AD-A129 891 DOD (DEPARTMENT OF DEFENSE) SHOULD CHANGE ITS APPROACH 1/1
TO REDUCING COMPUT..(U) GENERAL ACCOUNTING OFFICE
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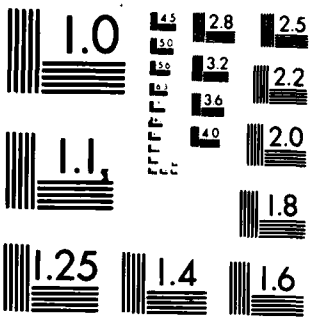

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BY THE COMPTROLLER GENERAL

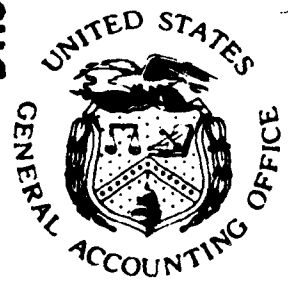
Report To The Chairman, Committee On Government Operations House Of Representatives OF THE UNITED STATES

DOD Should Change Its Approach To Reducing Computer Software Proliferation

In this report GAO encourages DOD to reduce computer software proliferation and accompanying high costs by taking advantage of opportunities to use a standard programming language.

In a January 1982 report, GAO recommended that DOD not implement a particular computer procurement instruction because it did not focus on making maximum use of a new programming language. However, DOD now appears to be proceeding to implement the instruction. This approach could (1) hinder DOD's ability to use advances in technology, (2) discourage beneficial competition within the computer industry, and (3) duplicate, at government expense, the commercial investment in computer technology advances.

The primary objective of the pending instruction is to reduce high costs resulting from computer software proliferation. GAO believes that DOD could more effectively achieve this objective by evaluating opportunities to use its new programming language Ada and by using this language when warranted. It is estimated that $1.5 billion in annual savings can be realized by adopting one DOD standard programming language.



GAO/MASAD-83-26
MAY 26, 1983

COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON D.C. 20548

B-199008

The Honorable Jack Brooks
Chairman, Committee on Government
Operations
House of Representatives

Dear Mr. Chairman:

On March 23, 1982, you requested that we (1) evaluate the ongoing efforts of the military services to standardize their computers, (2) determine if it is more cost effective to standardize on the software using a high-level language, such as Ada,[1] (3) determine if the Department of Defense (DOD) should rely on the computer industry to provide the stimulus for computer innovations, and (4) determine what possible rationale exists for DOD not moving rapidly ahead to implement Ada.

In our January 1982 report (MASAD-82-16, Jan. 27, 1982) we noted that dramatic advances have been made in software technology, and included in these advances is the DOD developed standard high-level programming language called Ada. Ada specifically aims to readily adapt a very wide variety of DOD applications to many present (and future) computers.

Likewise, there have been many advances in computer technology. The commercial sector of our economy is demanding more rigorous reliability requirements for computer parts. These advances most likely will be realized at little or no increased cost because of innovative computer designs requiring smaller and fewer computer parts, thereby reducing logistics support needs.

Using militarized versions of commercial computers will open competition to many firms that would not bid on contracts that involved DOD-owned computer hardware architectures.[2] The

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[1]Ada is a registered trademark of DOD and is its high-level standard computer programming language. The language was named in honor of Augusta Ada Byron (1816-1851). Ada the daughter of the poet Lord Byron and the first programmer, worked on Charles Babbage's mechanical computing engine in the early 1800s.

[2]In this letter we define computer hardware architecture as the interface between hardware and software.

resulting life-cycle costs will be less because DOD will not pay for duplicate computer development, as it is doing under the pending computer procurement Instruction 5000.5X.

We recommended that the Secretary of Defense not implement pending Instruction 5000.5X, which requires using standard computer hardware architectures. We also recommended that the Secretary of Defense direct the services to reevaluate their ongoing efforts in this area and demonstrate why they are more cost effective than (1) standardizing on software using a high-level language, such as Ada and (2) relying on the computer industry to provide the stimulus for computer innovations.

In an April 2, 1982, letter, DOD disagreed with our recommendations. We addressed the DOD disagreements in a May 24, 1982, letter to you (B-199008).

On August 16, 1982, the Senate and House Armed Services Committees' Conference Report on the fiscal year 1983 Authorization Act incorporated the above recommendations. The conferees required that before implementing DOD Instruction 5000.5X, DOD provide a report to the Committees regarding DOD's efforts to standardize military computers. Pending submission of the required report,[3] the conferees agreed that DOD should accelerate implementing Ada. The conferees also placed certain restrictions on the ongoing standard military computer programs of the three services.

DOD, IN EFFECT, IS IMPLEMENTING PENDING INSTRUCTION 5000.5X

The primary objective of pending Instruction 5000.5X is to reduce high computer system costs resulting from the use of many software languages. The instruction would attempt to achieve this objective by requiring the services to primarily use only government-approved and -owned computer hardware architectures. The architectures used by the Navy and the Air Force are limited in technology advances because they require compatibility with two older service-owned computer languages, CMS-2 (Navy) and JOVIAL (Air Force).

In addition, mandating the use of these computer hardware architectures (1) hinders DOD's ability to use advances in high-level software, such as Ada, and related hardware technology

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[3]DOD estimates that its report to the Committees will be issued by early May 1983.

advances in the commercial sector, (2) discourages competition from a significant portion of the commercial computer industry which offers advanced capabilities, and (3) duplicates at government expense the commercial investment in the development and implementation of computer technology advances.

The above three factors, in our opinion, occur because DOD is, in effect, implementing Instruction 5000.5X through individual service programs to develop and acquire military computers that are unique to each service and different from any commercial computers. The Navy is acquiring the unique AN/UYK-43/44 military computers; the Army is developing the unique Military Computer Family (MCF); and the Air Force is developing and acquiring the unique 1750A military computers. This implementation discourages commercial participation and innovation because the instruction requires the use of technical specifications, such as stipulating the use of government-owned computer hardware architectures.

In contrast to the use of technical specifications is DOD's Directive 5000.1. This directive encourages commercial participation by requiring the use of functional specifications based on mission or user needs. This is in compliance with the Office of Management and Budget (OMB) Circular A-109. The use of functional specifications allows a large number of commercial vendors to propose a variety of solutions which best meet DOD's mission needs at competitive prices.

In supporting Instruction 5000.5X, DOD is missing the main issue raised by the Senate and House Armed Services conferees. This issue is what approach is best for incorporating new computer technology and rapidly adopting Ada into the military computer environment. Although the pending Instruction 5000.5X had merit when considered in context of the computer environment that existed during the mid-1970s, our evaluation raises some serious issues that challenge its validity in the 1980s time frame. In the 1970s, when hardware technology was limited and costly, the need to closely manage the design and application of hardware was justified. However, major advances in hardware technology in recent years have resulted in substantial cost and performance improvements. These improvements have shifted major computer life-cycle costs from hardware to software, resulting in the need to place additional emphasis on software management.

We believe this means DOD needs to devote additional emphasis to defense-wide implementation of Ada in order to achieve improved reliability and economies of operation and to be more responsive to mission needs.

The Navy AN/UYK-43/44 military computers are outmoded and impair Ada implementation

The Navy is committed to producing new AN/UYK-43/44 military computers based on the obsolescent AN/UYK-7/20 hardware architectures.

It appears the Navy will experience major problems in transferring old application programs to the AN/UYK-43/44 computers. This is because of the various versions of the Navy's CMS-2 language and the use of a machine dependent programming language in these programs. Moreover, a Navy official stated that there are no cost studies to show what costs would be required to transfer old software to the AN/UYK-43/44 computers.

In addition, the AN/UYK-43/44 are inadequately designed for Ada, as discussed in our 1981 report (MASAD-81-28, May 15, 1981) and in recent studies performed for the Navy by Intermetrics, a software development firm. This would seriously constrain effective Ada implementation for the balance of the decade. The AN/UYK-43 Intermetrics study was disclaimed by a Navy official and is being redone to improve its presentation. However, we believe the facts relating to the inadequate design for use with Ada have not changed and that the AN/UYK-43 computer will not adequately support Ada.

The Army MCF program is questionable

The Army MCF program will place in the field, in about 1986-87, computer hardware technology which will then be about 2 to 3 years old. More importantly, the Army is adopting a life-cycle plan for the next 36 years that will restrict computer innovation and is essentially identical to what the Navy did during the past 15 years. The results could be that the Army will experience computer obsolescence problems in the field by the end of this decade.

We also found that MCF cost-benefit assumptions, which are the basis for justifying the program, are incorrect because they rely on outmoded logistics arguments. The MCF program director generally agreed with our assessment of the assumptions in the cost-benefit study. (See app. I, p. 4.)

Reduced maintenance and logistics costs have been cited as the main justification for the MCF program. However, modern

technology is rapidly improving reliability and redundant capabilities for all computers. This, plus decreased life-cycle, size, and power requirements are reducing logistics support needs. These developments lead us to question the Army's need to develop its own unique MCF.

The Air Force 1750A military computer program should only be an interim approach

The Air Force is encouraging production of the 1750A military computers by many companies. This was an adequate interim approach before Ada was available. However, the Air Force has several versions of its old software, JOVIAL. It appears the 1750A program is being continued so that JOVIAL software may be maintained for many years beyond its economic life in order to preserve the Air Force investment in this old language. This approach could result in a situation similar to the Navy, where the emphasis is on preserving old software instead of using the performance and maintenance advantages of newer software technology such as Ada.

ADA--THE STANDARDIZATION LEVEL FOR MILITARY COMPUTERS

In 1975 DOD began an effort aimed at reducing the rapidly increasing expense of military software systems, estimated to reach $32 billion annually by 1990. This effort has now evolved into one of the most promising and far-reaching developments for information systems--the Ada high-level programming language and associated support environment. The Ada language specifications were agreed to as of December 1982 and approved as an American National Standards Institute standard on February 17, 1983. This standard provides a single uniform base for potential users of the Ada programming language. DOD expects to be able to productively use Ada by 1984.

Studies made by the Defense Advanced Research Projects Agency and by Decisions and Designs, Inc., predicted that one standard DOD language will result in substantial cost savings DOD-wide through common software, improved programmer productivity, and new technical features. According to these studies, DOD could save as much as $24 billion for a 16-year period, or $1.5 billion per year.

DOD's Ada Joint Program Office (Ada office) would like to encourage the rapid development of Ada and Ada support

software. The Army is developing the Ada Language System, the Air Force is developing the Ada Integrated Environment, and the Navy is assigned to interface both. We are aware of isolated DOD applications of Ada for efforts at the project and/or laboratory level. For example, at the Naval Surface Weapons Center, Dalgren, Virginia, there is an experimental project using Ada for simulation application of the Aegis system.

However, we found no widespread DOD availability or use of Ada at the project and/or laboratory level. For example, the Ada office does not have any Ada programs on ARPANET[4] for actual experience and training. The Ada office should provide assistance to the services in gaining widespread experience before they are required to develop production systems with Ada. For example, Ada could be put on the ARPANET and thereby be available to a wide variety of military users for experience in accelerated testing, evaluation, and prototype development of Ada.

Industry is rapidly adopting Ada

Industry is rapidly developing computer systems suitable for military use that will use Ada. These computers appear to be forerunners of a new set of high performance and high technology machines that will effectively use the new capabilities offered by Ada. These computers could be more competitive--in terms of cost and performance--in meeting user needs for military applications than the unique computers being developed by the services under Instruction 5000.5X. However, industry's competitive offerings will be available only on an exception basis if the precepts of Instruction 5000.5X are adhered to.

The industry's commitment to produce Ada-oriented systems includes the following efforts:

—Norden has militarized the Digital Equipment Corporation computers, which will be available with Ada by mid-1984.

—Rolm has militarized the Data General computers, which will be available with Ada by mid-1983.

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[4]ARPANET is a common-user data communications network with many user locations within DOD and other communities.

--Electronics Memories and Magnetics Corporation has militarized the Intel 8086 microprocessor family. Intel has announced an Ada compiler for the 8086 microprocessor family which will be available by the first half of 1984.

--The Intel 432 microprocessor will also be made available in a militarized version that uses Ada.

Further, some of the commercial organizations we contacted are aggressively using Ada to develop application software. These organizations are training programmers and analysts in modular programming techniques using Ada for internal and/or commercial applications.

CONCLUSIONS

Implementing Instruction 5000.5X hinders DOD's ability to use current and anticipated advances in software and related hardware technology. We believe DOD can accomplish its objectives more effectively by using these advances, which would be available by adopting Ada as the standard for military computers.

In two previous reports (MASAD-81-28, May 15, 1981, and MASAD-82-16, Jan. 27, 1982) we were critical of the services' commitment to unique military computers. Based on our current work, the following conditions still exist:

--The three services' continuing military computer efforts--the Navy AN/UYK-43/44 military computer program, the Army MCF, and the Air Force 1750A military computer programs--are, in effect, implementations of Instruction 5000.5X.

--Eliminating DOD-owned military computer hardware architectures would encourage competition from a significant portion of the computer industry. In addition, DOD would not be duplicating the commercial investment in computer technology advances.

--The use of Ada could alleviate DOD's software problems and at the same time permit DOD to capitalize on hardware architectural advances.

RECOMMENDATIONS

We have previously recommended that the Secretary of Defense not implement DOD Instruction 5000.5X and that the services reevaluate their ongoing computer development programs. These recommendations were aimed at requiring the services to demonstrate why their development programs are more cost effective than (1) standardizing on software using a high-level language, such as Ada and (2) relying on the computer industry to provide the stimulus for computer innovations. DOD has not implemented these recommendations, and we believe they are still valid. In addition, we now recommend that the Secretary of Defense direct the Secretaries of the Navy, Army, and Air Force to:

--Assure that any new military computers acquired by the services are compatible with Ada and that contracts are awarded on a competitive basis using functional requirements as the procurement criteria.

--Begin reducing software proliferation by justifying, on the basis of cost and benefits, the use of a computer language other than Ada in new software development programs. These justifications should be submitted to the Ada Joint Program Office for evaluation and approval.

--Also, for the purpose of reducing software proliferation, evaluate the costs and benefits of converting existing major software programs to Ada, and if cost effective and beneficial to make such conversions, make them. Report quarterly to the Ada Joint Program Office on the status and results of these evaluations.

We also recommend that the Secretary of Defense assign the Ada Joint Program Office the responsibility to monitor the Ada efforts recommended above and to provide assistance to the services in gaining widespread experience with Ada.

SCOPE AND METHODOLOGY

During our review, we contacted officials representing computer manufacturers, software developers, system contractors who incorporate embedded computers in the systems they develop, and industry associations representing manufacturers of computers and electronic equipment. We reviewed congressional testimony, position statements, and correspondence regarding

Instruction 5000.5X. We also contacted program officials and reviewed program documents regarding Ada, the Navy AN/UYK-43/44, the Army MCF, and the Air Force 1750A military computer programs.

Our review was made in accordance with generally accepted auditing standards.

We did not obtain official agency comments on this report. As arranged with your office, unless you publicly announce its contents earlier, we plan no further distribution of this report until 30 days from the date of the report. At that time we will send copies to interested parties and make copies available to others upon request.

Sincerely yours,

Charles A. Bowsher

Comptroller General
of the United States

RESPONSES TO FOUR SPECIFIC CONCERNS REGARDING EFFECT OF INSTRUCTION 5000.5X ON DOD

EVALUATION OF ONGOING EFFORTS OF THE MILITARY SERVICES TO STANDARDIZE THEIR COMPUTERS

We reviewed the progress of the Navy, Army, and Air Force programs to standardize computers at the hardware architectural level, rather than at the Ada level. The services have, in effect, implemented DOD Instruction 5000.5X.

We have previously reported (MASAD-82-16, Jan. 27, 1982) that proposed DOD Instruction 5000.5X should not be implemented because (1) the major life-cycle cost for a computer system is software not hardware and (2) military computers can effectively use militarized versions of commercial hardware architectures which tend to be more technologically advanced than military hardware architectures.

The Computer Family Architecture Committee also pointed out in 1975 that military computers could use commercial hardware architectures. After a careful comparison of the features of military and commercial hardware architectures, it determined that data processing operations performed by military computers do not differ significantly from those typically performed by commercial computers.

Each service's standardizing program for service unique computers is briefly reviewed in the following sections.

Status of Navy AN/UYK-43/44 military computer program

The Navy is committed to developing and producing AN/UYK-43/44 computers to supersede its obsolescent AN/UYK-7/20 computers presently manufactured by the Sperry Corporation. During March 1983 the Navy awarded the Sperry Corporation a $354 million production contract for the AN/UYK-44. The Navy plans to award the production contract for the AN/UYK-43 in May 1983 to either IBM or the Sperry Corporation. We have summarized the major milestones for the AN/UYK-43/44 computers on the following page.

Milestones for the Navy AN/UYK-43/44 Military Computers

	UYK-43	UYK-44 processor
Award development contract	9/80	9/80
Delivery of eng. dev. model (EDM)	3/83	12/81
Selection of vendor	5/83	3/83 [a]
Completion of EDM evaluation	9/83	3/83
Production go-ahead	5/83	3/83
First production delivery	12/84	9/83

[a] Contract awarded to Sperry Corporation, the incumbent contractor, for $354 million.

In our prior report (MASAD-81-28, May 15, 1981) we stated that:

--AN/UYK-43/44 will not fully capitalize on software cost savings of Ada because the hardware architectures are not suited to Ada.

--The Navy's next generation of computers should rely on commercial development to meet stated functional needs.

The Navy did not agree with our assessment because it believes that AN/UYK-7/20 architectures are needed to save its investment in existing AN/UYK-7/20 application software. Subsequently, Intermetrics, a software development firm, studied these hardware architectures for the Navy.

The Intermetrics report on the AN/UYK-43 hardware architecture cited several serious problems in supporting Ada, including a directly addressable memory space restriction. A Navy official disclaims the report and is having it redone to improve its presentation. However, we believe the facts relating to the inadequate design for use with Ada have not changed and that the AN/UYK-43 hardware will not adequately support Ada.

The Intermetrics report on the AN/UYK-44 hardware architecture cited similar problems, but it has been accepted and sent to the developing vendors for comments on the feasibility of making changes to the AN/UYK-44 hardware architecture before production.

The Navy now recognizes the limitations of the AN/UYK-43/44 hardware architectures and has decided to discontinue the use of these hardware architectures in future acquisitions of these types of computers. The Navy plans to develop or select a new architecture in accordance with pending Instruction 5000.5X.

Status of the Army MCF program

The Army is committed to developing service unique computers based on a hardware architecture developed specifically for the Army MCF. The Army plans to retain this hardware architecture for 36 years with technology "windows" approximately every 5 years for improvements. The most likely result of this life-cycle plan is that this hardware architecture will become obsolescent in future years as the Navy's AN/UYK-7/20 architectures are today.

Highlights of the Army milestones for developing and producing MCF.

January 1983--begin delivery of advance development models.

September 1983--award engineering development contracts.

Mid-1986--award MCF production contract.

Mid-1987--begin delivery of MCF production models.

Funding for MCF is briefly summarized:

	MCF	MCF/operating system (control software)
	(millions)	
Obligated	$ 31.96	$ 1.46
Budget FY 83/89	155.69	-

We believe the Army's foundation for its MCF program is based primarily on claimed logistical benefits. These claimed logistical benefits require standardization for Army unique computers at three levels--language, hardware architecture, and hardware physical components.

The claimed MCF program benefits include

--reduced development and hardware acquisition costs,

--decreased maintenance and support costs for hardware and software,

--reduced training costs,

--elimination of hardware and software proliferation,

--increased marketplace competition,

--controlled infusion of new hardware technology, and

--achieved interface compatability.

The above claimed benefits for the MCF program are based on the following assumptions which we believe are inaccurate.

--Assumed computer life cycles of 5 years development, 5 years production, and 20 years operation, are much too long for military performance needs.

--Assumed integrated logistics support investment for 20 years operation is unrealistic because modern military computers that are more reliable and economical will be available.

--Assumed logistics support needs can be substantially reduced because of new technologies in the areas of redundant processors and replacement of complete processors.

--Assumed hardware/software development and production costs for alternative commercial systems are high because costs are not allocated to many commercial customers.

--Assumed software maintenance costs, based on past Army experience, are obsolete in light of projected lower life-cycle maintenance costs resulting from Ada adoption.

Status of the Air Force 1750A
military computer program

The Air Force has encouraged a large number of companies to build computers using 1750A hardware architecture.

Table 1

Companies using 1705A military computer architecture

Built and tested:

International Business Machines
Sperry Univac
Westinghouse
Control Data Corporation
Mikros
Delco
Teledyne
Tracor
General Electric

Built not tested:

Singer-Kearfott
Texas Instruments
McDonnell Douglas
Royal Aircraft Establishment (UK)
Royal Signals & Radar Est. (UK)

Development:

Marconi-Elliot
Rolm
Honeywell
Fairchild Semiconductor
Hughes Aircraft

We agree that the use of 1750A was satisfactory as an interim solution; however, there is little reason to believe that continued exclusive use of the 1750A in Air Force programs to preserve its investment in JOVIAL software will be cost effective because of the availability of Ada. This is because the claimed Air Force benefits of the 1750A listed below, are the same benefits that will be realized when using Ada.

--Reuse of available support software.

--Software development independent of hardware development.

--Reduction in total amount of support software.

--Programmers move from one project to another.

--Control of software proliferation.

--Independence from hardware vendors because of portable software.

--Proven support tools which will provide shorter schedules, lower costs, and fewer surprises.

In addition, Ada has the added benefits of

--modular programming to improve software reliability and reduce life-cycle maintenance costs;

--simultaneous processing of real-time operations;

--eliminating the need to write programs line by line, because of the capability to reuse coded software routines; and

--providing the best portability of any DOD programming language.

In summary, Ada is one of the major software achievements during the past 20 years and has been rigorously developed to meet DOD needs for a standard high-level language.

Mandating the 1750A hardware architecture, to preserve the various versions of JOVIAL, will result in substantially higher maintenance costs than using Ada. Ada was designed as an improvement over prior DOD languages. Therefore, by attempting to preserve the investment in JOVIAL, the Air Force will defer the economic and performance advantages of Ada.

SUMMARY

In summary, the services are proceeding as if Instruction 5000.5X has been implemented and are making major hardware

development and production commitments to unique service computers--the Navy AN/UYK-43/44, the Army MCF, and the Air Force 1750A military computer programs.

By mandating architectures for service unique computers, the services are unnecessarily precluding the use of commercially available computer hardware and software technology. In the private sector, commercial hardware architectures are continually upgraded to meet competitive demands rather than on a specific multiyear schedule, such as the 5-year schedule being proposed by the Army.

In addition, we do not consider the Navy's and the Air Force's justification to save aging, expensive to maintain software sufficient to delay the implementation of Ada.

DETERMINE IF IT IS MORE COST EFFECTIVE TO STANDARDIZE ON A HIGH-LEVEL LANGUAGE SUCH AS ADA

We have evaluated three standardizing alternatives.

--Standardize at the Ada language level.

--Standardize at the hardware architecture level.

--Standardize at the hardware physical components level.

In our prior evaluation of military computers (MASAD-82-16, Jan. 27, 1982), we did not support standardizing at the hardware architecture or physical component levels. Also, in our report concerning the World Wide Military Command and Control System (WWMCCS) (MASAD-82-2, Oct. 19, 1981), we recommended standardizing at communications levels such as network protocols, data formats, and data retrieval techniques. Standardizing at the hardware architecture levels resulted in a seriously flawed WWMCCS ADP system with major operational deficiencies.

In addition, we note that commercial computer users do not standardize at the hardware architecture or physical component levels. For example, there is no industry standard for a 32-bit hardware architecture. However, there is a trend toward standardizing at the language and communications levels.

In the case of DOD, we believe that standardizing at the language level, Ada, would be most cost effective. In general, this would require, as in industry, the adoption of other standards at the communications levels to insure added independence from hardware architectures or physical components.

DETERMINE IF DOD SHOULD RELY ON THE COMPUTER INDUSTRY TO PROVIDE THE STIMULUS FOR COMPUTER HARDWARE ARCHITECTURE INNOVATIONS

We have found that the computer industry is advancing more rapidly than the services in the following areas:

--Using new hardware and software technology.

--Reducing physical size of computers.

--Improving reliability and cost performance of computers.

--Adopting Ada.

For example, four vendors offer or plan to offer militarized versions of commercial computers.

Because of the commercial interest, we believe that the services should encourage industry to provide militarized versions of commercial computers. We also note that

--the commercial computers are generally available for military conversion years before their military service counterparts,

--DOD does not risk Government funds for the development of these computers,

--these computers are continually technologically updated and are highly cost-performance oriented, and

--these computers will allow use of Ada on an accelerated schedule.

DETERMINE IF DOD HAS A RATIONALE FOR NOT MOVING RAPIDLY AHEAD TO IMPLEMENT ADA

DOD's rationale for maintaining a relatively slow pace for implementing Ada is its concern for ensuring program continuity and success. While we appreciate this concern, we believe the pace is uneven and too slow in two of the services. The following are the current DOD Ada implementation plans.

Army

--January 1983-all programs entering advance development will use Ada.

--January 1984-any program entering engineering development will use Ada.

Navy

--Will adapt the Army's Ada Language System to the AN/UYK-43/44 starting mid-1984.

--Operational Ada will not be available until early 1986.

Air Force

--No specific deadlines, depends upon successful demonstration of four phases.

--Four phase approach:

--Laboratory developments and explorations.

--Parallel system development.

--Selected use (possibly 1986).

--Mandatory use (possibly 1990).

In our January 27, 1982, report (MASAD-82-16) we said:

"Dramatic advances have been made in software technology. DOD has recognized that a lack of a standard programming language is a major contributor to the high cost of developing and maintaining software for military applications. DOD is to be commended for its initiative to fill that void by developing a common high-order [level] programming language called Ada. Ada very specifically aims to readily adapt a very wide variety of DOD applications to most present (and future) computer

architectures. Ada can potentially encompass the particularly useful aspects of future architectural advances and make their gains available to users, without their having to learn and worry about how the gains were realized. In other words, aggressive pursuit of a standard high-order [level] language, such as Ada, could alleviate the software proliferation problem and at the same time permit the Government to fully capitalize on architectural advances." (Emphasis added.)

These dramatic advances, along with significant estimated annual savings of $1.5 billion in software costs, indicate that DOD should move as rapidly as possible to implement Ada.

As discussed on page 6 of this letter, industry is rapidly adopting Ada. We believe that the services should "catch up" with industry and could accelerate Ada implementation by providing

--extensive Ada training;

--access to Ada on major networks, such as ARPANET;

--coding of existing application programs in Ada to conduct performance comparisons; and

--phase in of Ada more rapidly into major military information programs supporting weapon systems, command and control systems, battlefield information systems, and so forth.

EXAMPLES OF MILITARY VERSIONS OF COMMERCIAL COMPUTERS:

NORDEN/DIGITAL EQUIPMENT CORPORATION

Currently available--militarized

Micro	LSI-11 M	Mean time between failure (MTBF) 27,000 hrs.
Minis	PDP-11/34 M	MTBF 6,000 hrs.
	PDP-11/44 M	Mid-range
	PDP-11/70 M	Most powerful in PDP/11 line

Available mid-1984

Super-mini 32 bit Mil - VAX 11/780*

Company funds were used for development.

*Note: Army Ada Language System will be hosted on the DEC VAX 11/780 computer which is comparable to the Army's MCF AN/UYK-41 super-mini which will not be available until 1987.

ROLM/DATA GENERAL

AN/UYK-19 family--militarized

Model	5605	
Model	1603A	
Model	1650	
Model	1602B	
Model	1666B	(Latest member of AN/UYK-19 family)
MSE/14 processor		16 bit
MSE/800 processor		32 bit*

*Comparable to the Navy AN/UYK-43 which will not be available until 1984-85.

Company funds were used for development.

Note: The Rolm Ada Work Center, currently available, is hosted on MSE/800 processor.

ELECTRONIC MEMORIES AND MAGNETICS (EMM)/INTEL

Severe Environment Systems Co.--subdivision of EMM

Militarized

SECS 86/05 dual board processor--equivalent to Intel 8086, 16-bit processor

SECS 88/25 dual board processor--equivalent to Intel 8088, 8-bit processor

SECS 80/10A single board processor--equivalent to Intel 8080

Company funds were used for development.

Note: Intel has announced that Ada will be available for the 8086, microprocessor family in the first half of 1984. There are also plans to militarize the Intel 432, a 32-bit microprocessor.

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