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ARMY ELECTRONICS COMMAND FORT MONMOUTH N J
COMPUTER FAMILY ARCHITECTURE SELECTION COMMITTEE FINAL REPORT. --ETC(U)
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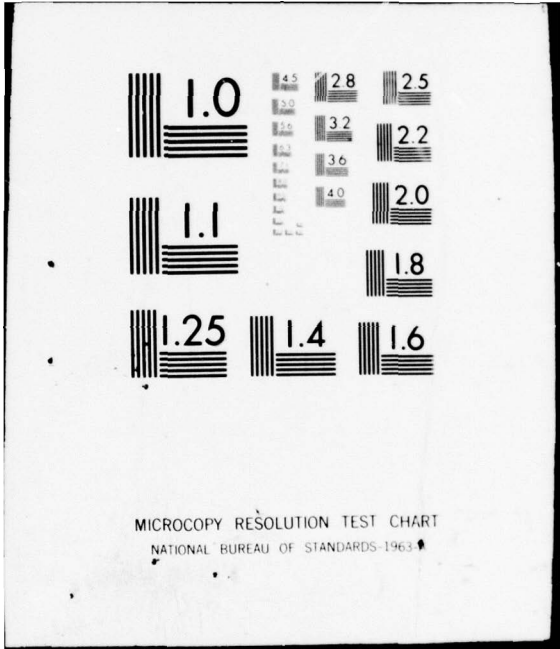
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Research and Development Technical Report
ECOM-4526

COMPUTER FAMILY ARCHITECTURE SELECTION COMMITTEE -
FINAL REPORT, VOLUME I-INTRODUCTION

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September 1977

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ECOM-4526	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Computer Family Architecture Selection Committee Final Report. Volume I - Introduction.	5. TYPE OF REPORT & PERIOD COVERED Research and development technical rept.	
7. AUTHOR(s) William E. /Burr, Aaron H. /Coleman William /Smith (NRL)	8. CONTRACT OR GRANT NUMBER(s)	
9. PERFORMING ORGANIZATION NAME AND ADDRESS Center For Tactical Computer Sciences (CENTACS) DRSEL-NL-BC Fort Monmouth, N.J. 07703	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 117 62701 AH92B109	17. B1
11. CONTROLLING OFFICE NAME AND ADDRESS	12. REPORT DATE Aug 77	13. NUMBER OF PAGES 20 Pages
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) CENTACS DRSEL-NL-BC Fort Monmouth, N.J. 07703	15. SECURITY CLASS. (of this report) Unclassified	
15a. DECLASSIFICATION/DOWNGRADING SCHEDULE		
16. DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribution unlimited.		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report) F		
18. SUPPLEMENTARY NOTES This report consists of a summary and nine (9) volumes. It is the result of joint Army/Navy work. The complete report maybe separately published by the Naval Research Laboratories.		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Military Computer Family (MCF), Computer Family Architecture (CFA)		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The Computer Family Architecture (CFA) Selection Committee was formed to evaluate computer architecture candidates for the purpose of selecting one as the basis for a family of software-compatible military computers. The military spends billions yearly for developing computer systems for tactical and strategic applications. The proliferation of incompatible computer instruction sets aggravates the problems of software development maintenance, documentation and training. A demonstrated approach to mitigating this problem is for		

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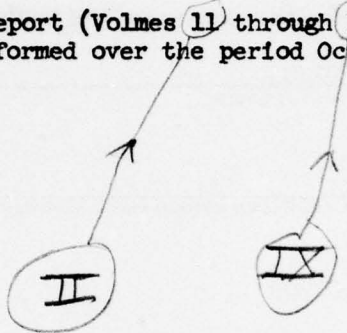
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20. the military to adopt a well-known, proven instruction-set architecture which can be implemented in advanced technologies as a family of software-compatible computers.

Important benefits of this approach include open competition among military computer vendors to build CFA computers using their own hardware production techniques and the availability of a large, mature set of software development tools and associated programmer expertise.

In pursuit of the CFA goals, a joint Army/Navy effort instituted to select a CFA and develop a Military Computer Family (MCF) using the CFA. An Army/Navy Selection Committee representing 10 Army and 17 Navy organizations was formed to evaluate and select architectures for the CFA.

The CFA Selection Committee Final Report (Volumes II through IX) describes the work of the Selection Committee performed over the period October 1975 through August 1976.



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TABLE OF CONTENTS

SECTION	PAGE
1. OBJECTIVE	1
2. COMPOSITION OF REPORT	2
a. Volume I - Introduction	2
b. Volume II - Selection of Candidate Architectures and Initial Screening	2
c. Volume III - Evaluation of Computer Architectures via Test Programs	2
d. Volume IV - Architecture Research Facility; ISP Description, Simulation, Data Collection	2
e. Volume V - Procedure for and Results of the Evaluation of the Software Bases of the Candidate Architectures for the Military Computer Family	2
f. Volume VI - Life Cycle Cost Analyses of the Computer Family, Architecture Candidates	2
g. Volume VII - CFA/Software Licensing Discussions with the Three CFA Finalists (For Official Use Only)	2
h. Volume VIII - CFA Finalists Selection	3
i. Volume IX - A Consideration of Issues in the Selection of a Computer Family Architecture	3
3. BACKGROUND	4
4. CFA APPROACH	6
a. Computer Industry Precedent	6
b. Alternative Levels of Standardization	7
c. HOL Standardization	7
d. Computer Hardware Standardization	8
e. Computer Architecture Standardization	8
f. Develop New Architecture	9
g. Use Existing Military Computer Architecture	10
h. Use Best Existing Military or Commercial Computer Architecture	10
5. ARMY/NAVY COMPUTER FAMILY ARCHITECTURE PROJECT	11
a. Multi-Service Development	11
b. Army/Navy Computer Family Architecture Selection Committee	12
c. Candidate MCF Architectures	15
d. Selection Committee Procedure	15
e. Selection Committee Chronology	15
f. Committee Meeting One	17
g. Committee Meeting Two	17
h. Committee Meeting Three	17
i. Committee Meeting Four	17
j. Committee Meeting Five	17
k. Selection Committee Structure	17

1. OBJECTIVE

The purpose of the Final Report of the Computer Family Architecture (CFA) Selection Committee is to make available the details of the considerable work accomplished by the Selection Committee during its evaluation of candidate architectures for the Army/Navy Military Computer Family.

This Selection Committee, representing 10 Army and 17 Navy organizations, was established by the Naval Research Laboratory and the Army Electronics Command as a part of a joint Army/Navy effort under the Navy's AADC Computer Family Architecture Project and the Army's Fourth Generation Military Computer Family Project. The Selection Committee was established for the purpose of evaluating candidate computer architectures and recommending one as the basis for a family of software-compatible military computers. To this end, the Committee worked from October 1975 through August 1976 and, during that time, held five full committee sessions lasting several days each and numerous other subcommittee sessions, leading to the results described in this report.

The object of this volume of the CFA Selection Committee Final Report is to describe the rationale and motivation behind the CFA effort and the organization and chronology of Selection Committee activity.

2. COMPOSITION OF REPORT

This report details the work of the Selection Committee in approximate chronological order. It is divided into nine volumes as described below. A summary volume is available which abstracts the entire report.

a Volume I - Introduction *A-049-468*

Volume I explains the background, rationale and organization of the Computer Family Architecture effort and the Selection Committee.

b Volume II - Selection of Candidate Architecture and Initial Screening *A-049-457*

Volume II describes the initial candidate selection, and discusses architectural issues pertinent to CFA evaluation. The evaluation criteria applied to the architectural candidates for preliminary screening are described in detail, and the results of that evaluation are discussed.

c Volume III - Evaluation of Computer Architectures via Test Programs *A-049-462*

Volume III discusses the development of the measures used to gauge architectural efficiency and describes the test programs selected for the evaluation. The method of specifying the test programs and the structure of the programming experiment to minimize programmer effects are also discussed.

d Volume IV - Architecture Research Facility: ISP Description, Simulation, Data Collection *A-049-483*

Volume IV discusses the use of the ISP machine architecture description language in describing the candidate architectures. It describes the ISP interpreter facility and its application to simulation of the candidates and in gathering the measurements discussed in Volume III.

e Volume V - Procedure for and Results of the Evaluation of the Software Bases of the Candidate Architectures for the Military Computer Family *A-049-464*

Volume V describes a menu of support software tools determined to be important to the development of military software. It discusses how a subset of those tools were selected as the necessary software base for the Military Computer Family and the results of a study to determine the availability and value of these tools.

f Volume VI - Life Cycle Cost Analyses of the Computer Family Architecture Candidates *A-049-487*

Volume VI describes the methodology used to compute and compare the life cycle costs of the CFA finalists and describes two life cycle models (top-down and bottom-up) and the results of applying the methodology to those two models.

g Volume VII - CFA/Software Licensing Discussions with the Three CFA Finalists (For Official Use Only)

Volume VII addresses the technical, financial, and legal issues arising out of discussions with the owner/manufacture of the candidate computer architectures and describes the outcome of these discussions.

h Volume VIII - CFA Final Selection

A-049-485

Volume VIII discusses the consideration by the Selection Committee of the results of the architecture evaluations described in Volumes II through VII of this report. The influences that the various results had on the final selection are described.

i Volume IX - A Consideration of Issues in the Selection of a Computer Family Architecture

A-049-486

Volume IX addresses questions and controversial issues regarding the CFA Selection process that arose from both within and without the Selection Committee during the course of the CFA effort.

3. BACKGROUND

Each new computer type added to the military complex brings its own unique requirements for system interfaces, logistics support, software development, maintenance, and training. Over a hundred computer types can be found in military systems, and many individual platforms such as aircraft and ships can be found with three, four, or more different computer types aboard. Heavy penalties are being paid in terms of exploding software development costs and high life cycle costs.

These costs are now several billion dollars annually and, relative to the computer industry at large, are buying inadequate returns in terms of military systems effectiveness and reliability.

The sources of proliferation are varied. There is lack of opportunity, lack of incentive, and lack of control which would promote unified software and hardware technology in military systems. Platform managers, under pressure to meet project cost constraints and schedules, must rely on the providence of a myriad of industrial firms, who, in turn, must contend with their own profit, performance and schedule problems. As a result, computers and software in military systems are invariably designed or chosen on the basis of local expediency rather than their impact on long range life-cycle costs. Little opportunity or incentive for choosing a standard is provided to these platform managers. Nor will an enforcement or control mechanism be truly effective until an attractive set of standards is available from which to choose.

Computer standardization of some form has always been proposed as a solution. But past standardization efforts in the military centered around hardware designs because the software issues were less apparent than the logistics of the hardware.

The Navy has been successful at utilizing standard hardware for computers (e.g. the UYK-7 and UYK-20) and providing some centralized acquisition and support management for fleet users. Other militarized computers have been used by the services (e.g. AN/UYK-19, AN/GYK-12, USQ-20, AP-101) in sufficient numbers and with enough support so as to effect a degree of defacto standardization.

Although past hardware standardization efforts have reduced hardware costs through packaging improvements and production/maintenance economies of scale, no similar economies of scale were pursued for the software associated with the above computers. That is, software that was already developed for one military computer could not be used when a newer computer model was brought out. So called "families" of compatible military computers were compatible in packaging characteristics only and required separate support and applications software developments. The military computer market provides little competitive inducement for commercial firms to invest in support software development for these computers. As a result, DoD pays over and over for development of computer systems that frequently fall short of expectations.

Computers that became technologically obsolete were belatedly observed to have large investments in software that could not be conveniently discarded and replaced along with a newer model computer. Indeed, production lines for old out-of-production military computers have had to be reopened at considerable expense in order to produce very costly exact copies of old obsolete-hardware machines because there was no other satisfactory way to duplicate the "software execution characteristics" of the originals.

However, in the last few years, managers in DoD have become painfully aware of the ever increasing investments in time and money that software development and maintenance are demanding. A concept is needed which will provide each platform manager with the computer that is right for his particular application and at the same time will provide him with a mature, complete, and well developed set of programming support tools (compilers, debugging aids, editors) and an established base of training and expertise to back it up.

4. CFA APPROACH

The need for standardization combined with the variety of application requirements warrant and justify a family of military computers. The instruction-set architecture of the computer (that which programmers need to know) would be standard, whereas environmental and performance parameters would be allowed to vary. Indeed, the feasibility of such an approach has been amply demonstrated by the success of the IBM System 360/370 and the DEC PDP-11 systems. The hardware implementation varies from model to model, providing a range of cost and performance. The architecture remains constant, allowing the development of a single common set of support software as opposed to the n sets necessary if the architecture were allowed to vary. Although the CFA models will vary along yet another axis, environment, the same basic approach (common architecture/varying hardware) is applicable and will be successful in combating unnecessary computer proliferation.

It is reasonable to inquire whether a similar approach will yield similar results in the weapon system environment. There is, indeed, sound reason to believe so, because the weapon system computer acquisition and life-cycle process, particularly in the software acquisition and maintenance phases, does not differ significantly from the commercial process (particularly in the original equipment manufacturer (OEM) market).

a Computer Industry Precedent

Any consideration of promulgating standards for military computer systems should begin with a recognition of the fact that the commercial computer industry is spending over one billion dollars annually for R&D as opposed to less than 100 million dollars per year in the armed services. This disparity is likely to increase in the future. Those developments and trends that have survived the test of the mainstream computing industry should receive serious attention as candidates for military standardization thrusts for two reasons:

- (1). Military dollars spent on adaptation of industry standards to military systems will return many-fold in capitalization on evolving commercial investments.
- (2). Adoption of mature and successful industry developments will minimize the risk of jumping into new or untried approaches.

The Army/Navy Computer Family Architecture Program is designed to take advantage of several proven computing industry trends:

- (3). A family of software-compatible computers in a variety of hardware and performance packages has been demonstrated to provide a cost effective means of serving a growing and evolving base of commercial consumer requirements while constraining support software development to the requirements of a single architecture.
- (4). The rapid growth of digital hardware technology has been largely responsible for the vast improvements in computer performance over the last two decades. This evolution in technology is expected to continue and to be the basis for continued decreases in processor price, size, weight and power, and increases in processor performance.

- (5) Microprogrammable processors in modern technology embodiments provide flexible and effective means of implementing single or multiple computer architectures. IBM, when it moved its mainstream support to the 360 family of computers, continued to support investments in existing 7090 and 1401 software through emulation of the older computers in micro-programmable 360 processors.

The Military Computer Family will limit variation in military computer systems where it can and should be limited - at the software interface between programmer and processor - and will allow diversity where it must be flexible - in the technology/performance areas - and, to this end, will capitalize on the best available industry developments. A family of software-compatible computers representing a wide variety of form, fit, and function capabilities will provide ample opportunity for platform managers to use the standard. An existing, tested, and widely-supported base of processors and support software will provide his incentive for choosing the standard. Enforcement of the standard will be viable because the standard will be an economically viable option.

b. Alternative Levels of Standardization

There are several possible approaches to lessening software costs through standardization. These are:

- (1) High Order Language (HOL) standardization only - no computer standardization.
- (2) Standardization on a single computer hardware design of advanced performance and environmental capabilities.
- (3) Standardization on a single computer architecture that is the basis for a software compatible-family of computers having a variety of performance and environmental capabilities. This standard architecture could be a new design or an existing commercial design.

HOL standardization may occur along with (b) or (c) but is not a prerequisite for (b) or (c).

c. HOL Standardization

Standardization at the HOL only means that all software would be written in certain approved high level languages (e.g. FORTRAN, JOVIAL, CMS-2, COBOL) but that no constraints would be placed upon the types of computers procured for military systems. Effectiveness of system development and support activities would depend upon having compatible compilers from each HOL to each machine instruction set and other appropriate support software associated with each computer type. Direct execution of intermediate or high level language is a possible alternative to multiple compilers and assemblers, but only if there is agreement on a precise description of the HOL.

A possible advantage of this approach is its minimal impact on the military computer vendor establishment and their investment in marketing an ever changing assortment of computers and software.

The disadvantages of standardization at the HOL only are:

- (1) The continued existence of multiple, support-software systems that aggravate software maintenance and logistics problems.
- (2) Incomplete software transportability between different computer types. Since certain HOL concepts are inherently machine-dependent, no truly machine-independent high level languages exist for applications and support software (e.g., compilers, operating systems). Parts of operating systems are by nature machine dependent because they must contain features to deal efficiently with the structure of a machine's architecture. Even applications programs written in what are frequently thought of as machine independent languages experience subtle machine dependencies (e.g., character manipulation, integer truncation, floating point precision and exponent scaling).
- (3) Direct execution of high order languages has been in R&D for a decade or more and has yet to become a proven mainstream development. The military should scarcely attempt to jump into an investment that the industry at large has not adopted.
- (4) The continued delivery of a variety of computer types into the military of necessity increases the variety and difficulty of hardware maintenance and logistics.

d. Computer Hardware Standardization

Some have held that a single computer hardware design incorporating advanced technology and architecture would be able to provide a standard for most computer system applications.

The advantage of this approach is that only one hardware design would have to be developed, manufactured and maintained.

There are a number of disadvantages:

- (1) A computer based on a specific hardware design will of necessity be relatively expensive, slow, large, heavy, or, in some other way, unsuitable for many applications as compared to other hardware designs, especially if the hardware must be built to meet all existing environmental requirements.
- (2) Today's advanced technology is tomorrow's out-of-production technology. Note the rapid turnover in digital device form, fit and function due to LSI technology.
- (3) A standard based on a hardware-level (gate, pin, card, etc.) design is very difficult or impossible to multiple-source due to differing manufacturing practices among vendors.

e. Computer Architecture Standardization

Standardization on a computer architecture controls the interface between the programmer and the computer.

By computer architecture we mean the abstract, functional description of a computer as would be seen by a machine-level programmer - that is, everything the

programmer needs to know to write programs that run on the computer. This view of the computer includes the instruction set, registers, interrupts, and memory address space. Architecture does not include hardware implementation features such as cycle time, instruction look-ahead, memory interleaving, bus width, or cache memory. Hardware design issues need not affect the software. More importantly, a clear and clean distinction between the architecture and implementation details allows software to be transported between computers with the same architecture, even though they may have very different implementation features.

By standardizing on architecture in this way, we have the option of choosing different hardware implementations according to the best technology that industry has to offer while maintaining a consistent and well known interface for software development and execution. With a single standard architecture, a program (whether written in HOL or assembly language) that runs, for example, on an avionic member of the computer family would also run on a different hardware (i.e. ground) version of that architecture, albeit faster or slower depending on electronic technology differences. In addition, the support software available for developing and testing programs for the avionic computer would be available for developing and testing programs for the ground computer.

The advantages of standardization on a family architecture are:

- a. Software transportability between members of the family is provided.
- b. One support software system can serve all members of the family. In addition, the software development computer itself can be a member of the family.
- c. Specification of the standard at the architecture level provides a tried and proven way of multiple-sourcing different hardware versions of the software-compatible computer.
- d. Family members can cover a wide range of applications (microprocessor to large support computer) through a variety of hardware technologies and design.
- e. Evolution and enhancement can be accommodated through technology improvements and architecture extensions.

There are three possibilities for obtaining an architecture on which to base a family of computers:

- a. Develop a new architecture.
- b. Use the architecture of an existing military computer.
- c. Choose the "best" architecture from among existing, proven military or commercial designs.
- f. Develop New Architecture

The military should not attempt to compete with the enormous thrust of the industrial mainstream in data processing developments. Designing a new computer architecture involves enormous capital investment, a long development cycle with little return on investment, and high technical risk.

Despite these obstacles, little is apt to be gained from developing a new computer architecture. Over the past decade or two the vast majority of increases in computer performance have come about through advances in technology and hardware design features and not through changes in computer architecture. The basic structure of general purpose data processor architecture has gone through no radical changes. Many so called advances in architecture (e.g., cache memory, instruction look ahead, and pipelining) are really advances in implementation techniques for increasing speed and do not affect the architecture or software interface. Such advances are architecture independent and can be incorporated into a computer without affecting software. Any architecture chosen for the computer family should be able to support future improvements in architecture capabilities through careful extensions to the basic instruction set, but only after such additions have been proven through test and experience. Jumping into new or radical architectures is a risk that the military should leave to the computer industry.

g. Use Existing Military Computer Architecture

Some would argue for choosing the architecture of an existing military computer as the basis for the Military Computer Family on the grounds that existing investments in that computer's software cannot be ignored. If it can be shown that the investment preserved by selecting a particular military computer architecture is greater than that which would be lost to users of a different military computer or greater than that which would be gained from the already available software base of an existing commercial computer, then the standard should be based on that military computer. It should be noted that military computer architectures are not unique, in that military data processing does not involve processor operations which are not common to data processing in general. In fact, many widely used military computers (e.g. AN/UYK-7, AN/GYK-12, AN/UYK-15, AN/UYK-19, AN/UYK-20 and the IBM "4 Pi" series) are military implementations of architectures related to prior commercial architectures.

If a military computer were chosen as the basis for a standard family, then the same problem would exist which would have to be faced if a commercial architecture were chosen - how to protect investments in software written for the military computers not selected as the standard. That is, choosing the AN/UYK-7 as standard would still leave open the status of investments in AN/GYK-12, AN/UYK-15, AN/UYK-19, and AN/UYK-20 software and the IBM 4PI series.

h. Use Best Existing Military or Commercial Computer Architecture

Opening the architecture selection process to all existing and proven computers, commercial and military, provides the best potential benefits with respect to all factors, including hardware and software. A selection process which considers commercial computers, will provide the widest potential benefits from computing industry mainstream developments. Be it military or commercial, a military computer family should be based on an architecture with the best proven track record. Given that the architecture of a commercial computer is selected, emulation of existing military computers will be provided in the advanced hardware of the MCF. Existing investments in military computer software will not be lost.

5. ARMY/NAVY COMPUTER FAMILY ARCHITECTURE PROJECT

The CFA goal is standardization on the best available, proven, and cost effective computer architecture as the basis for a family of software-compatible military computers.

In pursuit of this goal, a Memorandum of Agreement (MOA) was signed by Capt. H. B. McCaulley, (AIR-03) Naval Air Systems Command, and Col. D. L. Lasher, Commander, Communication ADP Lab, Army Electronics Systems Command in March 1975. This MOA formed the basis for a cooperative development of a Military Computer Family through the joint efforts of the Navy's AADC Computer Family Architecture Project and the Army's Fourth Generation Military Computer Family Project.

This effort is designed to provide military system developers with an available, qualified family of computers and associated systems and support software with the following salient characteristics:

- a. Range of Application. A high level of cost-effectiveness for a wide range of military computer based-systems.
- b. Life Cycle Cost. A significant reduction in life-cycle cost. The cost savings should be sufficient to justify the investment on a business-like basis; i.e., the return on investment should be attractive.
- c. Know-how. Availability of a broad base of programming knowledge and expertise both in the industry and military establishments.
- d. Software Reliability. Significant improvement in software reliability.
- e. Software Capture. Provisions for capture of existing military computer applications software without degradation of mission performance and with little or no reprogramming.
- f. Size, Weight and Power. Significant reduction in hardware size, weight and power through application of modern computer technology.
- g. Alternate Suppliers. Availability of multiple alternate suppliers for each computer family member or major subsystem so as to ensure reliable sources at reasonable cost via competition.
- h. Technology Independence. Maximum independence from hardware technology so that the government can benefit from technology advances with a minimum cost.

The state-of-the-art computer hardware and software technology will permit the achievement of these goals with a reasonable investment.

a. Multi-Service Development

The Army and Navy have joined together in a cooperative, coordinated development of the MCF. The advantages of this approach in maximizing government know-how, minimizing R&D investment and recurring cost and optimizing industry support are readily apparent.

b. Army/Navy Computer Family Architecture Selection Committee

Representatives of a number of Army and Navy R&D organizations were assembled for the purpose of specifying, evaluating and selecting a computer architecture as the basis for the MCF.

The objective of the MCF is to serve effectively as wide a range of military applications as possible. It was therefore appropriate and necessary to bring into the architecture selection process as broad and expert a knowledge of the requirements on computers in military systems as could be obtained in the military establishment. Moreover, the combined knowledge of a number of capable representatives served to submerge the effects of individual judgments and to strengthen the validity of the CFA recommendation.

To this end, letters were sent to various Army and Navy laboratories, project managers, and other organizations in early 1975 requesting those organizations to propose computer architectures that would be suitable as candidates for the MCF and to nominate representatives to the CFA Selection Committee. The Selection Committee convened for the first time at the Naval Research Laboratory in October 1975. Table 5-1 shows the Committee membership.

TABLE 5-1

ARMY/NAVY CFA COMMITTEE MEMBERSHIPARMY MEMBERS

<u>Organization</u>	<u>Primary</u>	<u>Alternate</u>
U. S. Army Electronics Command	D. Hadden/E. Lieblein	J. Mercurio
Project Manager, Army Tactical Data Systems	A. R. DeNezzo	1LT R. Atkinson
Project Manager, Navigation/Control Systems	2LT N. Herndon	
Satellite Communication Agency	R. Perle	J. Perrone
Project Manager, Patriot Missile System	CPT R. Sabin	R. Flights
U. S. Army Computer Systems Command	MAJ B. Blood	
U. S. Army Aviation Systems Command	W. Klees	
U. S. Army Missile Command	D. Wise	
ECOM Avionics Laboratory	H. R. Chambers	
PMO MSCS Ft. Monmouth, N. J. 07703 AMCPM-MSCS-TM-F	A. Buray	

NAVY MEMBERS

<u>Organization</u>	<u>Primary</u>	<u>Alternate</u>
Naval Underwater Systems Center Newport	T. Conrad	D. Watson
Fleet Combat Direction Systems Support Activity	R. G. Estell	
Naval Post Graduate School	LT B. E. Allen/ G. L. Barksdale	
Naval Avionics Facility, Indianapolis	Dr. J. Chaney	C. Eckert
Naval Air Development Center	C. Mattes	C. Joeckel
Fleet Combat Direction Systems Support Activity, Dam Neck	J. D. Warner	C. D. Upshur

Naval Surface Weapons Center, Dahlgren	W. L. McCoy	E. W. Nichols
Naval Air Test Center	J. P. Sharatz	G. S. Ryan
Pacific Missile Test Center, Pt. Mugu	M. Stevens/ P. L. Miller	R. Lindsey
Naval Undersea Center	J. K. Fogerty	T. L. Cloer
Naval Electronics Laboratory Center	N. L. Tinkelpaugh	
Naval Ship Research & Development Center	L. M. Culpepper	C. M. Chernick
Naval Underwater Systems Center, New London	A. Clearwaters	H. Watt
Naval Surface Weapons Center, White Oak	Dr. L. Haynes	
Naval Training Equipment Center	C. F. Summer	L. Healy
Naval Sea Systems Command	W. H. Hill	
Naval Research Laboratory	S. Fuller	

c. Candidate MCF Architectures

The Selection Committee formulated a list of candidate architectures based on proposals from the member organizations. The architectures evaluated by the Committee are:

Interdata 8/32
IBM S370
AN/GYK-12 (Litton)
AN/UYK-7 (Univac)
AN/UYK-20 (Univac)
Burroughs 6700
DEC PDP-11/45
AN/UYK-28 (ROLM)
SEL 32

d. Selection Committee Procedure

Volumes II through VIII describe the CFA selection process in detail. A salient aspect of this selection process was the emphasis placed by the Selection Committee on establishing evaluation criteria and selection techniques based on objective technical requirements rather than on subjective feelings or instinct.

The intent and the outcome of this approach was to build a fully auditable and verified trail of data and decisions leading to the CFA Selection.

In pursuit of this approach, all issues and data used by the Committee in examining the architectures were subject to scrutiny and approval by the Committee as a whole. All decisions and results were accepted or rejected by a mandatory two-thirds majority vote, where each represented organization exercised one vote.

The Committee was a working committee. Essentially all of the technical evaluations, development of criteria and test methodologies, and generation of reports were performed by members of the Committee. Subcommittees representing nearly all of the Committee membership were responsible for the results contained in this report.

Figure 5-1 illustrates the evaluation process employed by the Selection Committee in arriving at its recommendation. Volume numbers next to the boxes indicate the volumes of this report describing these aspects of the selection process.

e. Selection Committee Chronology

The CFA Selection Committee convened five times between October 1975 and August 1976.

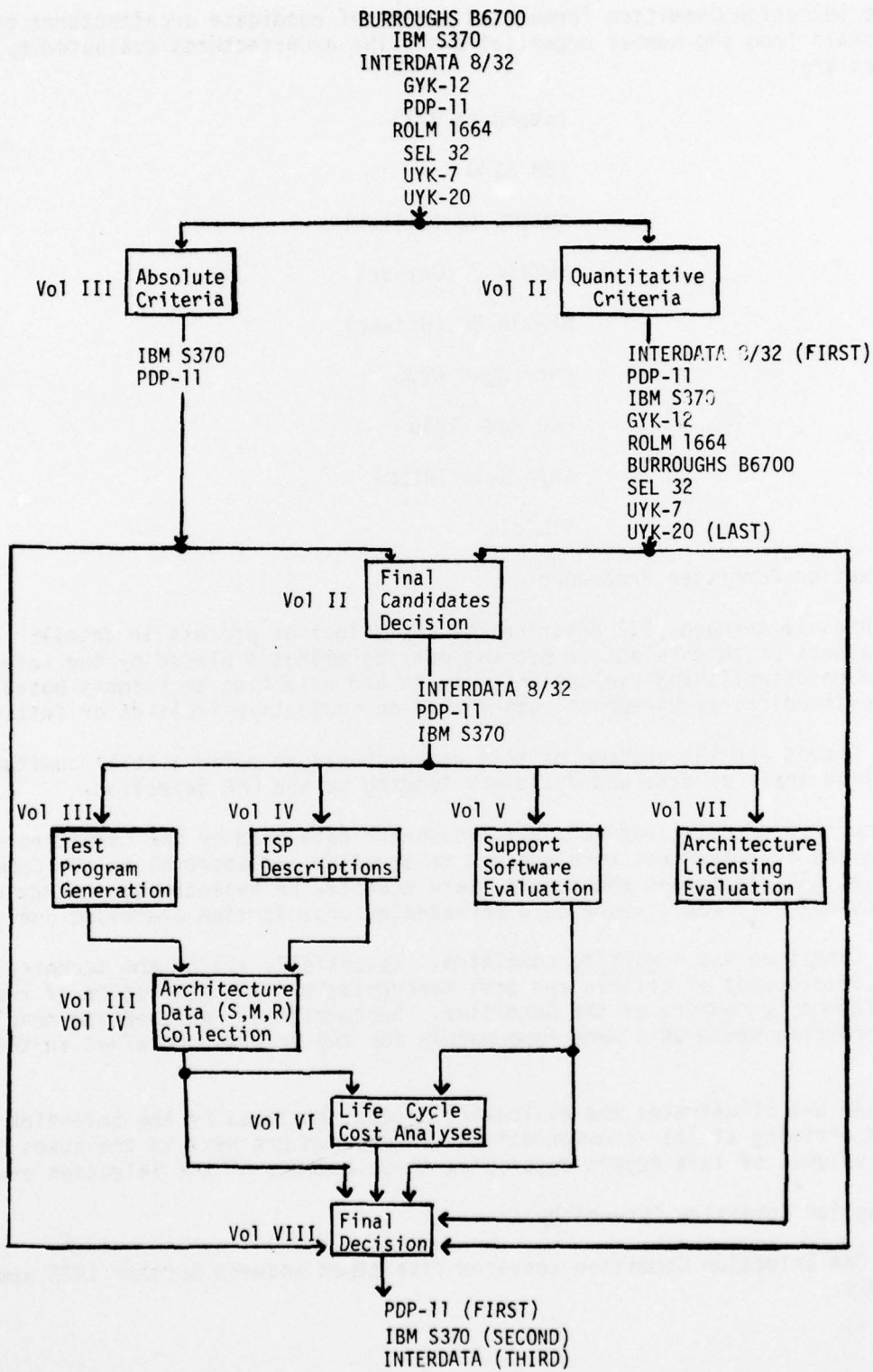


Figure 5-1. Selection Committee Procedure

f. Committee Meeting One

The Committee convened for the first time on October 1 and 2, 1975, at NRL, Washington, D. C. The background and goals of the CFA project were presented to the Committee representatives as well as initial considerations for computer architecture evaluation. Subcommittees were established to gather data on the candidate architectures and to formulate architecture evaluation criteria.

An initial list of architecture candidates was considered and approved by the Committee.

g. Committee Meeting Two

The second Committee meeting took place on December 3 and 4 at USAECOM, Ft. Monmouth, N. J. The Committee considered, revised, and approved architecture evaluation criteria formulated and proposed by a working subcommittee. These criteria were to be used by the candidate architecture subcommittees to gather data on those architectures. Also, the Committee representatives were to weigh the evaluation criteria for the purpose of applying those criteria to ranking of the architecture candidates.

h. Committee Meeting Three

The third Committee meeting took place on February 17-20, 1976 at NAVPGSCOL, Monterey, California, and was devoted to reviewing and applying the results of the architecture evaluation criteria. Quantitative scores compiled for each architecture and "absolute criteria" evaluations were used to select architecture finalists for more intensive evaluation. Subcommittees were then established to carry out these final evaluation phases. These phases included test program, support software, life-cycle cost, and licensing/royalty cost evaluations.

i. Committee Meeting Four

The fourth Committee meeting which occurred on April 28 and 29, 1976 at NRL, Washington, D. C., reviewed the results of the final candidates selection. One of the finalists was eliminated as a result. Preliminary reports of the finalists evaluation subcommittees were reviewed and approved.

j. Committee Meeting Five

The fifth and final Committee meeting took place on 24-26 August, 1976 at NUSC, Newport, R. I. At this meeting, the Committee considered and reviewed the results of all architecture evaluation work performed since the first meeting. As a result of these considerations, the Committee voted and made its final recommendations for the CFA. Committee members were organized to participate in the writing of this CFA Selection Committee Final Report.

k. Selection Committee Structure

The Offices and Subcommittees instrumental in carrying out the work of the Selection Committee are shown in Table 5-2.

TABLE 5-2

ARMY/NAVY CFA SELECTION COMMITTEE OFFICES AND SUBCOMMITTEES

<u>Chairman</u>	Aaron Coleman, USAECOM
<u>Vice-Chairman</u>	William Smith, NRL
<u>Secretary</u>	William Burr, USAECOM

Interdata 8/32 Subcommittee

Bill Burr - USAECOM (Chairman)
 Mark Stephens - PMTC
 Linwood Culpepper - NSRDC
 Forrest Summer - NTEC

IBM S370 Subcommittee

Al Clearwaters - NUSC, New London (Chairman)
 CPT Paul Sabin - PM, Patriot
 2LT Nancy Herdon - PM, NAVCOM

Burroughs B-6700 Subcommittee

Dave Hadden - USAECOM (Chairman)
 Bob Perle - SATCOMA
 Bob Estell - FCDSSA, San Diego (replaced D. Hadden as Chairman)

DEC PDP-11 Subcommittee

Dan Siewiorek - NRL/CMU (Chairman)
 Jack Chaney - NAFI
 LT Bill Allen - NPGS
 MAJ Ben Blood - USACSCS

NOVA/ROLM Subcommittee

Len Haynes - NSWC (Chairman)
 Tom Conrad - NUSC
 1LT R. Atkinson - PM, ARTADS

AN/UYK-20 Subcommittee

John Sharatz - NATC (Chairman)

AN/UYK-7 Subcommittee

Henry Hill - NAVSEA (Chairman)

AN/GYK-12 Subcommittee

Norman Taupeka - PM, ARTADS

SEL-32 Subcommittee

W. L. McCoy - NSWC, Dahlgren

Test Programs Subcommittee

Bill Burr - USAECOM (Chairman)
 LT Bill Allen - NPGS
 Mark Stephens - PMTC
 W. L. McCoy - NSWC, Dahlgren
 Forrest Summer - NTEC

Selection Criteria Subcommittee

Sam Fuller - NRL/CMU (Chairman)
Len Haynes - NSWC, White Oak
Doug Wise - USA MICOM
Bob Estell - FCDSSA, San Diego
Norm Tinkelpaugh - NELC

Subsetability Subcommittee

Harold Stone - ECOM/U. Mass. (Chairman)
Bill Burr - USAECOM
Dan Siewiorek - NRL/CMU
Al Clearwaters - NUSC, New London
Dave Hadden - USAECOM

Final CFA Selection Methodology Subcommittee

Bill Smith - NRL (Chairman)
Bob Estell - FCDSSA, San Diego
CPT Paul Sabin - PM, Patriot

CFA/Architecture Licensing Evaluation Subcommittee

A. H. Coleman - USAECOM (Chairman)
Y. S. Wu - NRL
Bill Smith - NRL
LTC A. Salisbury - USAECOM
Sam Levine - USAECOM

Software Evaluation Methodology Subcommittee

Ed Lieblein - USAECOM (Chairman)
Al Clearwaters - NUSC, New London
LT Bill Allen - NPGS
John Sharatz - NATC
MAJ Ben Blood - USACSCS
Norman Taupeka - PM, ARTADS
Jim Wagner - USAECOM

Architecture Test Subcommittee

Sam Fuller - NRL/CMU (Chairman)
Len Haynes - NSWC, White Oak
W. L. McCoy - NSWC, Dahlgren
Bill Burr - USAECOM
Lynn A. DeNoia - NUSC, New London
Dave Parnas - NRL/Darmstadt

Auditor for Quantitative and Qualitative Criteria Evaluation

Harold Stone - ECOM/U. Mass.