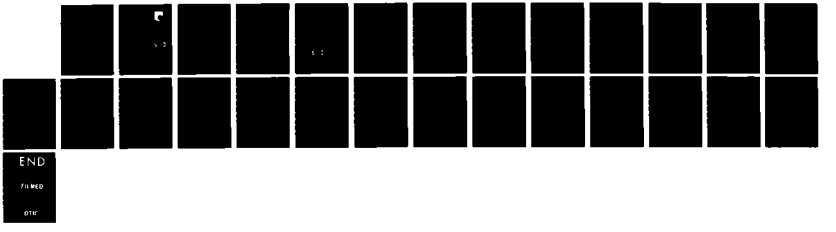

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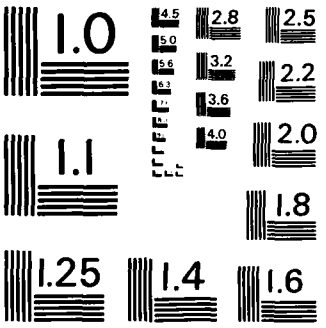

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ISSUES TO BE CONSIDERED IN THE EVALUATION OF TECHNICAL PROPOSALS FROM THE ADA LANGUAGE PERSPECTIVE

Virginia L. Castor

Support Systems Branch
System Avionics Division

June 1985

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Final Report

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Virginia L. Castor — 13 June 1985

Virginia L. Castor
Project Engineer

Date

FOR THE COMMANDER

Michael J. Goci — 18 June 1985

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

This report identifies issues for consideration in the assessment of technical proposals that are submitted in response to a Request For Proposal (RFP) which specifies the use of Ada. Detailed questions are provided on the following five main technical proposal elements; (1) Methodology; (2) Program Design Language; (3) Implementation Language; (4) Environment; and (5) Personnel.

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PREFACE

This report identifies issues relevant to the evaluation of technical proposals in which use of the Ada* programming language is addressed. In draft form, this report was entitled "Guidelines for the Evaluation of Technical Proposals From the Ada Perspective". However, because it did not include specific weighted responses to the questions presented, the title has been modified to more accurately reflect the nature of the report; i.e., to identify many of the issues from which the technical proposal evaluators may select and weight specific criteria.

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SECTION 1

1.0 INTRODUCTION

The purpose of this report is to provide issues for consideration in the assessment of technical proposals that are submitted in response to a Request For Proposals (RFP) which specifies the use of Ada. Regardless of the main thrust of a procurement effort, if the use of an Ada-based Program Design Language (PDL) and/or the use of Ada as the implementation language is required, issues identified from the Ada perspective can facilitate a more comprehensive, equitable technical evaluation. This report is intended for use in the technical evaluation only and, therefore, does not address the area of cost. This report should not be used as the sole reference for technical evaluations, but rather, as an aid to existing technical proposal evaluation criteria to provide emphasis on those technical areas which address the use of Ada.

The issues for consideration are provided at a relatively high level in an attempt to limit the size of the document to one which will be referenced more readily for actual evaluations. A list of references is provided as an assistance to those who wish to obtain additional detail on each of the areas addressed within this report.

Although the primary intent of this report is for use in the technical evaluation of responses to an RFP, the issues which are identified are also useful during the initial stages of RFP and/or proposal development. They can serve as a source for dialogue between government and industry personnel and they can also be of benefit to industries which seek to provide proposals that exhibit the most comprehensive information on Ada-related qualifications.

SECTION 2

2.0 ELEMENTS OF A PROPOSAL

There are many aspects of a proposal which are subject to evaluation; however, this report addresses those primary technical elements which are most significantly impacted through the use of Ada. This section is organized as follows:

- Section 2.1 (METHODOLOGY) identifies issues associated with the assessment of the methodology which is proposed for accomplishing the software life cycle tasks specified within the RFP Statement of Work. Much of the information provided in this chapter was extracted directly from reference [6]. Detailed information on software methodologies is also available from references [5], [8], and [21].

- Section 2.2 (PROGRAM DESIGN LANGUAGE) identifies issues associated with the assessment of the Ada-based PDL which is proposed for accomplishing the software design tasks specified within the RFP Statement of Work. Detailed information on Ada-based PDLs is available from references [11], [14], [17], [18], [19], and [20].

- Section 2.3 (IMPLEMENTATION LANGUAGE) identifies issues associated with the assessment of Ada as the implementation language, as well as the associated Ada compiler and run time support environment which are proposed for accomplishing the software development tasks specified within the RFP Statement of Work. Detailed information on compilers and run time support environments is available from references [1], [2], [10], [13], [15], and [16].

- Section 2.4 (ENVIRONMENT) identifies issues associated with the assessment of the programming support environment which is proposed for accomplishing all of the tasks specified within the RFP Statement of Work. Detailed information on environments is available from references [3], [4], [7], [9], and [12].

- Section 2.5 (PERSONNEL) identifies issues associated with the assessment of the qualifications of personnel proposed for accomplishing all of the tasks specified within the RFP Statement of Work. Primary emphasis is given to the level of expertise and training associated with each individual with regard to methodologies, Ada-based PDLs, Ada programming, and programming support environments.

2.1 METHODOLOGY

The methodology which is proposed for use in accomplishing the tasks specified within the RFP Statement of Work significantly impacts the process by which those tasks are accomplished. A proposal which does not address the issue of methodology is deficient in one of the most important aspects of the software development process. For those proposals which do address the issue of methodology, the following questions will be useful in evaluating the suitability of the proposed methodology for its use in the overall program.

1. If the RFP does not require use of a particular methodology, has a specific software development methodology been proposed? If so, what supporting rationale (productivity or product quality) has been provided for selection of this methodology over other potential methodologies?

2. What are the key concepts or underlying principles upon which the methodology is based?

3. What phases of the software development process are covered by the proposed methodology:

   - plans/analyses

   - software requirements analysis

   - preliminary design

   - detailed design

   - coding and unit testing

   - computer software component integration and testing

   - computer software configuration item testing

   - complete system testing

   - maintenance/evolution

4. How does the proposed methodology ensure a smooth transition from one phase to the next?

5. Is the proposed methodology particularly well suited for use on:

   - military sponsored software development efforts, with adherence to all military standards specified within the RFP Statement of Work

   - the software development application specified within the RFP Statement of Work

- the level of effort specified within the RFP Statement of Work, in terms of system and personnel resources required

6. Which of the following technical concepts does the proposed methodology support?

   - rapid prototyping
   - function hierarchy/decomposition
   - data hierarchy/data abstraction
   - interface definitions
   - data flow
   - sequential control flow
   - reusable components
   - concurrency/parallelism
   - formal program verification
   - others (specify)

7. What representation schemes are used?

   - Program Design Language (PDL)
   - flowcharts
   - hierarchical charts
   - data flow diagrams
   - finite state diagrams
   - control flow diagrams
   - decision tables/trees
   - entity-relationship diagrams
   - others (specify)

8. What work products are prescribed for users of the methodology and how are they defined? Do such work products conform to standards specified within the RFP Statement of Work?

   - MIL-STD-490

- DOD-STD-2167

- others

9. For each of the work products generated, what procedures are used to ensure the quality of the product:

   - author/reader cycle

   - structured walkthroughs

   - code audits

   - reviews

   - testing (unit, integration, system)

   - formal verification

   - others (specify)

10. Two critical areas of software definition are subsystem interfaces and common data definition. How does the methodology ensure that the interfaces and data are properly defined?

11. How does the methodology define the testing environment criteria and techniques? How well is testing tied to the requirements?

12. By what procedures is the completed software validated against the original requirements?

13. How does the proposed methodology accommodate modifications to the original requirements during coding, integration and testing phases? Through what mechanism does this methodology track and report such modifications?

    - engineering change proposals

    - software change notices

    - others (specify)

14. Does the proposed methodology specifically address personnel management:

    - team organizations

    - matrix management

    - others (specify)

15. Does the proposed methodology specifically address project management:

    - validated workproducts

    - configuration management

        * product identification

        * status accounting

        * configuration audits

        * version control

        * release identification

    - others (specify)

16. Does the proposed methodology specifically address maintenance (evolution) management? If so, how?

17. What automated tools support the activities of the proposed methodology? For each tool specified, is the use of that tool optional or mandatory?

18. What computer resources are required specifically to support the use of automated tools? How will the proposed tools assist in improving quality and/or productivity within the methodology?

19. In addition to the documentation specified within the RFP, what additional forms of documentation are proposed? Does the format for documentation adhere to standards specified within the RFP Statement of Work?

20. What "checks and balances" (both internally and externally from the issuing organization) are provided to ensure conformance to the proposed methodology?

21. Does the methodology provide a means to assess the progress of the software development?

22. Does the methodology encourage the early detection of errors?

23. What documentation is available on the proposed methodology?

24. Does the proposed methodology address allocation of timeline requirements and management of computer resource allocation to ensure that system timeline requirements will be met?

25. Does the proposed methodology include the use of cost models to evaluate the feasibility of the proposed development manpower, schedule, and cost?

26. On what other programs of comparable level of effort has the proposed methodology been successfully implemented? Are points of contact provided to enable confirmation of this information?

27. If Ada is being used as a PDL, how well does the proposed methodology support its use?

28. If Ada is being used as the implementation language, how well does the proposed methodology support the software engineering goals facilitated through use of the Ada language?

29. How does the proposed methodology specifically exploit the use of Ada (both as a PDL and as an implementation language)?

30. For each of the following Ada features, how does the proposed methodology facilitate mapping the software requirements specification and/or design into Ada?

    - packages (data abstraction)

    - tasks (concurrency)

    - generics (packages, types)

    - exception handling

    - machine representation specifications

31. Are there aspects of the proposed methodology which do not facilitate mapping to the use of Ada?

32. How does the proposed methodology ensure proper transition from design (using an Ada-based PDL) to implementation (using Ada as the implementation language)?

33. How does the proposed methodology ensure proper transition from design (using an Ada-based PDL) to implementation (using a language other than Ada as the implementation language)?

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SECTION 4

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SECTION 3

3.0 SUMMARY

The issues enumerated in this report provide a baseline from which to select those which are most appropriate for a particular procurement activity. Natural extensions to this report would include specific and weighted criteria to the RFP responses based upon the requirements of the application area and the overall program goals. The issues may also be applicable for use during the various phases of the project itself.

If detailed evaluation criteria are to be included in the RFP, page restrictions on responses to the RFP must be modified to accommodate the volume of information which will be required. Such responses will enable industry personnel to more accurately document their qualifications and expertise with regard to Ada. The end result will be a more detailed and organized approach to the evaluation and a more comprehensive and equitable assessment of the responses by government personnel.

7. What informal training mechanisms are provided to personnel:

   - self-help tutorial materials (documentation, video tape, on-line training)

   - periodic problem solving meetings

8. Have training needs been identified and reflected in the program schedule?

9. If the reuse of existing Ada software components has been proposed, what is the level of personnel expertise with regard to reuse of these components?

10. Do management personnel have previous experience with comparable Ada software development efforts? Are points of contact provided to enable confirmation of this information?

- participation in programs using Ada as the implementation language

    * level of effort of program

    * specific responsibility within program

    * duration of program involvement

4. Are personnel experienced in the use of the proposed environment? If so, what specific qualifications are provided for the proposed individuals:

   - formal training (source, content, duration)

   - in-house training (source, content, duration)

   - participation in programs using the proposed environment

       * level of effort of program

       * specific responsibility within program

       * duration of program involvement

5. Does the contractor propose to obtain outside or provide in-house professional training to personnel on:

   - the proposed methodology

   - application of the proposed Ada-based PDL

   - application of Ada as the implementation language

   - use of the proposed environment

6. What is the estimated training period required for new personnel to learn:

   - the proposed methodology

   - application of the proposed Ada-based PDL

   - application of Ada as the implementation language

   - use of the proposed environment

2.5 PERSONNEL

The cadre of people proposed to accomplish a software development program consists of individuals of varying levels of expertise and training. The specification of the qualifications of such individuals is sometimes misleading, with little factual data to substantiate high level claims of expertise. While the requirements of personnel qualifications will differ by necessity due to the nature of the application, the following questions will be useful in evaluating the suitability of the qualifications of the individuals proposed for the overall program.

1. Are personnel experienced in the use of the proposed methodology? If so, what specific qualifications are provided for the proposed individuals:

   - formal training (source, content, duration)

   - in-house training (source, content, duration)

   - participation in programs using this methodology

     * level of effort of program

     * specific responsibility within program

     * duration of program involvement

2. Are personnel experienced in the use of the proposed Ada PDL? If so, what specific qualifications are provided for the proposed individuals:

   - formal training (source, content, duration)

   - in-house training (source, content, duration)

   - participation in programs using this Ada PDL

     * level of effort of program

     * specific responsibility within program

     * duration of program involvement

3. Are personnel experienced in the use of Ada as an implementation language? If so, what specific qualifications are provided for the proposed individuals:

   - formal training (source, content, duration)

   - in-house training (source, content, duration)

9. What performance measurement information (efficiency, usability) is provided with regard to the tools?

10. What system resources (cpu, memory, peripherals) are required for use of the proposed environment?

11. Are available host resources adequate for efficient use of the tools?

12. If the host and target systems are different machines, what facilities are provided to enable interactive debugging and real-time monitoring of software execution?

13. Will the development or acquisition of new software tools be required in order to support the tasks specified within the RFP Statement of Work? If so, have the rationale for such tools and the availability schedules been provided?

14. Has program integrity been addressed in the transfer from host computer to target computer when they are physically different units?

15. Have the security requirements of multiple projects of different security levels resident on the computer been addressed?

16. What facilities (software test bed, dynamic simulation) are proposed to support the testing phases?

17. What proprietary data rights (if any) are associated with each tool within the environment?

18. By what procedures could the government acquire these tools?

19. By what procedures are these tools maintained? Are the risks associated with outside maintenance adequately addressed?

20. If the software system is to be developed on the contractor's environment and, upon completion, transferred to a government installation, has sufficient justification been provided to ensure that such a transition can be successfully accomplished? Is a schedule provided to accommodate such a transfer and, if so, is it realistic within the scope of the effort?

2.4 ENVIRONMENT

Although the Ada compiler is generally regarded as the most critical support software tool for Ada implementation, there are many other software tools in existence which are used to accomplish a software development effort. Such tools may or may not be written in Ada. This report does not presume that an Ada Programming Support Environment (APSE), in which all tools are written in the Ada language and interface to a Kernel APSE (KAPSE), has been proposed for use. The following questions will be useful in evaluating the suitability of the proposed environment for its use in the overall program.

1. What environment (support software tools) is proposed for use in accomplishing the tasks specified within the RFP Statement of Work?

2. Is the environment:

   - to be provided as Government Furnished Equiptment (GFE)?

   - to be delivered to the government upon completion of contract?

   - contractor owned/proprietary from which software must be ported to a government environment upon completion of contract?

   - other (specify)?

3. Reference [12] provides a detailed taxonomy of software tool features for a life cycle software engineering environment. Which of the features enumerated in this reference are provided by the tools indicated above?

4. What features other than those identified above are provided?

5. Does the environment support the proposed methodology?

6. What is the level of integration of the tools?

7. What is the maturity level of the environment; i.e., have the tools been used on other Ada software development programs of comparable level of effort?

8. Will the environment allow efficient use by both experts and beginners; for example, is prompting via menus provided for beginners and single keystroke capability provided for experienced users?

- input/output
- interrupt handling (enable/disable/reenable) from the Ada applications program
- system initialization
- system services callable from the Ada applications program
- task management
    * abnormal termination
    * advanced synchronization and communication
    * attribute access
    * basic synchronization and communication
    * cyclic tasking
    * delay and time services
    * initiation
    * interrupt handling
    * normal termination
    * scheduling
- type and data conversion

18. Has the run time environment been stress tested?

19. Does the run time environment have any limitations which are in conflict with the mission of the operational program?

20. Is the performance of the run time environment sufficient to support the performance requirements of the operational program?

21. How is casualty reconfiguration of the operational software handled?

22. Are sizing and timing studies planned throughout the software design process which include the evaluation of the run time operating system as an integral part of the system design?

8. Has a backup compiler been identified in case the proposed compiler cannot be used?

9. Has the proposed Ada compiler been validated? If not, is rationale provided for use of a non-validated compiler and is an approach for transitioning to a validated compiler outlined?

10. Have the issues and risks associated with periodic compiler revalidation been identified and addressed with contingency plans proposed?

11. What features of Chapter 13 of MIL-STD-1815A are supported by the compiler? Are any of these features proposed for use in the implementation? If so, has the impact of using such features been addressed?

12. What features of Chapter 13 of MIL-STD-1815A are not supported by the compiler? How will the lack of such features impact the project?

13. Has the proposed compiler previously been used for the intended target system?

14. On what other programs of comparable level of effort has the proposed compiler been successfully used? Are points of contact provided to enable confirmation of this information?

15. Is there an existing run time environment for the target system or will a new one be required? If one exists:

    - what is its maturity level

    - will modifications be required

    - is it robust enough to run on a bare target machine

16. What memory resources are required for the run time environment? Are these resource requirements reasonable in relation to the anticipated memory requirements of the application specified in the RFP Statement of Work?

17. Is specific information provided with regard to how the run time environment supports the following Ada features for their suitability with the application specific area addressed within the RFP Statement of Work:

    - constraint and numeric error checking

    - dynamic storage management

    - exception management

2.3 IMPLEMENTATION LANGUAGE

If Ada has been proposed as the implementation language, the most immediate aspects associated with its use are: (1) the guidelines to be used by programmers during software development; (2) the Ada compiler which is to be used during the effort; and (3) the run time support environment which will be used on the target machine. The assumption which is made in this section is that a specific compiler has not been mandated in the RFP. The following questions will be useful in evaluating the suitability of the proposed guidelines, compiler, and run time support environment for their use in the overall program.

1. What specific guidelines are used as a basis for implementation of Ada? Are these guidelines consistent with the software engineering principles which are promoted through use of the Ada language? (Example: what programming standards or style guides are proposed?)

2. What "checks and balances" are provided to ensure compliance to the Ada implementation guidelines?

3. In what ways will the proposed implementation exploit the features of the Ada language?

4. Are there existing software components proposed for inclusion within the program? If so, what rationale is provided for their use and by what procedure will these existing components be incorporated within the implementation? Is a reusable software library available?

5. If the proposed Ada implementation includes the import of code generated by another programming language, has the proposal:

   - provided sufficient rationale for the inclusion of foreign code

   - addressed the impact on the quality, integrity, and maintainability of the final product

   - cited previous experience with foreign code import for use on the same host and target machines

   - identified specific software development tools required

6. Are performance measurement techniques proposed for use during the implementation? If so, how will results be utilized?

7. What is the availability of the proposed Ada compiler? If the compiler is not currently available, but is or will be under development, has a risk assessment been performed as to the impact of the the compiler availability on the overall program?

13. What configuration control procedures are used for the PDL?

14. Will the PDL code be delivered as part of the product source code library?

15. Are there existing PDL components proposed for inclusion within the design? If so, what rationale is provided for their use and by what procedure will these existing components be incorporated within the design? Is there a reusable PDL component library available?

16. By what procedures will the PDL code be kept up to date once coding has begun?

    - manual

    - automated

17. On what other programs of comparable level of effort has the proposed Ada-based PDL been successfully used? Are points of contact provi ·d to enable confirmation of this information?

7. For preliminary design, does the proposed Ada-based PDL provide support for:

   - the validation of preliminary design (where "validation" is defined to be the process by which the final product is ensured to satisfy the initial specifications and requirements)

   - the verification of preliminary design (where "verification" is defined to be the iterative process by which the progressively more detailed product fulfills the requirements levied by the previous step)

   - capture of preliminary design information

   - ease of change to the preliminary design

   - ease of transition to the detailed design

   - documentation of the preliminary design

8. For detailed design, does the proposed Ada-based PDL provide support for:

   - validation of detailed design

   - verification of detailed design

   - capture of detailed design information

   - ease of change to the detailed design

   - ease of transition to code

   - documentation of the detailed design

9. Does the proposed PDL promote design portability or are there hardware dependencies imposed through use of the specific PDL?

10. Is there a clear demarcation between PDL design code and Ada implementation code?

11. What automated tools support the proposed PDL? What specific features do these tools provide to facilitate the design process?

12. What documentation is provided through use of the PDL and the PDL specific tools?

2.2 PROGRAM DESIGN LANGUAGE

A PDL is an effective mechanism for providing an accurate description of the design concepts. Through use of a PDL, the design of the overall system is: (1) more easily understood by both designers and nondesigners; (2) more readily tracked to system completion; and (3) more easily modified to accommodate correction of deficiences or expansion for additional capabilities. An Ada-based PDL is one which is based upon the syntactic and semantic concepts of Ada for expression of the design concepts. There currently exists within the Ada community many Ada-based PDLs, some of which adhere strictly to MIL-STD-1815A and some of which allow deviations from the standard. The following questions will be useful in evaluating the suitability of the proposed Ada-based PDL for its use in the overall program.

1. Has a specific Ada-based PDL been proposed? If so, what supporting rationale has been provided for selection of this PDL over other potential PDLs? If not, is there a mapping/transition path defined for PDL to Ada functionality?

2. What specific guidelines are used as a basis for implementation of the proposed PDL? Are these guidelines consistent with the software engineering principles which are promoted through use of the Ada language?

3. Is the proposed Ada-based PDL implemented through manual or automated procedures?

4. Is the proposed Ada-based PDL compilable?

5. What "checks and balances" are provided to ensure conformance to the Ada-based PDL guidelines?

6. Is the proposed PDL fully compliant with the Ada language (MIL-STD-1815A) or does the PDL support deviations from the standard? If deviations are supported, what rationale is provided as justification?

   - the Ada-based PDL is exactly Ada

   - the Ada-based PDL is a subset of Ada

   - the Ada-based PDL is a subset of Ada plus extensions

   - the Ada-based PDL is a superset of Ada

END

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