Proceedings

American Defense Preparedness Association

AMERICAN DEFENSE PREPAREDNESS ASSOCIATION

U.S.

Milcom III

Military Computers And Software

25-26 January, 1984
Washington, D.C.

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FOREWORD

INTRODUCTION

MILCOM I (January 1982) and MILCOM II (January 1983) were the first two seminars of a series sponsored by American Defense Preparedness Association to provide a forum on policy level issues concerning military computers and software. The issues of policy problems in doctrine and/or implementation, military threat to the United States, computer and software contribution to United States capability and readiness, economic threat from technological advances in computers and software by United States allies and measure to retain the United States position have all been presented and discussed. Perspectives of Congress, both Senate and House of Representatives, views of The Department of Defense, a broad spectrum of industry position on these issues and relations of this sector of the computer and software community to academia have been presented in depth but not yet exhausted.

The topic areas of industry drivers in the commercial and military marketplaces, program management, computer resources acquisition and management by DOD, distinctions between the commercial and military communities such as short and long life cycles, standardization practices and maintenance support, the pros and cons of software and hardware standardization, the role of competition and the technical areas of logisitics, automatic testing, evolutionary development, technology insertion and its relation to program implementation, have all been treated in varying depth in MILCOM I and II.

MILCOM III represented a continuation of the forum on military computers and software with emphasis on the theme: "Military Computers and Software: Systems Problems of the Future." In the introduction to this theme, the Conference Chairman, Mr. Alfred W. Hobelmann of Perkin Elmer Corporation stressed particularly the goals of improved partnership between Congress, DOD, Industry and Academia and of improved dialogue, both as a necessary ingredient to an improved partnership and as a source of problem identification and solution in meeting national technological, military and economic threats. He cited the recent remarks of Mr. Frank Press, President of the National Academy of Sciences (The Doughnut Effect) in this regard which stressed dealing with the problem of coordinating many activities and agencies and evaluating their impacts on national innovation.

Mr. Anthony Battista, Professional Staff Member, House Armed Services Committee, provided a comprehensive and penetrating overview and forecast of the Congressional appreciation of the computer and software situation and probable actions concerning it in the near term.

An industry perspective on the computer and software situation and its important driving forces was ably presented at dinner the first evening by Mr. Robert Miller, Senior Vice President, Data General Corporation.

This report condenses the attempt of the symposium to reflect issues, to identify interrelationships, suggest ways by which the computer and software community partnership can be strengthened and to point to ways solutions to problems in this area can be defined and articulated. The tape recording and some transcript material will be retained by the American Defense Preparedness Association.

SUMMARY

MILCOM III keynote "Directions in mission-critical computers and software", delivered by Dr. Edith Martin, was a comprehensive and current expression of problems and plans in the area of military computers and software and their technologies. It is, therefore, provided in virtually complete form. Problems facing the Services in the future included computer and software aspects of the Air Force Space Command, the Navy effort in increasing competition, the Navy Battle Group, and Army Field Command, Control and Communications. The problems are formidable and of scope to tax the evolving technology. The emerging technologies in the areas of software, micro elements, and supercomputers provided an excellent overview and projection of the state of the art in these areas. The Evolving Partnership was provided by speakers who gave incisive discussion of the partnership problem and a complete discussion of the cooperative effort of the micro-electronics industry to meet the technological and economic challenges from abroad. The tone of the discussion was set by Dr. Lyon who made the points of underuse of technology in the U.S. and whether or not we are bringing our tremendous technology heritage and current thrust to our national security interest. The differences between the U.S. and the U.S.S.R. in micro-electronic technology for defense, our commercial computer and microelectronic industry which they do not have and the need to provide leadership as well as management were emphasized.

Throughout MILCOM III there was a much improved climate, in comparison to MILCOM I and to a less extent MILCOM II, in the matter of reduced contentious debate and more earnest effort to define problems and address their solutions. The appreciation of the need for a Congress-DOD-Industry-Academia partnership, and how to make further progress toward it, threaded through MILCOM III.

There were a number of statements endorsing the continuation of the MILCOM series of seminars. Suggestions and recommendations from the floor and panel of topics to be included in MILCOM IV included

---If technology is being driven by forces out of DOD and industry control we need to learn how to use it, emphasize system-level management, new technology and technology insertion as possible solutions.

---Emphasize the management and insertion of technology, budget cycles and the management and configuration control of software

(at the policy level).

---A complete analysis and discussion of the "billion lines of code" problem.

---Solicitation from the community for additional topics for MILCOM IV.

A statement from the floor indicated that there is a Congressional rule against joint DOD-industry working groups. In attempting to provide an industry counterpart to the OSD/DOD Computer Systems Interface Working Group, announced in the keynote address, it was recommended that since the ADPA-MILCOM committee is not a professional society it be considered as the industry part of CSWIG and that congressional approval be obtained for it.

The assistance and support of ADA in the conduct of the MILCOM series of seminars was recognized by the Chairman.

KEYNOTE ADDRESS
DIRECTIONS IN MISSION-CRITICAL
COMPUTERS AND SOFTWARE

Dr. Edith W. Martin Deputy Undersecretary
of Defense for Research and Advanced Technology

DIRECTIONS IN MISSION-CRITICAL COMPUTERS AND SOFTWARE

- **WHERE WE ARE TODAY**
- **WHERE WE ARE GOING TOMORROW**

At this third participation in the MILCOM series, it seems important to see where we stand in the mission-critical resources area, where we are going, what we are promising, where we are heading tomorrow, and what we want to be able to say we have done in the years to come. There is no question that computers and software are critical components of our defense strategy. The tremendous growth in their capabilities has enabled us to implement functions in military systems that only a few years earlier were either infeasable or just unaffordable. We now have the single chip CPUs and are heading toward the single chip microcomputer. We have software measured in millions of lines and, at this point, some of it is starting to act rather intelligent. Technology seeks opportunities and rapidly finds them. That sounds like a wonderful story and if it were not true it would be difficult believing it could happen. But Babbage, Turing and Von Neumann would truly be astounded at what has happened with their ideas. Perhaps not Ada. Yet here we are with the theme of problems of the future. Why problems? We are growing too fast and at different rates, and we haven't quite figured out how to deal with it - the adolescence, you might say, because it means we are increasing the use of computers for better software than hardware. Software complexity is growing exponentially too and that is unacceptable. Software to which is entrusted much of the responsibility for correct system performance may just be a disaster that is waiting to happen. There are many who anticipate that and are trying to make measures to prevent it. How do we deal with yesterday's hardware products? They were the rage and now they are not made anymore. That was only two years ago and we still have them in our systems. The same is true for yesterday's standards.

OSD has just completed a study that supplements the report on computer technology it submitted to Congress last September. T study addresses the topics listed here.

KEY TOPICS

- SOFTWARE INITIATIVES
- MICROPROCESSOR POLICY
- MANAGEMENT OF COMPUTER SYSTEM INTERFACES
- EVOLUTION OF CURRENT COMPUTER PROGRAMS
- NEXT GENERATION MILITARY COMPUTERS

An overview of this work will be presented because it involves some very important new directions.

Comprehension of software problems is widely shared so software problems will not be discussed.

SOFTWARE INITIATIVES

- THREE-PRONG SOLUTION TO THE SOFTWARE CRISIS
  - Ada®
  - STARS
  - SOFTWARE ENGINEERING INSTITUTE (SEI)

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The status, plans and policy with respect to Ada, STARS and the Software Engineering Institute (SEI) will be discussed because there are some new things OSD has done with which the community should be familiar.

Ada®

- U.S. STANDARDIZATION
- INTERNATIONAL STANDARDIZATION
- FREE-WORLD DEVELOPMENTS
- DoD Ada® POLICY
- COMPILER VALIDATION FACILITIES
- DoD-SPONSORED Ada® SYSTEMS

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On February 17, 1983, Ada became an ANSI Standard. OSD/DOD is now participating in international standardization activities and we expect to have an ISO standard in 1985. That is extremely important for the Defense Department because it is the first step in the direction of system interoperability. OSD responsible officials are very pleased with the progress of Ada. There are now over forty developments of Ada compilers in the free world. These are sponsored by government, by industry and by academia. OSD/DOD intends to capitalize on these (developments) and accelerate the use of Ada. On June, 10, 1983 OSD issued a policy that mandates the use of Ada in all mission-critical systems that start Advance Development in 1984 - that is now - and they start Full Scale Engineering Development after July 1, 1984. There has been a lot of questions on whether or not OSD is serious about those dates and you can be assured OSD is (serious about them). All Ada compilers are required to comply with MILSTD 1815. To date, three systems have been validated. Validations have been conducted at the Insitute for Defense Analysis (IDA) thus far, and, in the near future validations will be conducted by th language Control Facility at Wright-Patterson Air Force Base and by the GSA Federal Software Testing Center here in Washington. So OSD/DOD is gearing up for the rest of those forty development activities. DOD has been sponsoring Ada activities for some specific military computers - SOFTECH Ada Language System (ALS), support of Ada for the Army's Military Computer Family the UYK-41 and 40 as well as the Navy's UKY-43 and 44. Right now a TELESOFT Ada System will be used early on for SUBACS. It will target to the MOTOROLA 68,000 and subsequently to the UYK-44 computer. INTERMETRICS Ada Integrated Environment (AIE) for the Air Force will target initially to the IBM 370: Also the Air Force will shortly have an Ada effort underway for MILSTD 1750 computer.

Ada® (CONTINUED)

- COMMON APSE* INTERFACE SET—"CAIS"
- LONG-RANGE POLICY ON APSE's
- INTERIM POLICY ON APSE's
- EVALUATION OF APSE's
- Ada® TRANSPORTABILITY HANDBOOK
- 30 SYSTEMS COMMITTED TO USE Ada®

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* Ada® PROGRAMMING SUPPORT ENVIRONMENT

The Department (of Defense) has been working jointly with Industry to develop some interface standards for Ada Programming Support Environments (APSE) and this is called "CAIS". These standards will facilitate the transportability of software tools across APSEs produced by different companies. CAIS is now under public review and we expect to have a very solid standard by the end of this year. When the CAIS Standard is established and the APSEs are modified to accommodate it, there will be a great deal of flexibility in the choice of Ada environments that would be used. OSD/DOD expects rapid technological growth in this area.

The CAIS will allow each company to use the APSE of its choice. Most important for OSD/DOD is that they use a "rich" environment. This is a good example of where standardization at the right level can accelerate rather than impede the use of new technology. OSD policy is to support this approach so long as steps are taken to permit the Government to transition over to another Ada environment when required at any point in the system life cycle. Conformance to the CAIS Interface Standards is extremely important to all (in the community).

Until the CAIS is implemented, our interim policy is to allow the use of company-owned environments where the government will benefit and where the means are provided for a transition to the government environment - OSD does not mean government owned by one that meets government standards.

OSD/DOD also has an effort underway to evaluate the capabilities and performance of various APSEs.

With CAIS taking care of the transportability of Ada-oriented software tools across different environments, let us turn to transportability of applications software across military computers with different ISAs. To address this problem we will be developing an Ada Transportability Handbook. It will contain rules to be followed in the use of Ada that will enhance the potential for transportability. The first version of that handbook should be available by the end of this year (1984).

Ada will have a tremendously favorable impact on the implementation and coding phase of software development and throughout the evolutionary life cycle of software. However, with software providing an increasingly higher percentage of functionality in a modern weapon system, and with software costs continuing to skyrocket, there are some opportunities to reap greater benefits.

Let us turn to the software activities other than coding - software requirements definition, architectural design, detailed design, integration and testing. They are largely manual and extremely labor intensive activities. They are only rarely supported by automated labor reducing and error reducing aids. Our new STARS program addresses that opportunity.

STARS

- OPPORTUNITIES BEYOND Ada®
- ORDERS-OF-MAGNITUDE INCREASES IN SOFTWARE PRODUCTIVITY
- ORDERS-OF-MAGNITUDE DECREASES IN LATENT DEFECTS
- FOCUS: THE AUTOMATED SOFTWARE "FACTORY" CONCEPT
  - COMPUTERIZED SOFTWARE TOOLS
  - REUSABLE SOFTWARE PARTS (BUILDING BLOCKS)

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FY 84 is STARS first year and we are pleased to say that we do have a new program this year. The goal is orders of magnitude increase in software productivity and a comparable reduction in the number of software defects that are latent in our weapon systems. STARS will focus on the automated software factory concept - a coherent and integrated system of computerized software tools and re-usable software parts or building blocks.

STARS (CONTINUED)

- ALL DIMENSIONS OF SOFTWARE WILL BE ADDRESSED
  - TECHNICAL (SOFTWARE ENGINEERING)
  - ACQUISITION
  - PROJECT MANAGEMENT
- NEW START FOR FY 1984
- JOINT PROGRAM OFFICE NOW OPERATIONAL
- DETAILED IMPLEMENTATION PLAN BEING FINALIZED

All of the dimensions of software activities will be addressed including technical, project management and software acquisition issues. STARS will also build on useable libraries or modules applicable across a wide range of functional areas such as navigation, intelligence and communications. The versions of the automated software factory will be used throughout the Services, the Defense Agencies and hopefully through Industry. STARS addresses Defense needs which are pushing the software capability of the Nation beyond its present limits. It also provides a much needed national focus to retain our world leadership in this critical technology - a leadership that is now seriously threatened by at least four projects outside of the U.S. One may disagree with Frank Press in this regard. The challenge is real and we would be fooling ourselves if we feel that we do not have tremendous competition. We do, and the time to address that competition is right now. The time we have available to solve the problem is three years. We can solve the problem in three years or resign ourselves to be second or third. The problem is real; the challenge is great; the opportunities are great. If we want to take advantage of the opportunities we had better get busy. (Top management) cannot sit around board rooms heming and hawing and deliberating what is going to be done next year. They should think about what they are going to do this year. Each of the (competitive) efforts that is underway right now is in some ways more mature than our own. We did a fine job of enunciating the software problem, we have had a lot of dialogue in discussing the software problem, we have outlined a program but there are others who are begining to address the issues. They have contracts in place and efforts in place and whereas they may not be quite as broad as ours, they are making inroads in various aspects of the problem. It behooves us to take heed. In the case of the Japanese, they have the first approximation, at least, of the end result of our STARS program. The reason for saying that is to let the community know that what OSD is proposing here in not "blue sky" and that the competition is not miles behind. It is at our sides and unless we are serious about it we should be prepared to lose.

The third segment of our software initiative is the Software Engineering Institute (SEI).

SOFTWARE ENGINEERING INSTITUTE (SEI)

- RAPID ADVANCES IN TECHNOLOGY ARE NOT CROSSING BRIDGE INTO PRACTICE
- JOINT TASK FORCE AND BLUE-RIBBON PANEL RECOMMENDATIONS
- MISSION: ACCELERATE THE TRANSITION OF EMERGING SOFTWARE TECHNOLOGY INTO USE ON MISSION-CRITICAL SYSTEMS
- NOT A RESEARCH OR TEACHING INSTITUTE

Software technology has been advancing very rapidly. A broad technical foundation for software engineering exists and continues to grow. That is all well and good. However, for a variety of reasons, most of the new technology has not crossed the bridge into widespread practice. There is very uneven use of good tools and good concepts. There are many research results and feasibility studies that are sitting on the shelf or being used by others rather than ourselves.

This situation was first addressed in early 1983 by a task force which proposed the creation of a Software Engineering Institute to tackle the problem of technology transition in the software area. This past summer (1983) OSD had the matter studied by an industry and academia panel under the auspices of IDA and they recommended very strongly that we move very, very quickly to establish the SEI.

The SEI will not be a research or teaching institute but an organization of world class software experts dedicated to accelerating the transition or the emergence of software technology into use in our defense systems. The primary mechanism for this acceleration will be automated software and the use of the "software factory" concept.

SOFTWARE ENGINEERING INSTITUTE (SEI) (CONTINUED)

- NEW PROGRAM ELEMENT IN FY 1985 BUDGET
- PLAN TO ESTABLISH NEW FCRC (E.G., LINCOLN LAB., MITRE, AEROSPACE)
- FORMAL ASSOCIATION WITH LEADING UNIVERSITY IN THE FIELD
- SELECTION PROCESS ABOUT TO START
- SELECTION PLANNED FOR SPRING 1984

The SEI is now in the FY 1985 Budget. That, in itself, is an accomplishment. Our plan is to establish a new FCRC along the lines of MIT's Lincoln Laboratory, Mitre Corporation or Aerospace Corporation. OSD will require that the SEI be linked with one of the top universities in the field. Initially, that will probably be a central focus. It is intended that in the future there will be centers of excellence that serve in a satellite fashion in coordination with that central SEI. OSD final planning for the SEI will be completed by the end of this month (January 1984) and we will shortly start the selection part of encouraging applications from interested parties. It is planned to announce the location of the SEI in the spring (1984).

MICROPROCESSOR POLICY

- ADDRESSES LOW-END OF COMPUTING SPECTRUM
- DISTINCTION BETWEEN SINGLE-CHIP MICROS AND STAND-ALONE COMPUTERS
- BASIS FOR POLICY
  - COMPETING SUPPLIERS FOR EACH CHIP
  - ATTRACTIVE PRICES DUE TO VERY HIGH PRODUCTION VOLUME
  - LOGISTICS COMMONALITY NOT AN ISSUE
  - LESS "SOFTWARE INTENSE"

Turning to hardware, there has been much confusion about the use of microprocessors vis-a-vis standard computers. Micros have all kinds of different instruction sets. Should waivers be granted for their use? The area, up until this point, has received benign neglect. Designers and managers were never sure if they eventually were going to get their wrist slapped for using them. OSD developed a policy of this area and it is contained in the OSD study report. This policy recognizes the important differences between the micro class where the CPUs on a chip or complementary chip sets all of which can be deeply embedded in the system almost to the point one hardly knows that it is there. The more powerful stand-along computer is in its self contained chassis - a part of the difference is physical. There are other important differences. First, we find competing suppliers for each chip. Second, prices are extremely attractive due to their high production volume. Third, the usual placement of micro chip sets on circuit boards that tend to be system-unique does not permit intersystem logistics commonality that we might have with stand-alone computers. Fourth, in comparison with stand alone high capacity computers, micro applications do not tend to be as software intense. This last point relates to the instruction set issue.

MICROPROCESSOR POLICY (CONTINUED)

- THE DEPARTMENT ENCOURAGES THE USE OF COMMERCIALLY AVAILABLE MICROPROCESSORS THAT MEET THE FOLLOWING REQUIREMENTS:
  - Ada* CAPABILITY MUST EXIST
  - LIFE-CYCLE COST EFFECTIVENESS
  - QUALIFICATION TO FUNCTION IN MILITARY ENVIRONMENT
  - MULTIPLE COMPETING SUPPLIERS FOR EACH CHIP
  - (LONG TERM) COMPLIANCE WITH INTERFACES ESTABLISHED THROUGH EFFORTS OF GOVERNMENT/INDUSTRY WORKING GROUPS

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Based on that distinction, OSD policy will be to encourage the use of commercially available micros where it makes sense from a systems engineering view point to use them. OSD requires, however, that several conditions be met. First, they must be programmed in Ada. Second, they must be cost effective over the life cycle. We do not want obsolete micros, and special runs just for DOD. Third, they must be suitable for use in the military environment to be encountered in operational use. That may mean that they do not need all of the MILSPEC requirements, but a sub-set. Fourth, multiple competing suppliers must exist for each chip. For the long term, micros used in defense systems have to comply with the interfaces that will be established through the efforts of government and industry working groups.

MANAGEMENT OF MISSION-CONTROL COMPUTER SYSTEM INTERFACES

- THE COMPUTER IS NOT JUST ANOTHER SUBSYSTEM BUT PROVIDES THE BASIS FOR INTEGRATION OF ESSENTIALLY ALL OTHER SUBSYSTEMS
- UNCONTROLLED PROLIFERATION OF INTERFACES TO COMPUTER SYSTEMS IS AN IMPEDIMENT TO THE INTEGRATION FUNCTION AND UNNECESSARILY COMPLICATES SYSTEM DEVELOPMENT AND EVOLUTION
- DoD MUST MANAGE THOSE INTERFACES THAT ARE IMPORTANT TO THE INTEGRATION FUNCTION
- COMMON INTERFACES WILL FACILITATE INTEROPERABILITY AND REUSE OF HARDWARE AND SOFTWARE

Here is where we obtain the delicate balance between the benefits of new technology and the benefits of standardization. Managing these interfaces properly is going to be an extremely important task because the computer and its software provide the basis for system integration. It is not just another subsystem plugged into a major system but one that provides the glue for joining subsystems into a cohesive system.

Uncontrolled proliferation of interfaces is guaranteed to complicate the processes of system development and system evolution. On the other hand, proper management of these interfaces will facilitate interoperability and effective reuse of hardware and software.

COMPUTER SYSTEM INTERFACES IMPORTANT TO DoD

- INSTRUCTION SET ARCHITECTURES
- OPERATING SYSTEM INTERFACES
- COMPUTER PERIPHERAL INTERFACES
- SYSTEM BUSES
- LOCAL AND WIDE-AREA NETWORK INTERFACES
- AUTOMATED SOFTWARE "FACTORY" INTERFACES

This is a representative list of interfaces that are important to DOD. Others not on here may be important. The list, no doubt, will change over time.

INSTRUCTION SET ARCHITECTURE

- DIFFERENT ISA's IMPEDE TRANSPORTABILITY OF RUN-TIME SOFTWARE
- Ada® TRANSPORTABILITY HANDBOOK WILL HELP BUT WILL NOT BE A PANACEA
- DoDI 5000.5X WAS DoD's INITIAL APPROACH TO THE MANAGEMENT OF THIS INTERFACE
- A SUPERIOR LONG-TERM ALTERNATIVE HAS BEEN DEVELOPED AND DoDI 5000.5X HAS BEEN ABANDONED
- FUTURE DIRECTION OF ISA's UNCERTAIN
  - HIGHER LEVEL?
  - SIMPLER?
  - HIGHLY PARALLEL?
- FUTURE DoD APPROACH VIA A COOPERATIVE GOVERNMENT/INDUSTRY EFFORT

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The subject that generated the greatest amount of controversy - instruction set architecture - will now be addressed. It was established in the OSD report to Congress that different ISAs, even with Ada, is an impediment to transportability.

The Ada Transportability Handbook will ease this problem, but do not expect it to be a panacea. The OSD/DOD's approach to this problem was Instruction 5000.5X. OSD now hopes it has a better approach.

OSD is looking at where the instruction sets are going. It is an area where there is a great deal of technical activity at this time. Eight years ago when OSD started to discuss instruction set architecture there was not a lot happening in the shift of ISAs. They could be lumped into a number of pretty straight forward categories. There were not major step changes in ISAs from year to year or month to month. That is not the case right now. One segment of the community believes that the higher level instruction sets should be used - ones with more compound instructions. Another segment believes that the next generation ISAs should be simpler than those we are using today. There is also a parallel consideration and a considerable amount of work underway on approaches for very highly parallel ISAs.

Perhaps the only thing agreed upon is the need to distill a future direction from among the various approaches now being investigated. OSD strategy is to treat ISA not as a separate issue, but in the context of a total computer system interface approachy. This involves a cooperative effort between government and industry.

COMPUTER SYSTEMS INTERFACE WORKING GROUP (CSIWG)

- MEMBERSHIP: SERVICES, OSD, DEFENSE AGENCIES
- DEVELOP LONG-TERM APPROACH TO ALL INTERFACES IMPORTANT ACROSS MISSION-CRITICAL SYSTEMS
- INDUSTRY ENCOURAGED TO ESTABLISH A PARALLEL WORKING GROUP WITH A LINK TO NATIONAL STANDARDS ACTIVITIES
- CSIWG WILL BE ESTABLISHED IN MARCH 1984

This March (1984) OSD/DOD will form a Computer Systems Interface Working Group with the mission to develop a long term approach to interfaces of the type discussed above. The goal of this effort is to facilitate interoperability and re-use of equipments and software produced from different programs and different companies, or even by the same company. OSD encourages Industry to work with it and establish a group that functions in parallel with the OSD/DOD group. We also want to link this effort to national standards activities because many of the interfaces could be identical to those used in the future commercial mainstream activities. Were OSD/DOD needs to depart, because of its requirements being unique, it will do so. Where OSD/DOD has an opportunity to go with the community at large, it certainly will follow that course.

EVOLUTION OF CURRENT COMPUTER PROGRAMS

- ALL SERVICES WILL USE MIL-STD-1750 AND MIL-STD-1862
- ARMY'S MILITARY COMPUTER FAMILY PROGRAM
  - MINIMUM OF TWO COMPETING PRODUCERS FOR AN/UYK-41 AND AN/UYK-49
  - FORM-FIT-FUNCTION INTERCHANGEABILITY WITH QUALIFICATION ON A SYSTEM BY SYSTEM BASIS
  - ADDITIONAL PRODUCERS OF MIL-STD-1862 COMPUTERS POSSIBLE
  - FIVE-YEAR PRODUCTION—START FIRST QUARTER OF 1987

We will discuss where our current computer programs are going and then come back to the OSD/DOD plan to use the interface work in the next generation of military computers. A proposal on the acquisition of DOD next generation of products will be presented. It will be of interest to industry because it is significantly different from the first OSD/DOD approach. OSD long range plan is to have production quality next generation computers in qualification testing in 1991 which is not far away. DOD present computer programs will see production starts continuing up to 1991 or 1992 depending on the program. New starts beyond that time will go with the next generation. All of OSD/DOD current program as well as next generation systems will support the use of Ada.

All of the Services will be using MILSTD 1750 and MILSTD 1862 ISAs. 1750 will be used for the Air Force avionics. It will be used only at the chip set level by the Navy and by the Army for 16-bit applications. The number of different hardware types will be tightly controlled by the Army, which will not develop 1750 computers but will build on those already available through the Air Force effort. 1862 will be used in the Army's MCF program, by the Navy in its single board computer effort and by the Air Force in 32-bit applications when computers come available. The Army's MCF program will award Full Scale Engineering Development Contracts shortly - two competing contracts - and ending with two competing production contracts. Later, additional producers may be included in the competition. Competitors computers will be form fit and function interchangeable but users are cautioned that the validation of the interchangeability will have to be made an integral part of the system design process.

EVOLUTION OF CURRENT COMPUTER PROGRAMS (CONTINUED)

- NAVY'S AN/UYK-43 AND AN/UYK-44 PROGRAMS
  - REPLACE AN/UYK-20 AND AN/UYK-7
  - USE FOR NEW SHIPBOARD SYSTEMS
  - AN/UYK-43 IN PRODUCTION (ACQUISITION FOR NEW STARTS WILL BE MADE THROUGH 1991)
  - AN/UYK-44 IN PRODUCTION (ACQUISITION FOR NEW STARTS WILL BE MADE THROUGH 1990)

The Navy's AN/UYK-43 and 44 programs are in the early phases of production. Production will continue for new starts of the 43 through 1991 and for new starts for the 44 through 1990. Production will continue after these points to support maintenance up to the point where buy-out can be made.

EVOLUTION OF CURRENT COMPUTER PROGRAMS (CONTINUED)

- NAVY's AN/AYK-14 PROGRAM
  - PRODUCTION STARTED IN 1976
  - SECOND SOURCE BUILD-TO-PRINT AWARDED IN DECEMBER 1983
  - 15 PROGRAMS WILL ACQUIRE OVER 10,000 COMPUTERS
  - ACQUISITIONS FOR NEW STARTS THROUGH 1990
- AIR FORCE COMPUTER POLICY
  - COMPUTER ACQUISITIONS ON A SYSTEMS BASIS
  - COMPLIANCE WITH Ada®, MIL-STD-1750, MIL-STD-1553
  - USE OF MIL-STD-1862 WHEN AVAILABLE IN HARDWARE

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The Navy's standard airborne computer, the AYK-14, is now in production and will continue to be produced for new starts through 1989. Last month a contract was awarded to Sperry for second sourcing of the AYK-14 on a build-to-print basis. The competition that will exist between Sperry and CDC is important in what OSD perceives to be a large production that is planned.

The Air Force does not have a standard inter-system hardware program because of the way it supports its systems. The Air Forces Ada, 1750 and 1862 approaches have been discussed above.

NEXT GENERATION MILITARY COMPUTERS

- EXTEND MICROPROCESSOR POLICY TO MICROCOMPUTER-ON-A-CHIP
- BASE NEXT GENERATION ON COMPUTER SYSTEMS INTERFACE ACTIVITIES
- ENCOURAGE INDUSTRY TO PRODUCE COMPETITIVE MILITARY COMPUTERS MEETING JOINTLY DEVELOPED FORM-FIT-FUNCTION SPECIFICATIONS
- QUALIFY MULTIPLE COMPANIES AS CERTIFIED SUPPLIERS FOR MILITARY COMPUTERS
- NEXT GENERATION COMPUTERS WILL BE NEEDED IN 1992
- COMPLETE INTERFACE EFFORTS PRIOR TO MID-1987
- CONTINUE SCIENCE AND TECHNOLOGY EFFORTS TO MAINTAIN U.S. STRENGTH AND LEADERSHIP

Regarding next generation systems where micros are concerned, OSD expects to see entire microcomputers on single chips and sees no reason not to extend the micro policy discussed above to these devices, with the condition that they comply with the newly developed interfaces.

As for the more powerful next generation stand-along computers, they will be based on this same interface work. OSD encourages industry to produce competitive military computers meeting jointly developed interface and form, fit and function specifications. OSD/DOD will posture inself to qualify industry sponsored products for use in (U.S.) military-critical systems.

The interface and form, fit and function efforts should be completed prior to mid-1987 in order to obtain fully approved production units in 1992.

OSD/DOD will continue its technology base work in this important area, and will conduct development work in support of the interface and form, fit and function activities. This is an important new approach and OSD/DOD welcomes Industry to join it and to help make this approach work.

In summary, we are talking about some new and exciting directions in military computers. It is a challenge that promises some very high pay offs. It will not be easy. OSD/DOD and Industry must work together because the success of each is shared by the other.

In response to questions, the following points were made:

---Dr. Lieblein's and Mr. Maynard's offices will be putting the Computer Systems Interface Working Group together within the government. OSD may look at a group of several industry organizations as a vehicle for industry participation. For individuals or companies not members of any included industry organization, some mechanisms will be provided for affiliation with some of the advisory activities thus established. The entire area of industry participation will be publicized, most likely through CBD.

---Discussions have been held with companies doing new work in expert systems and artificial intelligence using LISP and PROLOG and their assessment is that Ada is very well qualified to handle commands and processing required for expert systems and would not make the implementation of such systems difficult. None have been programmed in Ada. Unless there is a true penalty, OSD expects to specify Ada for expert systems. If in the future a much superior (to Ada) artificial intelligence language appears, OSD will use it.

SESSION I

PROBLEMS FACING THE SERVICES IN THE FUTURE

Chairman: Mr. Joseph Grosson
Assistant Deputy Commander
for Acquisition, Naval Sea Systems Command

Panelists/Speakers:

Commodore Stuart Platt (SC), USN
Competition Advocate, U.S. Navy

Brigadier General Alan B. Salisbury USA
Joint Program Manager, Joint Tactical
Fusion Program and All Source Analysis System
DCS.OPS, HQ U.S. Army

Rear Admiral Wayne E. Meyer, USN
Deputy Commander,
Naval Sea Systems Command

Brigadier John Paul Hyde, USAF.
DC/S Communications, Electronics, and Computer
Resources, USAF Space Command and N. American
Aerospace Defense Command; Chief, Systems
Integration Office, Space Command; and
Commander Space Communications Division,
Air Force Communication Command

Panelists: Col. Harold Archibald, USA
Chief, Battlefield Automation Division
H/Q DARCOM

Mr. Norman Brown
Special Assistant to the
Competition Advocate General, U.S. Navy

INTRODUCTION

Mr. Grosson opened the session with the projection that if 90% of scientists and engineers who have ever lived are alive today, we have not even begun an upswing on the "technology curve". This exponential growth we are seeing raises questions. Does the rate of advance exceed our ability to anticipate, plan, design, develop, procure and use? Are we moving too fast or too slow? Looking at, hopefully, unlikely extremes of this question suppose we are moving too fast? Because of the plethora of decisions required of the field commander, necessary reaction time increases reliance on machines. Does this pose the danger of losing control of tactical decision making? Suppose we are moving too slow. Does this pose the danger of our falling behind in our ability to handle the obvious threats and, more importantly, we may not be able to handle the unknown future threats? Will procurement policies artificially force us in the wrong direction? First, by requiring too much competition in systems development or are our mandates to use standards overly constraining? What about automation? What is the correct man-machine interface? How far do we dare remove the man from the system? Can we control the dyanmics of this technology by deciding how far and how fast we dare to go in such areas as decision making, command control and communications, target engagement or reliance on artificial intelligence?

Commodore Platt

This discussion will embrace four points - changes we are seeing in our economy; the Navy's thrust for increased competition; data rights and some problems in that area; and some Navy actions in data rights.

Changes in our economy include revitalization in general and in smoke stack America, redirection in most major businesses, interest rates more under control, low wholesale price index increases, and increased capital investment in industry. Additional changes included re-evaluation of their own portfolio managements and business thrusts by conglomerates, additional companies coming into the defense business, inordinate impact of Wall Street analysts on the thinking of major companies, and relearning and reuse of strategic planning. The Navy is trying to work its problems at the lowest levels - the project levels - and it is appearing that is where they can be worked best on both sides of the table. Government and industry are victims of the same data base using the same numbers and often coming up with different answers. Deregulation is another form of competition and it is being pushed by companies and in many sectors of our economy with some benefits to consumers. Concerning competition, the Japanese appear to read our books listed to what we say, believe we actually do it and then go home and do it. We are a country and have a Navy that operates well in crisis and it is managing a lot of problems now.

In fostering competition, the Navy is not trying for a minimum strategy but, hopefully, to do what seems best. The President has directed executive agencies to seek more competition. The Congress spelled out the desire for more competition in the FY 1984 Defense Appropriation Act. The Secretary of Defense has directed (more competition) and the Secretary of the Navy has instructed top executives to seek more competition. Our strategy is to try to do more (to foster competition). We are working on the action or how to do it - intelligently - not whether or not it is good. Inflexibility to change is not something the world rests with. In all dynamic. moving systems - technical, social or otherwise - change takes places as time moves on.

The Navy thrust for increased competition comes at a time of drastic events in the shipbuilding industry. In aerosace, fifty percent of the business is attributable to military requirements. Commercial aircraft sales are declining since 1980. Forecasts for shipbuilding and aerospace make military market segments much more dominant. In 1982 world trade dropped to the lowest level since World War II. The number of ships in the world trading fleet has declined for the first time in over thirty years. Very few deep draft commercial ships are ordered in this country. Thus, in some industries the military is becoming the demand curve. Corporate management at top levels and the Navy are learning to work with it. Many people feel that the defense computer business is counter-cyclical and that seems silly. The Navy market for ships and shipboard systems seems bright into the years to come and a major part of that business for the foreseeable future. When the Navy gets favorable buys it (still) wants to keep its options open for (follow-on) buys. The Navy's best interest is served by industry being smart sellers. A not-informed industry and a not-intelligent contracting business community is the last thing we need. One of the best things that can happen from meeting like this is that the (navy representatives) tell industry what they think. Industry likes it or it doesn't and may even get it changed. Most of the time the Navy gets hurt is from industry's uninformed, very lofty and treacherous business ventures.

In many cases, the government cannot compete where it seeks more competition because of data rights. The Navy is looking at how extensive that (restriction) is and what the Navy wants to do about it. It is very important for the Navy to get the data it needs and has paid for. The contract for procurement of U.S.S. MONITOR (circa 1862) follow-ons was a case where part was sole source and the remainder by competitors who paid a fee to the original designer for drawings. It is very important for the Navy to make sure it get the data it needs and has paid for. As Defense budgets increase, Navy contract professionals are told to review the data rights issues in formulating new contracts, as change orders are issued don't give up the rights the Navy already owns and challenge the limited rights stamps that go on many drawings when there does not appear to be a reason (for it). Data rights issues have been pursued by the Navy on a case-by-case basis. The other services may look at it somewhat differently, but it all seems to be the same problem. If the other services have a better way to do it, the Navy will join up. On a case-by-case basis, examples are: Litton providing listings of 4,500 inertial navigation system parts the Navy couldn't buy directly because of proprietary rights; Sikorsky has agreed to their licensee selling directly to Inventory Control Points;p Pratt and Whitney has agreed to the sale of aircraft engine parts and items they don't make themselves directly to Navy Supply Centers; Sperry has lifted the legends from their drawings with respect to Navy work and there are many other examples. The Navy is telling all of its contracting people what industry tells us in these letters, so they know and can help implement it. A point for encouragement is the responsive attempt to try to resolve some of the "horror" stories we hear about. Some of the stories we hear today on spare parts are intensely and frequetly discussed and are painful. Some good is coming of it. A lot of industry is responding as they see it and trying to make it easier and better for us to work in the spare parts area.

The Navy seeks to get more competitive and would like to let the marketplace seek competition. The Navy is trusting senior executives to be the ones to do it, to carry it out and to make it work. The Navy is very aggressively after more competition, wants to do it intelligently, understands there are some programs it can't (promote competition) and wishes to reserve those decisions for itself.

Brigadier General Salisbury

This presentation is a perspective from the position of program manager in the Army's All Source Analysis System and Joint Tactical Fusion Programs. This is not a policy position in Army computer matters. It is rather from a position of having to live with and implement these policies, with which there is, happily, complete agreement. This presentation is not as spokesman for the Army but rather personal experiences and observations based on a former appearance at MILCOM and as program manager for PLRS and TOSS (now Maneuver Control System).

From a Program Manager's viewpoint, problems of the future divide into development, survivability and supportability problems.

The first development problem is acquisition cycle vs. computer based systems which are nearly, but not quite incompatible. The classical acquisition cycle is easily within 12 years. The technology half-life is around two years today for major semiconductor innovations with shorter periods for some "leaps forward". Think back eight years ago to 1975-76, the birth of the microcomputer, and how far we have come since then. How can we compare where we are in the latter part of that cycle with the technology input of eight years ago? To put perception of the user problems in focus, take VISICALC. How could a top executive have been persuaded eight years ago that in eight years he could have a VISICALC desk top environment?

Corresponding to the problem of technology half-life there is doctrinal half-life. There are measurable changes in doctrine which, although not as rapid as technology changes, make doctrinal half-life much less than the acquisition cycle. Regarding computers in C^3I, the program manager in early stages must have tremendous insight to visualize problems and requirements eight to twelve years out in the future. Few have the insight to accurately forecast thym; and organizational and method changes as well. The Army is going to a light division of 10,000 troops vs. a 6,000 man conventional division with a communications electronic warfare battalion. The light division will have only a military intelligence company. Further, there is a policy half-life incident to changing administrations, top military leaders etc. with accompanying shifts in priorities. The only solutions to these problems of the program manager is evolutionary development. It was pioneered successfully in the Manuever Control System and is being used in the All Source Analysis System today. The evolutionary development starts with minimum implementation in the hands of troops so as to evolve the definition with the user. It may be a disappointment in not solving many or all problems in first iteration. It avoids, however, the problems of a system passing the test of the Engineering Development Model and then, "falling flat on its face" in the hands of troops to whom it is deployed because original requirements were almost "ivory tower" and many changes have taken place. In this sense it is a sort of Preplanned Product Improvement approach - starting small, using much user feedback and developing in increments. Opportunities for technology insertion are open all along the way and this is a tremendous benefit. It will be possible to use off-the-shelve computers in the initial iteration and shift to militarized ruggedized and/or augmented system computers in later iterations which will also meet expanding requirements.

The program manager's job is greatly eased if a total package of computer resources with all of the development and support tools is ready to go rather than to have to "reinvent all of those wheels". The laissez faire approach has not served the Army well in most of its program because the pressure to go for the latest development, special purpose or otherwise, requires reinvention of support, training and logistics tools which is very expensive.

The problem as we move into more standardization is properly balancing competition with the benefits of standardization. The MCF program is doing this. There may, however, be problems as MCF transitions into a more limited supplier environment, but they appear to be manageable. So for any new computer offered in a program the program manager will ask for complete documentation, a full support environment including Ada, a total Ada programming environment and compatability across contractor environments. The transition to Ada, standardization of tools and configuration control across multiple suppliers is a nontrivial problem.

Survivability, more than anything else, justifies a standardization approach. It is one thing to have compatible processors, perhaps through the Ada level, and another thing to have interchangeable processors on a form, fit and function basis. Visualize (CP) in the height of battle, with only partial logistic support, and the Maneuver Control or Intelligence Computer fails. The combat unit is hard pressed to continue operating with what is on hand and a combat service support or supply computer is still operating but can not be applied to the manuever control or intelligence functions.

This is a real problem. If downstream, the benefits of standardization can permit stopping computer operations for service support and applying that computer to manuever control or intelligence, the payoff will be tremendous. It is of no comfort to know that there were twenty three eligible to bid on the computer that failed.

In the Army today, affordability vs. survivability is a major dilemma in the Army today. The Maneuver Control System recently went through ASARC to go into a production decision. The Tactical Computer Terminal and the Tactical Computer System performed in superior fashion and met every imaginable necessary military specification but they were just too expensive to afford equipping the Army with them. The decision was to buy enough to meet the hard core requirements. This will provide a back bone manuever control capability throughout the tactical forces and will probably be complemented by a non-developmental terminal that can be made compatable and interoperable with the developed Manuever Control System elements. There survivability will be traded off. If the Army has a hard-core back-bone system it knows is going to survive under any operational excigences, where additional processors and terminals for other staff elements are needed, they can be taken from the commercial world and not worry about (their) survivability so much. New technology is working for the Army in this area. In the Tactical Combat Service Support area, TCSS System under the Computer Systems Command is evaluating three competitive systems. They are standard, commercial, off-the-shelf (equipments)painted O.D. and configured perhaps a little uniquely but with very little packaging change. They do not need much upgrade to survive reasonably well in the intelligence or maneuver control area. They are being looked at as possible surrogate terminals in those other areas. TEMPEST and "shake, rattle and roll" will be easier and cheaper to meet with the new technology and packaging leading to greater survivability of off-the-shelf equipment. Reduced costs may allow more throw away or radically different maintenance philosophies.

Considering interoperability vs. integration, it is one thing to have systems that can interoperate. It is another to have systems that are integrated in some sense. To illustrate, consider the display to operator ratio. If an operator in a command post has to interoperate with maneuver, intelligence, fire support, etc. should he have three different terminals in front of him? The laissez fiare approach says: "absolutely that is what he will get from three different contractors under three different programs". That generates logistics, training and affordability problems. But a common standard type terminal that can interface all three will improve those factors for the Army.

A related factor is the integration of systems, in a different sense, with distributed data bases. One concept is to continue to develop systems in a vertical fashion - one project manager and one requirements community looks vertically and defines what is needed in its operational area - fire support, manuever, combat service support, intelligence etc. Then when these systems are all put together there are major problems of interoperability and of duplication of data or data cannot be exchanged because the data base formats, data elements, data dictionaries are all different. The Army is now taking more horizontal looks across systems to develop horizontal as well as vertical integration. It cannot be assumed that there is just one magical interface point where the whole intelligence community interfaces with the maneuver community. In All Source Intelligence there are many intelligence dedicated sensors which an All Source Analysis System would process information from. There are other systems that produce good information that can be used in the intelligence area. Fire support acquisition radars, for example, provide information that is necessary for a complete intelligence picture. Does that information have to flow all the way up to the fire support chain to a control computer, then to a control computer in the intelligence chain and down to where it is needed or are these systems to be integrated at each and every level where it makes sense to do so? The Army is moving more towards the latter, from a simplistic to a more complex but a more survivable and more operationally useful environment.

In the supportability area, the man-machine interface is key in terms of trainability. How can very complex systems be made trainable to the average soldier in a reasonable period of time so that out of a two year hitch the Army gets a lot of productive time out of him? The related problem of how do you make complex systems simple enough for the General to understand as well? The utility of the computer processing capability can be applied to embedded training and simplification of the operation of the man-machine interface. We want to be able to move a GI trained in one environment to another without starting from ground zero on training. Field support of software is a problem doctrinally in the standard system sense the Army wants to be responsive to the man in the field without making unique changes to impact standard world wide operation with training and doctrinal implications. The right balance must be struck between responsiveness to the man in the field and maintaining standards. It is also a problem in resources to provide post deployment software support. It takes support groups of 100 or more in a climate of increasing scarcity of personnel with required skills incident to strengthening divisions up front and reducing the support elements. Logistic support over the long term is especially important in view of the short technological life and examples of unique support of spares production for older equipments. The support of the new high technology equipment has to be worked out for the life cycle of that equipment of 10 to 20 years. The MCF approach in reducing the number (of different kinds) of things to support is on track as is having a small number of multiple suppliers.

Rear Admiral Meyer

The military profession is war. It is not software, hardware or business. War is our number one requirement. Groups and interests in Washington tend to drift off that subject. This presentation will be a series of returns to this criterion to compare both contributions and readiness for war with it. An attempt will be made from my perspective to state what the problem is or should be and to discover whether or not Ada, TADSTAND, or 5000.z are going to help solve it. What mechanisms are going to be invented by people (in this community) who work on the solution to effective war?

A recent GAO report stated it could not cite a single Joint program that had been effective in spite of thirty years of trying. Their conclusion was: It ought to work and therefore we ought to work harder on it.

For my remaining time, I am going to work on the Battle Group within the Navy and try to influence the design of the Battle Group as the fundamental fighting molecule of the Navy. Battle forces are what we fight with.

We are starting with a cite at Wallops Island, Virginia and over the next 8 to 10 years significant and fundamental changes will be made. Work is commencing on installation at the (Systems) Engineering Center (SEC). There, the basic elements of a Battle Group will be designed and installed. From that, effort will be organized to "system engineer" the fighting molecule of the Navy. Will it work? I don't know. It will cost money and it is necessary in that it is the only direction I have found that is compatible and harmonious with the social, economic and logical conditions we are dealing with in the Navy today.

Passing over detailed discussion of instrumentation, the Battle Group in SEC, the engineering and the superiority of operations of the men in the Battle Group will be the edge in winning the battle. Functionally, it can be broken down to detection, control and engagement as in the AEGIS program. It has to be put together structurally and to function operationally. The AEGIS fleet is being put together that way but there are some problems and flaws associated with it. Through an extraordinary partnership, we have proven in the United States that we do know how to put together large real-time tactical programs that deal in the non-linear aspects of battle - to the tune of millions of words. There are 35 or 40 bays of computation right in the center of TICONDEROGA. The operational program alone is of the order of a million words and many million of words go to sustain it and support the different elements in it. The operability has been proven because, on her maiden voyage, TICONDEROGA sailed into harm.

The Navy will build 25 such cruisers but the question arises "How can the Navy keep up (programming for them) and keep (the software) together?" The answer today is a brute force approach and we are putting more people to sustain and maintain software than it took to develop it. It is expensive and if (these programs) are added up for the battle forces of the Navy today there would be on the order of a billion words (of program) to be maintained over the next decade or so. There are not enough people available to use that approach and to try it would be working on the wrong problem.

The Navy seems to have "worn itself out" on standardization and particularly in the hardware dimension - the computers. That time is past and (the Navy) needs to "wear itself out" on computer programs. The computers got where they are through the application of millions of dollars of technology, to the point today where the availability of computers is so high we don't attempt to measure it. Yet, it is a major breakthrough if the program in a ship like TICONDEROGA does not have to be reloaded in a period of twenty four hours. The computers run for thousands and thousands of hours. The Navy needs to change direction (in software development and maintenance) and it appears research, engineering and application is not being done in software and programs to provide techniques in software analogous to what was done in hardware. It does not appear the Navy will get them out of efforts underway today. That is where the basic problem is and where we have to find a way to solve it. We cannot sustain the software because of cost even if we can buy it. Maintenance is going to kill us (unless we do something about it).

In looking at a possible solution, the "stretch sock syndrome" - it fits everybody and nobody - should be avoided in considering standardization of computer programs. The (growth) of effective electrical power in this country was attained, in my judgment, through the Underwriters Laboratory and its system. A major thrust of the professional societies over the last 50 or 75 years has been the promotion of standards and specifications for effective use of electrical products. None appear to have been an instrument of government, but were a product of the profession. Underwriters Laboratory methods allow much variability in characteristics of electrical equipment so long as certain protocols are not violated. The protocols are relatively simple and very permissive, and protection devices are built into the system.

This (property) is missing from tactical warefare computer programs. We are not getting there from here and it does not appear Ada, HOLs or more DOD instructions will get us there. It looks as if industry will have to get us there and the question is: What will get industry to get us there?"

There has to be a partnership but there is question that there can be a partnership pursuing the policies we heard stated this morning. DOD and Congressional officials have discussed partnership between Congress, Industry and DOD. Real progress on it is not apparent. The fundamental motivation of partnership is ability of industry to continue its own development. There does not appear to be a scheme to accomplish the partnership.

Referring to the objectives of this session, emphasis was on discussion of known issues and creation of a partnership so as to have a viable (workable and likely to survive) computer and software operation. The known issues are: The Navy has a billion words of program and a monstrosity of a maintenance problem over the next two decades. The second issue is forming an effective partnership and discovering how, truly, such a partnership will come about. The third is survivability, not in the direct combat sense, but survival related to maintenance and productivity (of software). We have to avoid start-overs and endless searches when programs have to be changed. Otherwise we will have obsolescent tactical programs. We must pursue a partnership which can take root and grow over the next decade. The problem is a system-engineered battle force. Nothing less will win. One mechanism for creating that partnership is at the SEC at Wallops Island, in the next year or two, and industry is welcome to join up and participate. Finally, not estimating but controlling software costs is the only way we will get (Battle Group) system engineering.

Brigadier General Hyde

It is encouraging that Space Command was selected to represent the Air Force and provide an Air Force perspective on problems of the services in the future in the business of hardware and software. Space is where a great piece of our future lies. The Air Force - all the services - have a heavy dependence on space. Over 70% of our long haul communications are handled by satellites. Satellite systems are a key part of our warning capability. Our military weather satellites provide key meteorological data to all the services. The Global Positioning System will let us navigate world wide with unprecedented accuracy. It will ultimately have 18 satellites in orbit and provide positional accuracy to 10-15 meters. There is more to come in space.

This discussion will look into the future and future key requirements for military computer systems. It with our missions today and the challenges we have right now. The mission are: - To warn the NCA, the JCS, and key commands around the world of foreign ICBM and SLBM launches, and to assess each and all as possible attacks on North America (Air Force component of NORAD). - Space defense, which involves surveillance, protection and negation.

Space Command and its predecessors have been doing space surveillance for over 20 years. Its original charter was space surveillance - detect, track and catalog all man-made objects in space. It is the one and only agency that provides a space catalog for the entire free world - what is up there, who owns it, how it got there and where it is going. Presently, there are about 5100 objects in space and about 20,000 observations a day are required from sensors all over the world to maintain that catalog. Protection involves warning the owners of those objects in space when they might be getting too close to one another or when a new launch, friendly or foreign might come too close. In addition to protecting against hostile threats, Space Command provides collision avoidance prior to launch of space missions by comparing the programmed flight path against the space catalog. It is very important for missions of the Space Shuttle for example. Negation (derives) from both national and DOD space policies which direct, within such limits as might be imposed by international law, the continued development of an operational anti-satelloite capability to deter threats to friendly space systems and to preserve our right of self defense.

These missions are carried out by means of Satellite Early Warning Systems (SEWS), a system of sensor satellites and Ground Based Sensors - radar, optical, infrared and other - the outputs of which are processed and fed over an extensive Communications net to the Cheyenne Mountain complex in Colorado Springs. There these data are screened, collated, checked, verified and processed on over 80 computers for presentation in various operations centers such as NORAD/SPACE COMMAND Command Post or the Space Defense Operations Center. That is a quick tour through a very complicated system that takes over 9000 people, plus untold others associated with leased support systems, to operate and maintain. That sets the stage for a brief description of some key problems and challenges Space Command faces today - integrity, time urgency, surviveability and capability.

Because an inaccurate or ambigous assessment coming from the Command Post could, at the worst, set U.S. military forces in motion or, at the very least, cause an unnecessary preparatory posturing of forces that could be alarming to friends and enemies alike, the integrity of the total systems - sensors, communications, computers (both hardware and software), procedures, and people must be absolute. It simply may not fail, kiccup, be inaccurate or be ambiguous. Morever, the system must be extremely fast because ICBMs from the Soviet Union are only 30 minutes away and SLBMs, which are detected and tracked by the phased array (PAVE PAWS) radars on the East and West Coasts are as little as 13 minutes away. Survivability is a challenge, too, because even though the Space Command Post in Cheyenne Mountain is the hardest/most survivable Command Post in the Western World, some sensors like PAVE PAWS are obviously pretty vulnerable. Today we use a big phased array radar at Concrete, N.D. to help track and identify ICBMs and objects in space and it does that (function) extremely well. But it, and it along, is the only remnant of the anti-ballistic missle capability we didn't build. We have no capability either to negate other threatening spacecraft. That is a challenge as well.

Space Command is going operational with new systems and capabilities in and for space. Under development and beginning to test is our antisatellite system consisting of a miniature vehicle which is launched from F-15 aircraft stationed at Langley and McChord Air Force Bases. In operation, Space Command would inform NCA of a threatening satellite. If they make a decision to intercept, the orbital parameters would be computed in the Space Defense Operations Center in the space catalog and an engagement profile as well. ASAT Mission Control Center in Cheyenne Mountain would pass intercept data to communications processors at the ASAT F-15 Air Bases. A profile tape would be produced and inserted in the F-15 along with the super-cooled missle that is going to do the job. F-15 would take off and follow the profile to the launch box. At the programmed time and altitude in the launch box, the vehicle is launched and makes the interception.

Preparation is underway to replace the major computer systems in Cheyenne Mountain, using a new architecture in which the processing for each mission area is done in a distinct computer set. It is not done that way today. Mission areas are combined in various ways and carried out in common computers and we find that is not a good way to do it. Computer sets in this (new) architecture are connected to the common data input circuits and are connected to common display by some kind of local area network or data bus. With this design we can modify the processing for any one mission area without risk of disturbing the others. That is very important because without that capability each time some calculation or parameter has to be changed in one mission area, and mission areas are interlaced, lines and lines of code have to be examined for every mission area there is. In addition, with this kind of modular architecture processors can be added for new mission areas as they might be assigned.

Consolidated Space Operations Center (CSOC) is being built nine miles east of Colorado Springs. One side of the CSOC will be a Shuttle and Planning Complex which will functionally replicate the Johnson Space Center in Houston and provide a secured facility for carrying out Space Command mission as manager, planner and operator for all military space shuttle activities. The other side of CSOC will be a satellite operations complex which will be a duplicate of the Satellite Control Facility now at Sunnyvale, California and from which Space Command will exercise management and control of the major present and future DOD satellite systems SEWS...the Defense Meterological Satellite System...the new NAVSTAR Global Positioning Satellites...the Defense Satellite Communications Systems and the new MILSTAR constellation of survivable communications satellites all through a world wide network of ground based satellite tracking stations.

Put all together and it comes to distributed processing on a global scale, a global intertwined system of surveillance and warning, navigation, command, control and communications, satellites and ground nodes, with all manner of vehicles, manned and unmanned, whose on-board systems communicate in real time with ground based elements. It includes space borne data capture and processing, satellite-to-satellite communications, downlink and uplink communications from fixed and mobile ground and air control centers and tracking stations, and communications to and from these centers to fusion centers at various commands around the world.

Further in the future a space based radar and defense against ballistic missiles may be invisaged with possibly a laser or laser-like weapon that can destroy an ICBM or SLBM early during its boost phase. Future requirements in computers and software include micro-micro-miniaturization, very large scale and very high speed integrated circuits, higher-than-high order software languages and all the other technology advances industry can provide. There are a few requirements driven by Space Command mission and architecture that stand out sufficiently to be addressed individually.

Global architecture and space-wide deployment of those system elements absolutely demand distributed processing. This applies to the architecture overall and to all nodes in the architecture. More autonomous on-board processing at point of contact will be required to strike a balance between distributed processing and network communications.

Because the time-lines are short and the mission is critical, systems must be absolutely accurate, failsafe, fault tolerant and with comprehensive built-in self diagnostic features. Because they are space based they must be self healing. Reliability and maintainability are absolutely crucial.

The universal military requirement - survivability - including protection against physical and electromagnetic threats and multi-level security against tampering must be met in future space systems. The use of mobility for survivability of systems, such as are in Cheyenne Mountain, will tax the computer builders of the future.

In answer to questions and responses to comments the following points were made:

---The Air Force Advocate for Competition is not one man but the entire Air Force procurment structure.

---Expert systems are threshold state-of-the-art and as a facet of AI they offer the nearest term pay off. It appears they will be manageable for insertion into the Army system area. Documentation, specifications and testing are problems associated with it. It is estimated that the first useable systems will appear in five years in the intelligence area in limited classes of problems.

---Information and computer sciences curricula appear to lack the hard core disciplines characteristic of engineering curricula in the past but there are trends toward improving these curricula.

---In dealing with the data rights issue incident to purchases of commercial data equipment, the Navy looks at data rights to decide what data rights it needs for its purposes. In competitive strategies when data rights are not needed they will not be required. In systems acquisitions, data rights needs will be identified up from and measures will be taken the acquire them before development starts. Occasionally the Navy as determined that acquisition of data rights was not worth the cost and effort in the interest of war readiness.

SESSION II

THE EMERGING TECHNOLOGIES

Chairman: Dr. Edward Lieblein
Acting Director, Computer
Software and Systems,
Office of the Under Secretary
of Defense for Research and
Advance Technology

Panelists/Speakers:

Dr. David Patterson
Naval Research Laboratory
and Temporary Assignment
to VHSIC Program Office, OSD.

Dr. Robert Mathis
Director Ada Joint Project
Office, Office of Under Secretary
of Defense for Research and
Technology

Dr. John H. Manley, President
Computing Technology Transition Inc.
And Vice President Engineering and
Technology, NAFTEC Corporation

Mr. Steve Squires, Information
Processing Technology Office, DARPA

Mr. Brett Berlin, Vice President
Government Relations,
Cray Research Corporation

Dr. William Howard, Vice President and
Director, Research and Development
Motorola, Inc.

Dr. Lieblein

This session will cover emerging and emerged technologies. Technology in a military computer context is a mixed bag. To some it is a monster - how to deal with technology in the context of competition and standardization. To others it is an unstoppable train. The perspectives presented will be from those who both deal with technology and work every day at it - in important technology programs both government and industry sponsored.

Attention will be focused on where the technologies discussed are heading and where we will be in 5, 10 or 20 years. Topics are VLSI, VHSIC, the Software Factory concept, computer architecture, AI, strategic computing and super computing. Problems to be dealt with and near term opportunities will be pointed out.

Dr. Patterson

This discussion will point to silicon technology and not initially to gallium arsenide or J-J devices which could conceivably play a role in computer technology in the 1990s. It is based largely on the great effort being put into silicon technology and the inertia inherent in such a large and dynamic industry.

The VHSIC effort was started in the late 70's to reverse the erosion of (U.S.) technology lead over some adversary countries. We decided DOD was not doing a good enough job to get IC technology available in commercial industry into its systems. This was the prime driving force for the VHSIC program. OSD/DOD wanted to address the needs of the signal processing capability for military systems and direct its efforts totally at reducing this technology insertion gap and getting microelectronics into the military systems. In the 1960's DOD had advanced microelectronics in its systems before commerical (industry) did. In the 1970's commercial industry had developed LSI and DOD said let us see what we can do to get it into military systems. That added another five years to make these devices compatible with military requirements. With VHSIC DOD/OSD anticipated where industry would be in the mid 80's and engaged companies to see how this technology, as it emerged, could be applied to military requirements.

Inherent with the complexity of VHSIC chips is the added reliability which has always been a problem in military systems. In reducing part counts VHSIC could reduce life cycle costs. VHSIC thinks a hundred fold increase in reliability will come about. VHSIC Phase I development stressed built-in-test and should improve operational maintenance. New designs for fault tolerance have been examined. Military systems have radiation environment requirements that commercial industry does not have.

In the 80's time frame, commerical industry did not have the throughput that military systems needed from its integrated circuits. Then 10^8 to 10^9 operations per second were quoted for military requirements. These levels are being reached with some Phase I technologies. Later, submicron developments will be discussed for systems that need even higher throughputs.

In Phase I VHSIC wanted industry to address 1 1/4 micron feature size suitable for subsystem brassboards for military applications. Also, there was a smaller effort on device problems to get devices down to 1/2 micron feature size.

In Phase II pilot production for 1/2 micron chip sizes would be started and 1 1/4 micron chips would start to be put in military systems. A lot of perpheral and auxiliary studies needed to be done and nearly $50 million was spent on Phase II programs to address problems arising out of this technology.

In the early 80's the functional throughput rate defined as a function of gate density (gates per square centimeter) and the clock speed in Hertz was around 10^{11} and typical of better commerical chips today. VHSIC I addressed functional throughput of 5×10^{11}. VHSIC II will address a figure of merit of 10^{13} to be attained in the next few years. Radiation tolerance and easy insertion were also stressed for military systems.

A variety of vendors and four different technologies were used to address these problems. Six contracts provided a variety of architectural approaches and with brassboards assured applicability to military systems. Among the packaging problems were extremely high pin count, chip sizes approaching 300 mils on a side and power dissipation of 1 to 3 watts. Package types are being examined including pin-grid and package attachment to the board.

In 1984 the end of Phase I is upon us. There are no impediments to successful fabrication of 1 1/4 micron chips. DOD accepts and wants VHSIC for military systems and an equal number of pilot lines have been company funded. This has resulted in government and industry proceeding together with commerical benefits in competitive stature and near completion of six fully functional chips and 64k RAM types. Comparatively, VHSIC stresses high throughput and reliability while commercial industry tends toward higher gate density to get lower cost.

Looking at VHSIC Phase II and some of the goals of the sub-micron technology effort, chips are being put into a funded fifteen systems for insertion of VHSIC technology into military systems. Contracts for improvement of yield on Phase I pilot lines have been announced in order to bring cost down to a reasonable level - anticipated to be $500 per chip in the 1986-88 time frame. There is also a manufacturing technology program underway. The Integrated Design Automation System (IDAS) is aimed at a very big military problem and somewhat less commercial problem - improve the design time in getting to the chip mass from the system requirements.

In VHSIC Phase II interconnect and packaging technology in the 1985 to 1988 time frame will look at alternative board construction to get around packaging large pin counts onto the package, materials permitting faster speed because of the capability of the board material, tape interconnects, new methods of package attachment to the boards, new carriers for higher pin count and putting multi-chips into the packages for higher packing density.

The aim of IDAS is to develop software to facilitate going from the operational requirements to the system to automate as many of the steps as possible, and to get down to the final pattern generation for defining the silicon pattern on the chips.

A sub-micron capability is needed because speeds we are getting today are not sufficient for high throughput needed in some key areas. In this we will perhaps be leaving optical lithography and going to E-beam or X-ray lithography, double level metallization on the chip and dry etching.

Submicron devices have been made at the individual transitor level, modeling is improving and we see no real problems in being able to fabricate half micron technology in the late 1980's.

Soon, a statement of work for the sub-micron process development of chip needs where the clock speeds are going up to 100MHZ over the 25 MHZ now current will be addressed. Chips of gate density, in the logic area, of 100,000 gates per chip will be addressed. In the memory area we anticipate technology affording 256K static random access memory. Pin count for packages will go up to 300 again.

There is a commonality with commercial industry and both are approaching state of the art at about the same frame rate. DOD money is getting new developments put into military rather than commercial systems.

From the VHSIC program, we expect to be in sub-micron technology in the late 80's. We anticipate gate delay speeds of less than 1 nano-second. Chip complexities of 100,000 chips per device will give throughput rates of 10^{13} gate hertz per centimeter and 10^{10} and more operations per second throughput.

Dr. Mathis

Ada® PROGRAM

TECHNOLOGY
- —STANDARD LANGUAGE
- —Ada® PROGRAMMING SUPPORT ENVIRONMENTS
- —METHODOLOGIES

EDUCATION AND TRAINING

POLICY AND PUBLIC INTERFACE

APPLICATIONS

GENERAL MANAGEMENT

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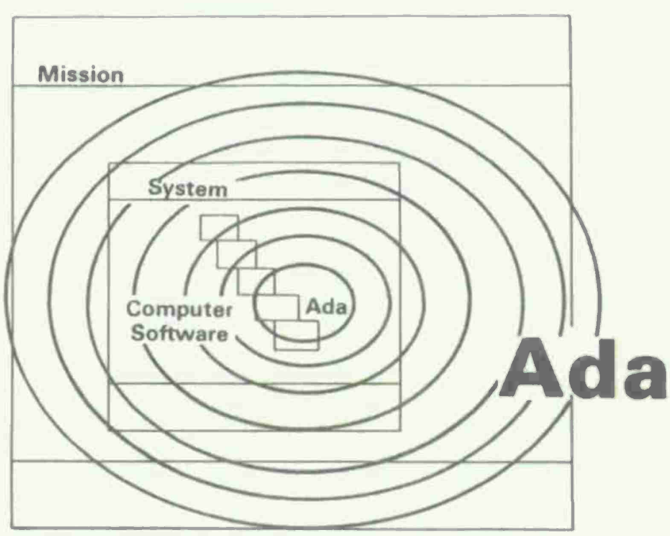
In the 1982 Fiscal Appropriations Act Congress mandated the acceleration of the Ada Program and that is exactly what OSD/Ada Program Office has been doing. In emerging technologies if you wait "until the horse has left the gate", you "cannot place a bet". In terms of emerging technology Ada is an existent technology - there are validated compilers and so on.

This slide shows the role of Ada and includes a "waterfall" diagram of software development, a small role in coding and the many other activities in software development we need to focus on. Ada is a way of focusing on mission systems requirements and other large areas that have to be addressed. DOD is also focusing its tremendous power as a consumer to get things done its way. Ada is really changing the way software is developed, purchased, paid for and maintained over the life cycle. That is why chose DOD - Industry cooperation is needed.



In a changing market place OSD/DOD wants to make sure that its friends, our ADA users - people who have gotten on the Ada bandwagon, turn out to be successful in the overall marketplace. Because it is with successful companies we like to do business.

At MILCOM I there was considerable support for Ada standardization and for software standardization to drive our overall mission critical computer programs. At MILCOM II there was considerable support - so much so that it was not really discussed as a controversial item. The message from MILCOM III might be, in baseball parlance, if you don't hear it the third time it is three strikes and you are out. I do not think there is any other software or software engineering game in town except Ada. Don't get the impression I am supposed to be impartial. I am the chief Ada pusher.

STANDARD ADA* LANGUAGE

o	ANSI/MIL-STD-1815A-1983	17 February 1983
o	Validated Processors:	
	New York University - Ada/ED	11 April 1983
	ROLM/Data General - ADE	13 June 1983
	Western Digital/Gensoft	9 August 1983
	Telesoft, Army ALS, Air Force AIE, etc	

After a long competitive requirements analyses and design competition, Ada was finally approved as an American National Standard on 17 February 1983. This is a significant accomplishment for the program in that it indicates both military and industry acceptance of the language as a standard. Following the acceptance of the standard, the first processors formally validated were from New York University, ROLM/Data General and Western Digital (now marketed by Gensoft). In the next twelve months, we expect to see compilers from TeleSoft, the Army's Ada Language System (ALS), the Air Force's Ada Integrated Environment (AIE), and probablly others coming for validation. The process of validation is a very rigorous testing for conformance to the standard; it does not necessarily indicate the suitability of a particular compiler for any given project.

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As to the status of Ada, there are three validated compilers - New York University, Rolm and Data General. Western Digital validated their compiler in August and immediately sold the rights to a new company called GENSOFT. The SOFTECH AOS being written for the Army will be coming for validation in the early summer (1984). The INTERMETRICS, written compiler for the Air Force Ada Integrated Environment (AIE).

will be coming for coming for validation in late fall of 1984. It is expected that the TELESOFT compilers written for their own purposes and in conjuction with IBM on the SUBACS project will be coming for validation in the early part of 1984. The Danish Datamatric Center, York University, ALSIS from Europe will all be submitting their compilers during the coming year, and other products are expected.

ADA* USE

- o DEFENSE AUTHORIZATION ACT, 1983
  " . . . ACCELERATE . . . ADA . . ."
- o DELAUER MEMO 10 JUNE 1983
  DODD 3405.xx (DODI 5000.31)
  ADA TO BE USED ON NEW PROGRAMS IN 1984
- o SERVICES AGGRESSIVELY PLANNING FOR ADA

IN THE DEFENSE AUTHORIZATION ACT FOR 1983, CONGRESS SAID THAT, "THE DEPARTMENT OF DEFENSE SHOULD ACCELERATE IMPLEMENTATION OF THE ADA HIGH ORDER LANGUAGE AND CONSTRAIN TO THE MAXIMUM EXTENT FEASIBLE SERVICE VARIATIONS ON ADA TO ENSURE THE UTMOST COMMONALITY OF SYSTEMS SUPPORT SOFTWARE". IN KEEPING WITH THIS DIRECTION, UNDER SECRETARY OF DEFENSE FOR RESEARCH AND ENGINEERING, RICHARD D. DELAUER ISSUED A MEMO DATED JUNE 10, 1983 CIRCULATING WHAT USED TO BE CALLED DOD INSTRUCTION 5000.31 FOR FINAL COORDINATION. DUE TO RENUMBERING THIS WILL BE CALLED DOD DIRECTIVE 3405.XX. IN THAT MEMO, DELAUER SAID THAT, "ADA (ANSI/MIL-STD-1815A-1983) IS APPROVED FOR USE CONSISTENT WITH THE INTRODUCTION PLANS OF THE INDIVIDUAL COMPONENTS AND THE

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VALIDATION REQUIREMENTS OF THE ADA JOINT PROGRAM OFFICE. THE ADA PROGRAMMING LANGUAGE SHALL BECOME THE SINGLE, COMMON COMPUTER PROGRAMMING LANGUAGE FOR DEFENSE MISSION-CRITICAL APPLICATIONS. EFFECTIVE 1 JANUARY 1984 FOR PROGRAMS ENTERING ADVANCED DEVELOPMENT AND 1 JULY 1984 FOR PROGRAMS ENTERING FULL-SCALE ENGINEERING DEVELOPMENT, ADA SHALL BE THE PROGRAMMING LANGUAGE... OTHER PROGRAMS ARE ENCOURAGED TO USE ADA AS SOON AS AND WHENEVER POSSIBLE."

THE SERVICES ARE CURRENTLY REVISING THEIR INTRODUCTION PLANS IN CONFORMANCE WITH THIS DIRECTIVE FOR ACCELERATION. ALTHOUGH THE DETAILS ARE STILL BEING WORKED, IT IS CLEAR THAT EACH OF THE SERVICES HAS AN AGGRESSIVE PLAN FOR EARLY USE OF ADA.

You are all familiar with the June 10 Dr. Lauer memo mandating Ada.

The next item is the really new emerging area that OSD/Ada Program Office would like everyone to become familiar with. These are the Ada Programming Support Environments (APSEs).

ADA* PROGRAMMING SUPPORT ENVIRONMENT

- o STONEMAN
- o REHOST, RETARGET, RETOOL
- o KIT, KITIA
- o COMMON APSE INTERFACE SET (CAIS)
- o EARLY RELEASE OF ALS
- o ENVIRONMENT EVALUATION AND VALIDATION

IMPORTANT AS THE ADA LANGUAGE IS, EVEN GREATER BENEFITS WILL BE DERIVED FROM THE USE OF COMMON ADA PROGRAMMING SUPPORT ENVIRONMENTS (APSE). THIS IDEA WAS RECOGNIZED EARLY IN THE ADA PROGRAM AND THE STONEMAN DOCUMENT DEFINED A MODEL FOR THE CONSTRUCTION OF AN APSE. THIS WAS THE BASIS FOR THE DESIGN OF BOTH THE ARMY'S ADA LANGUAGE SYSTEM (ALS) AND THE AIR FORCE'S ADA INTEGRATED ENVIRONMENT (AIE). OTHER SYSTEMS ARE ALSO FOLLOWNG THIS MODEL.

THIS LEAD TO OUR PLAN TO DEVELOP A PROGRAMMING SUPPORT ENVIRONEMNT WHICH WAS REHOSTABLE, RETARGETABLE, AND RETOOLABLE; MEANING THAT WE COULD RUN THE SAME PROGRAMMING SUPPORT ENVIRONMENT ON A NUMBER OF DIFFERENT HOSTS, TARGET IT FOR A WIDE

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2
REVISED 11-08-83

VARIETY OF MANY COMPUTERS AND ENVIRONMENTAL CHARACTERISTICS AND ALSO PROVIDE A MARKET PLACE FOR ADVANCED SOFTWARE DEVELOPMENT TOOLS.

THE KAPSE INTERFACE TEAM (KIT) AND THE KAPSE INTERFACE TEAM INDUSTRY/ACADAMIA (KITIA) WERE SET UP TO STUDY THE PROBLEMS OF REHOSTING, RETARGETING, AND RETOOLING PARTICULARLY AS THEY APPLY TO THE ALS AND AIE. THEIR WORK IN THAT AREA HAS LEAD TO A DOCUMENT NOW REFERRED TO AS A COMMON APSE INTERFACE SET (CAIS). THIS WAS RELEASED FOR PUBLIC DISCUSSION IN SEPTEMBER 1983 AND MAY EVENTUALLY BECOME A STANDARD FOR SOFTWARE DEVELOPMENT SYSTEMS.

IN NOVEMBER 1983, THE ALS WAS RELEASED FOR POTENTIAL REHOSTERS AND RETARGETERS TO BEGIN LEARNING ABOUT THE STRUCTURE OF THE ALS AND BEGIN WORKING WITH IT.

WITH A NUMBER OF ENVIRONMENTS POTENTIALLY AVAILABLE FOR USE ON A PROJECT, IT BECOMES IMPORTANT FOR US TO KNOW THE CHARACTERISTICS OF THEM AND THEIR APPLICABILITY IN THE SITUATION UNDER CONSIDERATION. FOR THAT REASON, THE AJPO HAS SET UP ANOTHER TASK CALLED ENVIRONMENT EVALUATION AND VALIDATION, WHICH WILL HELP DEVELOP THE APPROPRIATE EVALUATION CRITERIA FOR DECIDING BETWEEN THE VARIOUS TOOLS AND ALSO THOSE ASPECTS OF ENVIRONMENTS INTO WHICH WE CAN EXTEND THE COMPILER VALIDATION IDEAS.

Through the KIT or KITIA effort, Ada program office has now come out with a common APSE interface set. This is a model for standard interfaces between Ada development tools and the underlying operating system. In many ways, it is UNIX grown up and re-cast in Ada terms. People familiar with UNIX concept will find transition to CAIS straight forward. OSD/Ada Program Office is beginning to sponsor some projects that will be directly demonstrating how UNIX-related software techniques can be directly transitioned to CAIS. With the tools we have with Ada, OSD/Ada Project Office wants an expanded framework over UNIX in such areas as, for example, a better file structure.

CAIS SCHEDULE

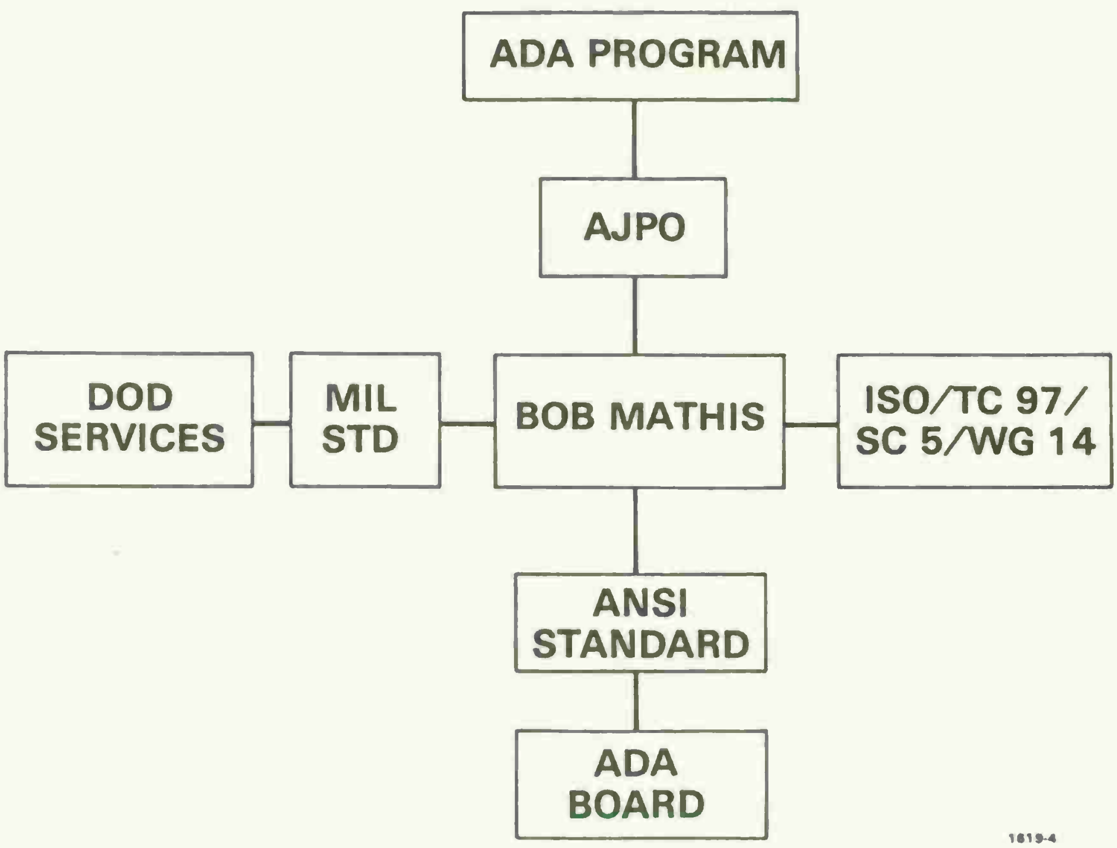
16 NOVEMBER 1983 (REVISED)

• DRAFT VERSION 1.0	-- 26 AUGUST 1983
• PUBLIC REVIEW	-- 14-15 SEPTEMBER 1983
• DRAFT VERSION 1.1	-- 30 SEPTEMBER 1983
• PUBLIC COMMENTS	-- 1 NOVEMBER 1983
• SERVICE TECHNICAL COMMENTS	-- 15 DECEMBER 1983
• DRAFT VERSION 1.2	-- APRIL 1984
• DRAFT VERSION 1.3	-- NOVEMBER 1984
• MIL-STD VERSION 1	-- JANUARY 1985
• INITIATE MIL-STD VERSION 2	-- JANUARY 1985
• DRAFT VERSION 2 (SEE NOTE)	-- JANUARY 1986
• MIL-STD VERSION 2	-- JANUARY 1987

NOTE: CONFIGURATION CONTROL OF ALS, AIE AND CAIS BY SOME JOINT SERVICE CONFIGURATION CONTROL BOARD

This is the CAIS schedule. It is out for technical comment. OSD/Ada Project Office expects to issue a revised draft in April and November 1984 with the goal of having a MILSTD in January 1985. The MILSTD (CAIS) will then be revised and put under configuration control by the Configuration Control Board that manages ALS and AIE, and probably the Navy ALSN. This will provide a link between people working on standards and interfaces and those who have existing systems to be maintained. A revised MILSTD is targeted for January 1987 at which time AIE, ALS, ALSN and the revised CAIS standard will all conform to one another. The CAIS will be the standard for any new Ada support-related tools.

OSD/Ada Program Office is moving into the methodologies area and expanding the role of Ada to cover requirements and design languages and expert development systems. Work is starting on the programming support environment for the next generation (computers). For example, the library system of the 1960's was a sequential listing of programs on a tape. It is totally unsatisfactory for reuse of complicated software modules. Ada program is headed for resueability of software and run-time standards are projected for the target environment. These will provide the same kind of services for executing programs that CAIS provides for development systems. The first draft of a Transportability Handbook is expected by the end of 1984. An Evaluation and Validation of Programming Environments Working Group is holding a workshop April 2-6, 1984. It is an extension of Compiler Validation efforts, it earlier KITIA efforts and was announced in CBD about 2 weeks ago.



OSD/Ada Program Office now has permission to work on International Standard Organization (ISO) standards. ISO has a technical committee on computer standards, sub-committee 5 on programming languages and working group 14 on Ada standards. ISO includes Soviet Union and People's Republic of China.

In conclusion, Ada and STARS are the mainstream of software engineering. It is a big advantage of Ada to the DOD. The community, as in the Ada program, wanted to look at the same kinds of software engineering problems first. Ability to work in Ada will be requisite to taking advantage of work to be done in industry and the university in expert systems and future computing in the 1990's.

Supplementary information on Ada Program is provided on the following five slide reproductions.

CAIS - COMMON APSE INTERFACE SET

CHARACTERISTICS

HAS A RELATIVELY SIMPLE, UNIFORM UNDERLYING MODEL

DOES NOT UNDULY INTERFERE WITH IMPLEMENTATION STRATEGIES

INTEGRATES SMOOTHLY WITH THE FEATURES OF ADA®

PROVIDES A FLEXIBLE FOUNDATION FOR CONFIGURATION MANAGEMENT

MERGES MODERN OPERATING SYSTEM AND DATABASE MANAGEMENT SYSTEM IDEAS

 334-4

KIT/KITIA

KAPSE INTERFACE TEAM

JANUARY 1982 MEMORANDUM OF AGREEMENT

A NAVY LED DOD TEAM

KAPSE INTERFACE TEAM FROM INDUSTRY AND ACADEMIA (KITIA)

CHARTERED TO FORMULATE INTERFACE STANDARDS
- —FACILITATE MOVEMENT OF TOOLS AND DATA BETWEEN APSES
- —AIE, ALS AND ALL OTHER DOD APSES CAN EVOLVE TO

 334-4

SATELLITE FACILITIES

INSTITUTE FOR DEFENSE ANALYSES

WPAFB - LCF
(LANGUAGE CONTROL FACILITY)

GSA/FCTC
(FEDERAL COMPLIER TESTING CENTER)

GERMANY MOD/IABG

ENGLAND NPL

CEC ("COMMON MARKET")

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- —MIL-STD
- —ANSI PUBLIC COMMITTEE
- —ISO EXPERTS GROUP

PLANNING MEETINGS

- —13 MAY 1983
- —4-5 AUGUST 1983
- —18 OCTOBER 1983

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Dr. Manley

This presentation will relate to STARS program, software engineering and software factories - present status and future prospects. STARS is aiming to solve the Navy "billion word" plus other services software maintenance problems. Software maintenance is labor intensive and it is growing. One driver was the projection that there would not be enough programmers to handle future problems. So one alternative was some way to reduce labor intensiveness.

STARS aims at an order of magnitude improvement over a seven year joint program. It is not only computer system practices but also business practices, the acquisition program, data rights and competition. It is not just technology but a very broad program of the whole spectrum in trying to improve computer technology.

In this session emphasis is on methodologies, tools and integrated software environments. In the Ada world "environment" is going outward from the compiler to minimum Ada support environment to a larger environment. Today, it starts with a concept of software that goes into a system - really it starts with the system - and allocation down to software through the software development life cycle, back to integration into a system and the whole life of the system over 10,20 or 30 years. The environment of a 30 or 40 year span is another perspective. "Life cycle" refers to the entire life cycle, not just building software.

There are almost as many definitions of "software engineering" as there are writers and experts on the subject. It is generally conceded "software engineering" started in 1968 in a NATO conference and was enunciated by Fritz Bauer. It is a young term, and in spite of not having a generally accepted definition of it, the overall principles of sofware engineering are generally accepted.

Systems in this context are becoming so large and complex there is great difficulty in coping with them. So one principle is to simplify the complexity. Although there are buzz words on how to do it, simplification is putting structure into the process, the code and modularization. Putting discipline not only into the process of programming but also into its management, into training of people, into personnel systems, subsystems and interfaces in a complete life cycle framework. In a life cycle approach, it is not just programmers or other separate skills involved. It is also managers, users, maintainers, developers and designers. It is not a one-person or one-skill operation. It is a lot of people and that is software engineering.

Recently the need and advocacy of re-usable parts or code or standard parts because the wheel keeps being re-invented - over and over again-in modules and algorithms in different systems.

A third point is automation, as far as possible, of the entire process from requirement specification to automatic code. In the MIS and BIS world fourth generation languages, which are rather trivial compared to military systems, the user can be led through to generate a COBOL program which will then generate a report rather than have the DP shop do it.

If the word "software" is removed it becomes principles of engineering or of systems engineering. So software engineering is things that have been done all along in other fields.

Software engineering is being practiced. Leading aerospace companies and most space andd efense contractors are using these principles in one form or another. Also, in the commercial world there are mission critical systems such as nuclear power plant control systems and electrical power control, CAT scan systems, eletronic funds transfer systems. Some MIS and BIS systems in commerce and the government are also using these systems. Engineers who are putting microprocessors into fuel injection and home appliances are treating software as a component part and have learned to program. Software engineering is now starting even in that small shop world.

The challenges are first, how to automate individual methodologies and to integrate steps of them. Second is education and training of people in these principles. This comes to the third challenge and biggest point - cultural change.

All the leading telecommunications companies are writing big public switching systems. The only way they can achieve success in writing those large, complex and interactive programs is to use software principles. There is no other way.

IEEE is now advocating standards for software engineering. ACM is at a "software engineering notes" level and is plugging software engineering in all of its literature. There are others. Major universities are now starting to shape curricula to include software engineering.

One thing of importance is the SEI of the DOD. Similarities between hardware and software engineering are growing but some differences remain. The art and craft of the single programmer is getting into the trade process - skill in techniques which are repeatable. Those trades, where the future is going, can be integrated into complete factories.

The hardware factory has the line that produces the product and support functions. The line is all steps from receipt of raw materials to exit of finished goods. Support functions include planning manaugement personnel, training and industrial engineering. Quality control, inventory controls, maintenance of plant equipment and the controller. All are involved except the repeatable manufacturing processes in software engineering and that too may exist (in some cases).

Software engineering is new, its principles are acceptable and in use and "factories" will be the next step. The caveat is that sotware technology is not standing still and state of the art is always ahead of state of practice. STARS is trying to make all of that happen. SEI is a catalyst that can accelerate the transition. These together with Ada can make it all happen. The principles of software engineering are:

...Structure
...System Perspective
...Life Cycle Framework
...Management Discipline
...Simplification of Complexity
...Multi-discipline Team Approach
...Reuseable Standard Parts
...Automation-Requirement Specification to Coding

MR. SQUIRES

The Strategic Computing Program is focused on machine intelligence technology, not supercomputing technology in the conventional sense. From the beginning DARPA intended to stay out of the supercomputing game in the conventional sense.

The goals start with development of a broad base of machine intelligence technology that will greatly increase national security and economic strength. These new technologies will be tied into demonstration applications in such a way that results will rapidly be made avaiable to industry for other spin-offs. Many of the architectures (the program) will be developing will have cost/performance and raw performance capabilities well beyond conventional super-computing architectures.

The underlying technologies which make this program possible have emerged over the last five years or so and by combining them and jointly leveraging them we expect to get this new generation machine intelligence technology.

Expert systems is the most useful result in recent times from the AI program.

There is a clutch of other kinds of artificial intelligence approaches which has to do with recognizing continuous speech, vision doing real time, scene analysis and related areas.

In addition, these application areas represent large scale system developments and DARPA intends to develop the applications in state-of-the-art system environments as they become available, LISP environments that are already available, and developing new tools to support use of the emerging multiprocessor technology.

There are some new theoretical insights into computer science that give us some idea how use can be made of large numbers of processors. Architectures that have on the order of hundred or thousands of micro processors. Architectures which support millions of small grained processors such as one bit wide processors. And the corresponding software to effectively use them.

The three main functional areas in computer architecture are signal processing (which are the front end of these (expert) systems), expert systems noted above and multi-function machines which are large number of conventional processors assembled in novel ways.

Use will be made of the rapid VLSI fabrication capabilities which DARPA developed over the years and these will be scaled up to the point of rapid turn around for VLSI parts, boards and whole systems. Thus decisions as to what systems to build will be deferred as long as possible and then "over the weekend" deliver the product loaded with software. This is an integrated rapid systems prototyping approach to these systems. In the early years development will be done the conventional way. By the second phase of the program which is about 3 years out in a 10 year program there will be this rapid systems prototyping capability and a new experimental base to work in.

Pushing on microelectronics fabrication, DARPA will be glad to make use of VHSIC foundaries as they become available. In the architectures being developed, VHSIC parts will not be used initially, since DARPA is interested in developing scalable designs in demonstratable form. The parts can be replaced by high performance parts without getting VHSIC on a critical path.

Work is starting on gallium arsenide for hardened technologies and that will support space applications. Architectures which are developed in other parts of the strategic computing program will be compatible with gallium arsenide. That will provide another level of integration. That is, the multiprocessor architectures, which are developed with more conventional technologies, can also be used in space.

Performance goals for Strategic Computer Program, which were worked up over a year ago, are as follows. By 1990, 10^8 logical inferences per second which can be thought of as rule firings per second in an expert system. Proposal are in place for very fine mesh architectures, involving millions of processors which can meet those goals. They are a little risky to build so they will be built in smaller forms, software will be developed for them and plans for application will be developed.

Major goals for Strategic Computer Program are to develop machine intelligence technology. Three representative (but not the only possible) applications areas have been selected each representing a different class of system. The battlefield management application is the support of a large enterprise with intelligent systems. The pilot associate is essentially a one-on-one system supporting one human doing a stressful task. The autonomous system is one that operates for the most part, alone with direction only now and then when there is an opportunity to do so. The battlefield management systems prototype is associated with the Navy. The pilot associate is an Air Force kind of application. The autonomous system is going to be a land vehicle since land is the safest environment for development of such systems.

Supporting these are some intelligent functions such as real time scene analysis for vision to be used in autonomous vehicles. Natural language navigation in expert systems in another. They are relatively generic to those military applications. Supporting them are the systems architectures such as signal processing, symbolic processing, architectures for the rule based systems, semantic nets, natural language understanding and multi-function machines which can do what these architectures can do but not as fast. This is all going to be done in a rich infrastructure on the ARPANET with rapid fabrication capability and first quality machine resources for the researchers involved.

The autonomous vehicle requires development of new vision and navigation systems plus stressing such things as planning, speech recognition, information fusion and graphics. Battlefield management system is stressing expert systems natural language exploitation and speech.

The near term intelligent functions which are expected to emerge are in division speech, understanding natural language, and expert system areas. The corresponding architectures to support them like systolic arrays and some signal processing functions in the vision and speech areas.

Later there will be system architectures to support additional functions. There will be demonstrations every couple of years. Prototyping will be done on top of existing technologies which will be the benchmarks for development of later architectures followed by test, selection of the best, and rapid insertion of elements to form a new level of intelligent system prototyping.

Mr. Berlin

It appears that Cray and DARPA are doing completely different things and confusion may have arisen in thinking of the DARPA program as a supercomputing project.

Much of this presentation will be based upon the significant problem of the acquisition of technology when it comes off the line. Many think of supercomputers as very large number crunchers, used in research and development. Some may ask why, in MILCOM III, super computers are being discussed and why is Cray Research here discussing them. The issue centers on how can we leverage technology that is going to be developing in the future to make it accessable - technology insertion if you will.

Supercomputers are thought of as very large, hardly able to fit into an airplane, and with just one problem - to miniaturize it. Very seriously, there will not be a supercomputer on a chip. It is not that very dramatic processing on a chip will not be developed but because a supercomputer by its very nature and essence is going to be the most advanced and high speed processor that we can muster. If we can put a super computer on a single chip we are going to want to put ten of them together. That is what we should do. But there always has to be focusing on what it is that can be brought to bear in terms of a maximum computing environment.

Here are some trends that are happening in supercomputers and some things that could have an impact on them in the 1990's.

Looking at the very high speed processors, there does not appear to be any guarantee, or even high probability, that these processors will be inserted into the operational military environment. That is not because they shouldn't be but because we have not faced the challenge of how to take technology that is off the shelf or coming off the shelf, and without creating a special program or weapons system program, evaluate and insert it. It cannot be done when the product is at the end of its life cycle. A way is needed then of pro-actively, if you will, looking to see where things are going in the new technology. If that challenge is not met there will be the situation as it is today where certain companies like Cray Research are pressing on to the goals of always developing the fastest possible computer while other companies in the industry are pressing on to the goal of fast processors that fit into a certain environment, having already geared up to programs and program requirements. It is a challenge with no certain answers and issues of great difficulty. Post 1990 we are going to have commercial products avaiable for insertion and we will have to face those issues.

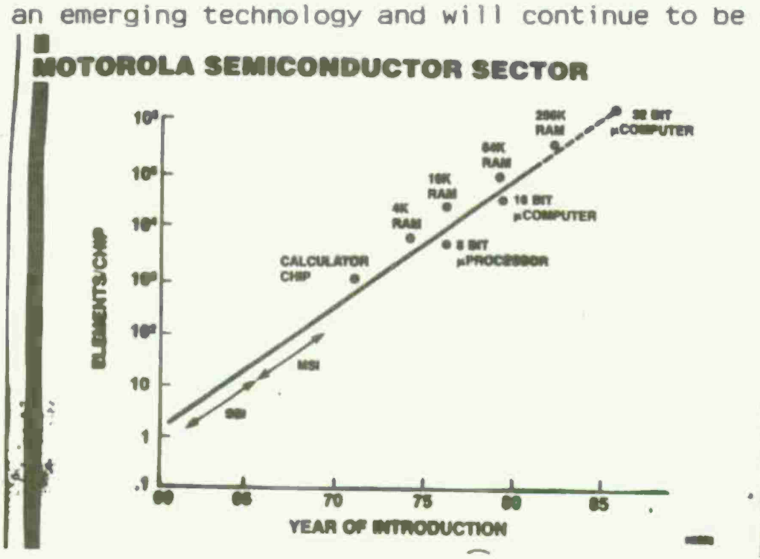
Looking back to past work in supercomputers, Fernbach calls supercomputers the bow wave of the computer technology ship. That is overstating it a bit because the computer ship has many technologies. The strategic computer presentation points out the breadth of technologies. Traditionally (supercomputer builders) have said they could make a certain processing speed at the supercomputer level with accompanying requirements of stability, floor space, cost etc. The users say they would like to have this processing capability for program X but cannot afford to pay those costs. So the user moves down the processing scale until he gets to a cost he can meet. That may be oversimplified but in one sense it may be a valid approach.

There are reasons for having to look at supercomputing in the military environment. First, the current application demand - synthetic aperture radars, high speed signal processing and others. Some applications are challenging the capability of the available machines and the assumption is made that they are all that is available. So, one result is to lash 4 or 5 or 10 or 20 of them together and pay the software costs to take a very large processing problem and spread it out over many processors. That is called but is not true distributed processing which is a scheme to take care of a number of applications. The multiple use of computers cited above is a "contingency plan" because what is needed is not available. Additional requirements such as directed energy programs and changes in the (military operational) environment which are in view but not yet known or defined. Survivibility requirements are increasing for which one suggested solution is putting major systems on vans. Cost constraints are obvious and cost performance will be more and more of a factor.

Fine key trends in supercomputing can be identified. We know about signal processor performance both in microprocessing and in high speed processing. Both are going to be components of different types of supercomputing architecture. Next is dramatic increases in I/O Danwidth. Production channels of 10 gHz per second are already accredited and these are being shipped in everyday systems by Cray now. It is a very significant problem both internally and externally. Third is parallelism is being looked at from two different approaches. First is small amounts of parallelism, each processor being very very fast. Second is massive parallelism, each processors being relatively slow. The software problems for the latter are much more difficult than for the former. Third, unfortunately the software problems for either have not been solved. That is a limiting technology that needs examination, not only in terms of operating systems and multi-tasking but also a very serious problem in terms of algorithms. If these processors were available today, we would not know how to use them. Fourth, Cray Resesarch is looking at two basic technologies. The Cray 3 will be built out of gallium arsenide. Cray Research has its own gallium arsenide facility which started in May 1983 and just produced its first circuit last month. The test chips for design of the system is expected by the end of 1984. It is a very agressive, and turning out to be quite successful, undertaking. The second is dense memories. Cray Research is constrained by something a lot of people are not - it needs very fast dense memories. Cray Research cannot afford to have nanosecond gate times - it needs picosecond gate times and lots of them. It is a limiting technology and for that reason Cray Research has built its own facility. The fifth trend is compaction. To illustrate, the CDC 6600, which was the supercomputer of its day took about 100 square feet or less of floor space. The performance curve linking CDC 6600, CDC 6700 and Cray XMP shows the latter 100 times the power of the 6600 on an expontential curve. The interesting thing is that the floor space and facility requirements have stayed about the same. The XMP has almost the same basic facility requirements as the VAX. The CRAY 2 will take about 16 square feet and will be another step in performance. The gallium arsenide machine will take even less than that. The reason is not an attempt to compact but one of the main ways to get speed is to put things closer together. Cray Research expects that, in 1990, the CRAY 4 (or whatever) supercomputers will not be on chips but in very small boxes. That has serious implications for the trends of (system tasks and functions) that will be (in work) then.

Dr. Howard

VLSI is an emerging technology and will continue to be so for some time.



This slide depicts the VLSI growth in terms of the number of transitors on a single die of silicon with time. An exponential growth in complexity has taken place since the invention of the integrated circuit in 1958 up through today and it is continuing. This is not the only progress that is being made in the field. The other progresses are important and will be addressed later.

The outgrowth of the exponential curve is shown on this slide.

<u>INCREASING DENSITY:</u>

- WHAT ARE WE GOING TO DO WITH THIS CAPABILITY IN THE COMMERCIAL WORLD?
- WHAT WILL THE PERFORMANCE BE?
- WHAT UNDERLYING PROBLEMS ARE THERE?
- WHAT ALTERNATIVE DO WE HAVE?
- HOW FAR CAN WE GO?

These are all pertinent questions because things don't increase exponentially in nature forever. Somehwere it ends. The other progresses in the conventional semiconductor integrated circuit area have, perhaps, in many ways as significant an impact at the systems level as the core device itself does. One is in a very mundane area called discrete devices which are thought of as single transistors in a single can that turn power on and off. One such is an interesting technology called smart power - that technology which enables the handling of hundreds of volts with 50 to 100 amperes of current, which protects itself automatically, and which carries out a number of very interesting interface functions that must be gone through to interface the kernel of the system (represented by this processor) to the real world through some sort of a physical transducer.

Another interesting thing is the ability to put power and bi-polar circuits on the same die with the MOS processor. As to speed, silicon is down to 100 picoseconds and appears to be going still lower. Gallium arsenide is thought of as a speed technology. A number of other things are going on and these all are happening in addition to the increasing complexity issue.

Increasing complexity implies the capability to perform complex logical and memory operations. Traditionally, they started out in the form of SSI and MSI and they were the standard logic family. They became the microprocessor and the dynamic RAM and various kinds of peripheral circuits. Then appeared some semi-custom circuits that tended to be programmable logic arrays and gate arrays. The technology is developing into an area and an era in which a significant part of the business is going to be some sort of custom integrated circuit - probably the structured custom integrated circuit.

The trends that were started by the standard high volume part - the SSI-MSI logic family like TTL and so on - were taken up eventaully by the microprocessor or the microcomputer.

That trend will continue with the caveat that there will be some additional kinds of processors - not general purpose but tailored to do such things as signal processing and a number of other major identifiable uses. Microprocessors of today are similar in architecture and performance to mini and super-mini computers. The 32 bit processors in design in most companies including MOTOROLA, have a performance level comparable to a VAX 11/780 on one chip. Microprocessor development is going to continue along the lines of the high performance mainframes pioneered by CDC, Cray, IBM, UNIVAC and a variety of other kinds of standard machines. That has broken the architectural water for it. Some new architectures will be added because there will be some additional capabilities (needed) but they will be limited to functional processors. Multi-processing is going to come to commercial VLSI just as it was predicted to come to the supercomputer a few moments ago. It will come on one or several chips. The exact architecture remains to be developed but it is going to come.

Usage - ability to apply it - is going to be a real problem. Complex chips of the future - custom chips - will be developed using standard macro-blocks which consist of todays MPUs only they will be core function where the designer will festoon about those core functions things such as memory, input/output, other peripheral functions and the glue necessary to make this operation take place.

One reason for a standard block is that it eases the software development problem. We cannot afford to write new software for every new architecture that comes along or somebody gets a hot idea to design a new chip.

The revival-meeting nature of the previous discussion of software (at this seminar) was impressive as are the accomplishments of Augusta Ada Lovelace. One thing that needs to be looked at in the microprocessor business is to look at a still more advanced standard as indicated on the next slide.

LESSER

OVERHEAD

VERY

EXCEPTIONAL

LANGUAGE USING

ARTIFICIAL INTELLIGENCE TO

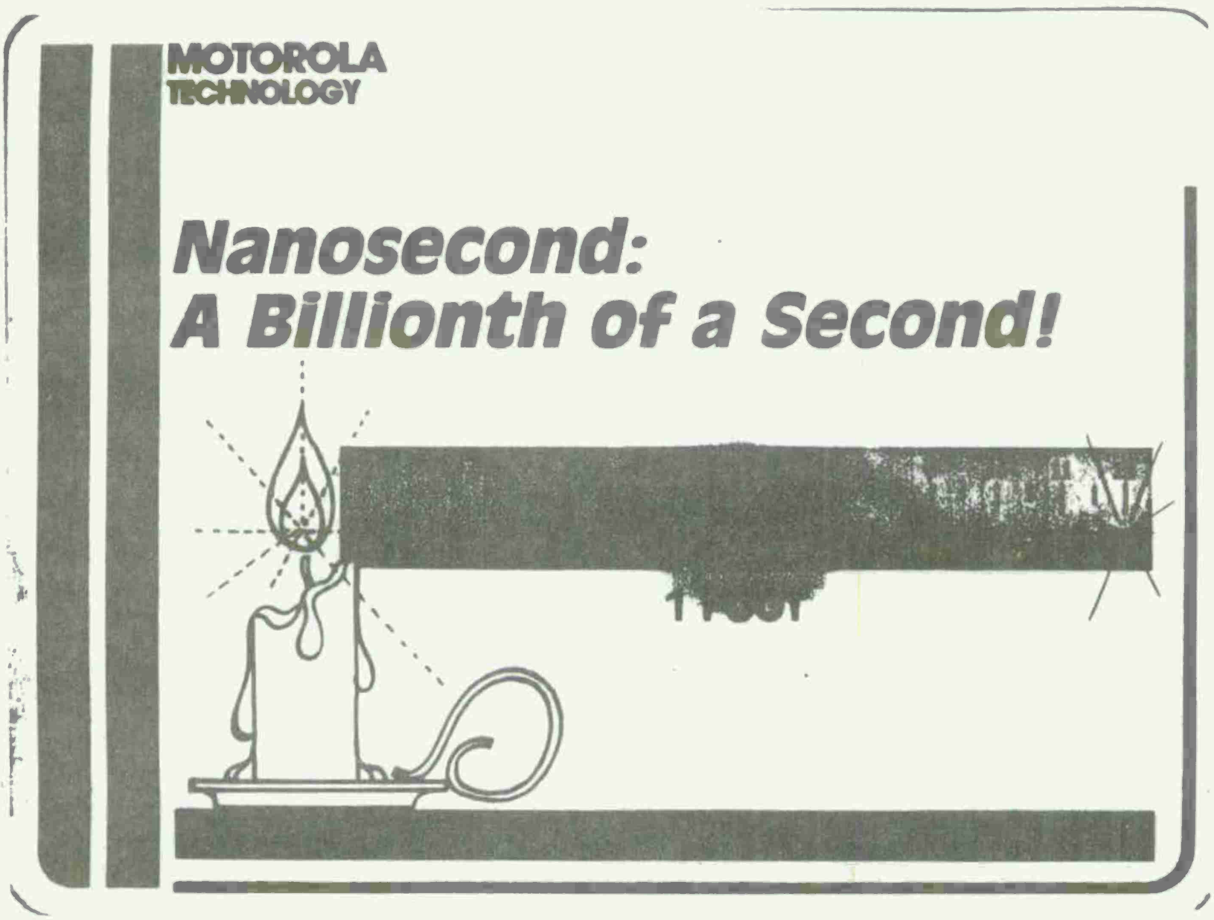
COMPUTE

EVERYTHING

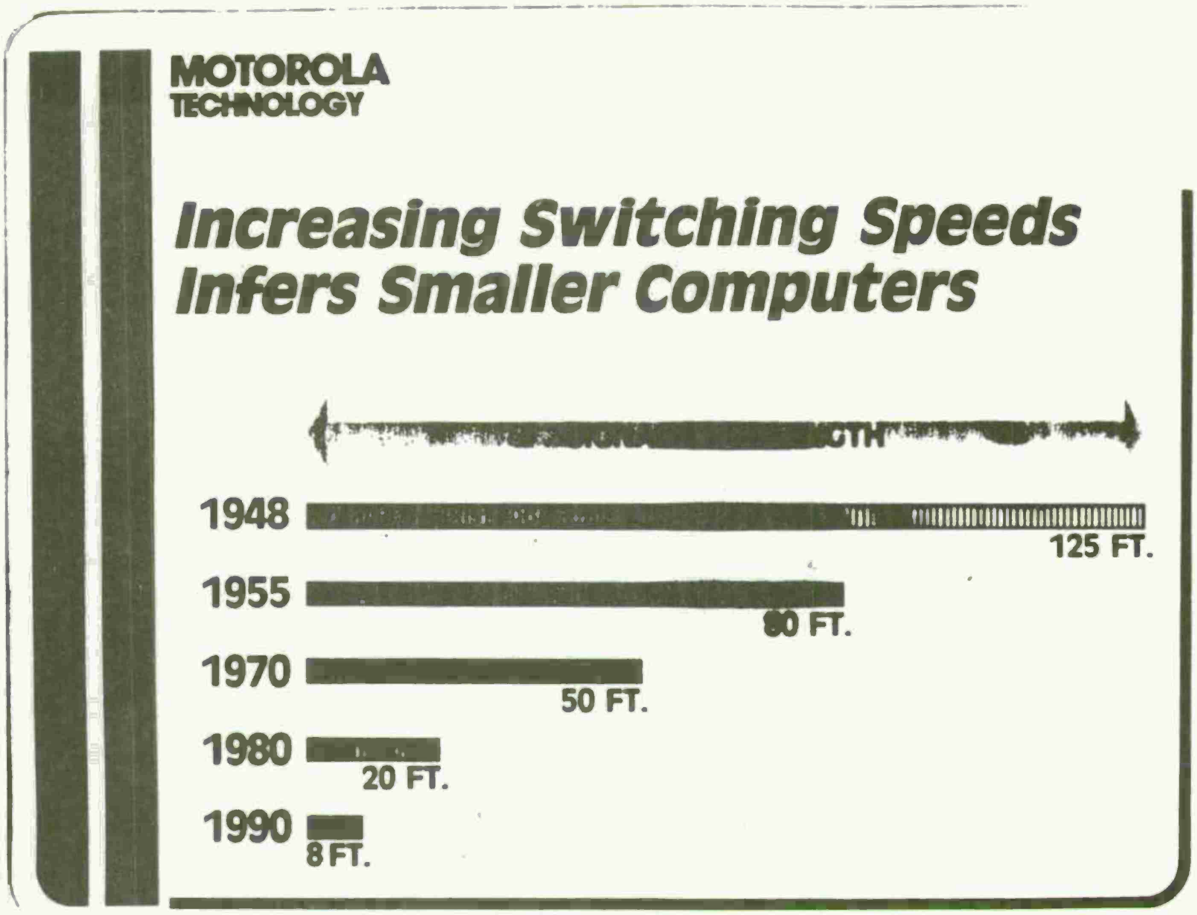
Software is beginning to be a major issue for those in the VLSI business. For years it has not been just a question of putting transistors down on silicon but a question of architecture and of some very substantial software problems in figuring out how to apply those machines. That can be fitted on a single chip of silicon. The organization of a lot of these (chips) is going to be unique and they will be functionally oriented.

Performance, in general, is going to improve some of which is automatic as size of devices shrink. The device man's index of performance is delay power product (DPP) which is roughly proportial to the dimension of the device cubed so that something half the size of its predecessor will have 8 times the performance in DPP. Delay power product is related to the function throughput rate (FTR) earlier used as the index of performance for VHSIC. FTR was thought to be basically an unuseable figure of merit in the device business. It turns out to be a constant times the power dissipated on the chip (which has been constant for quite some time) divided by the delay power product. That presupposes significant improvements of the order of 10 to 20 in function throughput rates over where we are now.

One thing that is very important as shown on this next slide.



Gate delays are expressed in current parlance in nanoseconds. A physicist might tend to think of one nanosecond as a unit of length - one light foot (11.82 inches). It's meaning in terms of performance of machines is shown on the next slide



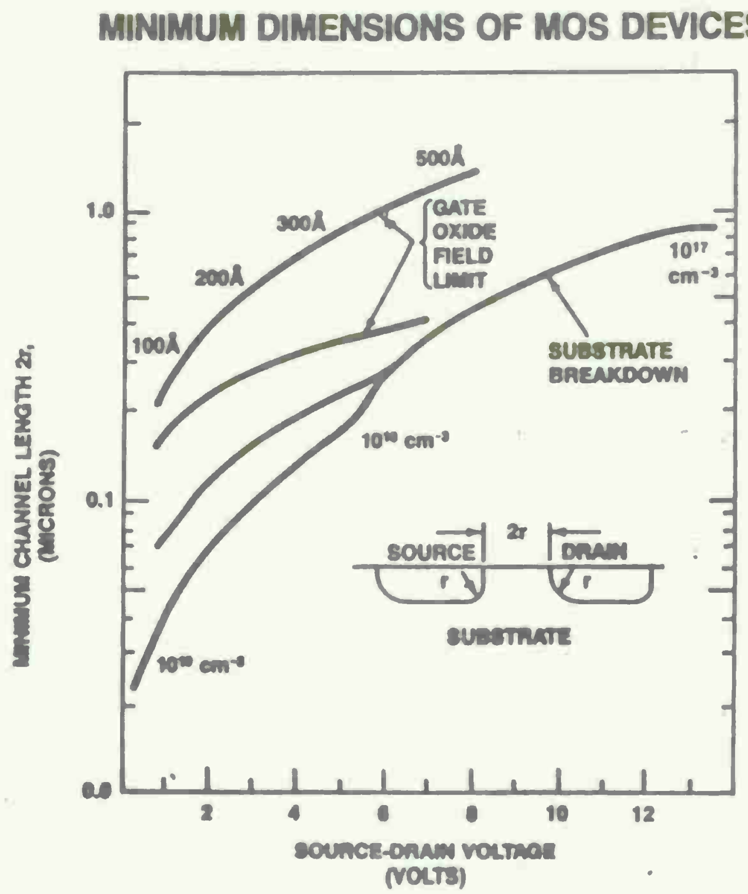
As time has gone on, the signal path length in amputers has gone from 125 feet in 1948 to 20 feet in 1980. Reducing that path length is the greatest contribution VLSI can make for the world of computing. Getting more on the die, even though the gates might not go faster, is a considerable improvement in performance just because gates are closer together.

Underlying problems are shown on the next slide.

UNDERLYING PROBLEMS:

- DEVICE PHYSICS
- INTERCONNECTIONS ON THE DIE
- PACKAGING
- TESTING
- COMPLEX CUSTOM I/C BUSINESS
- ECONOMICS

The first of these is the issue of device physics. As device sizes shrink the power supply voltage has to go down because as two points get closer and closer together for any given voltage, there will eventually be a breakdown. That happens when devices become less than one micron. Supply voltages which have been more or less standard at 5 volts will have to go down to 3, 2.5, 2 or something over 1 volt. Minimum dimensions of MOS devices are shown on the next slide.



Interconnections is related to device physics. Contact resistance goes as area not as size. Making contract with these devices is going to be a significant problem. Similarly it can be proven that the RC products of the lines that interconnect transistors on a die increase as the size shrinks. Because of second order effects, it is expected there will be a lot of cross-talk. Reliability of interconnects must be seriously looked at. Interconnects are a very important problem because 30 to 70 percent of the die area is space with nothing but metal going from one place to another. Getting the interconnect size down is the most significant thing that can be done to reduce the die size.

Packaging is related to the foregoing problems. Packaging is P to the fourth power times R-Pins, Power, Performance, Price and Reliability. The current standard is in the vicinity of 100 pins. Yet customers ask for functions that have 200, 250 or even 300 inputs and outputs. These cannot be handled with existing packages. Power dissipation. The function throughput rate is the quotient of two numbers - the delay power product into the power dissipated on the die. The fastest way to increase the performance of systems is to increase the power dissipation capability of the packaging by two orders of magnitude. It is a lot less expensive then building $100M factories to build sub-micron devices. We have to do both if we are going to squeeze the maximum out of the technology. Packaging is the biggest unsung area of future improvement that exists in the technology today. If we don't do it someone else is going to find a way to solve the packaging problem better than we have with the dual in-line, the small outline and other package configurations that are standards now.

The next subject is testing. Some examples are shown on the next slide.

<u>VLSI TESTING APPROACHES</u>

I. INCREASE TEST SYSTEM SPEED AND COMPLEXITY TO KEEP PACE WITH VLSI CLOCK RATE, WORD LENGTH, AND PIN COUNT.

II. MAINTAIN LOW VLSI TEST TIME BY PROVIDING ON-CHIP
- SELF-TEST AND DIAGNOSTIC FIRMWARE
- PRIVILEGED TEST INSTRUCTIONS IN INSTRUCTION SET
- SPECIAL TEST AND READOUT PATHS TO CRITICAL AREAS OF CHIP, E.G.:

MEMORY	COUNTERS	MULTIPLIERS
REGISTERS	ADDERS	CONTROL

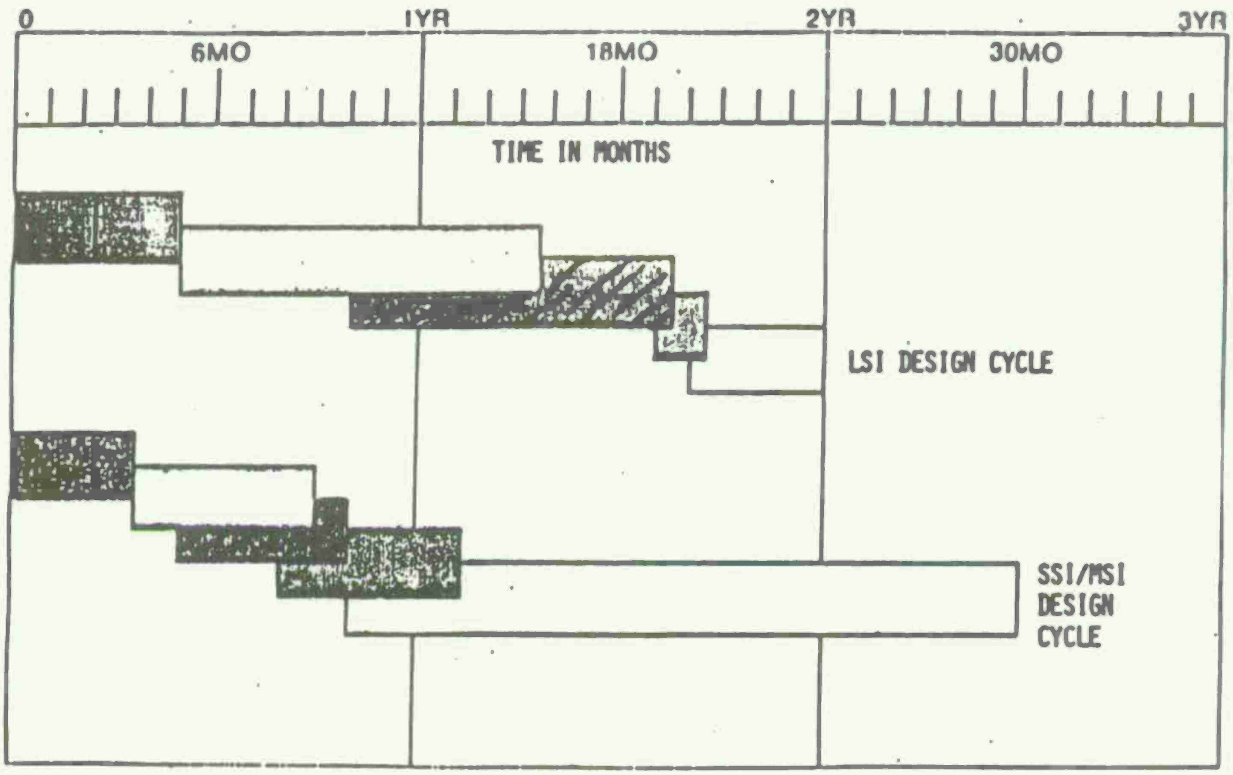
- MODULARIZATION OF LOGIC AND MEMORY

III. TRADE-OFF INCREASED DEVICE COUNT FOR REDUCED TEST TIME

Turning to complex integrated circuits, one thing it does is that it is one of the answers to the technology drain. If everything becomes a complex integrated circuit, there is not enough manpower around to copy them and duplicate them in functions of the same kind. Since they are functionally specialized, there are much more difficult problems in applying them. These advantages are interesting from a military standpoint.

There are problems in computer aids to design. The next slide shows a significant problem with design cycle.

DESIGN CYCLE FOR
35K-50K GATE COMPUTER



EDUCATION (SYSTEM APPL.)
EDUCATION (TECHNOLOGY)
SYSTEM DESIGN
COMPONENT DEFINITION & PROCUREMENT
ASSEMBLY
CHECKOUT

The bottom sector shows the time it took to design a system from conception all the way through working hardware by a major manufacturer using SSI. The cross-hatched section is component selection and design. The supper sector is LSI design cycle. Although the total has become shorter, the cross-hatched portion has become longer and is a much larger proportion of the total cycle. As the industry goes to VLSI the problems represented here are going to come back on the commercial manufacturers and the pressure will be on to solve those problems.

There is the significant problem of economics. It costs between $60 and $400 million to build a factory to make VLSI and no abatement is in sight. Unless the ability of the equipment to produce more circuits in less time using less floor space improves, there is a big problem in economics. In the final analysis, it may be the ultimate problem.

The alternatives are shown on the next slide.

ALTERNATIVES:

- OTHER SEMICONDUCTORS (GAAS, INP, SOS)
- OTHER DEVICES (J-J'S, BIO,...)
- WAFER SCALE INTEGRATION
- 3D,...

One is gallium arsenide. In some opinions the promise of gallium arsenide is considerably more limited than that of silicon for reasons of density and compaction. It is good for optical interconnects, high frequency fron ends where low noise figure is an important issue, for high frequency efficient power amplification, as in battery powered equipment and in certain types of microwave monolithic integrated circuits gallium arsenide will be the material of choice. It will not be the material of choice for large, very complex die. The integrated circuits of gallium arsenide will tend to be simpler but very high speed functions.

Wafer scale integration is one means of solving a complex packaging problem - to get more things closer together so that path lengths are smaller.

Josephson Junction, biotechnology and that kind of thing have not paid off to the extent that they look like general commercial VLSI made of silicon.

Three dimensional is probably where going beyond the planar technology lies. There will be devices, stacked one on top of the other. Using the third dimension is probably the best bet we have. When we run out of three dimensions we will really have a problem.

The final question is how far can we go?

HOW FAR CAN WE GO?

- To 1/2 MICROMETER, AT LEAST
- UNKNOWN PROBLEMS WITH SMALLER DEVICES
- SIGNIFICANT IMPROVEMENTS ARE POSSIBLE WITH PROPER PACKAGING!

Certainly the technology exists to get to a half micron - unlikely in two years; 3 or 4 years is a better bet. There should be a megabyte RAM's in the 1990's - a lot of memory in a very little space but there are no fundamental technical problems keeping us from getting there. Beyond the half micron level and that level of complexity there are some real fundamental problems. 3D is a possible answer. The real answer will be the animal cunning of those who succeed us working in VLSI. The old Chinese curse: "May you be condemned to live in interesting times" certainly applies to us in the commercial VLSI business. It is a technology which is emerging and will continue to do so at least for 10 more years. To take a defensive strategy and try to keep others from getting the technology is less important then to try to maintain a good offense, to push the technology as fast as we can and keep ahead of the pack.

The following points were made in answers to questions, comments and responses:

... In considering the Strategic Computing Program, the programs all go from the idea down to the chip. Tools do not exist to go the other way. If there is an attempt to steal a system and we produce better and better means of producing systems, they have to learn what we did to do the one they want to steal, so we would already be ahead. Seems more of an espionage problem rather than a technological problem. The question is not to reverse engineer a single chip. If a lot of chips are custom and there is no longer a large number of standard part types, the number of chips that have to be reverse engineered becomes overwhelming.

... Ada was not designed for artificial intelligence although it has a number of nice features (for AI). Researchers should do research with the tools that suit them best. If LISP and MACLISP and PROLOG are useful in doing demonstrations of AI concepts, that is what they were designed for. If the purpose is to build an AI system like a mission critical system with documentation, testing and reliability that is what Ada was designed for. Ten years from now, we may be able to build mission critical systems with LISP-like derivatives of that time. But in ten years when we will be getting artificial intelligence into our weapon systems, there may, and probably will be different ways of developing those programs than the languages we have now. In the Strategic Computing Plan first years Ada and LISP environments are called out for the multiprocessors which will emerge. It is recognized that Ada is a good thing to use and it will be used to the maximum extent possible. There are some things the AI research community doesn't like about Ada and no attempt will be made to jam it down their throats. The kind of systems which will be developed using the LISP environments will perhaps be very large scale systems and they will have to face the large scale software engineering problems which Ada very well addreses. It would not be surprising to see that, about five years from now, there may be a convergence of Ada and LISP into some refined version of Ada which supports AI very nicely.

... A revision of Ada standards is anticipated in 1988. One of the things which was avoided in the study for Congress was the evolution of Ada because it was felt the program had a signficantly long life so it was not a matter for concern. If we look 15 to 20 years ahead it will be natural to see Ada not only evolving to future versions of standard but also become a language like COBOL or FORTRAN in very wide popular use but one that is not representing the thinking of the day. So something like that should be anticipated and dealt with somewhere along the road. There is enough of a technology base in the language area in this country so it should not be a problem. New directions will emerge and advantage will have to be taken of them when they emerge.

... U.K. experience with an MOD standard language, CORAL 66, shows it takes a long time to get it established and one of the problems, both hardware and software, is assurance that the compilers will produce effective and "safe" code. The theme of these discussions, both hardware and software, is toward increasing complexity and size of capability which is excellent. A price seems to have to be paid in difficulty of assurance that the result is what people believe it is. The (Dr. Howard) slide on testing addressed this point to one of those major problems. Testing from the standpoints both of design verification and minimum test vector spaces required to thoroughly check out all the states of the machine so that it is kown that there isn't a hidden flaw in it. This is a major problem which is not getting solved. There may be a catch in this whole thing that this (assurance) problem is unsolvable. The same applies to software with its layers of support software, build standards and so on. One advantage in building a VLSI chip, and there may be a software analogue, before it is put in a package, it may be possible to get probes inside the circuit that may not be accessible at the outset. So there may be ways of dividing the problem into smaller more soluble problems. The chart was intended to show that there are several ways of getting (this capability). One is to increase the speed at which testing goes but, because of speed problems it is an unlikely alternative. A second is soft test and diagnostic firmware actually embedded in the die itself. The compoents will check themselves out and signal the outside world that check has been made and they are ok. Built-in test is the currently popular term for it. Another would be a privileged set of instructions so someone outside can reconfigure the machine along the lines of separation of memories the registers, the counters, the processors and so on and test them separately - a modularization. The final way is stop advancing complexity because it cannot be tested and it is to be hoped this does not turn out to be the case.

... Another point on using Ada as a focus for (OSD) activities. There has been considerable interest in the computer science community about formal definition of programming languages and formal methods for deriving software systems so that it could be assured that as the software development process progresses from step to step that (each step) would be done in an error-free way. There are very few people who have the background to adequately address that problem, and, in many ways, their energies have been dissipated in discussing toy systems. The EEC along with the Ada Program is sponsoring work in the formal definition of Ada and formal methodologies to see if that kind of work cannot be pushed in assuring the correctness of every step to cover a full programming language of the complexity of Ada - stage to stage transition in an error free way.

... This last approach may be solving the wrong problem exactly right. In the large complex military system with software the requirements keep changing continuously at the front end. They are not well specified and as one goes three to four to five years downstream in a software development project, even though perfect tools, perfect testing and so on are available, the end result may not be what is really wanted and it may not be known as the project progresses. Until that whole process is fully automated and have ways of going both directions - requirements all the way to code - project people cannot be assured it is correct.

... The program development process starts at the top with a decision to build something. The process proceeds down a decision tree where decision is made at each stage to do something and it moves to lower and lower stages, implementing the decisions above it. A lot of manual work is involved in each decision step. OSD/Ada Program Office would like to automate each of these steps in such a way that when a test is run or a program is modified the point of decision for the item to be changed can be traced back (by an expert system in strategic computing) and the correction through resulting subdecisions can be made.

... The design of the system may be lost and the knowledge used in developing the concret code may not be available in explicit form. If it were captured automatically there would be an explicit representation of the design.

SESSION III

THE EVOLVING PARTNERSHIP – CONGRESS/MILITARY/INDUSTRY

Chairman: Dr. Lyon B. Lyon, Jr.
Manager, Government Relations
Texas Instruments, Inc.

Panelists/Speakers:

Senator Jeff Bingaman (D-NM)
Senate Armed Services Committee

Dr. James P. Wade
Principal Deputy Under Secretary of Defense
for Research and Engineering

Mr. Larry Sumny
Semiconductor Research Corporation

Mr. John C. Cittadino
Director Theater and Tactical
Command, Control and Communications,
Department of Defense

DR. LYON

Opened Session III with the intention to cover four things.

First is the context of MILCOM III and Session III. MILCOM I and II were conducted without knowing how far and long it would take to get some issues clarified but it appears that they are beginning to pay off. From initial stressing of differences, through identification of some elemets of partnership, the concern was then whether or not enough pieces were identified and properly structured. In MILCOM III it is clear that there are a number of activities underway, that they can be related much better and that dialogue and communication must be improved. Yesterday morning users were asked to set forth the problems of the future. In the afternoon response in meeting those needs was presented.

This morning, leaders in their communities have been asked what additional needs to be done - as the glue between those islands of activity. In the area of politics of technology it needs to be stressed that the U.S. is regarded as underusing its technology while others are using theirs to a greater extent. The U.S. has a tremendous technological heritage and activity but there is a question that it is being brought to the national security interests properly.

The second point is that the Soviet Union does not have a commercial industry. Their leading edge technology is their military and it nearly all goes to national security. It determines the fielded capability of the Soviet Union. The U.S. is the opposite and its commercial marketplace is rolling over the technology every two or three years. It must be captured and brought to the Defense Department's needs.

The third point is the need for a positive attitude. The general fault-finding and over-concentration on the source of problems does not solve them. Constructive ways to solve problems are needed and they should be moved forward with a positive approach. There is evidence of that beginning to happen in yesterday's sessions.

The fourth point is that this Session III will be talking more about leadership than management. Some perceive that there is a broad attempt to manage a way out of leadership problems. Leadership is not only projection of the leaders will but creation of a climate for innovation by subordinates and motivation of people to do their best - not just a passing grade. There is a potential in the U.S. for both good leadership and good management and it must be tapped in the national interest.

An attempt was made to get people in this session who, by their sheer physical presence and commitment to principles would get the rest of the community together. They will be addressing an audience that as middle management is the group, as much as any of the country, that gets things done. If they are convinced things will change.

Senator Bingaman

Although new to the Senate and the subject of MILCOM III, Senator Bigaman stated his awareness of the substantial funds going into this area and his desire to pursue the subject and to try to make decisions on an intelligent basis. As a member of the Armed Services Committee, I am aware that computer technology is essential to this country and that it is essential that we reverse the trend of the diminishing lead we have in this area. The existence of this seminar is clearly testimony of the need for government industry and the academic world to come together if we are going to commend ADPA on having this conference and I hope it is an event that continues in the years ahead.

Twenty years ago, as you know, the United States was the undisputed leader in computer technology in the world. Our European and Japanese allies were emerging from post-war reconstruction. The Soviet Union lagged far behind in microelectronics and computer technology. Today, we face signficiant challenges, particularly from our allies in the commercial world and from the Soviet Union with regard to technology. Our alles are challenging us for the marketplace in the sale of these commercial computer capabilities. Over the last twenty years, Japan has emerged as a major competitor in this market. Japanese industry and government have worked together to all but eliminate our lead in very large scale integrated circuits, super-computers and some other areas. The national supercomputer and fifth generation computer projects in Japan are clear evidence what the Japanese have set themselves a goal of achieving superiority over this country and the rest of the world in these technologies by the 1990's. The remarkable success of the Japanese semiconductor industry during the last two decades (is a challenge). We in the United States obviously have to take the challenge seriously. Similarly the Japanese are moving out in the critical area of software development, were they have lagged behind the United States. They are now making intensive efforts to develop an automated software factory. We see similiar efforts in Europe both nationally and in the context of the European Economic Community. The EEC has drawn up its own joint information technology research effort which it is hoping to begin in the near future. This proposal envisions a five year program with a $1.3 billion budget to cover the entire spectrum of computer related research from microelectronics to software to artificial intelligence. This would complement such national programs as the $500 million British micro-electronics research program announced last year.

The question is: How should this country react to the challenge from abroad? What are the respective roles of government, industry and academia in meeting the challenge? I am confident that we can meet the challenge and that we will. In recent years remarkable changes have been made in the private and public sector's efforts. Industry has rapidly increased its research budgets and denoted more attention to building infrastructure for the long haul. The Semiconductor Research Cooperative is helping hard-pressed universities to expand their basic research efforts in new semiconductor technologies. Micro-electronics and Computer Corporation with a projected budget of

$50-80 million annually will work in generic information technologies. The Defense Department has launched research programs to improve the technology available to it. The Ada Higher Ordered Language development and the Very High Speed Integrated Circuit program have been successes by all accounts. DOD is now launching its Strategic Computing initiative and the STARS program and these promise to make substantial contribution to future weapon systems and have significant spin-offs for the private sector. I understand that Mr. Battista addressed you yesterday and gave some reservations concerning the strategic computer program that DARPA has indicated it will try to pursue. I agree that perhaps additional amplification is needed. Nevertheless, I think that proposal and similar proposals have been very useful in stimulating discussion. They will undoubtedly be highlighted in this year's fiscal budget. The President will submit that next week and we will get the specifics of what he has in mind.

One question I would have about the STARS program is whether it will do enough to stimulate basic research on software principles at our various univerisities. The proposal on the Software Engineering Institute seems to be more applied and short term. To quote from its description "It is to engineer and bring into military practice emerging software technology". My question is whether it would be useful to complement the Software Engineering Institute with a small basic research program on computer software. This is to be funded at select group of universities on a fairly modest level. I have in mind the model of the Joint Services Eletronics Program which has made so many contributions to basic electronic semiconductor research since World War II.

Let me turn back to the major question before us: Does the DOD R & D computer effort and the much smaller efforts of the civilian agencies combined with the massive private sector spending on research and development all add up to an adequate answer to the challenge we face from aborad? I am not sure that they do for several reasons.

First, I am concerned that we as a nation, and just on the policy level, do not pay enough attention to the education of the students in math and science which will be needed to man these efforts. This is not a problem which the Federal Government can solve alone. It is primarily state and local governments which must improve primary and secondary science education. But the Federal Government can make a difference at the university level by providing research support and improved instrumentation to professors and research assistant-ships and fellowships for graduate students. Federal programs in these areas today are simply in my view not commensurate with the need. Both the military and our society as a whole will suffer unless the science education gap which exists between ourselves and our principal competitors is not narrowed.

Secondly, I worry about the fact that our economic competitors are focusing their government subsidies almost entirely on the civilian sector of the computer industry whereas we carry the disproportionate share of the science alliance burden in developing military computers and their software. For carrying that burden we get some civilian spin-offs but certainly far less than we could reap if some of those resources were devoted to civilian applications. At how much of a disadvantage will our private sector firms be in the long run and do we run the danger of yielding much of the civilian market to our subsidized competitors even as we retain world leadership in military computer technology? On the other hand, would we really welcome the two-way street in weapon systems which would accompany a more equitable sharing within the alliance of the defense R & D burden? Or do we need separate government programs to spur computer technology for civilian applications?

Some would argue that this would be a civilian industrial policy to complement the military industrial policy we may already have in this area. I don't have the answers to these questions. After one year in the Senate I am still just trying to learn the questions. I can assure you there is a bipartisan consensus in the Congress on the importance of computer technology to our national security and to our economic competitiveness. There is also an enthusiasm among members of the Congress about the possibilities that future computer technologies will create for our nation. I don't think the relationship of the Congress with DOD and industry needs to be adversarial. I gather that is one of the questions that has been posed for this panel. You can question, and many people do (Dr. Wade may elaborate on this) whether Congress needs to consider in the budget process the level of detail that it, in fact does consider in this day and time. We do, I think, tend to look at the trees and not the forest and at the short term and not the long term. But the reality seems to be that at least 90% of both the Armed Services Committee's and Defense Appropriations Sub-Committee's time is devoted to detailed scrutiny of every line item in the Budget which the Department submits.

This year I am committeed to being one of those scrutinizing the computer-related line items and would welcome your help in doing that. I would also welcome your suggestions for what can be done by those of us in Congress who are attempting to be helpful and constructive on this issue. I hope that we can all say in ten years that we are in a better position vis-a-vis the Soviet Union and our economic competitors because of decisions we made today and discussions we've had at this conference this year.

DR. WADE

Opened by expressing appreciation of DOD for ADPA conducting MILCOM symposiums. He stressed the great importance of getting people together to talk through these kinds of problems, returning home, sharing experiences and looking toward the future in solving these problems which are so important to the national defense of the United States. In discussing the topic of DOD relationship to Congress Dr. Wade set aside a lengthly prepared treatment in favor of focusing on a couple of points as precursor to questions and answers.

Previous speeches have made it clear that software items are now on the list of first priorities for the Department of Defense. It was not always so and DOD feels it is important for ADPA to impress on all of its members the seriousness which officials in DOD and OSD see the problems of software definition, procurement and maintenance.

The word maintenance "in the case of software actually hides the fact that in data processing more than any other part of DOD activities, there is a need for continuous evolution of (software) programs to take into accout changes in geography, doctrine, threats and most important, the commander's style. Rephrasing these words to convince this MILCOM III audience, the DOD - Industry partnership needs to go far beyond Ada, VHSIC and SIARS initiatives. DOD and Industry must together find a way to express and particularly Industry to receive a clear definition of what those in the Department of Defense need.

The word "Requirements" is often loosely implied and used to define what DOD needs. The problem with software requirements can be and often is used radically in the wrong way in the context of trying to compare them to hardware requirements. An example from the area of Command and Control. It would be utterly unacceptable for DOD to have software that would impose on the Commander a style that is really not his own. In this case, the requirements change when the users change, a situation which occurs very seldom with specific hardware. This is the reason why software maintenance, if properly understood, becomes of great importance in the scheme of things surrounding the software issue.

Software then must be made also to evolve and follow the unavoidable change in geography, in the character of the enemy and the threat that he presents. There will always be changes in doctrine, weapon characteristics and, most importantly in the Commander's style. Put another way, DOD procurement procedures in this area must not be based on the incorrect assumption that the software package has the peculiar characteristics of immutability that one would characteristically give to a radar, a weapon system, a gun or a shell. If one were trying to find a hardware analogue to software, a display comes to mind. A display does change depending upon the user, upon strategy and upon doctrine. It is the responsibility of DOD and Industry to understand in the case of software, more than any other form, how the user or users influence the (software) program and that is how evolution comes about.

Following the discussions of yesterday, Industry is hereby offered to continually come forward, and tell those in DOD and OSD how they can do better, and how they can evolve at a faster pace to get to more satisfactory solutions in the sense of our operational weapon systems. In this conference, there is visible a better interaction between Industry and DOD and the Congress. It can be seen how to work together better in the future. As an example, the recently completed CODSIA report shows how all parties can work together in the future so that at the end of this decade there will be solutions the very serious problems of the last several years.

Answers to questions, comments and responses brought out the following points:

... Software should not pre-empt the commander in the sense that his style should not be pre-ordained by the software. The STARS program has adaptability in its title. A case in point is modification of British software enroute to the Falkland Islands which resulted in crucial contributions to the British success.

... Technology time is very short compared to configuration change and related management times. It takes years, literally, to get solutions to software problems into the field. It is not as much technology as management systems of technology that is needed to bring about changes in the field. Changes to airplanes get into the field four years later and yet the software changes. There needs to be in parallel with STARS etc a look at the management structure of programs to permit making changes in a reasonable period of time.

... The foregoing comment applies to more than software and is an endemic problem across the whole DOD. U.S. has superior technology vis-a-vis other countries but the same cannot be said of embedded technology. The problem has to be thought of in two regimes. The first is that the weapons system plan going

into DSARC ZERO must have provisions for these problems. The second is that Preplanned Product Improvement becomes more important downstream. Ways to insert new technology (promptly) must be found. We should not wait for the last 5% of the solution

it will cost more. If insertion is planned over time we will make progress.

... Returning to the question of the style of the Commander and adaptability to it, it is not clear that Ada or STARS or SEI is really addressing it but may have capabilities to provide for it. It is also not clear that there is any program which identifies that requirement or specifies what "style" is. In response, it was pointed out that in stratigic C^3 there is a set line of National Command Authority from the President on down, it is necessarily stylized and the process is clear. In tactical (C^3) systems there are different geographics, different areas, different threats. It is important, and must be appreciated that when the Commander comes in he will have his own way of doing things and how he will plan through to conduct his area of responsibility. This must be taken into account and C^3 is the area in which it applies.

... Doctrine can be too rigid - so rigid that if it is not effective alternates which are effective may have to be employed. So rigid that corrections to doctrine and its implementation cannot be put in place effectively. A number of scenarios for high technology would appear to make us scenario dependent and we become locked into an employment scheme that denies us the potential of (a particular) weapon system.

... Given that gallium arsenide offers similar powers to CMOS and silicon, and perhaps better throughput, its import to DOD is such that the program is being pushed in DARPA with very, very high priority. There are some very important aspects to it in radiation hardness. Focal points are DARPA which provides seed money, initiative and (authority) to proceed with new technology without requirements, and the Services.

... Preplanned Product Improvement and technology insertion have been discussed for future systems. Given the tremendous investment in strategic and tactical systems (now in inventory) the question of streamlining improvements in hardware and software in a kind of conventional product insertion in these systems in of interest. This process appears to take from 5 to 7 years from future requirements to arrival in the field and (comparatively) is shorter than the 12 to 15 year cycle for new developments.

... The above point is well taken. It is much easier for Preplanned Product Improvement if the system is designed to make changes with subsystem components without tearing the vehicle apart. 963 is an obvious example. In the main emphasis is to make sure that the system specifies when they come to DSARC will permit asking that kind of question - looking downstream. Regarding current systems it is more difficult but an area where money can be saved. The vehicle is not the gut of the system, but the weapon system that is on it. At the same time, there is the tendency within DOD that if there is money for the vehicle today and it is bought, then downstream money will be found for the ammunition or the smart system. The tendency is being fought. The OSD approach is to focus more on the "smartness" of the system and make the platform last longer. Congress and Industry work together and put that kind of "pressure" on the "system". The participation of Israeli scientists in military assignments and the quick turn around to meet very near form requirements, rather than to 5 to 8 to 10 years downstream requirements is of interest. The whole problem (of updating) is tough especially when budgets go down.

... Related to the above issue is that one of the first and most efficient uses of CAD/CAM and Robotics will be small lot manufacturing of spares, ability to get data packages, and make adaptations in the future in existing systems. A number of CAD/CAM and Robotics issues focus squarely on inventory and ability to deliver new designs and high technology portions into installed systems much more rapidly.

Mr. Sumny

This is a perspective on the Congress/Military/Industry partnership from the vantage point of an official in the Semiconductor Research Corporation (SRC). It is one of two cooperative industry programs attempting to deal with the competition coming from our allies. The other is Microelectronics and Computer Technology Corporation (MCC).

SRC - with a connotation on this slide of both cooperation and corporation - wanted to incorporate as a cooperative but there were obstacles. So SRC is incorporated as a corporation engaged in cooperative research.

SRC is a not-for-profit corporation that was established by the semiconductor and eletronic systems industry in this country because of recognition of neglect in many respects of a significant long term research program which would provide for improving the competitive position of the industry in the world market. The 64K bit RAM was perhaps the thing that brought the problem to the surface and caused the industry to seriously examine where is was and what its problems were. Traditionally, in the past, the industry, because of profit problems, focused on tomorrow's rather than next week's or next year's problems. It had gotten into a position where the direction of long term research in the industry needed additional attention. The industry put together the SRC and it was chartered to begin one, without government involvement and two, to start in the university community so that perhaps two problems could be solved at the same time. It was recognized that the education of the engineers that the industry needed was increasingly becoming more multidisciplinary. Perhaps SRC could play a role in making the education of these engineers more relevant, while at the same time, defining and executing a focused yet generic research program supportive of the needs of the industry. That was the original charter and SCR is up and running at this time. SRC has been in existence about 18 months and currently has about $15 million worth of contracts in the university community that focus on eight major thrusts important to the semiconductor industry. SRC is looking at what might be done in the longer range.

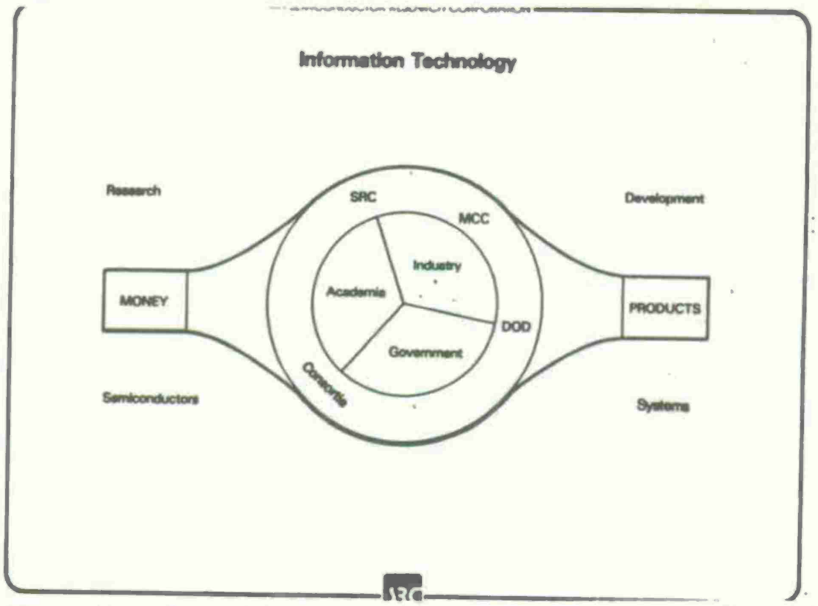
SEMICONDUCTOR RESEARCH CORPORATION

Trends and Context

- The previous separate domains of materials, devices, circuits, architecture, algorithms, and software for digital systems are rapidly merging into an interdisciplinary "Information Technology" continuum.
- The country is beginning to recognize "Information Technology" as a cornerstone of the economy.
- The Department of Defense is beginning to recognize "Information Technology" as a cornerstone of the future defense of the United States.
- The equipment to do meaningful research and development in this field is becoming increasingly expensive.
- Because of the importance and the expense, cooperation between the government, industry and academia is necessary if we are to compete effectively in the world economy.

SRC COOPERATIVE RESEARCH

All of the trends and context on this slide are known. As the semiconductor industry matures, its products become systems on a chip rather than integrated circuits on a chip. With interdisciplinary information technology in mind and recognizing its rising research and (almost) prohibitive equipment costs as well as its importance to the national economy, cooperation between government, industry and academia is obvious. We must explore alternatives to strengthen the link between them. That is the major point of this presentation.



The flow of information technology is shown on this side. The status and trends of industry are shown on the next slide.

STATUS AND TRENDS OF THE INDUSTRY

- Merchants — Capital shortages
- Vertical Integration — Increasing trend toward
- Japanese — Market penetration in key and targeted areas
- European — Stagnant but expanding cooperative efforts

The merchant manufacturers of intregrated circuits in this country, as compared to the Japanese (who are not really merchant manufacturers) are short of capital because of the profit margins associated with selling integrated circuits.

In Japan, semiconductors are sold by vertically integrated firms that make their profit primarily (and with some simplification) from the sale of systems. In integrated circuits they do not have to recoup the cost of the increasingly expensive design associated with them.

The "PROBLEM" is shown on this slide.

THE "PROBLEM"

- Increasing difficulty of U.S. merchant houses to compete
  - Trend toward U.S. market dominance by world competition
  - Major costs of new/future architectures, e.g.:
    - $40M — IAPX 432
    - $100M — 1 mega-transistor custom design
  - Projected high costs of manufacturing facilities

The trend is toward domination of the U.S. market by other countries. Examples indicate the cost of new and future architectures. There is little or no room for mistakes in the climate of these kinds of design costs. Projected costs for facilities are in the $100M range by the end of this decade.

The next slide addresses the U.S. strength in facing this problem.

The ultimate strength of our defense is the strength and capability of our industry and the strength and will of our people.

Emphasis will be placed on the strength and capability of our (semiconductor) industry.

The VHSIC program addressed certain key aspects from the military point of view from the beginning. Some needs not included in the VHSIC program are shown on the next slide.

NEEDS OF THE DoD NOT MET BY VHSIC

- Research
  - Silicon, materials, processes, devices
  - Manufacturing
  - Design
  - Systems – Beyond silicon
- Faculty
- Students
- Generic development for commercial industry
  - CAD
  - Architecture
  - Packaging
  - Software
  - Devices
- Stable, profitable items to generate capital to plow back into research
- Generic research and development support from the users to keep generating new commercial products
- Advanced VLSI process across the industry

They include major research initiatives in silicon and various materials, in processes and devices, research into manufacturing, research into design systems and, particularly into those system looking beyond silicon. It does not address the problems associated with university faculty or the training of students. It specifically avoids generic development for the commercial industry. It was established to meet the military needs in the integrataed circuit arena. So, such things as CAD, architecture, packaging, software and devices, as viewed from the generic standpoint of the industry are not addressed. VHSIC does not address R & D along the line of products that are stable and sell in high quantity such as memory, for instance. (These are) things it almost totally avoids. The generic research and development from users to generate new commercial products in something it does not address. The establishment of a generic long term process that is product independent is something the industry desperately needs. Again, it is something VHSIC does not address. These are not shortcomings of the VHSIC program which obviously has its objectives. These are things that the industry views as essential that VHSIC does not address.

What the semiconductor industry has done toward solving some of the problems it sees are shown on the next slide.

WHAT HAS THE SEMICONDUCTOR INDUSTRY DONE?

- Formed SRC to support generic research, faculty, and students
- Formed MCC to do generic computer technology development
- Lobbied Government and Congress for
  - R&D tax credits
  - Reciprocal access to foreign markets
  - Capital funding relief

Support of present and new faculty and students is especially important. MCC is a for-profit corporation to do generiac computer research. It consists of many of the same houses as SRC-systems houses, military houses etc. Some semiconductor houses are looking at MCC.

SRC strategy for the future is shown on this slide. Expansion of research in the university community may research $20-$25 million from our member companies who now number nearly 30. They range from major systems houses such as IBM, CDC and Honeywell to many semiconductor houses such as Motorola, Intel, National Semiconductor, to A&D houses such as General Electric, Westinghouse, E-Systems, Goodyear Aerospace, to equipment houses such as Eaton and to chemi-

SEMICONDUCTOR RESEARCH CORPORATION

SRC Strategy for the Future

- Expand Contract Research
  - —Centers
  - —Thrusts
  - —Elements
- Expand Research Base
- Expand Education Activities
- Increase Emphasis on "Systems/Components Interaction Thrust"
- Add Research Thrusts
  - —Software Research
  - —System Science
  - —Etc.
- Add Development Thrusts
  - —Memory
  - —Array Processors
  - —Etc.
- Discuss Establishment of Generic Research and Development Facility

SRC
COOPERATIVE RESEARCH

cal companies such as Union Carbide etc. They are a broad spectrum of companies that recognize the problem and have signed up on the dotted line to help solve it. SRC would like to expand the research base beyond silicon to gallium arsenide. SRC wishes to expand research in architecture because many of the payoffs to the semiconductor industry in terms of reduced costs will come through the design and architecture route rather than materials and devices. The key is the establishment of a generic Research and Development Facility that will carry research results on step further for this industry - always in a generic sense.

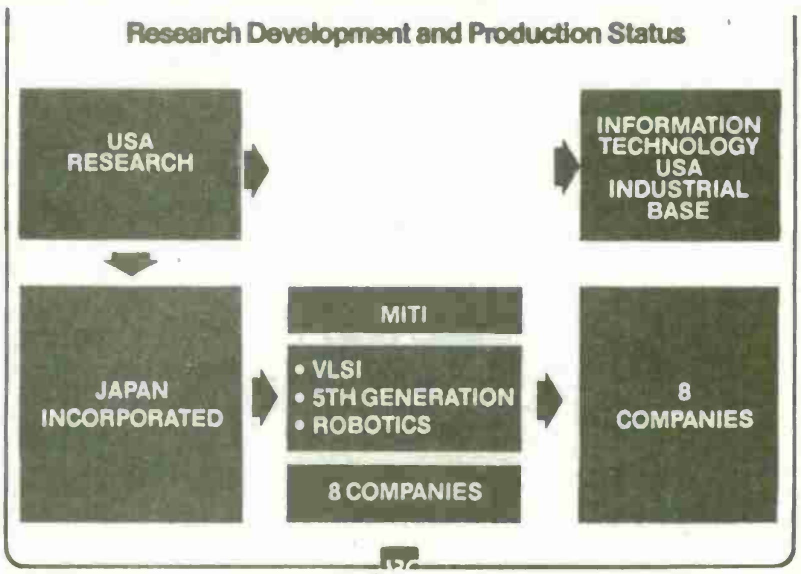
SRC goals as shown on the accompanying slide are

SRC GOALS

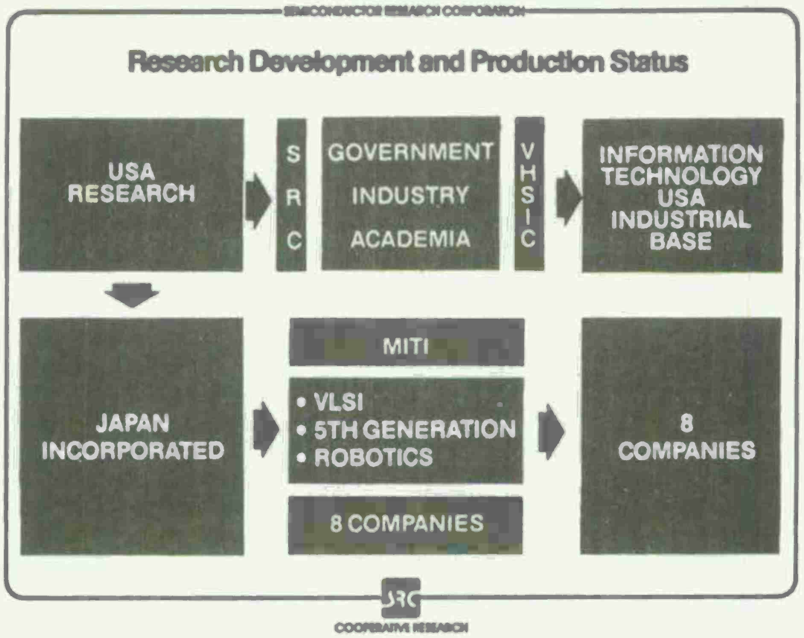
- 1000 Graduate students supported
- 300 Faculty supported
- $100 million per year budget including facilities and development under discussion
- National {Industry / University / Government} Research facility
- Integrate the information technology research domain
- Help the U.S.A. to dominate the world of information technology

1000 graduate students supported of which are there 350, 300 faculty supported of which there are 150 and a National Research Facility involving Industry, Universities and the Government.

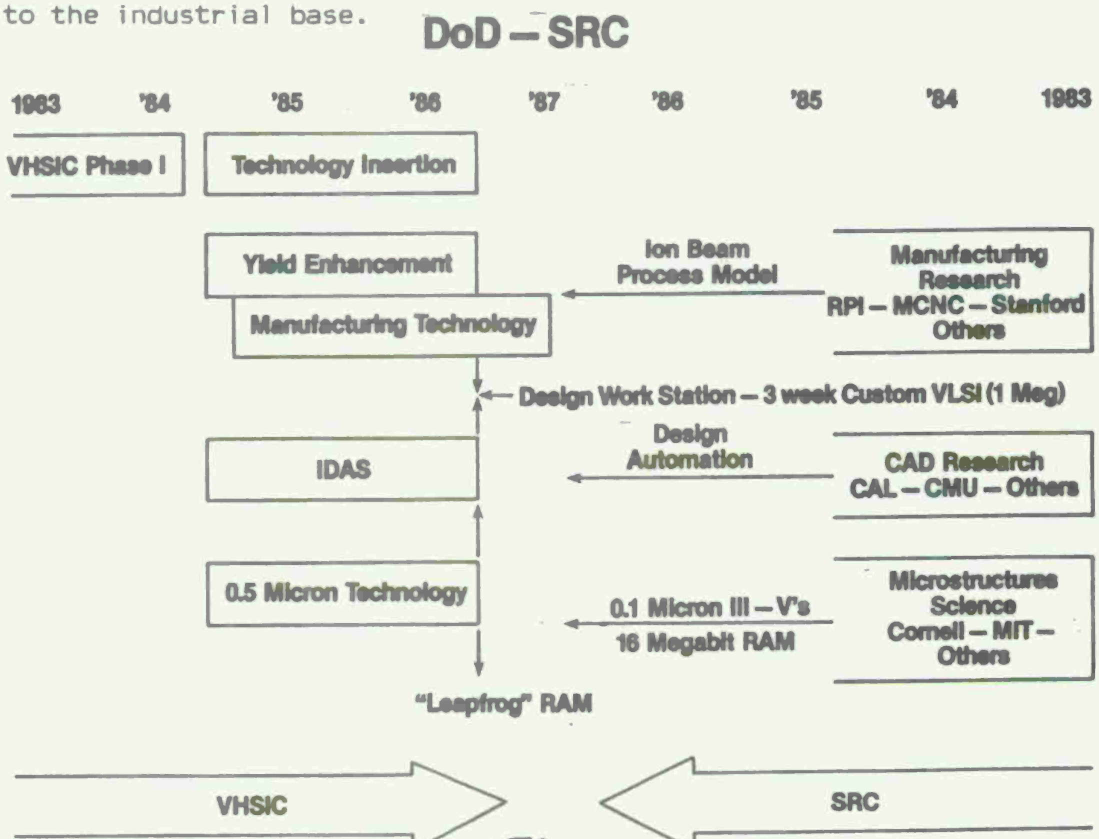
Research Development and Production status as shown on the next slide compares U.S. and Japanese processes.



A major problem for the U.S. is transferring its major research and development thrusts into the industrial base. Japan has found ways to address that problem for their country (which may not be satisfactory for the U.S.). They have shown an efficiency in going from research to the semiconductor arena of 8 major companies using MITI, VLSI, 5th Generation and Robotics with the cooperation of the 8 companies.



As depicted on this slide, SRC liked to think there is some way that, by recognizing what VHSIC and SRC are and their goals are, the government, industry and academia can be brought together to help the U.S. transition, in a more efficient and effective manner, from research to the industrial base.



The accompanying slide shows comparative DOD and SRC schedules, 1983-87, with VSHIC and its several components up to 0.5 micron technology in the 87 time frame. It also shows SRC with all its components coming to 0.1 Micron III-V and 16 megabit RAM in the 1987 time frame. Hopefully the two can be synergistic resulting in leapfrog technology advances for the U.S. in semiconductor electronics.

CANDIDATE "LEAPFROG" DEVELOPMENT PROGRAM

- 0.5-micron lithography
- Automated manufacture
- Automated CAD
- Flexible
- Variety of device demonstrations

Future

- Wafer scale integration
- Integrated CAD – CAM – CAT
- Maskless lithography

The elements of a candidate leap frog program are shown on this last slide. All of these program elements would emphasize generic research and resulting flexible capability.

In summing up it is emphasized that many of the leaders in the semiconductor industry played major roles in formulating underlying thoughts and concepts in this (SRC) program. They are most interested in what role the government might play in it. They feel the time is ripe to gain industry participation in SRC and are interested in what role the government might play. They would like to see the government participate with both finances and spirit. Thus the impact of cooperation could be increased. The recent SRC Workshop on gallium arsenide, in which the government participated, is an example. The result was a research program starting at $500-600K and growing to $1.5M per years. SRC would like to have government participation in further plans and actions so as to include their needs and avoid undesirable and non-productive duplication.

The following points were made in answers to questions, comments and responses:

... Concerning what DOD programs are doing to increase awareness at the Air Force Institute and Naval Post Graduate School, VHSIC worked fairly closely with Naval PG School where some programs tied in nicely with VHSIC program. To date, SRC has not put together programs in either school although they are in talk and under consideration.

... Considerable attention is being paid to the possibility of DOD providing added effort in graduate cirricula which might not be research programs and particularly in the service schools. Curriculum revisions are key in this effort. Visits by professors to service laboratories has been beneficial.

... There is no formal relationship between SRC and MCC concerning CAD. Informal coordination is provided by persons who are directors of both to assure cooperation and avoid competition. Formal ways of getting together will be discussed in board meetings in the next six to nine months. An almost identical set of companies support both and they want to see their money is spent efficiently. There is informal cooperation.

... SRC is a little different from MCC in that research it funds in universities is not restricted to member companies. DOD is finding it difficult to become involved because of the totally free publication policy of SRC which inhibits DOD from becoming a paying member. SRC is aiming for middle ground where government can become involved.

... Concerning implication that there would be a National Research Facility in integrated circuits, it was stated it would be an outgrowth of generic research programs. Sites have been studied and SRC would like government to participate so it can respond to government as well as industry needs.

... SRC seems to have recharacterized the university, to have moved away from the basic research kind of information development that is protected by the Constitution as private information and therefore not subject to prior review and constraints. At the same time (SRC seems to have moved) into the area of universities doing a lot more applied development and what would be considered as commercial technology. This introduces all kinds of questions of rights and prior review and screening of papers whether it be for export control, patent policy, secrecy checks, etc. We have opened up a whole area for dispute resolution are not prepared to deal with or haven't shown a lot of strength in dealing with. This is not only in the semiconductor area but also in biology, genetic engineering and pharmaceutical areas. There is a question how generic SRC programs really are and whether we can stop having all kinds of mechanisms in the university that restrict the free flow of scientific information and set up a whole new culture.

... Response to this comment indicated that apart from possible semantic problems, SRC is not funding development in the universities but is funding basic, and hopefully more basic, research. Basic research does not have to be totally undirected or non-focused. SRC has a standard contract that has been negotiated with over 35 schools that seems to be acceptable to all of them over this short period of time. Since there aren't really major amounts of money involved it is because both sides see the advantage of jointly addressing the problem. SRC encourages schools to apply for patents. SRC allows for open publication after an opportunity to review articles to see if there are patentable ideas that the universities perhaps have missed. Our member companies enjoy non-exclusive royalty. Free use of patents that might ensue from SRC research programs many of the foregoing problems are being addresses and approaches to them will be refined as we move forward. To date there has not been any fundamental problem on either side.

... There is great difficulty in taking a product from development (such as National R & D Faculty) into production, moving it from a partner to another and distributing it to 5 to 20 companies and have them all be able to accurately produce the product. SRC recognizes it as a fundamental important problem is not sure they have the answer and is making a series of visits to interested companies over the next three weeks. It is fundamental to success of anything SRC may do in this area. The thinking is that once the process is understood in a scientific way, in-process monitoring can be provided for and sensors developed to know what is going on in the process (rather than just input and output) and there will be better ability to transfer technologies. Most companies are totally unsuccessful in developing in one place and transferring to another line. The ability to do that is crucial to SRC approach.

... Referring to the "1000 student and 300 faculty" goal, and the current crisis in education, if students are not put into the pipeline at the high school level, there will not be enough students in the pipeline to meet national needs. SRC is not sure how to address that problem. One SRC goal is "to expand education" and high school input is included in that goal. Many of the companies are addressing it on their own in various ways, although not always coordinated with what SRC would like to do. It is under discussion and SRC is looking at it.

Mr. Cittadino

This speaker was introduced by Dr. Lyon who emphasized that there are two distinct areas in DOD requirements in the year 2000. The first is the tremendous amount of internal communication and interfacing with computers and software becoming almost the determinant of system performance. The second is vulnerability between systems and the dependency on communications between cooperative functional subsystems which can not be co-located.

This presentation covers how computers and software fit into the C^3 world, what the problems are, some things being done in DOD and some observations on what DOD, Congress and Industry can do to help (Theater Taactical C^3 Directorate) get its job done. Theater and Tactical C^3 will be emphasized but many observations will also apply to tactical intelligence, strategic systems, counter C^3 and the like.

There is an awful lot of equipment and systems out in the battlefield and it is all, in the future, going to be data oriented. Lines for data exchange between computers will be required. It is a big job to make sure they can be tied together. There are DOD programs aimed at precisely that requirement. Secretary Weinberger will shortly sign the establishment of a new agency called Joint Tactical C^3 Agency. Its main role will be C^3 systems integration and interoperability.

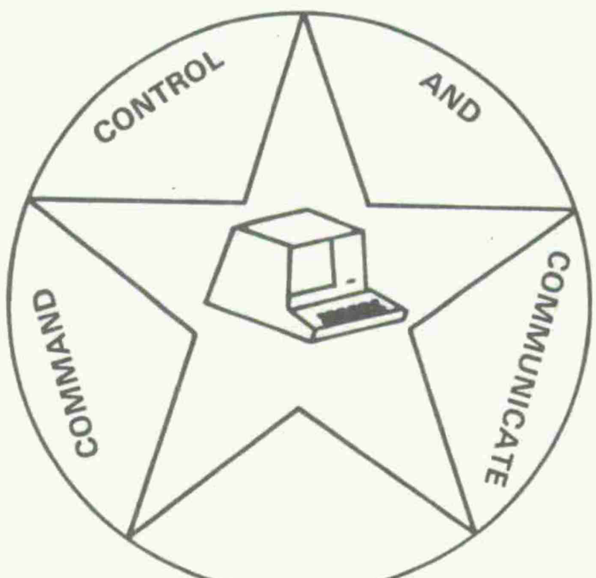
Tactical C^3 systems have to live in a tough environment. Survivability, both physical and in an ECM environment, is very important. Affordability is a very big issue. As an example, JTIDS will provide information exchange between tactical computers in a Navy environment of air, surface and subsurface warfare simultaneously.

The need is shown on this chart.

THE NEED

- **MOVE DATA**
- **PROCESS DATA**
- **DISSEMINATE DECISIONS**

The computer is central from main frames in fixed locations right down to microrpocessors in man-packs for navigation and digital voice communications.



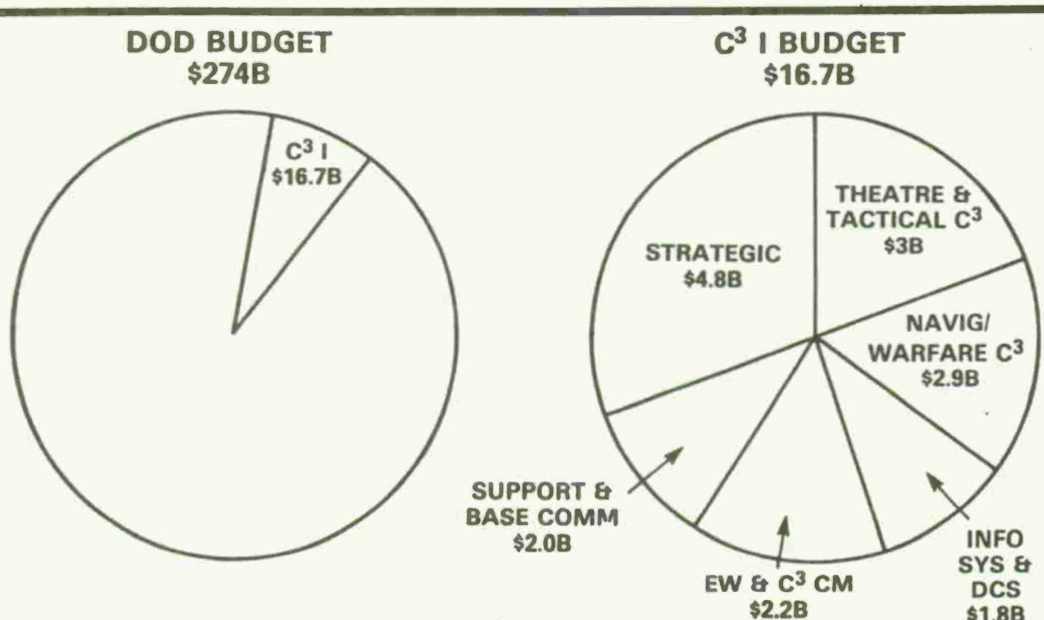
The job of DOD and industry is to get embedded computers out to the troops that need them. It is worth looking at what the job is and how we have been doing it. To an outside observer the solution should be simple.

THE SOLUTION SHOULD BE SIMPLE!

- **POLICY**
- **MONEY**
- **EXCESS TECHNOLOGICAL CAPACITY**

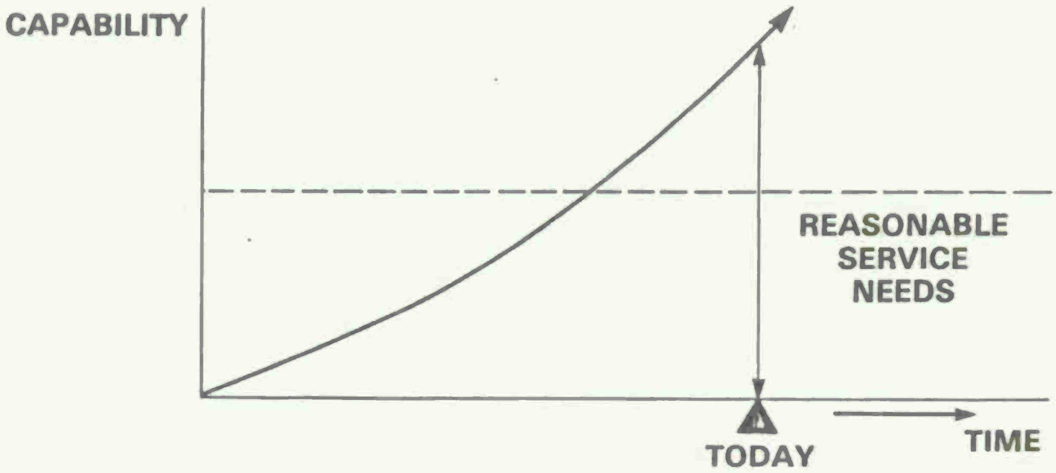
It is policy in the Carter and Reagan administrations that C^3 is a very important high priority. President Reagan in his Defense package named C^3 as the highest priority within our strategic defenses. OASD/DOD officials have led the fight to insure that C^3 is treated with equivalent priority and resource allocation to the weapon systems, that C^3 does not get swept aside by the services in the desire to get more weapon platforms into the field, and that there is a balance there. If C^3 budgets are examined, it can be argued that a lot of money is not being spent on them. The technology we have far surpasses anything in the world and, in the view of some we have more than we need to do the C^3 job.

FY 84 ALLOCATION OF RESOURCES



There was \$16.7B in the 1984 Budget which was out roughly 4% by Congress. Intelligence money is roughly the same ballpark as C^3. Of the C^3 money there is \$6B for theater tactical C^3 and navigation/warfare C^3.

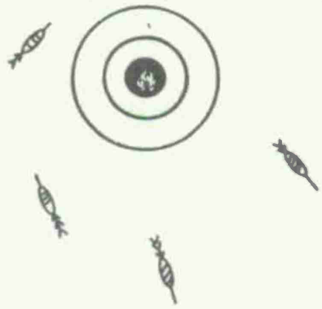
TECHNOLOGY FOR C^3 SYSTEMS



COMPUTER HARDWARE/SOFTWARE TECHNOLOGY HAS EXCEEDED OUR ABILITY TO APPLY IT

As depicted on this slide we have reached the point where technology is not the issue. We have exceeded the requirement for technology capability to satisfy our needs. OSD/DOD is looking at other solutions than just advancing the state of the art. In isolated cases, this is not, so such as VHSIC for processing we need in certain radar systems, and getting anti-jam communications down to smaller sizes. By and large we think we have more technology than we really need.

WE HAVE MISSED THE MARK!

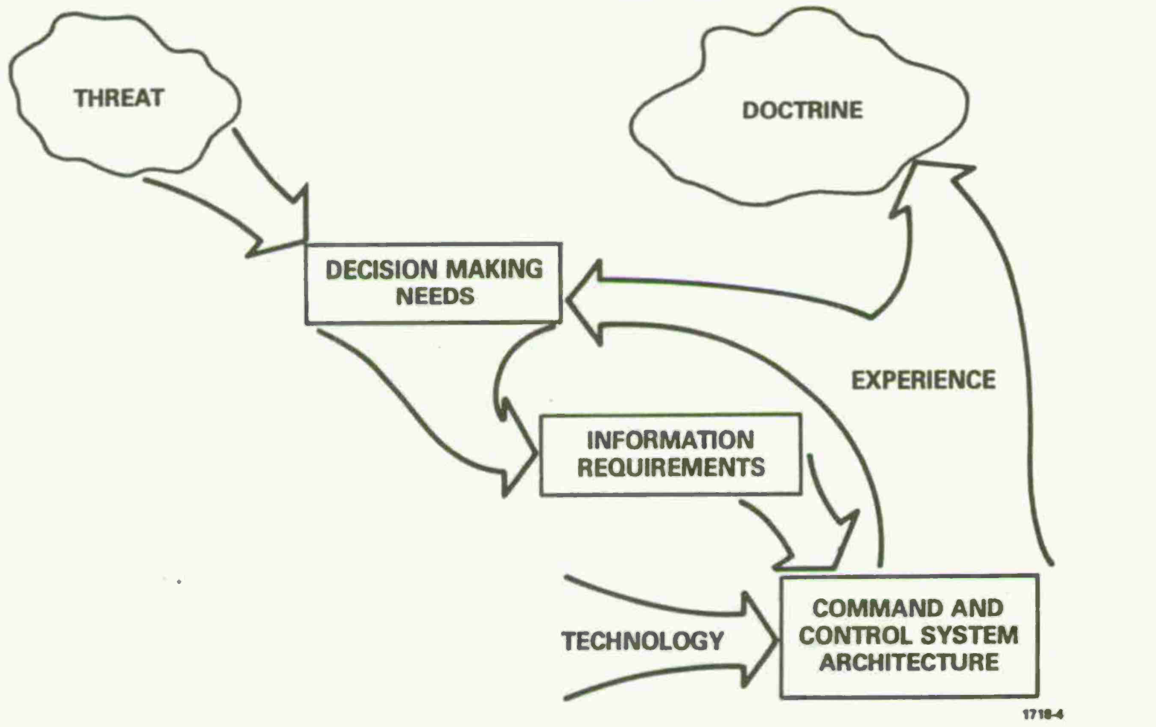


10 TO 15 YEAR DEVELOPMENT CYCLE IS NOT GOOD ENOUGH

So we are at the point where we have, and continue to, miss the mark and where the 10 to 15 year development cycle is just killing us. We should take a lesson from the Israelis. When the war starts, from all military authorities it is going to be a short war. If it is an all out conventional war in Europe, it is going to be a come-as-you-are war. There is serious concern that we are not as prepared for that war as we should be.

Why do we have this problem? Change is the problem we have to contend with. If you are familiar with the environment in which C^3 operates, every element of it is in a constant state of flux.

THE ENVIRONMENT



The threat is changing, doctrine changes to meet the threat, this changes the needs of decision makers and the types of decisions they have to make. That, in turn, feeds back, changes command and control architecture, technology shows better ways to do things which in turn iterates back into the architecture. Within all of this we have to allow the flexibility to send our systems to different parts of the world to be used by different commanders. We have to design our systems to handle the change that is inevitable. In addition to the change in the cycle, there are the basic political problems in keeping programs stable. Congress plays a role in this in their funding of programs and this has a tendency to create a lack of stability. DOD plays a role in that they constantly review programs looking for the better mousetrap that industry tells them is coming down the pike.

There are some things DOD is doing to promote stability and accelerate the acquisition cycle. In the C^3 world OSD/DOD has been using its version of Preplanned Product Improvement (P^3I). Recent AFCEA and NSIA reports give good explanations of P3I process and rationales for improving the cycle. P^3I had its genesis in 1978 when the Defense Science Board Task Force concluded that C^3 systems were indeed different from weapon systems from the development point of view. There is heavy man-machine interaction and flexibility to provide for different commanders (needs) to do the job. They are cheaper to build in development. There is the opportunity to use off-the-shelf equipment to put systems together and this is hard to do with a tank or an airplane.

TO COMBAT CHANGING ENVIRONMENT WE CHOOSE TO USE EXCESS CAPACITY

- EVOLUTIONARY ACQUISITION
- NON-DEVELOPMENT ITEMS APPROACH
- STANDARDIZATION OF MILITARIZED HARDWARE
  - ARMY—MCF/NAVY STANDARD CPU
  - MILITARIZATION OF COMMERCIAL MACHINES (NDI)
- HIGHER ORDER LANGUAGES
  - ADA

Basically, Evolutionary Acquisition says the user defines the requirements very broadly and works with the developer to provide a specification tree. This allows a system to put together in a hurry using existing hardware - military goverment owned or commercial off-the-shelf. An operating system is put together and a minimum set of applications software is provided to do a minimum job for the commander. Then the equipment is put in the hands of an actual user.

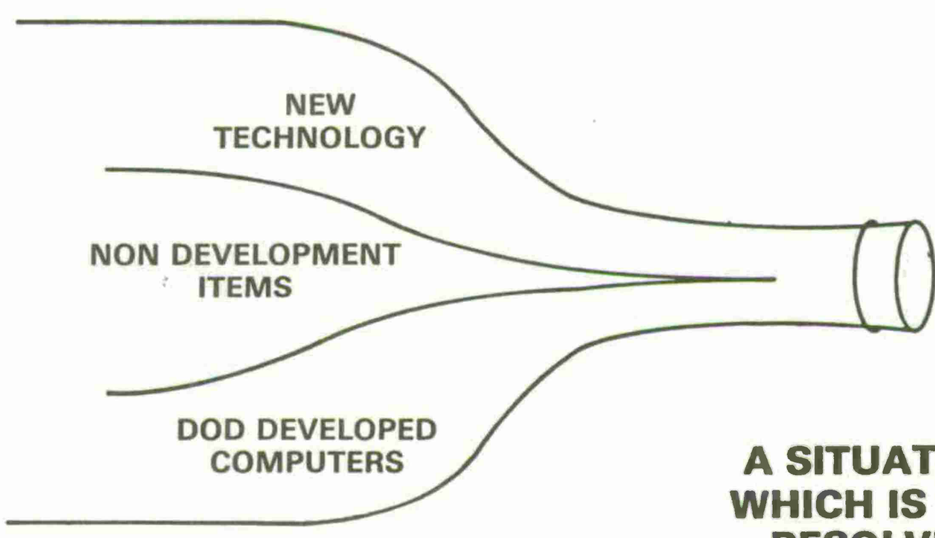
It is given to a user, not a test facility, and a mechanism is provided for feedback to the developer so he can improve and "grow" the system from a software point of view.

Aother thing DOD and the Army are doing is looking at commercial gear and systems that have been developed off shore, suiting them to the requirement and, if need be, giving up on the requirement in the interest of getting things faster and cheaper.

A third thing is the standardization of militarized hardware. Examples are the Army MCF and the Navy AN/UYK43 and 44 Program. Here the thrust is to see if it makes sense to standardize on a family of equipment and then, in a given period of time, redevelop that equipment. There may be changes in the standardization thrust to be consistent with Dr. Martin's presentation yesterday.

Next is the question of what to do about software which has been the "long pole in the tent" from both cost and time points of view. Here it is hoped that the answer is to get high order languages, get Ada out into the field. Then go through the long agonizing transition which must be experienced as new systems and subsystems with Ada are introduced and as previous systems (which are so costly to maintain and time consuming to keep modernized in the field) are phased out. It is hoped Ada is the "light at the end of tunnel" to help produce software quicker, cheaper and more error-free.

A CURRENT BOTTLENECK TO SUCCESS IN C^3



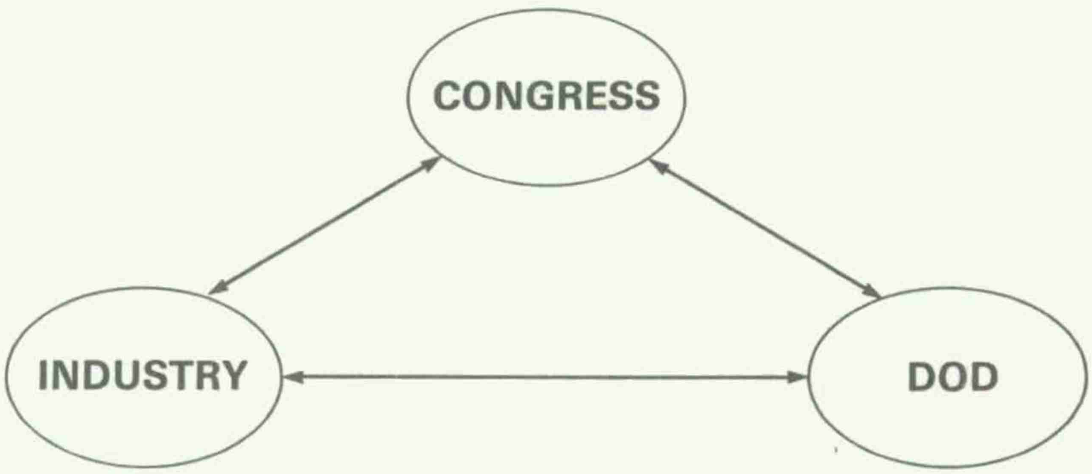
A SITUATION WHICH IS NOT RESOLVED

Standardization of military hardware is an issue that is not resolved. The question is whether to go for new technology, to make more thorough use of non-developmental items or to standardize on DOD/Service developed computers. DOD solicits feedback from industry on this issue.

To repeat, the two main thrusts of DOD are to push for use of higher order languages as a policy and to impress upon the development world of the Services that we just have to meet requirements quicker and more cheaply.

"The Better is the Enemy of the Good" is an old cliche but it applies and perhaps should be emphasized. One of the problems with stability is that industry is constantly telling the Services that, over the horizon, there is a better, cheaper, higher capacity, smaller and lighter alternative. Users may then think it is a lot neater than what is in development and that they should wait for it. There are numerous examples of systems that have gone through Full Scale Development, been tested, fixes installed during test and have never been produced because of better "over the horizon" prospects. GIs in the field can't wait 4 to 6 years for that "better mousetrap" to come along.

MUST WORK TOGETHER



Turning to a partnership theme of this session we have to get over the adversarial relationship that Congress, DOD and Industry have had in the past. It is improving but if we can't get it to be a partnership out into the field, we have not gotten there. We can put a lot of stuff into development and come up with a lot of good ideas but the bottom line for DOD acquisition is getting equipment out into the hands of the troops. It's not profit or loss.

DOD can foster the Evolutionary approach, convince developers they have to take some risk in building things quickly, getting equipment out into the field although it is not fully tested, set up mechanisms where developers are not antagonistic toward user and listen to what the users are telling them. DOD has to make sure the

Services scrub their requirements. The normal procedure in establishing requirements is for the user to write down all the things he would like to have in the system. He is not worried about the bill and is afraid that, if any item is not in the requirement he may never see it. Often, when it comes out of development we cannot afford to produce the system or equipment. Scrubbing, in C3 by the services, means to get all the bells and whistles out and have the product do the basic job that is required. DOD is pushing on this - in essence everything it can do to speed up the development cycle.

As DOD sees it, some of the things Congress could do would be to help understand the need, get a better dialogue going (which is happening), give direction to help keep programs stable and avoid micro-management and stringent conditions on programs.

To promote the partnership Industry can work closely with the government on the Evolutionary Acquisition idea. The NSIA study holds that Industry should be brought in while the requirements and specifications are being written so that Industry can cost the specification while the government is putting it together. The NSIA study was done for General Stansbury at ESD so its thrust is mainly towards the Air Force so far. OSD is working to get the Army and Navy to hear the results and decide if it also applies to them, which OSD thinks it does. To re-emphasize, pushing the better mousetrap for whatever business and marketing reasons creates a dilemma for the government. OSD needs industry help more in finding lower cost solutions rather than high technology solutions. OSD has a tremendous affordability problem when comparing what has to be produced among all the requirements it has. OSD just does not have enough production dollars to do it.

MAKE ONE CHANGE IN PERCEPTION

WE NEED: NOT THE BEST

*** * * * * ***

THE GOOD ENOUGH!

BUT WE NEED IT <u>NOW</u>!

In summary, OSD does not need the best, it does need the good enough, but it needs it sooner and it needs to cheaper.

The following points were made in answer to questions, comments and responses.

... There is a dilemma in encouraging industry to make available new technology in the climate of emphasizing good enough, cheaper and sooner and evolutionary development. There is no mechanism for government looking at technology while industry is developing it so there is a question how it is to be inserted. It appears that it can be done only over a period of time since there is no mechanism for developing things (for insertion) outside of the program requirements.

... In response, the C3 office in OSD wants it cheaper and faster, not better. It is not concerned whether we need better technology which will come as industry looks at each new requirement. The problem seems to be in management, not the horizons of technology. Comparing what we have in the field today to what we were capable of giving the military five years ago, we would be way ahead of the game. There does not seem to be a problem in the tactical C^3 world to push technology, it will take what is there. The problem is managerial implementation of systems. There is the question of having the use of a less capable system over several years or no capability at all while waiting for advanced technology. OSD needs things today. Industry can give technology to meet a system need to go into production in six years and it will be cheaper, better and lighter. The problem is that industry convinces people that it makes sense to stop and wait. We do that in a never ending cycle.

... Non-Development Items (NDI) seems to be a way to avoid the real issue (but) of how to get hardware, commercial or otherwise into the system. RFPs are out for C^3 which do not address software requirements in a meaningful way but emphasize NDI hardware. The real issue in system requirements is how to deal with the pervasive threat. This has nothing to do with equipment if the other problems are not solved. DOD seems always in a rush without enough front end inputs and then goes for hardware.

... When DOD talks NDI it is software and hardware, the total concept of which is going into Evolutionary Acquisition programs. If software is completed, it fits into NDI part of the acquisition programs. If software is completed, it fits into NDI part of the acquisition. Examples are field switching systems.

... Concerning DOD willingness to relax logistic support and data rights requirements in fielding NDIs, it was stated OSD procures very little; the Services do the procuring. Relaxation is encouraged where it makes sense - in data rights it depends on application, number being bought, expected life etc. Logistics aspects are being looked at by the Services on a case by case basis.

... Concerning valuable program features such as configuration management and preserving them in instances of "budget crunch" there has been a major reorganization in the C^3 world. JTC3A will become configuration manager. There is recognition in DOD and Congress that configuration management is a very important function. A recent Congresional query was how DOD will handle configuration management of software and interoperability. More emphasis and resources are being put on configuration management.

... Concerning management of change, a reported instance of initial design of a PROM to accommodate later changes possible of completion in two weeks in all systems in the field, removal from aircraft ran counter to removal publications and requirements and require a year to accomplish. This is a problem and it adversely affects the moral of people in industry. OSD admits DOD has been and still is guilty of causing problems in the management of change. It is difficult to overcome ingrained bureaucracy of customary methods. Specifications and requirements are never thrown away. There are so many people overlooking the doers. So much time is spent overviewing and criticizing that there are precious few resources to make progress. It starts with Congress and GAO and it goes down through DOD where these guardians of the regulations have to fill out all this paperwork before a piece of equipment can be taken out of an airplane. They insist that is the way it has to be done. At the same time DOD cannot have anarchy. It has to have some disciplined system. At this time we are upgrading our systems and it is not easy.

SUMMARY/WRAP UP SESSION

Mr. Hobelmann

The theme of the Wrap Up Session was future capabilities, perhaps a Cray in a suitcase in 1990, and impressions of the conference. MILCOM III would not have been possible without ADPA and Col. Bruce Holt and his crew. The conference expressed its thanks for their help. First, Session Chairmen were asked for a summary and sense of what has occurred, from their associations directly or indirectly with the issues over the last three years, and where we are now after having started with a tremendously discordant group at MILCOM I. Second, the floor was opened for remaining questions and comments.

Dr. Lyon

Session III on the evolving partnership - Congress/DOD/Industry - was structured to be more positive about this issue. Last year (1983) MILCOM II started with high level policy people. Senator Tower handled the subject with no special notes but with remarkable sophistication and knowledge of the subject. Senator Bingaman, although new to Congress and the topic, showed he is coming up on that curve very fast. Senators and Congressman do get information, and with their political backgrounds and sense of trade-offs, play a sophisticated and knowledgeable role in this process. It is very important for the community to listen to them.

The real issue of MILCOM II is that the growth of technology is driven by factors we cannot control. Things are going to happen at a rate discussed by Mr. Miller in his inustry perspective. The question is how to utilize these rapid advances in defense of this country and provide a deterrant.

Although there is lessening dissention and more talking, there is still a need to communicate. It should be based on understanding of principles, concepts and assumptions of the different roles of the various participants. It should encompass the transfer of values, if you will, across these various frameworks. Then are complex trade-offs and nearly half of the questions are "dilemma" questions. Because of that, there is no simple solution except constant continued discussion. As things evolve certain parameters become fixed and the variables change.

The MILCOM series has started a process and it must be decided when it ends. So this session will pose to the conference whether MILCOM IV makes sense and if so what should be done in it. It will come up in committee and it is not certain what form MILCOM IV should take. Sesion III here seems to have accomplished about 80% of its objectives but there is more to do.

Dr. Lieblein

Session II provided a good coverage of the spectrum of emerging technologies. Information systems and technology was most emphasized in strategic systems and computers. Software and hardware were covered.

It was pointed out there is a tremendous momentum in the technology and things will happen sooner than anticipated. The technology provides tremendous opportunities and poses problems of how to get it into our fielded systems. We should not sacrifice capability waiting for tomorrow's technology.

Improving of system capability through software is also a technology insertion. Mechanisms for inserting technology in both software and hardware is needed. On the hardware side, mechanisisms are needed for insertion of technology throughout the life of the system. This is possible in the computer area of technology and in ways suggested in the keynote address. Software insertion was not addressed in Session II. What we call softrware maintenance is really evolutionary software development. We have institutionalized around "software maintenance" and in (up to) very large systems which never have a stable, rather a continually evolving requirement. At some point, it is declared "development" is done and software is passed to a government support or maintenance activity. The developing activity consists of 20-500 software experts. Some of the software is on paper but a lot is in the experts heads. Although there are reasons why this has been done, there are concerns about lock-in to the original contractor. A way has to be found for the system of hardware and software to evolve together. It is not a solution where we have the initial developer, so long as he is able to do a good job, provide support through the evolution of the system. This problem was not in the studies referred to above. Management of change is a government responsibility.

There are some very new ideas in the study referred to in the keynote address that both government and industry contributors thought were good. The ideas have not (yet) stood the test of time and they need work.

We should look at a total computer - system interface approach and see if industry will build necessary products that the government can acquire as off-the-shelf or as NDI items. We probably should not develop anything we don't have to - we always seem to have trouble developings things. This is a radical departure and will take some maturing, OSD has an open door, would like feedback, and has proposed a framework for solutions. Now, we have to work at it.

OSD is very serious about establishing Computer Systems Interface Working Group (CSIWG) and hopes industry will set up a "sister" group through an organization such as CODSIA where all of the commercial and government defense community are involved. We would like to proceed to a solution for the next generation. We are going ahead with the present operation and it is the right thing to do. We have time, not a lot but enough, to work out a good solution. It is tremendous opportunity because usually everything is "crash", because we can work together, because we don't have to worry about vested interests -

favorite architectures, busses, etc. and because we are not going to be thinking about what exists today unless there is nothing better. It is a "clean slate" situation and OSD is looking forward to working with the community on this.

Mr. Grosson

General Hyde presented a perspective of the formidable scope of systems problems and systems of the future. Admiral Meyer made the central point that the job of DOD is ware fighting too. After DOD's primary mission gets diluted with social programs, business management policies and adversarial game playing. Adminral Meyer made the further point that everything that will contribute to our war fighting capability must be pursued. We should cut costs to deploy more systems. We should beat schedules in order to have more systems available. We should optimize performances to do the job particularly in the areas of reliability, fault tolerance, survivability, self-healing techniques and security. The bottom line and the highest priority concern should always be war fighting capability.

The following points were made in answers to questions, comments and responses:

... There should be a MILCOM IV and if there is it should emphasize management and insertion of technology dealing with budget cycles ALCs, configuration control of hardware and software and users in the field - lots of persons and viewpoints. It is the biggest issue. We can generate more technology than we can every insert. We are passing the stage in computers that by the time they are in the field there are two more generations. The management and insertion of technology is really what DOD should be concerned with. It ties in with the problem that we develop systems that don't go into inventory - valuable resources are put into a development and then there is not profit in the program. It is a major issue which should be addressed and it is recommended it be adopted for MILCOM IV.

... If technology is being driven by forces outside of DOD - Industry control we need to learn how to use it. My comment is for MILCOM IV - system level management, new technology and technology insertion - not at the policy level but down at the program/project level.

... Some disagreement with the foregoing was expressed. There was a 1976 Science Board Study that said the commercial marketplace was adequate to meet the needs of the Defense Department and therefore funding for R & D in commercial circuits was not needed and could be reduced. One year later we had VHSIC. People

recognized that the program manager could not reach to that commercial marketplace had to be found and structured to put that technology within the reach of the program manager. What might be called an "off line maturing program" was created. In the last year and a half (1982-83) a lot of time was spent in looking at the technologies in this country that would allow for technology insertion in the field of existing systems. It was found there are a number of holes where the spontaneous forces of the commercial marketplace are not going to perform that technology and get it within the reach and grasp of the programs. It is a technology maturation policy problem. Theoretical solutions cannot make technology get into the field. It is getting technology formed in such a way a manager can grasp it and bring it into his program. That is where there is a policy issue left to be resolved.

... There may be a policy question but at the systems level there is a problem of VHSIC insertion. It is one of the major VHSIC problems - how that technology is to be disseminated among the job shops and managed at the system level. This needs to be tackled because it is not going very well.

... Although the CODSIA report is in circulation to the industry associations who must accept or reject it and has not yet been approved it can be stated three segments of industry - commercial sector, systems integrators and specialty houses that design things strictly to MILSPEC - can all agree in some areas and will never agree in others. Then CSIWG was discussed and an industry group to work with it. There are, however, four members in the partnership (Congress, DOD, Industry, Academia). Congress being concerned about the military-industrial complex, a couple of years ago, set up a rule whereby, in order to have a single working group, Congressional approval is required. It was mentioned yesterday a possible way around that would be to have two working groups and coordinate them. It was then suggested that the ADPA-MILCOM group, which is not a professional society, might become part of CSIWG and Congressional endorsement sought for it. Additional comment agreed this suggestion had a lot of merit.

... Returning to the use of technology by program managers, and, based on experience in the Navy, there is a very, very significant disconnect between the technology community and the program manager. Program managers respond to very specific operational requirements, a documented budget profile and milestones with reports. The attention paid to technology - leading edge of technology - by program managers who must focus on delivery is not done too well. The connectivity between 6.1 and 6.2 programs and the program manager has some of the seeds of the problem. There has to be a better way of advertising technology to program managers for technology insertion and planning for future insertion, which is the job of the program manager who succeeds him. It is not a comfortable situation.

... MILCOM IV should cover thoroughly the help needed in maintaining a billion words of code. It is crucial. The dilemma is the mortgage of supporting these systems. There is concern it may consume all available resources in the near future. We will be unable to build new systems unless we focus on new technologies or new approaches for dealing with it. What is likely is not supporting the systems that are out there. We need to deal with that problem and the working group is good but technology is not politically neutral. Nor is its introduction. The only solution seems to be a two-tiered working group where one tier has the confidence of the rest of the group, proposes a solution and the rest ratify it. Attempts to craft a solution in committees will (not succeed). People must be identified who recognize they have to sell the solution. After the Battle of Midway, the Japanese realized they had lost the war. They took twelve of the brightest and best, exempted them from military service and set them to plan for the rebuilding of Japan. What Japan has done is the main outlines of that plan. Okida and ten others are alive today and are unofficial advisers to the Prime Minister. We need to find a category of people, who have had government, industry and academia experience, embed them in a broader community of interest and have them all grind out a solution. We cannot get there on a serendipity approach. There are problems - who will be in the group - will debate get the right answer - etc. But unless we get something along that line, we won't to get the common goals and objectives in operational language that we need.

... Participants will be solicited for comments and suggestions for MILCOM IV.

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