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TECHNICAL REPORT

For The

Cargo Movement Operations System (CMOS)

Ada Waiver Input



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Prepared for

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## SECTION I

INTRODUCTION. Purpose of this Technical Report is to provide a written input for the CMOS Program Office (PO). The input will be used by the PO to formalize an Ada waiver request for the CMOS project.

SUMMARY. Not Used.

CONCLUSION. Not Used.

SECTION II

RESULTS. The SAIC input is provided in the ensuing pages. The format is as directed by HQ USAF/CVA Letter, dated 9 Nov 88.

I. Program Description

A. System Overview: The Cargo Movement Operations System (CMOS) is a top down directed program (DEP SECDEF Memo, 7 Sep 84) that will contribute to five major DOD objectives: 1) It will be the Air Force System to implement the FY86 Defense Guidance mandated Transportation Coordinators - Automated Information for Movements System (TC-AIMS); 2) It will extend Logistics Marking and Reading Symbology (LOGMARS) capability to base-level transportation; 3) It will introduce Electronic Data Interchange (EDI) to base-level transportation; 4) It will complement the intransit visibility capability present in other transportation systems; and 5) It will be a primary source of information for Air Force Logistics Command, Control, and Communications ($LOGC^3_u$). The CMOS Program Management Directive #5272 (2)/38610F, 5 Dec 86, as revised 21 Jun 88, lays out an incremental development strategy. Increment I will automate the base level traffic management processes of cargo movement. It establishes the first nine electronic interfaces with other transportation systems and provides a solid foundation from which to add the enhancements to satisfy the requirements of increments II and III. Increment II will add the capability to process cargo and passengers in a unit move environment and report the movement laterally and upwardly. Eleven systemic interfaces will be initiated in this increment to augment those already implemented. Additional requirements, known as Preplanned Product Improvements ($P^3I$), will be developed in Increment III on a schedule that has yet to be determined.

B. Hardware and Software Environment. Hardware and non-development software will be purchased from standard government contracts. These are: Desk Top III, Standard Multiuser Small Computer Requirements Contract, Unified Local Area Network Architecture, and the LOGMARS Non-Tactical Radio. Development Software and system integration services will be provided by Evaluation Research Corporation International through a GSA contract (#GS-OOK-89-AJDO11, 21 Jun 89).

II. Program Status. The CMOS Program is currently in the Software Requirements Analysis phase. The Software Requirements Analysis will conclude with the Software Specifications Review, 15-18 Jan 90. The most recently passed milestone, the System Design Review (11-13 Oct 89), established the Increment I functional baseline. The next major program phase will be the Increment II System Requirements Analysis, which will begin in Nov 89 and conclude with the System Requirements Review in Jan 90.

III. Analysis for Software Solutions.

A. Introduction. A solution was proposed by Evaluation Research Corporation and selected by the CMOS Source Selection Board. This solution takes advantage of the Fourth-Generation Language (4GL) capabilities provided by the ORACLE RDBMS for the majority of the software development effort (estimated at 96 percent). The remaining 4 percent will be accomodated by the use of the High Order Language C. What follows is an analysis of the six factors used in determining the selection of the C language in lieu of Ada:

1. System Life Cycle Cost. AFR 173-15 defines life cycle cost as the net present value of the total cost stream of an alternative. The source selection process demonstrates that the proposal met the pertinent criteria for life cycle cost. The action of reevaluating life cycle cost now is the result of the possibility that Ada tools will become available in time to allow CMOS to adhere to the Ada standard instead of using C language as originally proposed. The CMOS project will be primarily developed using the ORACLE RDBMS. However, certain systems level programming will be done using either Ada or C as prescribed by the RFP. The purpose of this examination is to estimate the value of the systems level programming for the C and Ada languages in life cycle cost terms.

a. C Language. The systems level programming needed represents 4 percent of the total expense attributed to software development for CMOS as originally proposed. The incremental cost of the systems level programming can then be defined as the total software development costs multiplied by the percent attributed to systems level programming. This amount represents the estimated net present value of the C language portion of CMOS.

b. Ada. In a March 1989 study conducted by the GAO, systems development and maintenance cost savings attributed to the use of Ada could not be substantiated by historical data. For this reason, a conservative estimate of Ada driven expense would be approximately the same as that expected for C language as defined above. There are no significant cost differences between C and Ada.

2. Software Portability. The hardware environment of CMOS is not expected to change for the foreseeable future. Both C and Ada are designed to be as device-independent as possible, so that either could be readily adapted for another environment when hardware replacement eventually becomes necessary. The C language environment is currently the most widely used for open systems development, so its availability on any future hardware platforms is highly likely. Neither language enjoys an advantage in the area of software portability.

3. Software Reuse. The augmentation provided by the HOL in CMOS is envisioned primarily in the "binding" of NDS to the CMOS applications developed in ORACLE. The small amount of HOL code required will, therefore, be rather specialized in nature, and its potential for reuse rather limited. The Ada language is somewhat more oriented to modular design than C, but the C language makes extensive use of common libraries

and shared header information, so that it also lends itself to reuse where possible. No measurable differences exist between C and Ada in software reuse.

4. Performance. Both languages are capable of meeting the processing speed requirements of CMOS. The extensive memory requirements of Ada present a potential problem on the Zenith Z-248 PCs which are to be used as workstations, because of the large (2 Megabyte minimum) size of the ORACLE RDBMS. The use of a C language environment requires much less dedicated memory. As a result, the C language presents much less of a performance risk.

5. Schedule Risk. Two specific concerns in the area of schedule risk are the ORACLE/Ada interfaces and the Ada compiler for the 3B2.

a. At present, there is no Ada precompiler for the ORACLE RDBMS version used on the 3B2, although one is slated to begin Beta testing in December, 1989. The C precompiler is already included as part of the suite of HOL interfaces for the 3B2 version of ORACLE. Even more significant is the lack of any existing Ada interface for the MS-DOS version of ORACLE to be used on the PC workstations. Furthermore, Oracle Corporation has no current undertakings to make such an interface available. The 3B2 and Z-248 environments each have available proven C language interfaces with ORACLE.

b. The Ada compiler for the 3B2 has not yet been delivered to the government for testing, whereas the C language compiler has been available for use since the award of the Standard Multiuser Small Computer Requirements Contract in October 1988.

c. A final issue regarding schedule risk concerns the recruitment and training of Ada programmers. With regard to software development productivity, there is no clear distinction that can be made between Ada and C. Both are well structured modern programming languages which have a variety of tools available to enhance the development process. However, there are fewer experienced Ada programmers available. This could lead to a reduction in software productivity incurred by the requirement to train new programmers or retrain existing staff.

6. Technical Risk. A report published in March 1989 by the General Accounting Office which examines the use of Ada within the DOD has the following statement in the chapter presenting its conclusions and recommendations:

> Reliance by DOD on Ada or any new language as a standard to support all computer systems - weapons systems, mission-critical systems, and information management systems - carries with it risks. Programming languages and their associated software development tools are

complicated. It takes time and considerable experience using them in a variety of applications before they mature, and most experts agree that Ada has not yet matured.

In contrast, the C language is widely used for a multitude of applications, with particularly heavy emphasis on system level functions. For these reasons, Ada presents a much more significant technical risk in the CMOS development effort.

B. Summary. The primary drawback inherent in the use of Ada as the HOL for CMOS development lies in the schedule risks it presents. The development schedule for CMOS is highly aggressive, and the current non-availability of Ada products presents a major obstacle to the timely completion of the tasks required for schedule milestones to be met. The use of C language in place of Ada has several distinct benefits, primarily in the areas of lower schedule and technical risk. Given an unlimited amount of time for development, the use of either would serve equally well. However, the acute need of the transportation community for an automated system makes the rapid deployment of CMOS a prime concern and the use of C as the HOL in system development will have a direct and positive impact on the development process.