Annual Reports of FCCSET Subcommittee

Annual trip reports to supercomputer manufacturers trace the changes in technology and in the industry, 1985-1989.

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FY 1986 Annual Report of the Federal Coordinating Council
on Science, Engineering and Technology (FCCSET)
by the FCCSET Committee on High Performance Computing

Summary

During the past year, the Committee met on a regular basis to review government and industry supported programs in research, development, and application of new supercomputer technology. The Committee maintains an overview of commercial developments in the U.S. and abroad. It regularly receives briefings from Government agency sponsored R&D efforts and makes such information available, where feasible, to industry and universities. In addition, the committee coordinates agency supercomputer access programs and promotes cooperation with particular emphasis on aiding the establishment of new centers and new communications networks.

The Committee made its annual visit to supercomputer manufacturers in August and found that substantial progress had been made by Cray Research and ETA Systems toward developing their next generations of machines. The Cray II and expanded Cray XMP series supercomputers are now being marketed commercially; the Committee was briefed on plans for the next generation of Cray machines. ETA Systems is beyond the prototype stage for the ETA-10 and planning to ship one machine this year.

The supercomputer vendors continue to have difficulty in obtaining high performance IC's from U.S. chip makers, leaving them dependent on Japanese suppliers. In some cases, the Japanese chip suppliers are the same companies, e.g., Fujitsu, that provide the strongest foreign competition in the supercomputer market. There is continued evidence that the Japanese companies are not shipping their latest state-of-the-art components to their U.S. customers. This represents a serious problem if U.S. supercomputer vendors are forced to use IC's with performance inferior to their main competitors. Now, with the prospect of a Fujitsu takeover of Fairchild Semiconductor, an important alternate source of logic chips for Cray, the prospect is worse. Furthermore, the recent semiconductor trade agreement with Japan, in attempting to deal with competitive pricing problems of U.S. merchant chip vendors, has created very serious problems for U.S. computer manufacturers.

The impact of such pricing upon domestic manufacturers, and domestic manufacture, were discussed during the annual committee visit to domestic supercomputer manufacturers. Subsequently, their views were conveyed by the Committee to the FCCSET chairman and to cognizant officials at the Office of the U.S. Trade Representative. The semiconductor problem for U.S. supercomputers is a manifestation of much more general and basic problems with the U.S. semiconductor industry as a whole. Other elements of government, such as the Defense Science Board and the National Security Council/Economic Policy Council are addressing more general issues related to the declining state of the U.S. semiconductor industry. The Committee has contributed to these efforts with advice and input from the supercomputer perspective. The semiconductor problem is a difficult problem which does not lend itself easily to a government solution. But a solution is required if the U.S. intends to be self-sufficient in computer technology.

Another continuing technology problem is the need for the development of high performance peripherals required to match the capabilities of new supercomputer systems. Of particular concern is disk storage. Again the primary problem is the small market for supercomputer peripherals. Some progress had been made in establishing communication between supercomputer vendors and the Government sponsored work on magneto-optical storage initiated by RCA and 3M Corporation. This development promised the large storage capacities and transfer rates required for supercomputer systems. Now the project is at a standstill because of lack of funding.

The Committee is presently engaged in the production of a Spring 1987 report on the current state of U.S. high performance computing. The report will update the 1983 Report's to FCCSET on Recommended Government Actions to Retain U.S. Leadership in Supercomputing, and the 1982 Report of the Panel on Large Scale Computing in Science and Engineering (Lax Report).

Annual Visit to Industry

The Committee annually visits supercomputer manufacturers in order to maintain the established dialog, to observe R&D activity, to obtain information on new systems and to gain a better understanding of industry problems. Since the last annual report, the Committee visited Cray Research, Inc., and ETA Systems, Inc. At each company, proprietary performance forecasts or goals of new systems and products were presented. A typical presentation by manufacturers included the following: Progress in developing their next supercomputer and any plans (proprietary) for machines beyond the next one that they wish to share; any bottlenecks to advanced machine development that are of particular concern to them; their views of Japanese supercomputer efforts; recommendations for Government actions related to supercomputers; topics or problems they wish to raise, such as the impact of the recent semiconductor trade agreement with Japan.

These visits give the Committee perspective about future technology, possible issues for the Government to address, an up-to-date perception of industry thinking, and a deeper understanding of industry problems. Committee activities and progress are reviewed by the Chairman at these sessions. He also outlines future activities of the Committee.

A topic of major concern to both vendors is their continued difficulty in obtaining high performance components from U.S. chips vendors. A large fraction of the IC's in a Cray computer are of Japanese manufacture. Fujitsu is the dominant supplier to Cray and, at the same time, Fujitsu is likely to become Cray's primary foreign competitor in the supercomputer marketplace. Both vendors claimed some evidence of Japanese companies not shipping their latest high performance components to outside markets until their needs for their own products are satisfied. This represents a serious problem to dependent U.S. companies who may be forced to use components that are a factor of two or more lower in performance than their Japanese competitors.

According to the U.S. supercomputer vendors, their component problem is caused by the fact that the supercomputer market offers a small number of chips compared to other markets such as microcomputers. The combination of a small market, together with high development costs and high capital equipment costs make the high performance component business unattractive to U.S. chip makers. The large, vertically integrated Japanese companies such as Fujitsu can justify development of these components based on their own product needs. Several Committee meetings with U.S. semiconductor manufacturers have confirmed this view of the problem.

The supercomputer chip dependency problem has become compounded by features of the recent semiconductor trade agreement with Japan. Provisions to protect American merchant semiconductor manufacturers from predatory pricing practices have led to drastic chip price increases by Fujitsu to Cray and by Hitachi to ETA as well as other U.S. companies that are consumers of semiconductors. Furthermore, the agreement does not address chip pricing on boards and sub-assemblies, an omission that further disadvantages U.S. manufacturers and tends to further encourage offshore assembly of components.

Because of the seriousness of the component problem to the U.S., the Defense Science Board (DSB) established a Task Force on Semiconductor Dependency and the National Security Council (NSC) convened an interagency Semiconductor Study Working Group. A FCCSET Committee member made a presentation to DSB on supercomputer issues and served as an advisor to the task force as well as participating as a member of the NSC working group. The DSB ~~report is expected~~ ______. ~~The NSC group~~ ______.
and NSC reports are expected in early 1987.

A similar problem exists with high performance peripherals. In particular, there continues to be concern over development of high performance rotating storage to meet the requirement of new supercomputer systems. Supercomputer computational forecasts for the 1990's approach one trillion floating point operations per second, (terraflops). Affordable peripherals that meet the related high capacity and high transfer rate requirements will be needed. One of the most encouraging developments was a Government (NASA and DOD) supported RCA/3M project on magneto-optical storage. Although not originally intended for supercomputer use, the storage density, data transfer rates, and price appeared promising. The project is presently on hold for lack of funding.

Network Subcommittee

With the significant increase in the number of Government supported supercomputer centers and the need to provide communications networks to serve the rapidly growing user community, the Committee recognized the need to address the communications problem across the Government. In 1985 a Networks Working Group was established to coordinate agency networking activities in order to avoid duplication of effort and to maximize the productivity of the Nation's research community.

A Committee report "Interagency Networking for Research Programs" was published in February 1986, (Appendix). The Networks Working Group determined the feasibility of interconnecting existing federally supported telecommunications networks and so recommended in the report. This approach facilitates practical and cost effective use of resources. The formation of an Interagency Research Internet Organization to build the networking infrastructure is recommended and its functions, responsibilities and funding requirements are outlined. This Committee effort is a useful introduction to the larger FCCSET task of responding to P.L. 99-383 which requires that OSTP "undertake a study of critical problems and current and future options regarding communications networks for research computers, including supercomputers at universities and Federal research facilities in the United States." The Committee now plans to incorporate the P.L. 99-383 mandated study in a report in progress on the current state of supercomputing in the U.S. Such a study has been in preparation as a chapter of the report.

Report on State of U.S. Supercomputing

The Committee plans to issue ~~the~~ a report in Spring 1987 on the current state of U.S. high performance computing.

Widespread concern developed during the early 1980s that the U.S. could lose its position of dominance in the design, manufacture and utilization of the largest scientific computers (supercomputers). This concern was expressed in a number of reports and congressional hearings. Options and recommended actions that the Federal government could take to help maintain U.S. leadership in supercomputers were outlined in the June, 1982, workshop report entitled, "Large Scale Computing in Science and Engineering" (Lax Report) and the 1983 Reports to FCCSET on Recommended Government Actions to Retain U.S. Leadership in Supercomputing.

The Lax Report recommended the establishment of a four component National Program to stimulate the exploratory development and expanded use of advanced computer technology. The components were:

- o Increased access for the scientific and engineering research community through high bandwidth networks to adequate and regularly updated supercomputing facilities and experimental computers.
- o Increased research in computational mathematics, software, and algorithms necessary to the effective and efficient use of supercomputer systems.
- o Training of personnel in scientific and engineering computing.
- o Research and development basic to the design and implementation of new supercomputer systems of substantially increased capability and capacity, beyond that likely to arise from commercial requirements alone.

The purpose of the present effort is three fold:

- o Review the status of large scale computing in the U.S. and assess the changes that have occurred in the last four years.
- o Examine the response of the Federal government to the recommendations of the Lax Report and other reports.
- o Formulate any new recommendations for steps that should taken by the Federal government to ensure continued U.S. leadership in supercomputers U.S. industry and the academic community.

PROCUREMENT/ACCESS GROUP

Dr. James F. Decker (Chairman)
Deputy Director
Office of Energy Research
US Department of Energy
1000 Independence Avenue SW
Washington, DC 20585

Mr. James Burrows
National Bureau of Standards
The Technology Building
Gaithersburg, MD 20899

Dr. John Connolly
National Science Foundation
1800 G Street NW
Washington, DC 20550

Dr. Craig Fields
DARPA/IPTO
1400 Wilson Boulevard
Arlington, VA 22209

Dr. Randolph Graves
National Aeronautics and Space Administration
600 Maryland Avenue, SW
Washington, DC 20546

Mr. Norman H. Kreisman
US Department of Energy
Office of Energy Research
1000 Independence Avenue, SW
Washington, DC 20585

Dr. Allan T. Mense
Special Assistant to the Chief Scientist
Office of the Secretary of Defense
SDIO, The Pentagon
Washington, DC 20301-7100

Dr. Harlow Freitag
Deputy Director
Supercomputing Research Center
4380 Forbes Boulevard
Lanham, MD 20706

Dr. John Riganati
Supercomputing Research Center
4380 Forbes Boulevard
Lanham, MD 20706

Mr. Kermith Speierman
National Security Agency
Ft. Meade, MD 20755

Dr. Paul G. Huray
Office of Science and Technology Policy
New Executive Office Building
Washington, DC 20506

LTC Carl E. Oliver
AFWL/CCN
Kirkland AFB, NM 87117-60008

Federal Coordinating Council
on
Science, Engineering and Technology

Committee on High Performance Computing

ANNUAL REPORT

January 1987

Office of Science and Technology Policy
Executive Office of the President
Washington, D.C. 20506

FY 1986 Annual Report of the Federal Coordinating Council on Science, Engineering and Technology (FCCSET) Committee on High Performance Computing

Summary

During the past year, the Committee met on a regular basis to review government and industry supported programs in research, development, and application of new supercomputer technology. The Committee made its annual visit to supercomputer manufacturers in August and found that substantial progress had been made toward developing new generations of machines by Cray Research and ETA Systems. The Committee was briefed on plans for the next generation of Cray machines. ETA Systems is beyond the prototype stage for the ETA-10 and planning to ship one machine this year.

The supercomputer vendors continue to have difficulty in obtaining high performance IC's from the U.S. chip makers, leaving them dependent on Japanese suppliers. Further, the recent semiconductor trade agreement with Japan has created very serious problems for U.S. computer manufacturers.

The Defense Science Board and the National Security Council/Economic Policy Council are addressing the more general issues of the declining state of the U.S. semiconductor industry. The Committee has contributed advice and input from the supercomputer perspective to these efforts.

In addition to state of the art IC's, high performance peripherals are required to match the capabilities of new supercomputer systems. Disk storage is of particular concern.

The Committee is presently engaged in the production of a Spring 1987 report on the current state of U.S. high performance computing which will update the three 1983 Reports to FCCSET on Recommended Government Actions to Retain U.S. Leadership in Supercomputing, on Access to Supercomputers, and on Advanced Computer Research, as well as the 1982 Report of the Panel on Large Scale Computing in Science and Engineering (Lax Report).

Annual Visit to Industry

The Committee maintains an overview of commercial developments in the U.S. and abroad. It regularly receives briefings on Government agency sponsored R&D efforts and makes such information available, where feasible, to industry and universities. In addition, the Committee coordinates agency supercomputer access programs and promotes cooperation with particular emphasis on aiding the establishment of new centers and new communications networks.

The Committee annually visits supercomputer manufacturers in order to observe R&D activity, to obtain information on new systems and to gain a better understanding of industry problems. Since the last annual report, the Committee visited Cray Research, Inc., and ETA Systems, Inc. Substantial progress had been made by both companies toward developing their next generations of machines. The Cray II and expanded Cray XMP series supercomputers are now being marketed commercially; the Committee was briefed on plans for the next generation of Cray machines. ETA Systems is beyond the prototype stage for the ETA-10 and planning to ship one machine during FY 86. At each company, proprietary performance forecasts or goals of new systems and products were presented. A typical presentation by manufacturers included the following: Progress in developing their next supercomputer and any proprietary plans for machines beyond the next one that they wish to share; bottlenecks to advanced machine development that are of particular concern to them; their views of Japanese supercomputer efforts; recommendations for Government actions related to supercomputers; topics or problems they wish to raise, such as the impact of the recent semiconductor trade agreement with Japan.

These visits give the Committee perspective about future technology, an up-to-date view of industry thinking, an understanding of industry problems and possible issues that the Government needs to address. Committee activities and progress are reviewed by the Chairman at these sessions. He also outlines future activities of the Committee.

A topic of major concern to both supercomputer vendors is their continued difficulty in obtaining high performance components from U.S. vendors. A large fraction of the IC's in a Cray computer are of Japanese manufacture.

Fujitsu is the dominant supplier to Cray and, at the same time, Fujitsu is likely to become Cray's primary foreign competitor in the supercomputer marketplace. Both vendors claimed that Japanese companies were not shipping their latest high performance components to outside markets until their needs for their own products are satisfied. This represents a serious problem to U.S. companies who may be forced to use components that are a factor of two or more lower in performance than their Japanese competitors. Furthermore, prospects of Japanese takeovers of U.S. semiconductor and other high tech firms, important sources of components for U.S. supercomputer manufacturers, threaten to exacerbate serious existing problems.

According to the U.S. vendors, this component problem is a consequence of the small volume of high performance chips required for their supercomputers in comparison to other markets such as microcomputers. The combination of a small market, together with high development costs and high capital equipment costs make the high performance component business unattractive to U.S. chip makers. In contrast the large, vertically integrated Japanese companies, such as Fujitsu, can justify development of these components based on their own product needs. Several Committee meetings with U.S. semiconductor manufacturers have reinforced this view of the problem.

The supercomputer chip dependency problem has been compounded by features of the recent semiconductor trade agreement with Japan. Provisions intended to protect American merchant semiconductor manufacturers from predatory pricing practices have led to price increases of chips sold by Fujitsu to Cray and by Hitachi to ETA as well as other U.S. companies. Although the agreement addresses pricing in other markets, experience to date indicates continued dumping below fair market value prices, particularly in Pacific rim countries. Such dumping, often from gray markets, is evienced in de facto chip pricing on boards and subssemblies. This places U.S. manufacturers at a disadvantage and tends to encourage offshore assembly.

The seriousness of the component problem has prompted the Defense Science Board (DSB) Task Force on Semiconductor Dependency and the National Security Council (NSC) to convene an interagency Semiconductor Study Working Group. A FCCSET Committee member made a presentation to the DSB on supercomputer issues and served as an advisor to the task force as well as participating as a member of the NSC working group. The DSB and NSC reports are expected in early 1987.

Another critical problem is related to the supercomputer's need for high performance peripherals. In particular, there continues to be concern over development of high performance direct storage to meet the requirement of new supercomputer systems. Again the primary cause of the problem seems to be the small market for supercomputer peripherals. Supercomputer industry's forecasts for the 1990's approach one trillion floating point operations per second, (terraflops). Peripherals that meet the related high capacity and high transfer rate requirements at a reasonable cost will be needed.

Network Subcommittee

With the significant increase in the number of Government supported supercomputer centers over the last few years and the need to provide communications networks to serve the rapidly growing user community, the Committee recognized the need to evaluate the efficiency of communications between Government-sponsored centers. In 1985 a Networks Working Group was established to coordinate agency networking activities in order to avoid duplication of effort and to maximize the productivity of the Nation's research community.

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Report on State of U.S. Supercomputing

The Committee plans to issue a report in Spring 1987 on the current state of U.S. high performance computing. Widespread concern developed during the early 1980s that the U.S. could lose its position of dominance in the design, manufacture and utilization of the largest scientific computers (supercomputers). This concern was expressed in a number of reports and congressional hearings. Options and recommended actions that the Federal government could take to help maintain U.S. leadership in supercomputers were outlined in the June, 1982, workshop report entitled, "Large Scale Computing in Science and Engineering" (Lax Report) and the 1983 Reports to FCCSET on Recommended Government Actions to Retain U.S. Leadership in Supercomputing.

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- Formulate any new recommendations for steps that should taken by the Federal government to ensure continued U.S. leadership in supercomputers.

FCCSET Committee on High Performance Computing

Dr. James F. Decker (Chairman)
Deputy Director
Office of Energy Research
U.S. Department of Energy
Washington, DC 20585

Mr. James Burrows
National Bureau of Standards
The Technology Building
Gaithersburg, MD 20899

Dr John Connolly
National Science Foundation
1800 G Street NW
Washington, DC 20550

Dr. Harlow Freitag
Deputy Director
Supercomputing Research Center
4380 Forbes Boulevard
Lanham, MD 20706

Dr. Craig Fields
DARPA/IPTO
1400 Wilson Boulevard
Arlington, VA 22209

Dr. Randolph Graves
National Aeronautics and Space Administration
600 Maryland Avenue, SW
Washington, DC 20546

Dr. Paul G. Huray
Office of Science and Technology Policy
New Executive Office Building
Washington, DC 20506

Mr. Norman H. Kreisman
U.S. Department of Energy
Office of Energy Research
1000 Independence Avenue, SW
Washington, DC 20585

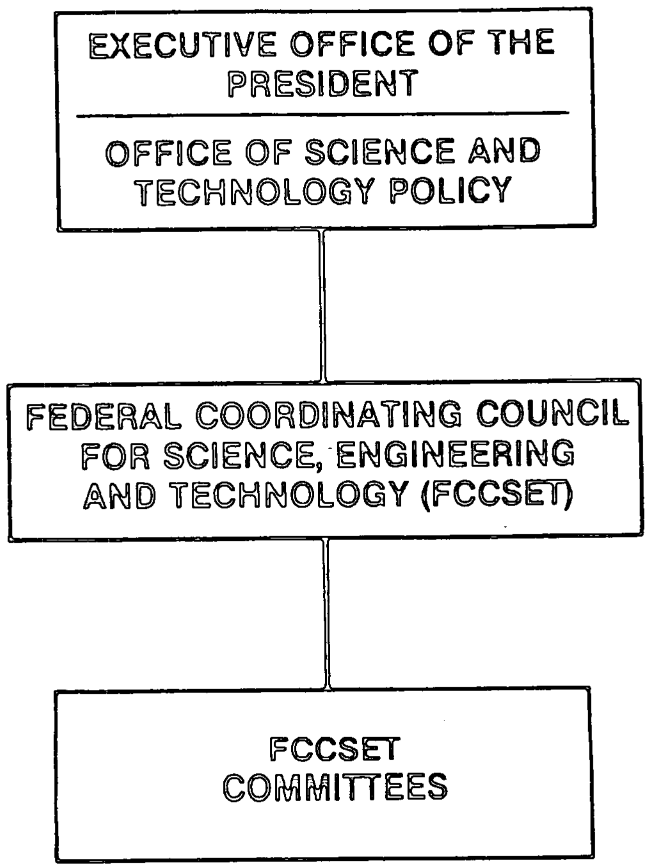
Dr. Allan T. Mense
Special Assistant to the Chief Scientist
Office of the Secretary of Defense
SDIO, The Pentagon
Washington, DC 20301-7100

LTC Carl E. Oliver
AFWL/CCN
Kirkland AFB, NM 87117-60008

Dr. John Riganati
Supercomputing Research Center
4380 Forbes Boulevard
Lanham, MD 20706

Mr. Kermith Speierman
National Security Agency
Ft. Meade, MD 20755

FCCSET ORGANIZATION



DOE/ER-0368

Federal Coordinating Council on Science, Engineering and Technology

Committee on Computer Research and Applications
Subcommittee on Science and Engineering Computing

Annual Report

March 1988

Office of Science and Technology Policy
Executive Office of the President
Washington, DC 20506

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FCCSET Committee on Computer Research and Applications Subcommittee on Science and Engineering Computing

Summary

The Committee maintains an awareness of technical and commercial developments in the supercomputer arena, both domestically and abroad. Regular briefings on government agency sponsored R&D efforts are provided to the Committee and the information is made available, where appropriate, to industry and universities. Further, the Committee coordinates agency supercomputer access programs.

In the past year the Committee initiated efforts that resulted in the report "A Research and Development Strategy for High Performance Computing" and will presently provide a government-wide implementation plan to address the technological opportunities possible with the achievement of significantly enhanced supercomputer capability. Such a strategy would be based on building upon present relevant government R&D programs.

The Committee met on a regular basis to review government supported programs in research, development and application of new supercomputer technology. The Committee annually visits supercomputer manufacturers to be briefed on their plans for future generation machines. Cray Research and ETA Systems continue to make progress toward developing more advanced supercomputers.

The U.S. supercomputer manufacturers remain dependent upon their emerging Japanese competitors for high performance IC'S although progress has been made toward achieving more adequate domestic sourcing. Reports by the Defense Science Board and the National Security Council/Economic Policy Council, which addressed semiconductor issues, were completed during the year with advice and input from the Committee.

IBM has re-entered the supercomputer marketplace. The current 3090 series with expandable vector processing capability has achieved a low end position in the supercomputer performance spectrum. Subsequent development and marketing by IBM of more powerful machines would have important and far reaching impact on the domestic and world supercomputer market.

Computers with massively parallel architecture - thousands of processors - are entering the market place and are beginning to become more of a factor in the computational productivity scale.

The U.S. Government entered into a trade agreement with Japan on the issue of market access to Japanese Government funded domestic supercomputer projects. The Japanese agreed to a set of rules regarding market access and open bidding procedures. Japanese compliance is already in question. The agreement does not cover pricing/dumping issues which are yet to be negotiated.

FCCSET Strategic Computing Initiative Report

Early in 1987 the Committee initiated the effort to update the 1982 workshop report "Large Scale Computing in Science and Engineering" (Lax Report) and the 1983 Reports to FCCSET on Recommended Government Actions to Retain U.S. leadership in Supercomputing. With the passage of P.L. 99-383, which required OSTP to "undertake a study of critical problems and current and future options regarding communications networks for research computers, including supercomputers at universities and Federal Research facilities in the United States." the Committee decided to combine the two efforts into one comprehensive report "A Research and Development Strategy for High Performance Computing" (Report).

The networking element of the Report built upon the Committee report "Interagency Networking for Research Programs" published in 1986. The Report is based on a broad based cooperative effort by government, university and industry computer and communications experts. The Report made four basic findings and four basic recommendations:

Summary of Findings on Computer Research and Applications

1. **High Performance Computers:** A strong domestic performance computer industry is essential for maintaining U.S. leadership in critical national security areas and in broad sectors of the civilian economy.

- **U.S. high performance computer industry leadership is challenged by government supported research and development in Japan and Europe.**

- **U.S. leadership in developing new component technology and applying large scale parallel architectures are key ingredients for maintaining high performance computing leadership. The first generation of scalable parallel systems is now commercially available from U.S. vendors. Application-specific integrated circuits have become less expensive and more readily available and are beginning to be integrated into high performance computers.**

2. **Software Technology and Algorithms:** Research progress and technology transfer in software and applications must keep pace with advances in computing architecture and microelectronics.

- **Progress in software and algorithms is required to more fully exploit the opportunity offered by parallel systems.**

- **Computational methods have emerged as indispensable and enabling tools for a diverse spectrum of science, engineering, design, and research applications.**

- **Interdisciplinary research is required to develop and maintain a base of applications software that exploits advances in high performance computing and algorithm design in order to address the "grand challenges" of science and engineering.**

3. **Networking:** The U.S. faces serious challenges in networking technology which could become a barrier to the advance and use of computing technology in science and engineering.

- **Current network technology does not adequately support scientific collaboration or access to unique scientific resources. At this time, U.S. commercial and government sponsored networks are not coordinated, do not have sufficient capacity, do not interoperate effectively, and do not ensure privacy.**

- **Europe and Japan are aggressively moving ahead of the U.S. in a variety of networking areas with the support of concentrated government and industry research and implementation programs.**

4. **Basic Research and Human Resources:** Federal research and development funding has established laboratories in universities, industry, and government which have become the major sources of innovation in the development and use of computing technology.

Summary of Recommendations For a National High Performance Computing Strategy

1. **High Performance Computers:** The U.S. Government should establish a long range strategy for Federal support for basic research on high performance computer technology and the appropriate transfer of research and technology to U.S. industry.

2. **Software Technology and Algorithms:** The U.S. should take the lead in encouraging joint research with government, industry, and university participation to improve basic tools, languages, algorithms, and associated theory for the scientific "grand challenges" with widespread applicability.

3. **Networking:** U.S. government, industry, and universities should coordinate research and development for a research network to provide a distributed computing capability that links the government, industry, and higher education communities.

4. **Basic Research and Human Resources:** Long term support for basic research in computer science should be increased within available resources. Industry, universities, and government should work together to improve the training and utilization of personnel to expand the base of research and development in computational science and technology.

Strategic Computing Implementation Plan

In order to implement a research and development strategy for high performance computing in a coherent, coordinated, cooperative effort between government, industry, and universities, a comprehensive perception of present government supported R&D effort relevant to the grand challenges is needed. Such a matrix will be distilled from comprehensive analysis of present programs. The Committee is presently preparing a Strategic Computing Implementation Plan that will blueprint the incremental effort needed to pursue grand challenges. In response to Congressional interest, and a request for economic justification for such incremental (budget) investments, the report will provide examples of forecastible technology than can be expected from the implementation of significantly more powerful computers with estimates of related benefits to the economy.

Annual Visit to Industry

Visits to the supercomputer manufacturers give the Committee perspective about future technology, a current understanding of industry thinking, a view of industry problems and possible issues that the government needs to address. At the same time the FCCSET Chairman reviews activities and progress of the Committee and outlines future activities. At least one annual visit to supercomputer manufacturers is a regular committee activity in order to observe R&D activity, to learn of new systems in planning or in development and to achieve a firsthand insight into industry problems. In the past year the committee again visited Cray Research, Inc. (Cray) and ETA Systems, Inc. (ETA). Both companies continue to work toward the development of next generation machines.

Cray recently introduced the Y-MP line of supercomputers as an extension of the current X-MP series. The Y-MP, with up to eight processors, is two to three times as fast as the most powerful X-MP at only 25% greater cost; the Cray 3 is expected to be eight to sixteen times faster than the Cray 2. Cray has forecast the Cray 4 in the 1992 - 1994 time frame - a 64 processor machine with one thousand times the original Cray 1 performance potential.

ETA shipped the first ETA-10 machine to Florida State University and completed installation in 1987. ETA introduced two lower-end air-cooled supercomputer models in 1987: The 10-P and 10-Q systems, priced under $1 million, are available with processing speeds in the 350 to 450 million calculations per second range. ETA-10 model E, cooled with liquid nitrogen, can be configured with one to four processors to attain speeds up to 3.4 billion calculations per second; the eight processor configuration of the model G, also cooled by nitrogen, is designed to reach 10.3 billion calculations per second. ETA presently has orders or letters of intent for 20 systems, half are for high-end systems. ETA has shipped four liquid nitrogen cooled and two air cooled systems; an eight processor ETA-E is being prepared for shipment to Tokyo Institute of Technology.

Development work is reported underway for a successor product to the ETA-10: a system to contain more and faster processors and to be software compatible with the ETA-10 product line.

Cray and ETA are very small companies as compared to the large vertically integrated Japanese conglomerates that are emerging as their competitors in the supercomputer marketplace. Cray and ETA do not manufacture components but are dependent upon Japanese firms such as Fujitsu for some of such parts. In the past year, Cray and ETA have made progress away from total dependency on foreign suppliers: ETA states that over 90% of the components of the ETA-10 can now be sourced in the U.S.; Cray can now acquire a larger percentage of semiconductors from domestic manufacturers.

Semiconductor Supply Problems

Recently Japanese semiconductors have been in short supply with significant increases in price, especially in DRAMS. Among the reasons suggested to explain this situation:

- Increased demand due to an upturn in business.
- Manufacturing capacity in Japan manipulated at the direction of MITI.
- Fair Market Value (FMV) pricing requirement in the U.S./Japan semiconductor agreement.
- Increased valuation of the Yen.
- Manufacturing difficulties in Japan with megabit DRAM production.

There is growing concern among U.S. producers dependent on Japanese suppliers that they will suffer competitively because of higher semiconductor prices as well as concern about an adequate supply. Apprehension about the hazards of dependency upon foreign sources of supply have finally concerned U.S. consumers of semiconductors in general, not just supercomputer manufacturers.

The semiconductor agreement with Japan called for better U.S. access to the Japanese domestic market, with an agreement for increased consumption of U.S.- made chips. So far the market, if anything, has declined.

The gravity of the component problem prompted the establishment of the Defense Science Board (DSB) Task Force on Semiconductor Dependency and the National Security Council Working Group on the Semiconductor Industry (NSC). The DSB and NSC reports were completed in 1987. A FCCSET Committee member briefed the DSB on supercomputer/semiconductor issues, served as an advisor to the DSB task force, and as a member of the NSC working group.

Need For Peripherals Development

The smaller U.S. firms are also at a disadvantage in acquiring computer peripherals, compared with the large vertically integrated Japanese manufacturers. Again, U.S. firms must source externally. More importantly, future developments in rotating (disk) storage are needed to match the capabilities of present and future supercomputers. Advances in candidate technologies such as optical and magneto-optical disks are needed in order to provide the tertiary storage and data transfer requirements for the next generation of supercomputers. Supercomputers are rapidly exceeding the capability of conventional magnetic recording technology to provide adequate input/output data rates. U.S. efforts to exploit new developments in magneto-optical disk technology are promising. However, the resources required to develop this new technology and associated manufacturing capability are large. There is little incentive for independent companies to take the risk, and the development is too expensive for small, domestic supercomputer manufacturers to finance.

Significant Events of 1987

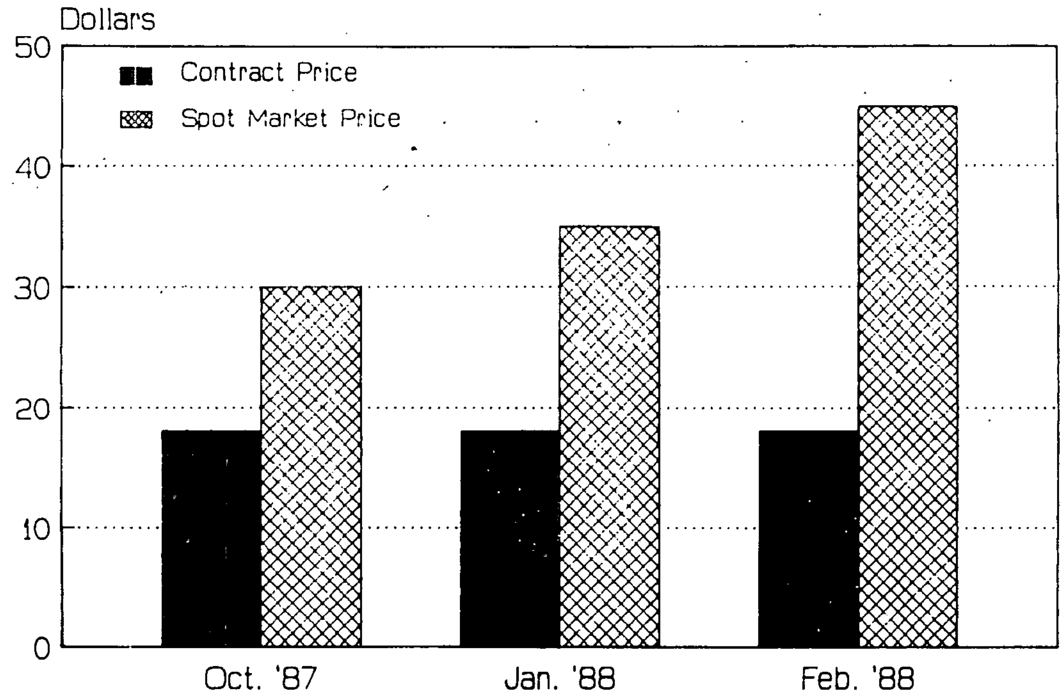
Supercomputer Trade Agreement With Japan

In August 1987, after nine months of discussion, Japan agreed to implement new procurement procedures which, in concept, will help United States supercomputer manufacturers compete more effectively in the Japanese Government financed sector. These new procedures are comparable to those followed in the United States and are consistent with the requirements of the GATT Government Procurement Code.

Prior to this agreement, vague procedures, closed bidding practices, and a unstated, "buy Japanese" policy had effectively kept U.S. manufacturers out of the Japanese market, particularly the government funded market. Despite the fact that Japan represents one of the largest markets outside of the U.S., American supercomputer manufacturers were able to install only ten (10) machines from 1980 through 1987. All of these machines went to the private sector. However, from 1983, when Hitachi installed its first supercomputer for internal use, through 1987, Japanese supercomputer manufacturers placed 71 systems in both the public and private sectors, satisfying an obviously pent-up demand. In other words, although the U.S. has approximately 70% of the world supercomputer market share (including Japan), NEC, Fujitsu and Hitachi control over 85% of the market in Japan.

The new procedures are designed to eliminate the bias in Japan's procurement process that has kept U.S. firms out of that market until now. They entitle American supercomputer suppliers to be involved in early stages of procurement planning when important decisions, such as setting the criteria for the final selection, are made. They also establish a new discussion phase in the procurement process that will provide all potential bidders with an opportunity to demonstrate the merits of their product to the Japanese government.

A SURGE IN PRICES
Price of 1 Megabit DRAM's



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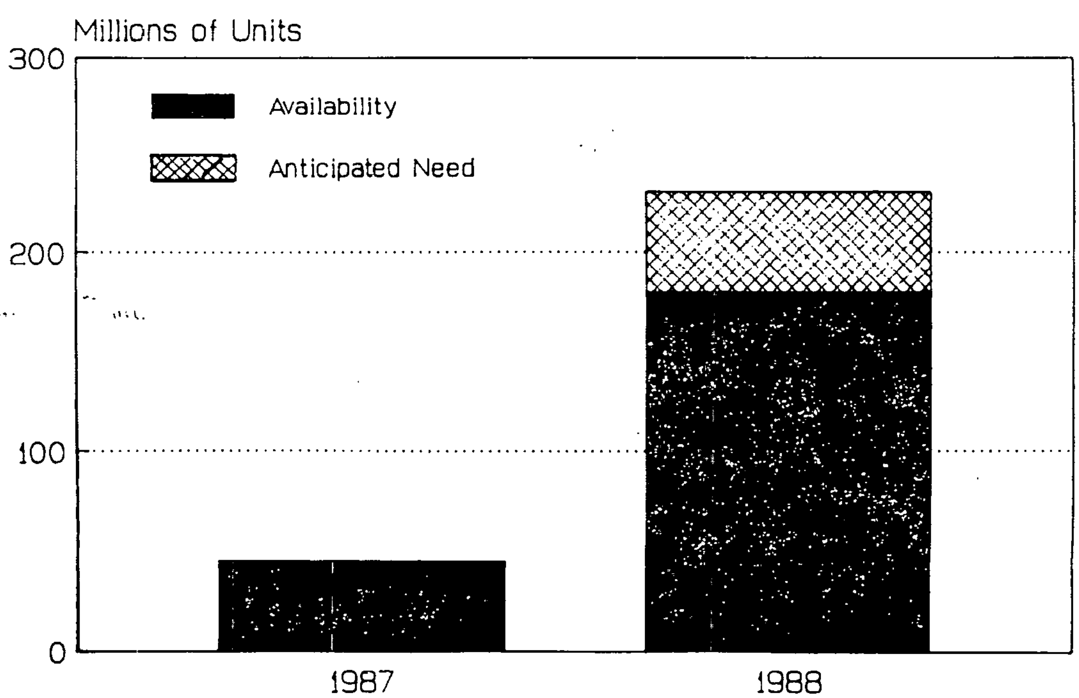
NEED OUTPACING AVAILABILITY
OF ONE MEGABIT DRAM'S



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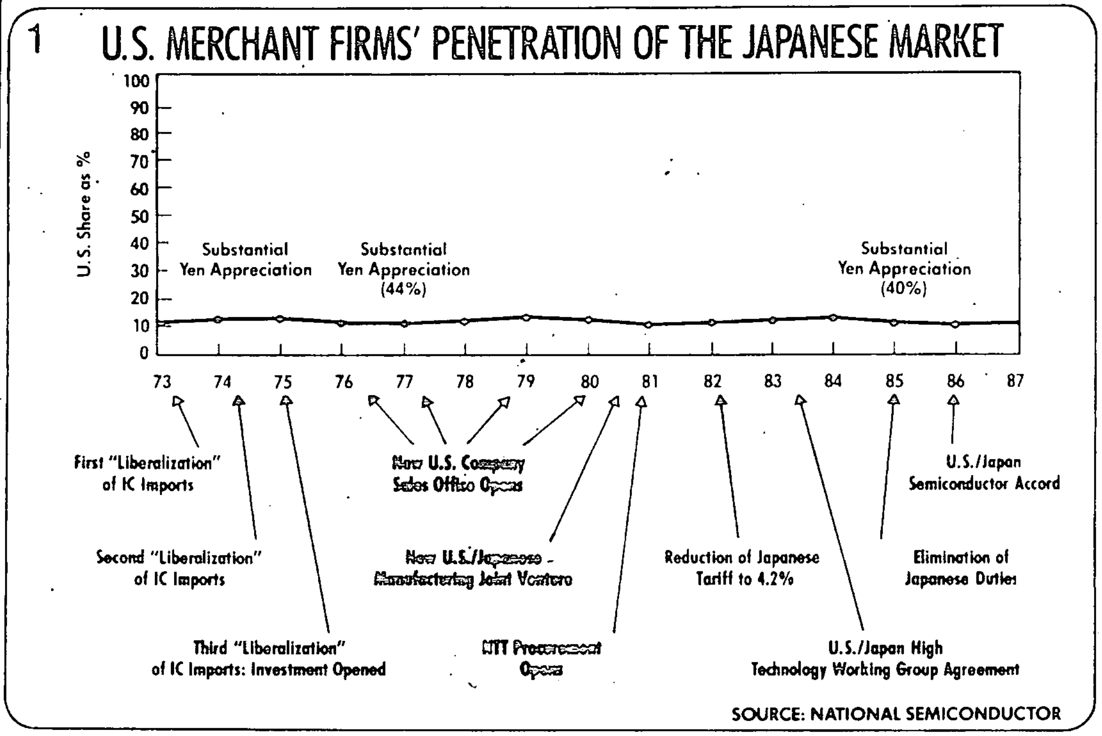
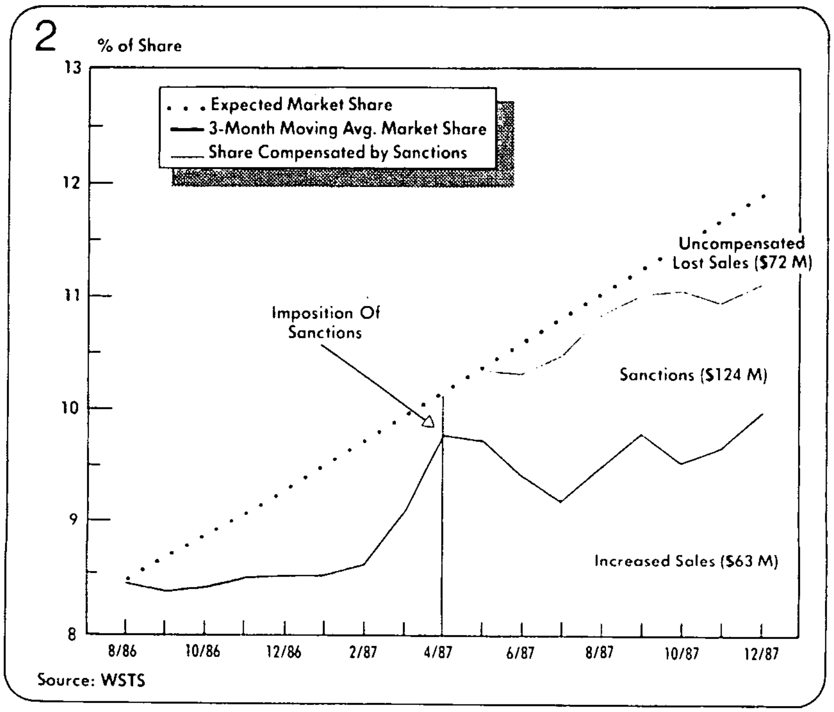


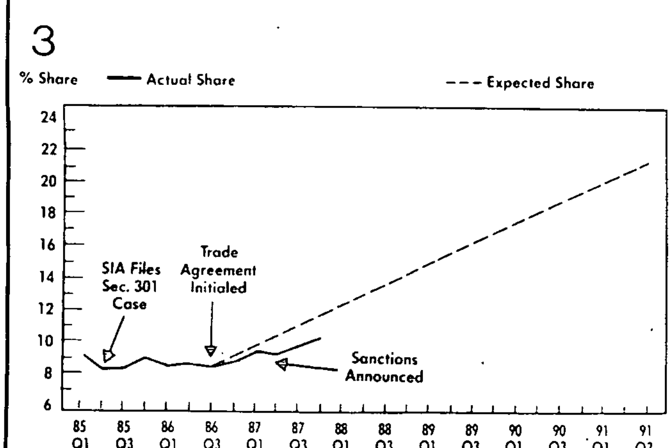
1. Chart at top shows consistently flat pattern of penetration against a backdrop of major trade developments between U.S. and Japan.

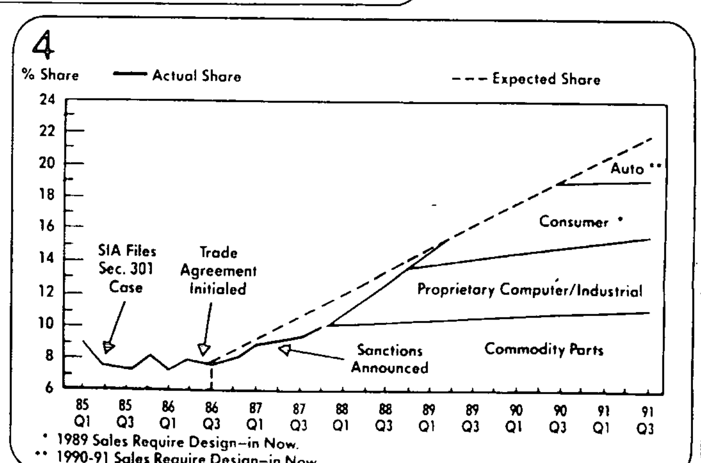
2. Chart at right provides a detailed breakdown of U.S. market share in Japan since the trade agreement.

3. At lower left, the market share gap widened after the trade accord as penetration fell far short of expectations.

4. Last chart shows what is perceived by the SIA as an inadequate expansion in the breadth of purchases by Japanese firms in several markets and an insufficient level of design-in activity.







These procedures also establish several other important disciplines in the Japanese procurement process. In addition to prohibiting discrimination against U.S. products, they establish significantly longer time periods in which companies can prepare bids that are responsive to the requirements of the procuring entity; they make it more difficult to use single-tendering or sole-sourcing; they provide for the release of more information on contract awards; and they establish complaint and protest procedures that may be initiated by the company itself.

One measure of success for the agreement would be sales of U.S. manufactured supercomputers in Japan more proportionate to the U.S. worldwide market share. To date, such sales have not materialized. (The Japanese ordered two U.S. made supercomputers for the public sector; funding came from a supplemental import budget appropriation.) The few announcements of intended supercomputer purchases that have appeared have specified technical parameters that favor the incumbent Japanese computer supplier.

Dumping Issues

Dumping by Japan into the U.S. domestic supercomputer marketplace became a serious issue in 1987. A proposal by Nippon Electric Corporation (NEC) to furnish a SX-2 supercomputer to the Massachusetts Institute of Technology (MIT) under an arrangement unrelated to normal pricing caused serious concern throughout the U.S. supercomputer industry and the Government. MIT canceled the procurement after receiving a letter from the Department of Commerce stating that a dumping action against Japan as the result of such a sale was a serious possibility. MIT has expressed the intent of recasting the scope of the original supercomputer project to a more extensive demonstration facility, probably incorporating competing advanced computer technologies.

The question of ascertaining dumping becomes most difficult in the university marketplace because virtually all computer vendors sell systems to universities at discount prices. The situation is further complicated by the issue of evaluating university contributions to software developments for supercomputer systems when part of the quid-pro-quo in an acquisition arrangement.

The U.S. manufacturers fear the financial power of the large Japanese firms to "buy in" to the supercomputer market. Such a strategy was suggested as a natural way of doing business by a senior Japanese negotiator during recent talks in Tokyo; he stated that there was no way the smaller U.S. firms could stand up to such an assault unless they were "nationalized" by the U.S. Government.

IBM Returns to Advanced Scientific Computing Market

IBM evidenced further intent, in 1987, to return to the supercomputer arena by backing Supercomputer Systems Inc., a new venture led by Steve Chen, formerly Cray vice president in charge of X-MP/Y-MP programs. Chen intends to create and market, within a five year timeframe, a 48/64 processor supercomputer with advanced architecture and components significantly superior to the present state-of-the-art. Chen's move, at least in part, is related to the policy of a relatively small company such as Cray (1987 revenues under $700 million) not to invest in the costly, high risk R&D necessary to advance component technology. The relative vulnerability of Cray and ETA to their larger, emerging Japanese competitors in the supercomputer marketplace is discussed in this report.

However, a sustained effort by IBM, a $50+billion company with world-class R&D resources and the potential for exploiting advanced technology in hand or in prospect, could significantly affect the competitive equation. IBM has made such strategic investments in the past, such as purchasing approximately 25% of Intel Corporation, a major U.S. integrated circuit and microprocessor manufacturer.

Emergence of Mini-supercomputers

Mini-supercomputers are entering the market from a growing number of start-up and established firms. These new high speed machines, some designed for specific classes of problems, some using the same instruction sets as supercomputers, compete cost effectively with supercomputers for certain applications. They achieve a cost advantage over supercomputers by adapting less expensive, lower performance microcircuits originally developed for other purposes. The proliferation of mini-supercomputers will make less clear the boundary between supercomputers and other computers.

The introduction of mini-supercomputers is likely to expand sales of supercomputers. By acquiring mini-supercomputers new customers can gain experience with supercomputer applications at lower initial cost. As their experience and requirements grow, they will likely migrate to higher performance supercomputers. Mini-supercomputers employing the same instruction set as true supercomputers offer the additional advantage of running exactly the same operating system, compilers, and applications codes; they may be used as high-end stand-alone workstations or may be interfaced to remote supercomputers. Experience gained from mini-supercomputers with novel architectures may continue to nurture new entrants into the industry.

The proliferation of mini-supercomputers will complicate the implementation of U.S. export controls. It will be increasingly difficult to argue that there is a qualitative difference between supercomputers and lower performance mini-supercomputers, yet the relatively simple technology employed by some mini-supercomputers may make it difficult to control their export.

U.S. Efforts to Regain Semiconductor Leadership

Defense Science Board (DSB)

The DSB 1987 Report on Defense Semiconductor Dependency detailed the accelerating U.S. dependency on foreign components. The members of the DSB Task Force on Semiconductor Dependency, (DSBTF) according to their Chairman, consider this growing dependency to be among the most serious matters they have had the occasion to address in their various associations with the Department of Defense.

The DSBTF recommended the establishment of an industry/government supported Semiconductor Manufacturing Technology Institute (SEMATECH) to "develop, demonstrate, and advance the technology base for efficient, high yield manufacture of advanced semiconductor devices, and to provide facilities for production of selected devices for DOD needs." The DSBTF further recommended:

- **Establishment of Eight University Centers of Excellence for Semiconductor Science and Engineering.**

- **Increased DOD spending for R&D in semiconductor materials, devices, and manufacturing infrastructure.**

- **Provision of discretionary funding to DOD semiconductor suppliers for independent research and development (IR&D).**

- **Sponsorship of a government/industry/university forum to continually assess the state of the U.S. microelectronics technology base, U.S. industrial competitiveness, education, research in related fields, and effectiveness of this and related government programs.**

A Committee advisor to the DSBTF made a presentation on the supercomputer situation vis a vis foreign semiconductor dependency and assisted representatives of Cray and ETA with their testimony to the DSB.

SEMATECH

The semiconductor inductor industry, through the Semiconductor Industry Association (SIA) and the Semiconductor Equipment Manufacturers Institute (SEMI) adopted a plan to implement SEMATECH. A $250 million per annum, six year joint industry/government plan was formulated: $100 million annual funding from industry; $100 million proposed from federal government and $50 million in dollars or equivalent from state and local resources. Upon favorable Congressional response (see below), and after evaluating many prospective sites, SEMATECH selected Austin, Texas to be the base of the effort.

Department of Energy (DOE)

The DOE National Laboratories are a major national R&D asset with important potential for transferring advanced technology to the microelectronics industry. Throughout 1987 four DOE laboratories conducted a series of workshops to describe such capability and potential to U.S. industry:

- **Brookhaven National Laboratory proposes to build upon its leading position in synchrotron light source experience to develop manufacturing prototype equipment for X-ray lithography - the leading candidate technology for fabricating multimegabit chips in the mid-1990's;**

- **Lawrence Berkeley Laboratory, with it's Center for Advanced Materials, offers cooperative R&D in materials science and process technology.**

- **Oak Ridge National Laboratory, offers expertise and R&D capability across a broad range of process and materials technology;**

- **Sandia National Laboratory offers expertise in semiconductor manufacturing technology, including cleanroom design.**

These workshops were summarized in the reports "The Semiconductor Industry and the National Laboratories" and "DOE National Laboratories and the Semiconductor Industry: Continuing the Joint Planning." (National Academy Press, 1987), by the Manufacturing Studies Board and the National Materials Advisory Board of the National Research Council, which took an active role in the meetings.

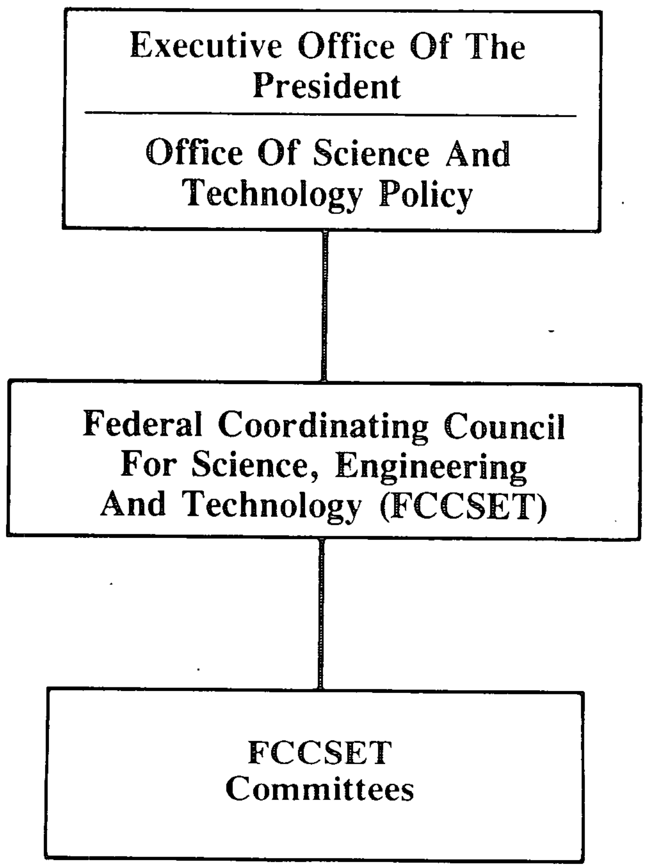
Congressional Response

The Congress responded to Administration requests for funding with line items in the FY 1988 DOD and DOE budgets. SEMATECH received first year funding of $100 million; $35 million was provided for X-ray lithography and advanced semiconductor R&D at DOE laboratories, as well as $12 million for a university synchrotron development project. Such funding support in an era of reduced budgets indicates Congressional recognition of the importance of semiconductors to the U.S. future in supercomputers and in technology in general.

1988 FCCSET Committee Priorities

The Committee is in the process of completing the previously mentioned Strategic Computing Implementation Plan (Plan). The Plan will provide the basis for Administration testimony at forthcoming Congressional hearings on Supercomputers and will provide the design for cooperative effort within the Federal Government and interactively with industry. FCCSET will maintain the coordinating and facilitating roles.

FCCSET Organization



FCCSET Committee on Computer Research and Applications

Paul G. Huray, Chair
Office of Science and Technology Policy

Subcommittee on Science and Engineering Computing

James F. Decker, Chair
Department of Energy

James Burrows
National Bureau of Standards

John S. Cavallini
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National Science Foundation

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Supercomputer Research Center

Paul B. Schneck
Supercomputer Research Center

K. Speierman
National Security Agency

Federal Coordinating Council
Science, Engineering and Technology

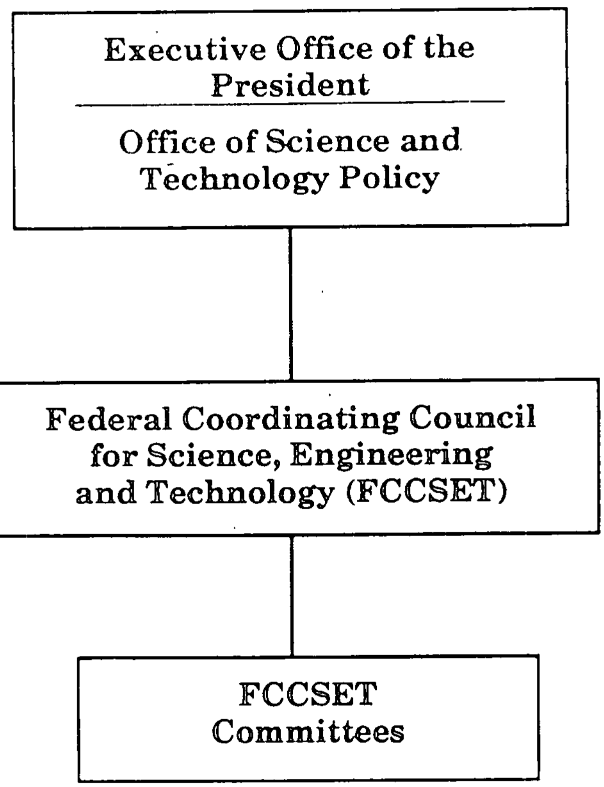
Subcommittee on Science and Engineering Computing

Annual Report

FY 1989

Office of Science and Technology Policy
Executive Office of the President
Washington, DC 20506

FCCSET Organization



The Office of Science and Technology Policy is resposible for overall science and technological development and coordination. The Federal Coordinating Council on Science, Engineering, and Technology (FCCSET), chaired by the Director of OSTP, is an interagency body which was established by P.L. 94-282 to address policy matters involving more than one agency, to plan programs, identify needs, and promote international cooperation in science and technology. The FCCSET is composed of policy-level representatives from the various agencies. It assists OSTP in assessing situations and taking appropriate action to ensure that the science and technology goals of the President are carried out.

Standing committees have been established to assist the FCCSET in carrying out specific tasks. The committees consist of experts from relevant agencies. This document is the Annual Report of the Subcommittee on Science and Engineering Computing of the FCCSET Committee on Computer Research and Applications.

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FCCSET
Subcommittee on Science and Engineering Computing (Committee)
Annual Report FY 1989

Preface

The Committee maintains an awareness of technical and commercial developments in the supercomputing arena, both domestically and abroad. Regular briefings on government agency–sponsored R&D efforts are provided to the Committee, and the information is made available, where appropriate, to industry and universities. Further, the Committee coordinates government agency supercomputer access programs.

Summary

In the past year, OSTP initiated and supervised the efforts that resulted in the government-wide "High Performance Computing Plan", the implementation plan for the FCCSET report, "A Research and Development Strategy for High Performance Computing." The Plan implements a strategy based on building upon present, relevant government R&D programs.

The Committee met on a regular basis to review government-supported programs in research, development, and application of new supercomputer technology. The Committee visited supercomputer manufacturers to be briefed on their plans for future generation machines, to determine industry assessments of foreign competition, and to assess their future technological perspectives.

Cray Research, which progressed in the development of two families of supercomputers, decided to split into two separate corporations and spun off Cray Computer Corporation. Control Data Corporation (CDC), after investing $350 million dollars in the ETA systems effort, withdrew from the arena. Supercomputer Systems, Inc. (SSI), an IBM-supported start-up led by Steve Chen, a former senior Cray project director, has concluded the first year of a new supercomputer development program.

IBM's entry into the supercomputing marketplace, the 3090 series with expandable vector processing capability, has been very successful commercially (over 300 sold or leased) in the low end of supercomputer performance. IBM continues to improve the capability of the 3090 system, and is expected to make further improvements.

Computers with massively parallel architecture – thousand of processors – are achieving important niches in the supercomputing spectrum. Such machines hold the promise of circumventing the basic limits of physics that ultimately will constrain systems with limited numbers of processors. Manufacturers of such machines could be less dependent on foreign sources for components.

An anniversary review of the October 1987 Supercomputer Trade Agreement was held in Tokyo in October 1987. In the agreement, the Japanese government agreed to a set of rules regarding market access and open bidding procedures. The agreement did not cover pricing/dumping issues. In the year following the agreement, there were zero sales of U.S. supercomputers in the Japanese government-supported market; discounts of 80 to 90 percent were demanded (and received) by Japanese (government-supported) universities from the successful bidders. A FCCSET Committee member participated in the agreement review as an advisor to the United States Trade Representative-led U.S. delegation. In May of 1989, the U.S. Government cited Japan, under the Super 301 provision of the Omibus Trade Act of 1988, for trade barriers in supercomputers.

Japanese supercomputer manufacturers Fujitsu and Nippon Electric Corporation have announced next generation multiprocessor supercomputers architecturally based on combining single processor machines, with peak performance comparable to the fastest present U.S. multiprocessor machines,

into multiprocessor systems. Delivery is forecast about the time the next generation of some U.S. machines are due.

In June 1988, the United States signed a new 5-year agreement with Japan on Cooperation in Research and Development in Science and Technology. In October 1988, the Chairman of the FCCSET Committee on Computer Research and Applications addressed the Joint High Level Committee – the policy review forum for the S&T Agreement – in Tokyo, proposing areas of joint cooperation.

The United States supercomputer industry continues to suffer chronic dependency upon foreign sources for semiconductors. The primary vendors are large, vertically-integrated competitors, such as Fujitsu. The U.S. Government and the semiconductor industry, recognizing the importance of semiconductors as the DNA of modern technology, are jointly involved in Sematech, x-ray lithography, high resolution displays, and other semiconductor-related R&D efforts. The Committee stays in close touch with such efforts and provides technical support to interagency and government/industry programs to advance such programs.

FCCSET Strategic Computing Initiative

Early in 1987, the Committee initiated the effort to update the 1982 workshop report "Large Scale Computing in Science and Engineering" (Lax Report) and the 1983 Reports to FCCSET on "Recommended Government Actions to Retain U.S. Leadership in Supercomputing." With the passage of P.L.99-383, which required OSTP to "undertake a study of critical problems and current and future options regarding communications networks for research computers, including supercomputers, at universities and Federal research facilities in the United States," OSTP initiated the report "A Research and Development Strategy for High Performance Computing" (Report). The networking element of the Report built upon the Committee report, "Interagency Networking for Research Programs," published in 1986.

The Report, based on a broad-based cooperative effort by government, university and industry computer and communications experts, made four basic findings and four basic recommendations, which are summarized in Appendix i.

Laboratory Directors Letter

A meeting of Department of Energy National Laboratory representatives was held to review the Report. After discussion and review, the laboratory directors issued the "Joint Statement by National Laboratory Directors on The Need for National High Performance Computing Strategy." (Appendix ii). The bottom line of the Joint Statement is that: "The National Laboratories are prepared to take a major role in this crucial effort to implement a national high performance computing strategy."

High Peformance Computing Implementation Plan

In order to implement a research and development strategy for high performance computing in a coherent, coordinated, cooperative effort between government, industry, and universities, a comprehensive perception of present government-support R&D effort relevant to the "grand challenges" was needed. Such a matrix was distilled from a comprehensive analysis of present programs. The Committee prepared "The High Performance Computing Program Plan" which blueprints the incremental effort needed to pursue grand challenges.

The goals of the High Performance Computing Program Plan are to:

- maintain and extend U.S. leadership in high performance computing, and encourage U.S. sources of production;
- accelerate the pace of innovation in high performance computing technologies by increasing their diffusion and assimilation into the U.S. science and engineering communities; and
- improve U.S. economic competitiveness and productivity through greater utilization of networked high performance computing in analysis, design, and manufacturing.

A summary of the "High Performance Computing Program" is in Appendix iii.

The Supercomputer Industry

U.S. Supercomputers

Presently the fastest supercomputers in the field peak-perform in the 2 – 4 gigaflops range; the American machines approach such performance by combining 2 to 8 parallel CPU's. To date the Japanese supercomputer manufacturers have marketed single-processor–only machines; these single CPU machines tend to have high clock speeds, with highly complex internal architecture. Table A shows a simple comparison between the Cray Y-MP/8, Hitachi H-820M, NEC SX-2, and Fujitsu VP-2600. While the peak performance indicated for some Japanese machines is higher than for the Y–MP, comparative benchmarks for computational fluid dynamics codes, for example, show the Cray Y-MP to be significantly superior for this type of computational problem.[1]

Table A

Present Supercomputers

Make	Model	GFLOPS (per CPU)	CPU's	GFLOPS
NEC	SX-2	1.3	1	1.3
Cray	Y-MP/8	0.5	8	4.0
Hitachi	S-820/80	3.0	1	3.0
CDC	ETA-10-G	1.3	8	10.4

The supercomputer industry may be within a year of witnessing the emergence of a new class of computers. Cray Research, Inc. and Cray Computer have each announced two 16 processor, 16 gigaflops machines: the C - 90 (Cray Research) for 1990, and the gallium arsenide-based Cray 3 (Cray Computer) by 1991, the 64 processor Cray 4 to follow. NEC has announced the 4 processor, 22 gigaflops SX-3 for 1990; Fujitsu is reported to be planning to introduce an 8 processor, 40 gigaflops supercomputer in late 1989[2]. See Table B. The successful introduction of such machines could affect the relative competitive status of U.S. and Japanese firms. Supercomputer Systems, Inc. expects to introduce very powerful supercomputers sometime after 1990 with affiliated IBM producing significantly enhanced versions of its current 3090 line in the interim.

Table B

New Supercomputers

Maker	Model	GFLOPS (per CPU)	CPU's	GFLOPS	Due
NEC	SX-3	5.5	4	22	1990
Fujitsu	VP-xx	5.0	4-8(?)	20-40(?)	1991
Cray	Cray-3	1.0	16	16	1990
Cray	Cray-C-90	1.0	16	16	1990

See Appendix v for a table of current vector architecture supercomputers and Appendix vi for a table of vector architecture supercomputers in design.

ETA Systems

Control Data Corporation (CDC), 125th on the list of U.S. industrial corporations, seventh of the 26 largest manufacturers of office equipment, 1988 annual sales volume $3.6 billion, retreated from the supercomputing manufacturing field; CDC lacks the profitability and the assets needed to sustain $100 million per year operating losses in a subsidiary corporation. The sales forecasted for 1989, prerequisite to maintaining viability, were not forthcoming, primarily due to software deficiencies.

After re-entering the arena in 1983, CDC invested about $100 million per year for 4 years in order to complete the development of the ETA-10 supercomputer, presently the highest rated peak performance machine in the world, by 1987 (Table A). However, speed isn't the whole story; the ETA-10 lacked the software needed to enable the system to achieve its hardware potential. CDC allocated $360 million of a recent $490 million restructuring charge to the closing of ETA Systems.

In May 1989, CDC entered into an OEM agreement with Cray Research which would enable CDC to market Cray supercomputers as part of integrated computing packages that could include the CDC Cyber (mainframe) computer.

In June, CDC signed a letter of intent to sell its Imprimis OEM disk drive manufacturing subsidiary to Seagate Technology for $450 million (see"Peripherals").

Cray Research

Cray is the one remaining high-end U.S. supercomputer manufacturer delivering machines after the demise of ETA. Cray dominates the U.S. supercomputer market, having placed 132 of 161 machines by March 1989; in Europe Cray has placed over 60 of 80; in Japan Cray has placed 13 of 91 machines, a respectable showing since the Japanese Government-supported mainframe computer and supercomputer market has been closed to the U.S. (Fujitsu dominates the Japanese supercomputer market with over half of the installations). Cray's annual volume in 1988 was $756 million, with a very healthy 21% return on sales. The forecast for 1989 is flat, recently revised from a projected 10% increase.

In May 1989, Cray decided to break up into two companies: Cray Research to continue the Y-MP series, with the follow-on C-90; and the newly formed Cray Computer Corporation which would continue development of the Cray 3, Cray 4 series.

An analysis of the resources required to develop a new generation of supercomputers – on the order of hundreds of millions of dollars – and the revenues available to Cray for R&D, in the past a very high 15 to 20% of revenues, shows a maximum of $150 million generated from earnings – probably not sufficient to fund two parallel supercomputer developments. Cray Research intends to provide $150 million in cash and assets to the new firm in return for 10% of the stock, the remaining 90% to be spun-off to present stockholders. If successful, Cray Computer will ultimately have to deal with the same financial fundaments facing Cray Research or any other small, high technology company.

Some uncertainty about Cray Computer is related to the effort to develop the Cray 3 with gallium arsenide logic circuitry (see "U.S.Technology Developments").

IBM

IBM is the fourth largest industrial corporation in the U.S.. Annual volume in 1988 was $59.7 billion; profit was $5.8 billion, largest in the U. S.. IBM has re-entered the supercomputer arena, initially at the low end.

IBM has expressed a long-term commitment to supercomputing through its partnership with Supercomputing Systems, Inc. (SSI), which expects to produce, in the early 1990's, a 64-processor supercomputer that will be 100 times more powerful than today's fastest machine. The SSI's projected performance is (believed to be conservatively) estimated at over 50 gigaflops.

IBM's supercomputers are upgraded with new hardware and software technology from the company's extensive research and development laboratories worldwide. IBM is not dependent on outside suppliers for critical technologies. One example is the four megabit chip, which IBM first put into production in 1988 and is now making available to other manufacturers. IBM researchers believe this technology can be extended to provide 256 megabit chips and beyond in the near future.

Performance characteristics of the IBM 3090 vector series are not compiled in the supercomputer category in this report; however over 300 have been placed world-wide and IBM is extending the capability of the 3090 series; the latest version is essentially a cluster of two 3090 - 600 machines with twice the capability of one.

Supercomputer Systems Inc. (SSI)

Presently SSI sees itself on schedule after completing the first year of a development program intended to produce a marketable product in the early 1990's.

Japanese Supercomputers

Fujitsu

Fujitsu is the dominant mainframe and supercomputer manufacturer in Japan. By March, 1989, Fujitsu had placed 49 of the 91 systems installed in Japan. While Fujitsu's total sales volume in 1988 was $15 billion, less than rivals Hitachi ($40 billion) and NEC ($20 billion), the firm's manufacturing is relatively more computer and semiconductor intensive, lacking the consumer electronics diversification of NEC and Hitachi.

Fujitsu announced the VP 2000 series of supercomputers: each CPU is rated at 4Gs; the VP2600 would be a 4 processor, 20Gs machine. Adequate software for such machines would be crucial.

NEC

Nippon Electric Corporation (NEC) has joined with Honeywell (U. S.) to form the joint venture HNSX Supercomputers Inc. to market NEC supercomputers in the U.S. NEC has placed one supercomputer in the U.S. and 16 in Japan. The top of the HNSX line is expected to be the SX-X44, rated at 22 Gs. The introduction is to be sometime in 1990.[3]

Hitachi

Hitachi has placed 12 supercomputers in Japan. Presently the top of the line supercomputer is the H820-80, a single processor machine rated at 4Gs. No multiprocessor Hitachi supercomputer has been announced.

U.S. Technology Developments

U.S. Semiconductor Industry

Dependency on foreign sources (Japan) for high speed memory and logic chips has been a chronic problem for U.S. supercomputer manufacturers, other than IBM. Cray Research is dependent on Fujitsu, an emerging competitor in the supercomputer arena. There is no rule of business that requires Fujitsu to furnish its competition with the most advanced chips they manufacture.

Cray, to date, has been unable to become domestically self-sufficient in bi-polar memory chips, for example. Such dependency represents vulnerability; the industry recognizes the problem and, in cooperation with the Government, is beginning to address some aspects.

Sematech[5]

The Sematech (Semiconductor manufacturing technology), mission is to provide to the U.S. semiconductor industry the domestic capability for world leadership in manufacturing. Sematech, established in 1987, is unique in that it brings together American companies in an environment of precompetitive cooperation. Through Sematech, American semiconductor manufacturers, each of whom competes against the other, are working with national laboratories and universities in a cooperative environment in order to restore American manufacturing capabilities as quickly as possible. American semiconductor equipment and materials companies, 150 of which comprise an organization known as Semi/Sematech, are part of this information and resource sharing.

To accomplish such an aggressive role, Sematech must work quickly to develop world-competitive manufacturing capability, demonstrate those capabilities, and transfer the knowledge to its member companies and the government. Once American manufacturing leadership is restored, the impact on defense and consumer electronics, computers, and telecommunications should be significant. Prior to 1985 the American electronics industry had contributed to the balance of trade by being a net exporter; in 1985 the industry became a net importer for the first time. Sematech's success could have a direct bearing on America's ability to compete globally in the fast-paced and growing electronics industry and further provide a model for such consortia in other critical arenas.

The Sematech mission is time-dependent; consistent, sustained funding is required. Sematech aims to recover leadership in manufacturing capability over a five-year period, achieving parity for circuits with minimum geometries of 0.5 micron and taking the lead for 0.35 micron circuits by 1992.

Semiconductors are the foundation of the electronics industry, the largest in America; it employs 2.6 million. Used in products ranging from televisions and automobiles to computers and aircraft, semiconductors were invented in the United States in the late 1950's; the U.S. enjoyed world market leadership until the early 1980's.

Because of the importance to the electronics industry, the semiconductor market has been targeted by other nations, which have supported major programs to establish a strong semiconductor industry within their own domain. The Japanese program, initiated in 1975, has been particularly effective. In the last ten years, America has lost its world lead in semiconductor production and a significant portion of production in the equipment needed to produce semiconductors. As a result, the American supercomputer industry has become dependent upon foreign sources for a high percentage of basic components.

Dependency on foreign sources concerns both American industry and government. The Department of Defense (DOD), through its Defense Science Board, in a February 1987 study on semiconductor dependency, concluded: "The most significant finding of the Task Force is that U.S. technology leadership in semiconductor manufacturing is rapidly eroding and that this has serious implications for the nation's economy and immediate and predictable consequences for the Defense Department."

The report further concludes that action must be taken to:

- Retain a domestic strategic semiconductor production base, and;
- Maintain a strong base of expertise in the technologies of circuit design, fabrication, materials refinement and preparation, and production equipment.

The Defense Science Board (DSB) Task Force on Semiconductor Dependency saw the need for bringing American industry together with the DOD. The Task Force pointed to the critical need to restore American semiconductor manufacturing capabilities as soon as possible because of the crucial relationship between the U.S. economy and the national defense. *"Specifically, the Government is concerned that if U.S. semiconductor manufacturing capabilities continue to erode, the U.S. may not have the domestic technological base in key industries to produce the defense systems needed to protect this country and its allies."* In addition, critical supplies might not be available from foreign sources in a time of crisis. Continued market share erosion will lead to the demise of a domestic industry and have serious economic implications for the nation."[6]

While the U.S. industry continues to lead the world in innovative design and creative applications of semiconductors, America has lost its lead in the manufacture of quality, high-volume, cost-competitive semiconductors. Unless decisive action is taken, the U.S. stands to lose additional market shares at a rate of approximately two percentage points per year. Should that trend continue, the U.S. could lose $1 billion annually in sales (compounding to $5 billion per year at the end of five years) with corresponding losses in jobs, tax revenues, and profits. Without profits, the U.S. firms will be unable to invest in future technology.

The consumer electronics products made in Japan, particularly those of high semiconductor content such as videocassette recorders, television receivers, and personal computers (PC's), provide advantageous economies of scale to the vertically integrated Japanese electronics manufacturer: approximately 40% of Japanese semiconductor production is taken by consumer electronic firms, another 40% by computers, and 20% by the domestic telecommunications industry. (Each of the five major semiconductor manufacturers consume less than 35% of their own production, but as a group consume over 70% of their joint production.

Foreign competitors are continuing to exceed the United States in semiconductor research and development. For example, in 1985, Japanese companies surpassed U.S. merchant company spending on semiconductor R&D for the first time.

Europe has also realized the implications of a strong domestic semiconductor industry. The Joint European Sub-micron Silicon (JESSI) project will receive more than $2 billion in government and industry funds. Sematech, by comparison, is jointly funded by American industry and Government at $200 million per year for 5 years.[7,8]

U.S. Memories, Inc.

Seven U.S. semiconductor and computer companies announced in June 1989, that they would form U.S. Memories, Inc. (USM), a joint venture to manufacture DRAM's, using IBM technology. (Only three other U. S. firms remain in the technology - driven DRAM market: Texas Instruments, Micron Technology, and Motorola.) The group included IBM, Digital Equipment Corporation, Hewlett-Packard, Intel Corporation, National Semiconductor Corporation, and Advanced Micro Devices. USM President Sanford Kane, former IBM vice president and a founder of Sematech, stated that the venture would require $500 million in equity capital and $500 million in loan financing.

The effort failed to achieve adequate financing and was stillborn. Various reasons were given, including a glut on the DRAM market and a perception by potential investors of a significant overestimate of the capital requirements. The failure to achieve a viable consortium, albeit from such strong auspices, has serious implications for the prospects of the U. S. to create practical measures to aggregate the resources necessary to achieve competitive manufacturing economies in industries where capital requirements for plant and equipment are rapidly growing beyond the means of many producers.

X-Ray Lithography[9]

Lithographic technology has been the pacing feature of the advances in microelectronics since the invention of the integrated circuit three decades ago. During that time optical lithography has evolved through several generations until it now appears that the practical limit will be about 0.35 micrometers for features defined by photolithography. Two lithographic approaches will enable the fabrication of integrated circuits having even smaller features - electron beam and x-ray. E-beam technology is the near-term approach to reach beyond the limits of optical lithography; however, present configurations of E-Beam equipment provide limited throughput. (It does, however, offer advantages for fabrication of circuits needed in low volume, and is used for fabricating x-ray masks).

X-ray lithography promises high production rates for wafers with the small geometries characteristic of future integrated circuits. Laboratory efforts to date have demonstrated the feasibility of the many facets of a complete x-ray lithography system. Extensive development remains to be done in key areas, including x-ray sources, aligners which position the wafer relative to the mask during exposure, and mask technology including fabrication, inspection, and repair. Further, the individual processes must be integrated and optimized for efficient manufacturing.

A Department of Defense x-ray program addresses the solution of these and associated problems. Throughput, uptime, automation, quality control, and ease of operation, are critical in the overall system design; the goal of this development is to provide the capability for U.S. industry to produce a commercially viable x-ray lithography system. The program will meld together the synchrotron expertise from past Department of Energy programs, manufacturing expertise of the semiconductor industry, system integration capabilities of the equipment industry, and the wide spectrum of science and engineering available in the universities.

The synchrotron is the leading contender as an x-ray source; it provides acceptable parameters in wavelength, intensity, collimation, and spatial uniformity over the exposure field. Two synchrotron designs merit consideration - the conventional magnet, and the cryogenic-magnet storage rings. The cryogenic approach is primary because of more favorable cost and size. Conventional x-ray sources offer advantages in cost, but lack the intensity and collimation of the synchrotron.

The program plan takes advantage of two significant industrial efforts in the semiconductor industry:

- IBM has a major effort in x-ray lithography; this program has been coordinated with that effort.
- Sematech, the industrial consortium for improving semiconductor manufacturing, will serve as the prime avenue for technology transfer.

An aggressive schedule is required because of efforts already underway in Japan and Europe. The major milestones provide for evolution toward a process for 0.25 micrometer technology.

Gallium Arsenide[10]

New solid-state technology is needed to accommodate high-speed computing, optical communications, and other special purposes, are urgently exploring the development of non-silicon semiconductors. Government and electronics industry are committed to research into semiconductors made from elements in groups III and V of the periodic table. The ultimate goal is, – the world market in semiconductors made from compounds such as gallium arsenide, a market that the Japanese estimate will exceed $50 billion by the turn of the century.

There are two principle reasons for the conviction that non-silicon semiconductors appear destined to be the wave of the future, complementing traditional silicon technology for a wide range of special purposes. First, microelectronic devices made of III–V compounds can be expected to operate much faster and with lower dissipation of energy than those made with existing silicon–based technology. Second, some optoelectronic devices, such as semiconductor lasers and light–emitting diodes, cannot be made of silicon; it does not glow brightly enough, nor does it last.

In the quest for ultra high–speed supercomputers of the future, in which optical as well as electronic functions will be carried out on one substrate, compound semiconductors will be used. The III–V compound semiconductors of prime interest are binary compounds such as gallium arsenide or quaternaries such as indium gallium arsenide phosphide.

High Resolution Displays[11]

The core technology behind an emerging series of high resolution display devices will drive other electronics segments, such as semiconductor manufacturing, telecommunications, computers, microprocessors, and software. The advanced semiconductors, signal processors, and other components that create advanced high resolution images will have applications in the fields of medicine, computer sciences, the military, communications, entertainment, factory automation, and education.

The Japanese and Europeans have invested aggressively over the last decade to help develop commercially viable high definition or advanced television (HDTV) technology. Prototypes have been available, and production units are expected to be ready in 1990. Both the Japanese and Europeans incorporate different standards which are, for the most part, not compatible with current U.S. television.

The U.S. HDTV market is expected to be large, with estimates for cumulative sales approaching $150 billion over 20 years, possibly creating hundreds of thousands of domestic jobs. But the market is broader than television sets. It includes equipment for production, transmission, and reception of signals that meet different standards from those currently in use. Widespread HDTV use would require the replacement or modification of most production and broadcasting equipment.

The central issue is whether the United States will become a key participant in this important opportunity, competing not only for the benefits from the production and sales of various high resolution display devices, but also from the new semiconductor and enhanced resolution technology needed for them.

Peripherals

Significant advances in rotating (disk) storage are needed to balance the capabilities of future supercomputer systems. Supercomputers with 10x current performance levels are forecast for the near term (early 1990's) with another 10x in sight. Furthermore, programs with a terraflops goal; such as the advanced prototype development effort within the High Performance Computing Program and beyond, cannot fulfill potential if adequate secondary storage, with attendant necessary input/output data rates, is not available.

Independent U.S. disk drive manufacturers, such as IBIS Systems, Inc. and Imprimis (subsidiary of Control Data Corporation with merger pending with Seagate), lack the financial resources to risk developing futuristic systems. Further, the United States supercomputer market may not provide the sales volume needed to enable competitive unit costs. Manufacturers such as Fujitsu are seen as exploiting advantageous economies of scale by producing parallel disk drives for the much larger mainframe computer market. The possibility of such a strategy by a Seagate/Imprimis or an IBM/SSI arrangement remains to be seen. Comments on related economic and technical problems are set forth in a letter from Imprimis (Appendix x).

Japanese Market Issues

Background

The Japanese Government has pursued policies designed to develop a strong indigenous supercomputer industry. It suppressed public sector demand for supercomputers in the early 1980s until Japanese manufacturers developed their own machines and then procured exclusively from Fujitsu, Hitachi and NEC. Various tax and research benefits are available to Japanese supercomputer manufacturers.

In January 1986, the President's Trade Strike Force began examination of supercomputer trade issues. In December 1986, the Economic Policy Council (EPC) requested an investigation under section 305 of the Trade Act. The final 305 study found that U.S. firms were being excluded from the Japanese Government-supported market. It also concluded that Japanese price discounting could seriously harm the U.S. industry. The EPC chose to continue negotiations as a means of resolving the procurement and pricing problems.

Coinciding with the 305 investigation, a sub-cabinet level USG delegation concluded after consultations with the GOJ in Tokyo in January 1987 that *the Japanese authorities and industry are engaged in the early stages of a comprehensive long–term program of industrial and technological targeting aimed toward dominance of the computer industry as part of Japanese long-term industrial strategy through the aggressive tactics of their large scale companies.*[12]

Additional evidence was gathered indicating systematic GOJ protection of the domestic market from foreign (i.e., U.S.) supercomputers. Japanese machines were given away to universities with the explicit purpose of developing software so that they could eventually compete with U.S. machines in foreign markets. Reports of Japanese machines offered (and bought) at 10 or 20 percent list price came from such markets as Australia and Denmark. The trade press in Japan reported that the Japanese manufacturers had divided up the domestic university market to prevent any real competition among the three companies (NEC, Fujitsu, and Hitachi).

Supercomputer negotiations with the government of Japan culminated in an agreement (Agreement) on August 7, 1987, which aims at open and transparent supercomputer procurement in the Japanese Government supported market. The August 1987 procurement agreement does not address the price discounting issue, a serious weakness in the Agreement.

To date, the agreement has led to zero sales for U.S. supercomputer manufacturers. U.S. companies have faced the usual obstacles in recent Government of Japan procurement such as technical specifications that favor the incumbent Japanese suppliers but far more compelling are the limited public sector budgets for supercomputers which require up to 80–90 percent discounting from list price.* Japanese suppliers have regularly discounted supercomputers and mainframes as well.

Supercomputer Talks

U.S. concerns about Japanese implementation of the August 1987 agreement and price discounting were raised in February 1988 at the NTT and supercomputer talks in Hawaii at the April and September 1988 Trade Committee talks with the Japanese. For the Agreement anniversary review, Ambassador Bruce Smith, Deputy USTR, and Glen Fukushima, Deputy Assistant USTR for Japan, requested that a FCCSET Committee member who had participated in prior relevant USTR-convened interagency advisory meetings and conferences with U.S. manufacturers join the U.S. delegation.

In the fiscal year prior to the August agreement, 12 supercomputers were procured in the Japanese government-financed sector, including 2 U.S. machines purchased at full list price under a 1987 supplemental budget specifically earmarked for imports. In February 1988, a Cray X-MP/48 was installed at an Agency of Industrial Science and Technology (AIST) laboratory at Tsukuba and the first eight processor ETA-10 was installed at Tokyo Institute of Technology (TIT); the bid specifications were de facto sole source in each case. CDC/ETA had difficulties meeting the delivery dates and getting the installation running; much has been, and continues to be, made of this in the Japanese press; with CDC/ETA out of the supercomputer market, the TIT installation has the potential of becoming a white elephant, with the attendant public relations and marketing problems for the U.S. industry.

In the fiscal year following the Agreement, four machines were purchased in the government sector. (Bidding takes place in 2 stages: first round is for determination of technical acceptability; second round is price).

It serves no useful purpose here to review in detail the discussions about whether or not bidding specifications were rigged, whether they reflected what the various institutions really wanted, the intent to sole source, or whether a scheme if any, was dictated by government. All three bids in the government sector (Railway Institute considered private) were awarded to the incumbent. The pricing issue is far more compelling because in the two stage bid process, meeting specifications is a prerequisite for qualification to bid in the second round.

Site	Successful Bidder	Reasons
Hokkaido University	Hitachi (Incumbent) S820-20 replacing S810-10	Front end interfacing questions; subsequent pricing at 80% off list
High Energy Physics Laboratory (KEK)	Hitachi (Incumbent) S820-20 replacing S810-10	0.5 gigabyte memory required Cray couldn't meet delivery date. Price 80% off list
Tohoku University	NEC (Incumbent) SX-2A replacing SX-1	Both NEC and Cray met specifications. Cray exited "auction." Net price 80% off list
Japan Railway Technical Insitute	NEC replacing Fujitsu VP-50	Considered private sector by Japanese; not covered by agreement

Meetings with Japanese Government Officials

The U.S. delegation met for two and one half days with Japanese government officials representing the Ministries of Foreign Affairs (MOFA); Education (MOE); International Trade and Industry (MITI); Transport, Posts and Telecommunication; the Cabinet Secretariat; Science and Technology Agency and the Fair Trade Commission. The Min-

* The Japanese Government is expected to advise Fujitsu, Hitachi, and NEC, *through an administrative ordinance*, that academic discounts be limited to 50%.[13]

istry of Finance (MOF), with major relevance to issues under discussion, was listed but absent.

The MOFA spokesman opened the meeting with a statement claiming good faith in the implementation of the Agreement. The U.S. statement, by the Deputy Assistant United States Trade Representative (USTR), expressed the basic U.S. dissatisfaction that not one U.S. supercomputer was sold in the Japanese market in the year following the Agreement. The MOE spokesman replied that all bidding followed agreed procedures. Subsequent discussion essentially focused on the issues of specifications for bidding and price discounting.

Most of the discussion addressed the pricing/budgeting issue; the Japanese supercomputer manufacturers were forced, even after becoming sole source by virtue of specifications, to price at 80% or more off list. The Japanese were questioned in detail on the bidding process; the heart of the matter is that the Japanese claim that their universities determine the "market price" for the class of supercomputer under consideration, put that figure in their budget which then goes to MOE, then to MOF, and then to the Diet, during the fiscal year cycle, for approval. After reiterative questioning on how the "market price" is determined, the closest response to an answer was the "last price paid by a university or laboratory."

The U.S. made the point that such "market pricing" in the budget process essentially precluded the U.S. firms. The Japanese stated the hope that the U.S. firms would be successful in the future and expressed the view that 3 of 6 supercomputers purchased by government last year were of U.S. manufacture: the TIT and ETL procurement under the special appropriation (at list price) and one at NTT.

In reply to U.S. questioning about the feasibility of selling at 80% discount without compensation from other sources, the senior MITI representative (Honda) replied that the Japanese firms:

- were very strong financially;
- had a commitment to achieve supercomputer leadership for a variety of reasons;
- had the resources and the patience to pursue such a policy; further, he compared such policy to the short-term profit policy of U.S. industry.

Prospects for U.S. Supercomputer Manufacturers in Japan

After the U.S. dissatisfaction with the specification/budgeting process had been expressed, the prospects for supercomputer sales in the government sector for this fiscal year was raised. Answer: 1 machine (Astronomical Observatory of the University of Tokyo). To put this in perspective, particularly with the forecasts of more powerful Japanese machines on the horizon: in the year before the Agreement, the Japanese government financed the purchase or lease of 12 machines including the special purchase of one Cray X-MP/48 at ETL and one ETA-10 eight processor machine at TIT; in the past fiscal year, 4 machines in the public sector, 3 not counting the Railway Institutes purchase – no U.S. winners; in the next fiscal year, 1, plus a special arrangement likely for an advanced prototype at a university. This fiscal year should be interesting: the size of the procurement (apparently 10 supercomputers over the next 10 years) may reflect the perception of an enhanced competitive status of Japanese machines now ready for introduction into the government/university market; the four year procurement history may reflect planning based on the delivery forecasts of the next generation of Japanese supercomputers.

Lack of applications software was often described as a minor factor in government/university; part of the discounting rationale is based on the expected value of software developments from government supported institutions.

Japan Cited Under 301

Late in May 1989, the U.S. cited Japan for Super 301 trade barriers in supercomputers and communications satellites (but not semiconductors). The USTR stated that the Super 301 action on Japanese supercomputer (and communications satellite) practices was due to *"persistent refusal of the public sector to procure American products"*.

"The United States supercomputer industry has been effectively denied access to the Japanese public sector market despite a 1987 agreement with Japan on supercomputers. The Government of Japan has engaged in a variety of exclusionary practices that have the effect of thwarting the open procurement process, in order to ensure purchase of supercomputers by indigenous producers."

U.S./Japan Trade Committee Talks

The Japanese Government refused to discuss supercomputer issues in the context of the Super 301 action but agreed to have discussions on supercomputers as an agenda item during the semi-annual Trade Committee talks. Such a discussion was held during the trade talks of September 7 - 11, 1989, in Hawaii. A FCCSET Committee member attended as consultant to USTR.

The Japanese flatly denied any collusion between government and industry to close the Japanese Government market to U.S. supercomputers and claimed that they acted in good faith to implement the agreement of 1987. The U.S. representatives forcefully reiterated the statements in the Super 301 citation and stated that the Japanese were treating supercomputers (and satellites) as other industries in the past, under "infant industry" protective measures and it was time a nation which achieved the present economic stature of Japan started behaving accordingly.

The Japanese raised issues about access to the U.S. government-supported market. They asked if there was a "buy American" policy in U.S. procurements and for details of DOE and NASA supercomputer procurements. The U.S. responded with a detailed explanation of government purchasing policy under GSA regulations and reported that DOE contractor-operated laboratories were held to such standards by the Department.

Under the law, in the Super 301 implementation, the Government is required to make a decision about trade sanctions within a fixed period of time. Such an action would be due by June 1990 unless resolved earlier.

U.S. – Japan S&T Agreement Meetings

On June 20, 1988, the United States and Japan signed a new five year agreement on Cooperation in Research and Development in Science and Technology. Among other provisions, the agreement calls for collaborative research in seven named areas.

The main bone of contention in the negotiations leading to the agreement was over the U.S. demand for reciprocal access to Japanese Government-supported research; such research is conducted primarily at private corporations whereas most U.S. Government-supported research is conducted at universities or government laboratories and is freely accessible. Under the agreement, the U.S. will now have previously denied access to Japanese Government supported research at private corporations.

Tokyo Meeting

The Joint High Level Committee – the policy review forum for the Agreement – held its first meeting during October 11–12, 1988 in Tokyo. The meeting was chaired by Minister for Foreign Affairs Uno and Minister of State for Science and Technology Ito on the Japanese side, and the Science Advisor to the President and Director of the Office of Science and Technology Policy, Dr. William Graham, on the U.S. side. The high level involvement of the Japanese Government is a indicator of the importance of the agreement in Japan.

Dr. Graham stated that the coordination between the U.S. and Japanese task forces would be handled by the respective FCCSET committees, which would determine the appropriate technologies for cooperative activity; the four FCCSET chairpersons made brief presentations on possible areas of cooperation. The Chairman of the Committee on Computer Research and Applications suggested large data base management and Japanese/English translation by computer as an area of cooperative research.

The Japanese announced the intention of creating an intragovernmental structure based on the FCCSET model. The Japanese stated that all property rights from Japanese Government supported R&D are owned by the Government. This policy has important implications for foreign technology transfer, which is closely controlled by the government.

JTEC

To help FCCSET determine attractive areas for collaborative research, the Department of Energy and the National Science Foundation (NSF) have funded the Japanese Technology Evaluation Program (JTEC) for a study and report on Japanese research and development activities in advanced computing technology. The study panel includes experts from universities and industry.

In order to gather first-hand information on Japanese activities, the panel spent two weeks in November 1989 on a study visit to Japan. The panel report is available from NSF.

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Appendices

Summary of Findings on Computer Research and Applications

1. High Performance Computers: A strong domestic performance computer industry is essential for maintaining U.S. leadership in critical national security areas and in broad sectors of the civilian economy.

- **U.S. high performance computer industry leadership is challenged by government supported research and development in Japan and Europe.**

- **U.S. leadership in developing new component technology and applying large scale parallel architectures are key ingredients for maintaining high performance computing leadership. The first generation of scalable parallel systems is now commercially available from U.S. vendors. Application-specific integrated circuits have become less expensive and more readily available and are beginning to be integrated into high performance computers.**

2. Software Technology and Algorithms: Research progress and technology transfer in software and applications must keep pace with advances in computing architecture and microelectronics.

- **Progress in software and algorithms is required to more fully exploit the opportunity offered by parallel systems.**

- **Computational methods have emerged as indispensable and enabling tools for a diverse spectrum of science, engineering, design, and research applications.**

- **Interdisciplinary research is required to develop and maintain a base of applications software that exploits advances in high performance computing and algorithm design in order to address the "grand challenges" of science and engineering.**

3. Networking: The U.S. faces serious challenges in networking technology which could become a barrier to the advance and use of computing technology in science and engineering.

- **Current network technology does not adequately support scientific collaboration or access to unique scientific resources. At this time, U.S. commercial and government sponsored networks are not coordinated, do not have sufficient capacity, do not interoperate effectively, and do not ensure privacy.**

- **Europe and Japan are aggressively moving ahead of the U.S. in a variety of networking areas with the support of concentrated government and industry research and implementation programs.**

4. Basic Research and Human Resources: Federal research and development funding has established laboratories in universities, industry, and government which have become the major sources of innovation in the development and use of computing technology.

Summary of Recommendations For a National High Performance Computing Strategy

1. High Performance Computers: The U.S. Government should establish a long range strategy for Federal support for basic research on high performance computer technology and the appropriate transfer of research and technology to U.S. industry.

2. Software Technology and Algorithms: The U.S. should take the lead in encouraging joint research with government, industry, and university participation to improve basic tools, languages, algorithms, and associated theory for the scientific "grand challenges" with widespread applicability.

3. Networking: U.S. government, industry, and universities should coordinate research and development for a research network to provide a distributed computing capability that links the government, industry, and higher education communities.

4. Basic Research and Human Resources: Long term support for basic research in computer science should be increased within available resources. Industry, universities, and government should work together to improve the training and utilization of personnel to expand the base of research and development in computational science and technology.

Joint Statement by National Laboratory Directors on the Need for National High Performance Computing Strategy

The United States currently leads the world in the development and use of high performance computing. However, our Nation has lost significant ground in the manufacture of computer components, fabrication equipment, and testing devices as well as in market share in supercomputers. Out ability to continue pushing the leading edge of science and technology is being jeopardized by this lost ground. Our country needs a more effective policy for computer-related research and development and a continuing national effort to maintain leadership in the rapidly accelerating arena of computing technology. Computing is the prerequisite technology for information management, communications, engineering design, advanced manufacturing techniques, and scientific and technical progress. Leadership in the development and use of high performance computing is essential if the Nation is to retain a viable industrial economy, be competitive in the world marketplace, and be capable technically and financially to provide for national security.

Future advances in scientific computer technology, including computers themselves and associated infrastructure such as software, numerical methods, networking, and visualization capabilities, are expected to enable solutions to "Grand Challenges" in science and engineering that will have profound and permanent impact on the history of nations: an impact on those that achieve such advances as well as on those that fail to do so. In the future, the nation must expand its capability for the timely and effective design and development of new materials, electronic components, and biochemicals; advanced commercial and military aircraft; accurate long and short term weather forecasting techniques; advanced energy systems; and computer systems capable of speech recognition and response, language understanding, manufacturing design and control, and automated behavior far beyond today's capabilities. Fundamental scientific opportunities such as mapping the human genome and investigating the basic structure of matter should be addressed; these require significantly advanced computing capability.

Competitor nations, including trading partners such as Japan, have a national understanding of the technological and economic implications of the future and have focused coherent national efforts to achieve dominance in high performance computing and in concomitant advanced technology. Japan has stated leadership in supercomputers and dominance in advanced technology as national goals. Concerted U.S. effort will be needed if we are to respond effectively to this challenge.

The national laboratories have a long history of advancing the development and use of supercomputers and related technology. We, the directors of the national laboratories, urge the mobilization of the Nation's technological resources in order to retain scientific leadership, technological independence, and industrial competitiveness. Such an effort will require the cooperative efforts of industry, universities, and government. We recommend implementation a national program based on the recommendations of the November 20, 1987, report from the Office of Science and Technology Policy titled "A Research and Development Strategy for High Performance Computing."

The national laboratories are prepared to take a major role in this crucial effort to implement a national high performance computing strategy.

Alan Schriesheim
Argonne National Laboratory

Leon M. Lederman
Fermi National Accelerator Laboratory

David A. Shirley
Lawrence Berkely National Laboratory

Alex Zucker
Oak Ridge National Laboratory

Burton Richter
Stanford Linear Accelerator Center

Nicholas Samios
Brookhaven National Laboratory

Seigfried S. Heckler
Los Alamos National Laboratory

John C. Nuckolls
Lawrence Livermore National Laboratory

William R. Wiley
Pacific Northwest Laboratory

Irwin T. Weber
Sandia National Laboratory

ENTITY POSITION STATEMENT

U.S. SUPERCOMPUTER VULNERABILITY

The Institute of Electrical and Electronics Engineers, Inc.
1111 19th STREET, N.W. WASHINGTON, DC 20036-3690
(202) 785-0017

The United States position as a world power is strongly dependent on U.S. technological leadership--a strength that is eroding on many product fronts in the face of determined global competition. One of the most critical risk areas is that of U.S. leadership in supercomputers.

It is not just the product itself that is cause for concern, but also the whole spectrum of other high technolgy areas that are so dependent on supercomputer capability for design leadership. If U.S. leadership in supercomputers goes--there is a strong possibility that U.S. leadership in a broad array of other high-tech products will go with it.

The IEEE United States Activities Board recommends that the new administration recognize the critical importance of supercomputing capabilities. That such capabilities are basic tools on which leadership in a variety of other high-tech product areas important to the United States is heavily dependent.

IEEE-USAB further recommends that the Office of Science and Technology Policy assign a high priority to developing a program that will encourage and foster continuing U.S. leadership in this important resource area.

UNITED STATES ACTIVITIES BOARD — FEBRUARY 22, 1989
Approving Entity — Date

Supercomputers are an embodiment of this country's highest technology. They are essential to the design of an increasing range of high and medium technology products from aerodynamic automobiles to integrated circuits, to advanced aircraft, to advanced weapons systems. American firms currently dominate the supercomputer industry. Yet, given their dependence on the eroding technology base of the United States, they are vulnerable to a focused strategy by other nations. For the U.S. to overcome its current vulnerability, it must first recognize the problem unambiguously. Then, rather than engage in protectionism, it must undertake a cooperative, comprehensive solution at home: an integrated effort among industry, universities and government. This solution may well require coordination by government and cooperation by industry to a degree seldom achieved in this country in peacetime, but it must be undertaken. The threat to supercomputers represents only another step in an accelerating process that has seen the U.S. driven from market after market.

These are the key points:

- The U.S. supercomputer lead is vulnerable to efforts by other nations to achieve technical superiority, lower prices, and greater market share.
- Other nations can and do follow a pattern of using success in dominating a given area of technology to provide leverage for extending their power into related areas.
- The U.S. has lost leads similar to that in supercomputers to concerted action by the Japanese in many fields of high technology, the most recent being DRAMs, dynamic random-access memory semiconductor chips.
- Our lead in supercomputers is critical to our military and economic security and to our international competitiveness.
- To overcome its vulnerability, our country needs a coordinated, cooperative, solution, rather than separate, fragmented initiatives; this approach will require generic problems to be solved; solutions to the generic problems will strengthen U.S. competitiveness in many other areas.

We in the U.S. must be able to compete effectively in the current global environment. Our challenge is to establish an institutional framework through which government, industry and academia can effectively pursue objectives that benefit the nation as a whole. Only through a coordinated, comprehensive approach--from science to technology, to industry to trade--will we be able to ensure a strong U.S. base for innovation, productivity, and international competitiveness--a base in which supercomputers constitute a vital factor.

Supercomputers demand very high-performance logic and memory semiconductor devices; these in turn demand manufacturing equipment built to exacting standards. Supercomputers also require specialized software to control their systems and to run applications. Further, they require what we will call "integration" with other computing facilities. These elements fall along a continuum. Japanese firms dominate the merchant market for supplying high-capacity memory devices (in addition to making these devices for their own internal use). The Japanese also dominate the business of supplying equipment for manufacturing semiconductors. They are among the leaders in the traditional areas of high-performance logic devices. They have demonstrated their ability to produce world-class systems software for their supercomputers by the excellence of their compilers; while their applications software is, as yet, less well-developed. The U.S. does have an unambiguous lead in integrating supercomputers with other computing facilities.

Over 90% of the high capacity DRAM memory devices available in the merchant market are now manufactured in Japan. Most U.S. firms exited from the market two years ago after experiencing very large losses. The Japanese accepted $4 billion in losses and currently dominate this business. The recent world-wide shortage of DRAMs has had, and continues to have, a highly negative impact on U.S. manufacturers of computer systems--whether supercomputer, mainframe, mini, or micro-computer. Many U.S. firms have been unable to ship products and generate revenue solely due to lack of DRAMs. When they can ship products, their new DRAM component costs, and thus the prices of their systems, rise sharply and the competitiveness of their systems vis-a-vis those of the Japanese, fall in proportion.

The lead of the Japanese in high-performance logic devices gives them an edge on individual processors in their supercomputers; American manufacturers no longer match the Japanese on individual processors. But the U.S. firms have maintained their market position by including more than one processor in their systems.

A few short years ago, U.S. firms dominated the business of supplying equipment for manufacturing semiconductors. Today, the Japanese dominance in this field is nearly complete. All U.S. manufacturers of semiconductors are now dependent on the Japanese for their most critical equipment--and for high quality materials as well.

It is ironic that such cascading impacts could result, in large part, from dominance in a product area--DRAMs--that has reached almost commodity status. Yet these impacts are taking place.

In the meantime, U.S. development efforts related to this industry are beginning to bear fruit in two areas--the long-sought evolution of applications software that will run on anyone's supercomputer, and the procedures and devices required for integrating supercomputers with other facilities. Ironically, these achievements, while desirable, can help speed the penetration of the Japanese into the supercomputer business. To date, efforts by U.S. merchant manufacturers to recoup in semiconductors (including Sematech, the consortium of 14 U.S. firms with financial support from the U.S. Government), have been halting, fragmented and of only indirect relevance to U.S. supercomputer firms. No current initiative, including Sematech or IBM's recent involvement in supercomputers, assures that our objectives can or will be attained. An overall solution cannot be achieved through discrete, uncoordinated initiatives, no matter how worthy.

The pattern on both sides of these issues is familiar. The Japanese government coordinates the actions of Japanese firms in accord with long-range strategic goals--in this case the goal of becoming the dominant supplier of information technologies to the world. When the Japanese achieve technological advantage in one area, they use it to ensure penetration into the next. U.S. firms complain at each step in the process; the U.S. Government protests on occasion, while expending most of its political capital on opening the Japanese market to items other than strategic, high-technology goods.

To achieve a solution we must first accept the global competitive environment as it is. Markets are not totally free. We live in a world where other countries adopt strategic goals, coordinate the actions of their firms, provide government funding for commercial research and development, develop targeted industry and export policies, provide test sites in universities and government, focus resources, finance sales with low-interest loans and use one technological advantage to launch the next.

The solution to the problems of the U.S supercomputer industry does not lie in imploring the Japanese to forego their approaches to high technology, especially when they result in advantages to them. Rather, it lies in the U.S. taking positive actions at home to regain the power to compete with the Japanese directly and over the long run in semiconductors, in supercomputers and in software. We must coordinate the activities of government, industry and universities sufficiently to achieve rapid innovation and significantly enhanced productivity. This will require us to solve a number of generic problems such as our low savings and investment rates, as well as to achieve timely, effective technology transfer from stage-to-stage in the innovation process, and to pay careful attention to the application of suitable human resources at each stage.

We in the U.S. must be able to compete effectively in the current global environment. Our challenge is to establish an institutional framework through which government, industry and academia can effectively pursue objectives that benefit the nation as a whole. Such a framework must ensure that economic and technological decisions are made on the basis of economic and technological criteria. Only through a coordinated, comprehensive approach--from science to technology, to industry to trade--will we be able to ensure a strong U.S. base for innovation, productivity, and international competitiveness--a base in which supercomputers constitute a vital factor.

1. Executive Summary

High Performance Computing° is a pervasive and powerful technology for industrial design and manufacturing, scientific research, communications, and information management. A strong U.S. high performance computer industry is essential for maintaining our leadership in critical national security areas and competitiveness in broad sectors of the civilian economy.

The goals of the High Performance Computing Initiative are to:

Goals

- maintain and extend U.S. leadership in high performance computing, and encourage U.S. sources of production;
- accelerate the pace of innovation in high performance computing technologies by increasing their diffusion and assimilation into the U.S. science and engineering communities; and
- improve U.S. economic competitiveness and productivity through greater utilization of networked high performance computing in analysis, design, and manufacturing.

Strategy

These goals will be accomplished through Federally coordinated government, industry, and university collaboration to:

- accelerate the pace of revolutionary computational advances through a more vigorous R&D effort to expedite solutions to U.S. scientific and technical challenges;
- reduce the uncertainties to industry for development and use of this technology though increased cooperation between government, industry and academia and the continued use of government and government-funded facilities as a market for HPC prototypes and commercial products;
- expand the underlying research, network and computational infrastructures on which U.S. high performance computing technology is based; and
- expand the U.S. human resource base to meet needs of industry, academia and government.

° *High performance computing* refers to the full range of advanced computing technologies including existing supercomputer systems, special purpose and experimental systems, and the new generation of large scale parallel systems.

1. Executive Summary

The Initiative

The Initiative will consist of four complementary, coordinated Components in each of the key areas of high performance computing. The Components are planned carefully to produce not only long term results but a succession of intermediate national benefits. Figure 1 shows the relationship of the Components of the Initiative. The High Performance Computing Initiative will build on those programs already in place, providing additional funds in carefully selected areas to meet its goals. Selected computational challenges, which will have significant effect on national leadership in science and technology, will be used as focal points for these efforts.

High Performance Computing Systems: The United States' leadership in supercomputing is being challenged. We have developed new, more powerful supercomputing architectures based on innovations, particularly in parallel processing, but we must capitalize on these innovations or we will be overtaken in this area as well. To do this a long range effort will be established for Federal support of basic research on high performance computing technology and the appropriate transfer of research and technology to U.S. industry, consisting of efforts in the following areas:

- research for future generations of computing;
- system design tools;
- advanced prototype development; and
- evaluation of early systems.

Advanced Software Technology and Algorithms: Historically, software improvements have increased computational performance much more than hardware investments. Yet software productivity is recognized to be dismal and existing software can seldom be re-used. In computing systems for industrial, scientific and military applications, software costs have exceeded those of hardware more than fivefold. Advances in software will be critical to the success of high performance computers with massively parallel architectures. To improve software productivity, an interagency effort will be established to support joint research among government, industry and universities to improve basic software tools, data management, languages, algorithms, and associated computational theory with broad applicability for the *Grand Challenge*[*] problems. These complex problems will require advances in software that have widespread applicability to computational problems in science and technology.

[*] A *Grand Challenge* is a fundamental problem in science or engineering, with broad economic and scientific impact, that could be advanced by applying high performance computing resources.

1. Executive Summary

Organization

Leadership of the Initiative is the responsibility of the Office of Science and Technology Policy, through the FCCSET Committee on Computer Research and Applications, whose members include representatives of the key agencies that fund R&D in high performance computing. Duties and responsibilities of the Committee include:

- interagency planning and coordination;
- technology assessment;
- policy recommendations to OSTP; and
- formal annual reports of progress to OSTP.

A High Performance Computing Advisory Panel will be formed, consisting of eminent individuals from government, industry, and academia. Members of the Advisory Panel will be selected by and will report to the Director of OSTP. The Panel will provide the Director and the Committee on Computer Research and Applications with an independent assessment of:

- progress of the Initiative in accomplishing its objectives;
- continued relevance of the Initiative goals over time;
- overall balance among the Initiative Components; and
- success in strengthening U.S. leadership in high performance computing, and integration of these technologies into the mainstream of U.S. science and industry.

This implementation plan was prepared by the FCCSET Committee on Computer Research and Applications under the leadership of the Office of Science and Technology Policy. It represents a broad spectrum of government, industrial and university interests. The Committee has established subcommittees that will be responsible for planning, organizing, monitoring and coordinating the Components of this Initiative.

1. Executive Summary

Effort in this Component focuses on:

- support for Grand Challenges;
- software components and tools;
- computational techniques; and
- high performance computing research centers.

National Research and Education Network: For the past decade technology developed by the U.S. has been available to eliminate distance as a factor in computer access and in collaborations among high technology workers. Yet other countries are ahead of us in networking their national technical and academic communities. To recover our leadership, the U.S. government, together with industry and universities, will jointly develop a high-speed research network to provide a distributed computing capability linking government, industry and higher education communities. This network will serve as a prototype for future commercial networks which will become the basis for a distributed industrial base. This Component will consist of:

- an interagency effort to produce an interim National Research Network;
- research and development for a billions of bits per second (gigabits) network adequate to support national research needs;
- deployment of the gigabits National Research Network; and
- structured transition to commercial service.

Basic Research and Human Resources: U.S. universities are not meeting the expanding needs of industry for trained workers in computer technology. There is not an adequate number of high quality computer science departments in this country, and many industrial and Federal laboratories have inadequate research capabilities. Furthermore, existing university, government, and industrial groups do not collaborate effectively enough, and their interdisciplinary activities are too limited. To correct these deficiencies a long term effort to support basic research in computer science and engineering (creating computing systems) will be established by building upon existing programs. This Component will also establish industry, university, and government partnerships to improve the training and utilization of personnel and to expand the base of research and development personnel in computational science and technology (using computers).

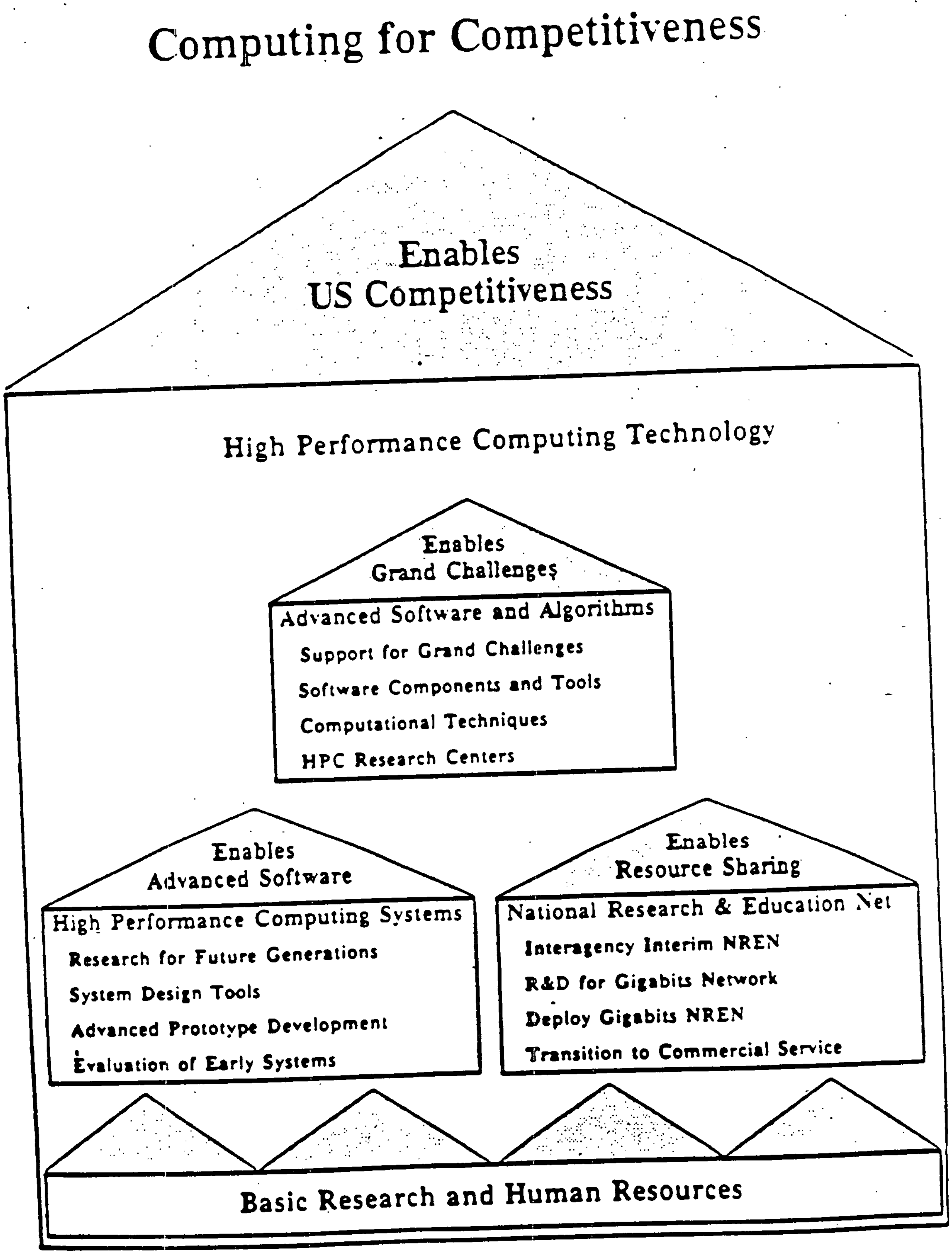


Fig. 1 - Relationship of Initiative Components

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF SCIENCE AND TECHNOLOGY POLICY
WASHINGTON, D.C. 20506

In November 1987, my predecessor, William R. Graham, transmitted to Congress A Research and Development Strategy for High Performance Computing. That report laid out a five-year strategy for federally supported R&D on high performance computing, including hardware for state-of-the-art supercomputers, software, computer networks, and supporting infrastructure. It was written with the assistance of the Committee on Computer Research and Applications under the OSTP Federal Coordinating Council for Science, Engineering, and Technology (FCCSET). This strategy document was to be followed by a detailed program plan.

I am pleased to transmit to Congress that program plan -- the result of an intense interagency effort by a special task force within the Committee on Computer Research and Applications. Following the general organizational structure of the 1987 strategy report, it lays out a broad R&D policy and program plan designed to advance U.S. leadership in high performance computing. This plan calls for a federally coordinated government, industry, and university collaboration to accelerate the development of high speed computer networks and to accelerate the rate at which high performance computing technologies -- both hardware and software -- can be developed, commercialized, and applied to leading-edge problems of national significance.

High performance computing is a vital and strategic technology, exerting strong leverage on the rest of the computer industry and other cutting-edge areas. However, U.S. leadership and diversity in the supercomputer industry itself has declined dramatically; and history shows that a scant 15 years separates the first appearance of a top-of-the-line supercomputer from the appearance of that same computing power in the higher end of the personal computer market. A future national high speed computer network could have the kind of catalytic effect on our society, industries, and universities that the telephone system has had during the twentieth century.

We cannot afford to cede our historical leadership in high performance computing and in its applications. We need to encourage the dynamism of the U.S. computer industry and, hence, our economy. I would ask all of the federal agencies with research programs in high performance computing to work toward implementing the recommendations in this report.

D. Allan Bromley
Director

Appendix VI

TABLE I - CURRENT VECTOR ARCHITECTURE SUPERCOMPUTERS*

Manufacturer & Series	CRAY X-MP	CRAY 2	CRAY-YMP	CDC/ETA 10G	IBM 3090S	Fujitsu/Amdahl VP400E	Hitachi S-820-80	NEC SX 2
Announcement of Series			Feb 1988	Oct 1985		April 1982	Aug 1982	1983
First Installation of Series	June 1983	Oct 1984	Oct 1988	1987	May 1986	Nov 1983	Nov 1983	May 1985
Number of Processors	1,2,4	1,2,4	1,2,4,8	1,2,4,8	1,2,3,4,5,6	1	1	1
Peak Performance+ (per Processor)	235	488	333	572	133.3	1710	3000	1300
Total Peak Performance	940	1951	2670	4600	800	1710	3000	1300
Cycle Time (ns)	8.5	4.1	6	7.0	15	7 (vector 14 (scalar)	4(vector) 8(scalar)	6
Maximum Main Memory**	5	4	1	1	.5	.25	.5	1
Extended Memory	4	-	4	0	2	1	12	0
Technology								
Logic (gate delay)	16 gate ECL (650 ps)	16 gate ECL (650 ps)	2500 gate ECL (350 ps)	20K gate CMOS (300 ps)	612/2360 ECL ( )	400/1500 gate ECL (350 ps)	2500/5000 gate ECL (200 ps)/(250 ps)	1000 gate ECL (250 ps)
Main Memory (Cycle Time)	64K CMOS (68 ns) 64K ECL SRAM (34 ns)	MOS 1M DRAM (185 ns) 256K SRAM (54 ns)	ECL (30 ns)	256K SRAM (35 ns) 1M DRAM (150 ns)	NMOS 1M DRAM (80 ns)	256K SRAM (35 ns)	256 K SRAM bi-CMOS (20 ns) 1M MOS DRAM (120) [extended]	256K MOS SRAM 1M MOS DRAM ( )
I/O (Disk, Solid State Secondary Storage)								
No. Paths (Total)	32,2	36,-	48,4	16;-	16-128;-	32;-	64;-	6;1
Max. Data Rate Path (MB/SEC)	26.6;1250	26.6,500;-	26.6;1250	50,-	4.5;-	3;-	4.5;-	15.9;1300
Max Aggregate Data Rate. (MB Sec)	400;2500	2000;-	800;5000	1000;-	500;-	96;-	288;-	95.4;1300
Cooling	Freon	Liquid immersion (Flourinert)	Flourinert (CPU & memory) Freon (I/O)	Nitrogen ($77^{o}k$) (logic) Freon (Memory)	water (100-132 chips/thermal conduction module)	Air	Air	Water (logic) dehydrated air (memory)
Operating Systems	CTSS/COS/UNICOS	UNICOS/CTSS	CTSS/COS/UNICOS	SYS V, EOS	MVS, VM, AIX/370	MSP/MVS/XA/UTS/M		SXOS
Languages/Compilers	Fortran 77, C Pascal, ADA	Fortran 77, C Pascal, ADA	Fortran 77, C, Pascal, ADA	Fortran 77, C, Cybil Meta assembly	Fortran 77, APL-2	Fortran 77	Fortran 77	Fortran 77
Features								
Pipes (vector)	4 Add 4 Logical 4 Shift 4 Popcount 4 FP MPY 4 FP Add 4 FP Recip	4 MPY 4 Add 4 Logical 4 Integer 4 Popcount	8 Add 8 Logical 8 Shift 8 Popcount 8 FP MPY 8 FP Add 8 FP Recip.	16 Add 16 Integer 16 Divide 16 Multiply 16 Shift 16 Logical	6 Add/Sub/Logic 6 MPY/DIV	4 MPY 4 DIV 4 Add/Logical 4 MASK	4 MPY 1 DIV 4 Add/Logical 4 FP MPY 4 FP Add	4 MPY/DIV 4 Add 4 Logical 4 Shift
Load/Store	8 Loads AND 4 Stores	4 Loads OR 4 Stores	16 Loads AND 8 Stores	4 Loads AND 4 Stores	6 Loads OR 6 Stores or any combination	2 Loads OR 2 Stores OR 1 Load 1 Store (only if data is contiguous)	8 Loads OR 4 Loads 4 Stores	8 Loads AND 4 Stores
Registers (words) per processor — scalar	64B,64T,8A,8S	8A,8S	64B,64T,8A,8S	256	16 GP 4FP	-	--	120
Registers (words) per processor — vector	512 = 8 x 64	512 = 8 x 64	512 = 8 x 64	-	2K = 8 x 256	16K (dynamically reconfigurable 64-2048 elements per vector)	16K = 32 x 512	16K
Other		No chaining local memory (128KB/processor)			Cache			Scalar Cache

* all 64 bit words, data are for the largest member of the series

** in units of 2^{30} bytes = 1,073, 741, 824, often loosely called a "gigabyte" (even though it is 7% l---er)

\+ M Flops

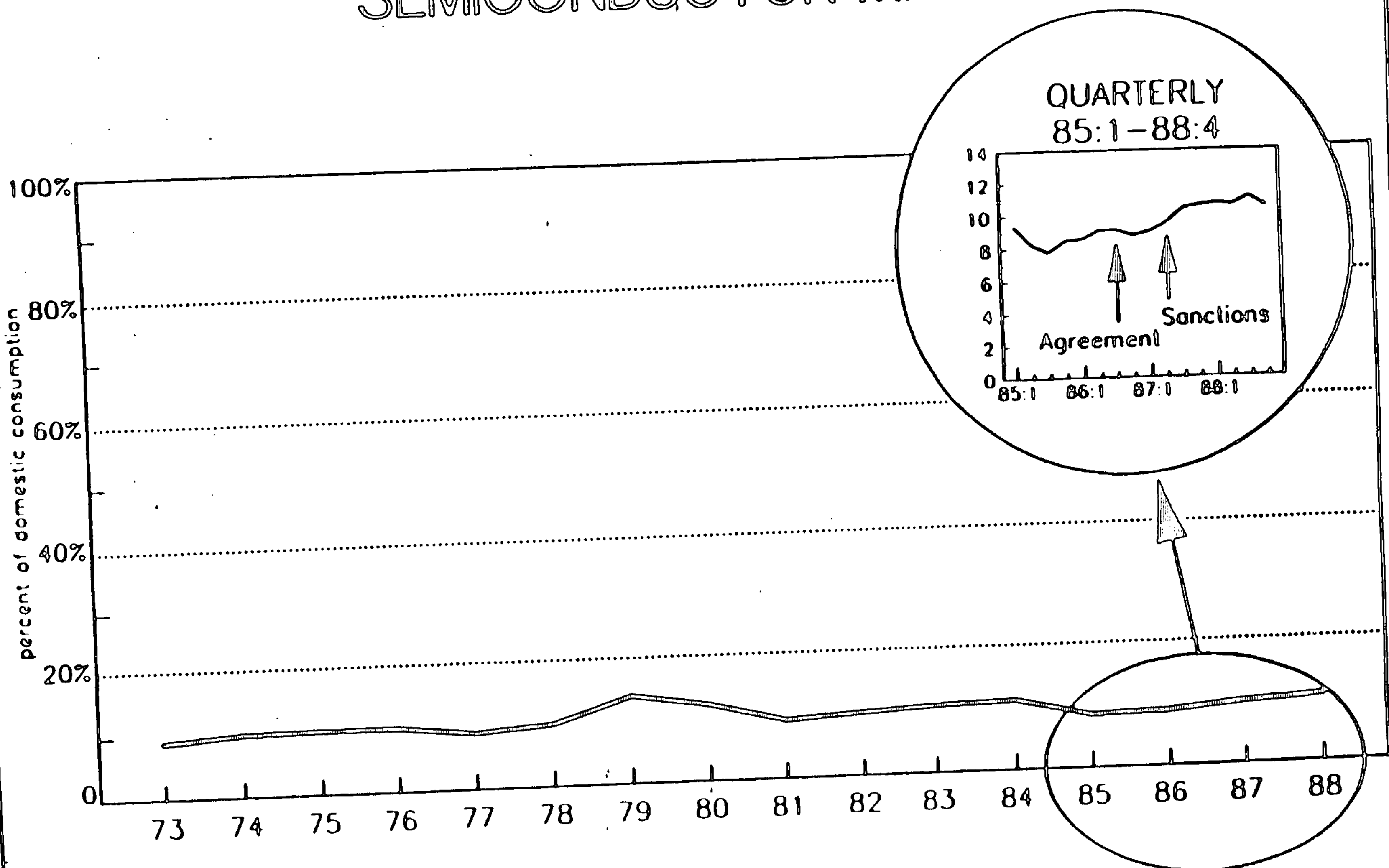
IEEE

Table 2 - VECTOR ARCHITECTURE SUPERCOMPUTERS IN DESIGN*

Series & Maximum Model	SSI	CRAY 3	CRAY 4++	CRAY C-90	NEC SX-X/SX-3/44++++	FUJITSU VP2000/VP2600/20+++
First Installation Expected	199X	199X	199X	199X	1989	1990
Number of Processors	16,32,64	16	64	16	1,2,4,	1,2
Peak Performance Per Processor+	-	1	2	1	5.5	2
Total Peak Performance	-	16	128	16	22	4
Cycle Time (ns)	2	2	1	4	2.9	4
Maximum Main Memory Size**/ Extended Memory					2/16	2/8
Technology Logic (gate delay)		ECL 500 gates/chip GaAs	GaAs		ECL 20,000 gates/chip (70 ps)	ECL 15,000 gates/chip (80 psec)
Main Memory		MOS			256K Bi-CMOS SRAM (20ns)	1M SRAM (35ns)
Extended Memory					1M DRAM (150ns)	
I/O No. paths (total)					256+48+8	16-128
Max. data rate path(MB/sec)					3,4,5,6,9/20/100	9 (optical fiber Fujitsu proprietary)
Max. aggregate data rate(MB/sec)					1068	1000
Cooling					Water (logic) Air (memory)	Water
Operating System	-UNIX	UNICOS	UNICOS	UNICOS	Super-UX, SXOS	MSP, UTS/M
Languages/Compilers	Fortran,C C++ ?	Fortran,C C++ ?	Fortran,C C++ ?	Fortran,C C++ ?	Fortran 77/SX C	Fortran
Features Pipes (Vector)					8 MPY/Shift 8 ADD/Boolean	-dual scalar/single vector per processor
Registers (Scalar) (Words)					512	
(Vector)					72K	16K
Other					Cache	

* all 64 bit words
** in units of 2^{30} bytes
\+ G Flops
++ Early in Design Process
+++ Announced Dec. 1988
++++ Announced April 10, 1989

U.S. PENETRATION OF THE JAPANESE SEMICONDUCTOR MARKET



Source: SIA/WSTS (corrected from 1986)

Semiconductor Forecast Summary 1989-1992

(U.S., Europe and Japan; Shipments in millions of dollars)

	1988	88-89 Change	1989	89-90 Change	1990	90-91 Change	1991	91-92 Change	1992
TOTAL SOLID STATE									
U.S.A. Total	13,417.9	+13.8%	15,271.2	-3.3%	14,760.9	+11.1%	16,404.0	+19.5%	19,598.4
Western Europe	8103.8	+16.5%	9444.6	-0.3%	9419.8	+ 9.0%	10,271.2	+15.0%	11,816.1
Japan	18,108.9	+11.9%	20,259.8	+0.5%	20,355.7	+11.4%	22,680.4	+17.9%	26,744.8
Other International	5374.0	+20.7%	6488.0	+0.8%	6540.1	+14.4%	7484.6	+20.4%	9010.1
WORLDWIDE TOTAL	45,004.6	+14.4%	51,463.6	-0.8%	51,076.5	+11.3%	56,840.1	+18.2%	67,169.5
PRODUCT SUMMARY									
TOTAL IC'S	35,892.4	+16.5%	41,815.9	-1.4%	41,229.5	+ 12.5%	46,371.8	+20.4%	55,835.5
TOTAL DISCRETE & OPTOELECTRONICS	9112.2	+ 5.9%	9647.7	+ 2.1%	9847.0	+ 6.3%	10,468.3	+ 8.3%	11,333.9

Source: World Semiconductor Trade Statistics

Imprimis Technology Incorporated

7801 Computer Avenue South
Minneapolis, Minnesota 55435
612-830-5345

IMPRIMIS

September 21, 1989

Mr. Norman H. Kreisman
Advisor, International Technology
U. S. Department of Energy
Office of Energy Research
Washington, D.C. 20585

Ref: Talsoe/Kreisman Telecon on Supercomputing

Dear Mr. Kreisman:

The American supercomputer industry is built on a small, highly specialized customer base. It requires vast amounts of capital which is at high risk because of limited market size and increasing Japanese competition. In essence it is facing the challenge of survival. The demise of ETA emphasizes that fact.

The domestic high performance disk drive business which underpins our supercomputer industry faces a similar challenge. It consists of a fragile infrastructure dedicated to servicing a small, highly specialized market. Disk drive memories required to support the gigaflop performance demanded by supercomputers, unlike those used for general purpose computing, are more complex, expensive and often demand new, state-of-the-art technologies. Imprimis is specifically concerned whether the domestic high performance drive vendor base, responsible for delivering these state-of-the-art drives, can survive the powerful threat of vertically integrated Japanese companies.

The general disk drive industry serves a $25B market which generates sufficient revenue to provide the R/D necessary to sustain continuing product developments. In contrast, the high performance OEM drive market, supplying domestic supercomputers, is estimated to be approximately $100M/year and requires a disproportionate share of R/D dollars to remain competitive.

Supercomputer throughput depends implicitly on the performance of its mass storage subsystem. While the general market only requires data rates of 6 megabytes per second, (Mbs),or less, supercomputer applications demand 10 to 100 Mbs or more. Designing and building such high data rate devices involves a considerable R/D effort with significant technical risk. The return on the required investment is typically inadequate to sustain a business unless the high performance drive platform can be leveraged from a design dedicated to the general purpose market. Because of downsizing pressures in the market, the larger form factor drives, which are more attractive as high data rate platforms, are in jeopardy. This implies higher future cost, for supercomputer vendors wishing to retain the larger form factor, as the ability to leverage disappears.

Domestically there are only three active American high performance drive vendors: Imprimis, Ibis, and Century Data, who must compete with growing Japanese participation from strong, vertically integrated companies such as Fujitsu and NEC. Clearly the Japanese with "deep pockets" and a captive domestic supercomputer base are in a better position to support the development necessary to supply high performance drives. Vendors who survive solely on revenue from this niche are especially vulnerable since their profitability is inclined to be marginal in supplying the investment required for the improved performance and reliability demanded by each successive generation. A small market, large capital investment, and hardware uniqueness are all negative inducements for domestic drive vendors to become supercomputer mass memory suppliers.

Our analysis of the OEM minisupercomputer disk drive market shows, for instance, that Fujitsu and NEC already own 60% of that segment. Although, the Japanese have minimal presence in the OEM supercomputer drive market, it is only because the largest share holder, Cray, has yet to use Japanese drives. It must be remembered that the Japanese supercomputer suppliers manufacture their own drives and will use that base to spawn the future drive technology needed to compete for our markets. Their share of the OEM minisupercomputer market is only an ominous sign of things to come.

Without a proactive government posture in the form of R/D incentives, procurement policies favoring domestics, some form of risk funding or other innovative approaches that encourage and nurture the fragile domestic supplier base, there is a substantial risk of continuing to lose this strategic high ground to the Japanese. Within the next year we, for one, will have to make some hard choices based on the current business climate and a forecasted return on investment for different projects. Magnetic memory programs supportive of supercomputing are in jeopardy for all the above reasons.

If the Government, in defining the supercomputer industry as a critical national resource, intends to protect that resource from erosion, then it should be equally concerned with the secondary memory industry servicing it. In reading the '87 FCCSET report on supercomputing, it was somewhat disheartening to find only two short references highlighting the requisite need for encouraging design of supportive high performance magnetic storage systems. To paraphrase a succinct observation made in the report by L. M. Thorndyke, former ETA Chairman of the Board, he stated: "The pressing demand for supercomputer mass storage disks can only be met by a concerted, dedicated, several year effort involving human and financial resources sustained by the prospect that "ready and willing" buyers exist. The niche market for supercomputer mass storage does not have an abundance of ready and willing buyers to support all the competition. This again could leave the Japanese in a strong position to "walk" away with the market because of "deep pockets", strong vertical integration, a tendency for predatory pricing and a captive home supercomputer market. It is Imprimis's belief that the supercomputer magnetic mass memory industry is in jeopardy and needs to be included under any protective umbrella that may occur as a result of planned Government initiatives.

We appreciate this opportunity to express our views concerning the pending Japanese threat, and the difficulties of providing magnetic memory solutions to the supercomputer environment. I hope this information is useful and look forward to any further communication.

N. B. Talsoe
V. P. Technical Programs

THE ROLE OF THE U.S. FEDERAL GOVERNMENT IN THE PAST, PRESENT AND FUTURE OF SUPERCOMPUTING

By James F. Decker*
Deputy Director, Office of Energy Research
U.S. Department of Energy

The U.S. federal government and its laboratories have played a key role in the development of computational science and supercomputer technology. Today, supercomputing is an essential component of research in many fields of science and its importance is growing in other fields. The government's role in supporting basic research in computer science and applied mathematics related to improving supercomputing performance for the future is vital.

In addition, the government's role in providing access to supercomputers for its research programs at the leading edge. Substantial federal investment will be required in the coming years to meet the growing requirements of the U.S. research community for more supercomputer capacity and capability.

History

From the early days of computing, government laboratories have played a key role in the development and application of supercomputers. The government interest was driven by need to solve large computational problems related to national security. Consequently, much of the early supercomputer development and use occurred at national laboratories in the secret environment required by national security applications.

Two of the most prominent laboratories in supercomputer development have been the Los Alamos National Laboratory and the Lawrence Livermore National Laboratory. Both laboratories have as a principal mission the design and testing of nuclear weapons for the Department of Energy (DOE-formerly the Atomic Energy Commission and the Energy and Development Administration).

The first digital general purpose computer, and therefore the first supercomputer, was called the ENIAC. It was built under the contract with the U.S. Army's Ballistic Research laboratory by a group of engineers at the Moore School of the University of Pennsylvania. The first problem run on that machine was an implosion calculation done by a team from Los Alamos. The ENIAC was followed by a series of increasingly more powerful machines built by universities and national laboratories.

As the U.S. computer industry began to develop, a very fruitful relationship emerged between the government laboratories and industry. Los Alamos took delivery of the first commercial digital computer built by IBM, the 701. IBM and Los Alamos then entered into a joint research and development agreement under which the STRETCH computer was designed and built. It was delivered in 1961. The STRETCH was 75 times faster than the 701. At about the same time that IBM and Los Alamos were working on the STRETCH, the Lawrence Livermore National Laboratory collaborated with Univac to build the LARC. Following the LARC, Livermore scientists also helped design the CDC 6600, built by the newly formed Control Data Corporation.

It became standard practice for either Los Alamos or Livermore to take delivery of serial number one or two of each new supercomputer. Each new machine came with little software, and considerable government investment was required to make them usable. Essentially, all of the initial computational techniques and applications software were developed by government laboratories.

Other government agencies also began to use supercomputers. The Department of Defense and Commerce used supercomputers for weather predictions, the National Aeronautics and Space Administration for aerodynamics calculations, and the National Science Foundation for atmospheric research. The Atomic Energy Commission expanded its use of supercomputers to nuclear reactor design and magnetic fusion research.

For 25 to 30 years, the government market was, for all practical purposes, the only market for supercomputers. The close working relationship between the government laboratories and computer vendors was

* Dr. Decker is past Chairman of the FCCSET Subcommittee on Science and Engineering Computing.

essential. With such a limited market, it was clearly necessary and appropriate for the government to share in development risks.

In addition to contributing to supercomputer hardware and systems software design and development, the government laboratories also made major contributions to the development of computational science. Development of numerical techniques to solve the many complex problems faced by government programs in nuclear weapons development, airplane design, weather forecasting, etc., formed the basis for a new approach to research and development, i.e., computational science.

Today, computational science is a well established tool for R&D and is used widely not only in government programs, but in industry. It has become an accepted method of reducing the time and cost of developing new products by substituting numerical modeling for much of the interactive building and testing of hardware.

Because of the national security nature of nuclear weapons and other defense-related R&D programs, much early supercomputer use was in a classified environment. One of the first major uses of large scale computing in a nondefense program came in the Atomic Energy Commission's magnetic fusion energy program. The program's scientists and managers realized that the extremely complex physical problems of stability and heating of magnetically confined plasmas would require computational approaches for understanding and solution.

The program then faced an interesting dilemma. Unlike nuclear weapons research, located in just two laboratories, fusion research was located at five major laboratories and a host of universities. None of the major laboratory sites could, by themselves, justify a supercomputer, and certainly none of the universities could. The total cost of locating a supercomputer at each site was prohibitive. The solution chosen was to establish one supercomputer center for the program at the Lawrence Livermore National Laboratory and provide the other laboratories with access through dedicated wideband communications. Even small university contractors could have access through telephone lines, albeit with less bandwidth.

Today, this seems like the obvious solution, but at the time, it was a new, untested way to access supercomputers. The National Science Foundation used a similar solution for its atmospheric research community by establishing a supercomputer center at the National Center for Atmospheric Research. These pioneering efforts have served as models for a number of government and private sector supercomputer networks.

Present Status

The federal government has clearly been responsible for the development of state-of-the-art supercomputers, computational science, and supercomputer networks. However, in the early 1980s it became clear that while a great new capability had been developed by the government, its use was limited for the most part to a few government programs.

Of primary concern was the fact that while computational science had broad applicability to many areas of research, very few scientists had access to large computers. In addition, new supercomputer capabilities were not being developed aggressively enough by U.S. vendors to meet the needs of government R&D programs. Moreover, the Japanese had announced their intent to enter the supercomputer business in a major way. These concerns led to a number of studies and congressional hearings. The most important recommendations for government action arising from these studies were:

1. The government should greatly increase access to supercomputers by scientists, particularly university scientists.

2. The government should increase research on parallel computing as the most promising approach for achieving greatly increased computing power in the future.

3. The government should increase the training of personnel scientific and engineering computing.

4. The government should continue to act as a "friendly" buyer of new supercomputers.

Steps were taken by several government agencies to implement the recommendations. Access to supercomputers has been increased substantially by a number of federal agencies, including the National Science Foundation (NSF), Department of Defense (DOD), National Bureau of Standards (NBS), National Institute of Health (NIH), and the Department of Energy (DOE). Of particular note is the establishment of five university supercomputer centers by NSF. The approach taken by most agencies has been to connect their supercomputer centers to networks that allow researchers at geographically dispersed locations to access these new machines.

Federally sponsored research on parallel computing has increased. New parallel architectures are being developed and tested. Research on algorithms and software has been expanded at DOE, NSF, and DOD.

Summer training courses in supercomputing have been run by NSF, DOE, and DOD. However, probably the most effective training comes about because university scientists have access to supercomputers and because undergraduate and graduate students have opportunities to use the machines as part of their research and course work.

The government's role as a "friendly" buyer continues, but the relationship between vendors and government laboratories has changed. The close working relationship that existed at the design and development stage on the STRETCH and LARC has not been in effect for the last several generations of machines. The government does not share the R&D costs, and vendors are now expected to deliver much more complete software with a new machine. Why has the relationship charged?

During the 1980s, there was a large growth in the supercomputer market. For example, the leading manufacturer of supercomputers, Cray Research, produced nine machines in 1980 and 42 machines in 1987. During that time, Control Data Corporation and its subsidiary ETA Systems continued to produce machines and developed a new generation, the ETA-10. IBM added vector processing capability to its 3090 series as its entry into the scientific and engineering computing market. Three Japanese companies, Hitachi, NEC, and Fujitsu, all entered the supercomputer market. The largest growth came in the industrial section with a large variety of industries recognizing the value of large-scale computing to their R&D efforts.

With this large market growth, the supercomputer business has become much more profitable. Whereas, in the past, software development by vendors was nearly nonexistent, each vendor now must make a substantial effort to develop software. Customers, particularly industrial customers, put a premium on eases of use and reasonable total cost. Thus the development of the software market for supercomputers and the attendant increased demand for quality software from the vendor has reduced the burden on the federal laboratories to develop software.

From the viewpoint of managers in the federal laboratories, it also makes sense to take advantage of what the vendor will provide, thus conserving resources. While the government laboratories still buy some early serial number machines, the result has often been to buy supercomputers with the philosophy,-a much more conservative approach, applied when buying smaller computers.

While this arm's-length relationship works reasonably well for incremental supercomputer developments that do not involve changes in basic architecture, more innovative changes require a closer working relationship between vendors and the experienced users. This helps to assure high performance on real problems. The most experienced users today are still located at a few government laboratories.

Recently, IBM and Los Alamos have entered into an agreement that will again provide a close working relationship between a vendor and a national laboratory during the development stage.

The Challenges of the Future

The federal government moved aggressively to meet the demands for supercomputing in the mid-1980s. However, the demand for more supercomputer capacity and capability by the scientific and engineering communities will continue to grow more applications emerge and more scientists and engineers are educated in their use. Supercomputing is a rapidly advancing technology. To stand still is to fall behind the needs of the U.S. scientific community and lose scientific and technological competitiveness with other nations, as well as posing a threat to national security.

Today's supercomputer is tomorrow's mainframe. As supercomputer technology of networks, workstations, visualization, etc., to take full advantage of new computational capabilities. Of immediate concern is expanding and upgrading communications networks to provide users proper access to the supercomputer center and keeping existing centers at the cutting edge of technology with upgrades to new supercomputers. The financial investments required are significant, with new supercomputers costing $15 million or more.

A study of future computing requirements with recommendations for government actions was recently completed by an interagency committee formed by U.S. federal departments. A summary of the committee's findings and recommendations are contained in the Office of Science and Technology Policy report, "A Research and Development Strategy for High Performance Computing." The four broad recommendations for government actions to meet the nation's needs are:

1. High Performance Computers: The U.S. government should establish a long range strategy for federal support for basic research on high performance computer technology and the appropriate transfer of research and technology to U.S. industry.

2. Software Technology and Algorithms: The U.S. should take the lead in encouraging joint research with government, industry, and university participation to improve basic tools, languages, algorithms, and associated theory for the scientific "grand challenges" with widespread applicability.

3. Networking: U.S. government, industry, and universities should coordinate research and development for a research network to provide a distributed computing capability that links the government, industry, and higher education communities.

4. Basic Research and Human Resources: Long term support for basic research in computer science should be increased within available resources, industry, universities, and government should work together to improve the training and utilization of personnel to expand the base of research and development in computational science and technology.

COMPUTERS

Government Information Society FY89 Projects Outlined

[Article by T. Suzuki, Ministry of International Trade and Industry [MITI], Machinery Information Industries Bureau, Electronic Policy Department. "Synopsis of FY89 Policy on Information Projects and Efforts Toward the Achievement of an Advanced Information-Based Society"]

[Text] The information industry in Japan has steadily progressed to the point where there are now more than 270,000 general purpose computers in use. Information-related industries have grown to lead the Japanese economy, accounting for 6.4 percent of the GNP at ¥19 trillion.

However, the computer and information-related industries have experienced growth chiefly in terms of quantity, while the foundation of the information-based society has experienced qualitative problems. These problems require immediate attention in order to bring about a highly advanced information-based society. In particular, the foundation of the information-based society must be strengthened by training personnel in such areas as data processing engineering and information services. Steps must be taken to improve both the amount and quality of software, and internal corporate systems should be expanded into inter-corporate networks.

The Ministry of International Trade and Industry set out in FY89 to address these issues, and established the following requests in order to achieve a continuing overall policy with regard to information-related projects.

I. Promotion of Policies for Information Education and Training of Personnel

In order to respond to the increasingly varied and complex needs which have accompanied the advancement of the information-based society, it is critical to promote computer utilization in educational systems from a long-range point of view, and to educate personnel to support the various fields involved in information processing.

In fiscal 1989, MITI will promote the concept of a college for information education, and also carry out a composite project for information education and personnel training.

A. Promotion of Information College Concept

Although facilities have been quickly established for technical schools for information-related training, the problems of course content and instructor performance have arisen. For this reason, the information college concept will continue to be agressively promoted with the aim of training superior data processing engineers and revitalizing the regional information industries.

1. Promotion of Information Colleges

At the Central Information College (which started out as the Central Data Education Laboratory 1 June 1987), research has been done regarding educational methods for software technology, and instructors are being trained for regional information colleges (associated facilities for training information-oriented personnel). In this way, training methods which meet the needs of society can be established, and data processing training efforts can be enriched in outlying areas. Budget: ¥100 million (¥80 million in FY88). Note: Hereafter, figures in parentheses indicate FY88 budget.

2. Courseware for Data Processing Engineers (the CAROL system)

At present, data processing engineers (system engineers, high level programmers, etc.) are extremely lacking in both quantity and quality. Therefore, software will be developed to train data processing engineers as one provision of the information college concept.

More specifically, this involves: a) the establishment of the CAI system (CAROL) specification for training data processing engineers, b) developing a standard curriculum for data processing engineer training, and c) promoting the use of the CAROL system.

Budget: ¥90 million (¥90 million).

B. Promotion of Computer Use in Schools

As the use of information networks increases in today's society, it is necessary for computers to be freely adopted into school curriculums in order to enable today's youth (and tomorrow's leaders) to learn how to use the computer as a natural tool.

1. Basic Technology for Educational Information Processing

The Information Processing Advancement Association (IPA) is to carry out a fundamental study to develop an easy-to-use computer for school curriculums. This will be chiefly done by the Computer Educational Development Center (CEC) in an effort to promote computer uses in school educational programs.

Budget: ¥260 million (¥240 million).

6. **Regional Industrial Information Development Project**

This project provides an overall support policy with regard to strengthening data processing capabilities and stepping up the level of regional information industries.

B. Financing for Data Processing Advancements (Japan Development Bank)

This provides the funding for equipment and non-equipment capital needed in the automation of software development, education projects for software development engineers, and for the development of software needed in inter-corporate data processing systems.

Financing: ¥ 66 oku (included in the ¥ 110 billion figure for information promotional projects).

C. Extension of Preparatory Funding System for Programs (see below)

III. Personalized Information Systems

A. Technological Development for Basis of Future Distributed Data Networks (Friend 21)

In order to promote the establishment of a high level information-based society, a man-machine interface is needed that will achieve distributed data processing which a wide range of ordinary customers can comfortably operate. This addresses the need for the mass implementation of data systems which are personalized and also diversified.

Only specialists can use the current computer system, and it is difficult to process non-standard and analog data. Therefore, it is feared that at the current stage of development, large numbers of people will not be able to sufficiently use the data equipment, resulting in economic inefficiency.

To address the above problem, it is necessary to develop the following: a) analog data processing technology for images, b) techniques for processing Japanese language and ambiguous information, and c) human engineering interfaces.

The above technology is planned to be developed over a 6-year period beginning fiscal 88.

Budget: ¥ 160 million (¥ 100 million).

IV. Promotion of System Compatibility and OSI (Open Systems Interconnection)

As networking becomes more advanced in our society, it has become evident that there is a problem in connecting various different types of data-related equipment and systems. Computer users are also trying to upgrade their networks by interconnecting different types of computers.

With regard to this problem, standardization based on the Open Systems Interconnection (OSI) will continue to be promoted in order to enable interconnection of different types of computers. OSI will also be promoted in terms of supporting efforts made by private computer manufacturers and customers.

In addition to continuing to support private efforts, international cooperation will also be solicited on a governmental basis.

A. Promotion of International Efforts for OSI

1. Government-based international cooperation will be solicited at high-level meetings with specialists from European countries and other countries involved in OSI.

2. Promotion of mutual cooperation between POSI (Japan), SPAG (Europe) and COS (U.S.) which are private organizations promoting OSI.

B. Testing of Products Conforming to OSI Standards

The Data Processing Compatible Technology Association (INTAP), is performing tests to determine whether data processing equipment meets the OSI standards. It has established a test and inspection center and strengthened its position regarding product testing.

C. Research and Development of a Database System for Electronic Computer Compatibility

At present, various types of database are established separately for different types of systems, and the databases cannot be interconnected. Customers which require various types of data are compelled to use separate terminals to access various databases. The data itself is insufficient, being limited to characters and diagrams.

To solve this problem, a multi-media database system is needed which can be built using different computer models and varying structures. Research and development will be done to achieve a system which solves all of these problems simultaneously.

In particular, with regard to OSI:

a. OSI-based subsets and functional standards will be developed.

b. Verification testing will be done using a model system.
Budget: ¥ 1.43 billion (¥ 1.14 billion)

D. Promotion of Standardization of Leading, Flexible Data Technology Using Japan Industrial Standards, Etc.

The OSI standards will be established by the Japan Industrial Standards (JIS) based on results of an examination made by the International Standardization Organization (ISO).

2. Promotion of Educational Computers (New Project)

In accordance with a revision of the educational curriculum planned by the Ministry of Education in 1983, the capital needed to obtain personal computers and software from rental agencies will be funded by the Japan Development Bank at a low interest rate in order to facilitate the use of computers and software in middle schools.

Financing: Japan Development Bank financing, ¥ 2 billion.

II. Advancement of Overall Software Development

The rapid implementation of computers has resulted in an explosive demand for software. The gap between supply and demand is expected to grow even more in the future. In addition, more reliable and better quality software is greatly needed, thus adding to the current critical situation surrounding software development.

For these reasons, the IPA, which is the central agency promoting software development, will continue to aggressively promote the Sigma project, in addition to carrying out overall software development programs to utilize the financing and tax structure provided.

A. Data Processing Promotional Business Association Projects

This program will undertake the following projects in addition to establishing the industrialized system for software production (the Sigma system).

1. Industrial System for Software Production (Sigma project)

At present, software development is at the hand-made production level. Its productivity and reliability are extremely low. It is therefore necessary to implement computers in the various processes of software development and to automate and mechanize the production process.

In view of this situation, beginning the fiscal 1985, IPA will build an industrialized system for software production.

The Sigma system will improve productivity and reliability by taking the following basic approaches.

a. Establishing a standard software development environment that is independent of any hardware used in executing programs.

b. Establishing a network system for indexing and transferring technical data and programs.

In FY89, the developmental stage of the Sigma system will be completed, and a survey of system users will be made to solicit their comments. The prototype system which has been developed so far will be made available for general use. Also, a post-project conceptual design will be made in an effort to advance the Sigma system to a higher level of operation.

Financing: ¥ 2.5 billion (¥ 2.9 billion). Development Bank financing ¥ 1 billion (¥ 600 million).

2. Program Development and Circulation Project

At the IPA, it is particularly necessary to promote development. The program results are regarded to be widely used in industrial activities (advanced, general-purpose programs), and those programs which cannot be easily developed privately will be contracted out for development. The results of these efforts will be made freely available.

Basic software development will also be promoted to establish common interfaces that will be required to achieve an advanced information-based society.

Financing: ¥ 1.5 billion (¥ 1.5 billion).

3. Computerized Personnel Training Promotional Project (see above)

Financing: ¥ 900 million (¥ 900 million).

4. Evaluation of Software "Usability"

The IPA Technology Center has taken the initiative to serve as a neutral organization in the evaluation of requests presented by both users and suppliers regarding software quality and performance. In this way, it has established an inroad into evaluation in the circulation market.

5. Promotion of Development of Leading Data Processing Technology

In Japan, data processing technology has only a short history, even though it has developed rapidly in the past few years. However, compared to European and American countries, software-related fields are particularly lagging in technical developments. Data processing technology has taken on a new importance in both academic and business circles as a consequence of the increasing number of fields which are based on data processing.

For these reasons, the IPA was established in October of 1981. A wide range of engineers were invited to join, including specialists in main frame computers and data service industries, to form a project team that is now involved in the research and development of leading data processing technology.

Budget: IPA project ¥ 1.21 billion (¥ 1.2 billion).

To prevent this type of situation from occurring, low interest financing is provided for a backup center which provides replacement and reorganizing functions for computer systems. This financing also covers the acquisition of various facilities to promote security measures at each business office.

Financing: ¥5.3 billion (included in 110 billion figure).

E. Basic Maintenance Account (NTT no-interest financing by Japan Development Bank, etc.)

A request has been made to finance the new composite EMC Center, data advancement in regional industries, and maintenance of model regions which are using high definition equipment by utilizing proceeds from the sale of NTT stock. This system was established in the revised FY87 budget for type C in the NTT no-interest loan system (loans originated by the Japan Development Bank). This would add to the already existing funding for cooperative data processing facilities within the regional "new media community."

F. Tax Structure for Information Advancement Programs

1. Extension of Program Preparation Funds

a. Preparatory Funds for General Purpose Program Development

Thirty percemt of sales of general purpose programs registered by the IPA would be established as preparatory reserve funds.

b. Preparatory Funds for Construction of Databases

Ten percent of sales related to databases would be reserved.

c. Preparatory Funds for Integrated System Maintenance

Ten percent of income related to contracting system integration services would be reserved.

d. In each case, 4 years deferred, 4 year equal breakdown (profit included).

2. Extension of Preparatory Funds for Computer Repurchase Loss

In accordance with the rate of loss due to the repurchase of computers, a certain proportion of the computer sales amount of the repurchase agreement is reserved as preparatory funds.

When a repurchase occurs, the old amount will be broken down successively (profit included), or a 5 year deferral, 5 year equal breakdown will apply.

3. Other New Tax Items

A request has been made for an investment promotion tax system with regard to the acquisition of equipment that is invested to promote network development and which serves as the foundation for industrial and social expansion. The necessary tax system is requested.

G. Promotion of Individual Industries

With regard to individual industries that have a high degree of importance in terms of their effects on other industries and regional computerization, the status of the computerization efforts of the individual industry will be examined, and when necessary, a "cooperative directive" policy will be established based on the "legislation pertaining to data processing."

VI. Promotion of Information-related Technology Development

The fifth generation computer, compatible database system, high speed calculating system for science and technology, etc. will continue to be strongly promoted in FY89, as they are essential to the promotion of technical development in the field of computerization.

Also, the financing function of the Basic Technology Research Promotional Center will be fully taken advantage of to promote activites of those R&D companies that were established using the funds.

A. Research and Development of the Fifth Generation Computer

Heading toward the 1990's, the research and development of the new generation (fifth generation) computer will continue to be strongly promoted. This computer will utilize revolutionary technology such as artificial intelligence and non-Neumann type high level parallel processing.

Budget: ¥6.45 billion (¥5.73 billion).

B. Research and Development of Inter-operable Database System (Major project) (see previous)

Budget: ¥1.43 billion (¥1.15 billion).

C. Development of High Speed Calculating System for Science and Technology (Major project)

Research and development of a high speed calculating system with greatly increased operational speed for scientific and technical processing, will continue to be enacted.

Budget: ¥2.42 billion (¥2.78 billion).

E. Establishment of Low Interest Financing System by Japan Development Bank and Tohoku Financial Corporation To Promote OSI-based Systems

Financing: Japan Development Bank data processing/comunications systems promotion, ¥ 17.4 billion. New: Tohoku Bank Regional Information Promotion, ¥ 5.3 billion.

V. Computerization of Industry and Establishment of Computerization Basis

Focusing on the Japanese economy, industrial computerization has led the movement toward computerization in Japan. However, it is necessary to advance compouterization efforts which surpass the business and industrial frameworks, by establishing inter-company networks.

To achieve this, measures will be developed needed to promote the establishment of intercompany networks as well as to fulfill the "Directives Regarding the Cooperative Utilization of Electronic Computers." At the same time, the computerization of individual industries will continue to be promoted.

In addition, in order to establish a computerization basis, the financing will be used, such as for "promotion of data processing and communications systems."

The "electronic computer system safety standard" has been presented in view of the high degree of dependency which industry and society place on information networks. The "Data Processing Services Industry Computer Safety Enactment" has been approved and "system inspection standards" have also been presented. Safety measures will continue to be promoted in the future.

A. Loans for Computer Promotion (Japan Development Bank Financing)

Financing will be arranged for the funds needed to establish a computer rental business.

Financing: ¥ 74 billion, included in 110 billion figure for promotion of information advancement.

B. Promotion of Data processing/Communications Systems (financing provided by Japan Development Bank)

Funding will be provided to meet the requirements of industry and society for the diversification and advancement of computerization activities, for equipment and non-equipment capital needed to promote the implementation of leading and high-level data processing/communications sytems; and for foundations to establish databases, system integration, and high definition systems.

These systems will be: a) on-line data processing systems used jointly by several companies, b) on-line data processing systems to be purchased by data processing service dealers or information supply service dealers, c) medical, transportation, and disaster-prevention systems, d) the so-called VAN and a data-processing version cable television systems, e) videotext systems, and f) regional data processing and communication systems such as the "new media community" system.

A system to provide capital for foundations which design and provide basic databases will be established in fiscal 1986.

Financing has been approved for non-equipment funding for systems a), b) and c) above, beginning fiscal 1987. For these systems, together with system f), financing is provided not only for equipment, but also for software development.

In response to the microwave problem, the "Electromagnetic Environment Maintenance Promotion" financing system was established in fiscal 1988 for dealers to meet the needs of customers in designing, providing and maintaining optimum systems. The system will also provide financing for foundations which promote the development and implementation of the "system integator" and high definition equipment. In fiscal 1989, a request will be made to renew financing of the mobile composite data processing system, the ISON type data processing system, and model regions utilizing high definition equipment.

Financing: ¥ 17.4 billion, included in ¥ 110 billion information advancement promotion.

C. Improvement of Data Equipment Reliability (Japan Development Bank Financing)

The improvement of reliability and performance of data related equipment, parts and materials is essential in establishing a high level information-based society. To achieve this, financing is provided for equipment investment to improve reliability in the manufacture of data equipment.

Financing: ¥ 20 billion (included in 110 billion figure for computerization promotion).

D. Promotion of Data Processing Safety Measures (Japan Development Bank Financing)

As computers have become more prevalent, they have already developed a dependency in many fields of economics and society. This being the case, natural disasters or human-related factors could cause the functions of the computer system to cease and thereby cause the destruction or loss of data. When this occurs, the damage is not limited to the system alone; it has far-reaching effects on economic and social activities.

D. New Data Processing Technologies (Neural Computer, etc.)

With the aim of opening new frontiers such as data processing which simulates human senses, the potential of new technologies such as the neural computer, bio computer and optical computer will be examined, and their future outlook and social impact will be evaluated.

Budget: ¥ 20 million (new).

E. Superconductive Devices and Materials

In order to provide for mid- and long-range applications of superconducting technology in industrial fields, policies related to development of superconductivity will be aggressively adopted and international cooperation will be solicited.

In particular, private systems will be established to perform investigative reports regarding superconductivity, to seek international cooperation regarding superconductivity, and to solicit international exchange of research and development activities.

Budget: ¥ 1.88 billion (1.06 billion).

F. Development of Medical Support Systems

Medical information has sharply increased with advancements made in medical technology, but computerization of medical business has lagged. Therefore, physicians are in a critical situation where they cannot utilize the large amounts of knowledge and data. To resolve this problem, it is necessary to design an information system that will directly support medical examinations made by physicians. The development of a consultation system will continue in an effort to achieve an "expert system." This sytem will use the results of tests and examinations to display the probable diagnosis and suggested test procedures in support of the physician's decision.

Budget: ¥ 60 million (60 million).

G. Utilization of Basic Technology Research Promotional Center

The Basic Technology Research Promotional Center is an organization that will provide "risk money" needed to promote the testing and research of basic technologies performed in the private sector.

In FY89 also, technical development will be promoted by providing funds and restricted no-interest financing for cooperative testing and research foundations.

Financing: investment, ¥ 21 billion (¥ 19.2 billion), financing ¥ 7 billion oku, financing ¥ 7 billion (6.8 billion).

VII. Promotion of Future City Computerization

This project promotes the collective computerization of industry, society, and home life in a model city development equipped with advanced information systems which are expected to be implemented in the 21st century.

Overall Concept

1. To design a future city where one's residence and work place are close together, and which integrates a highly functional business sector with a pleasant residential area based on international and information advancement.

2. This concept is to establish an information infrastructure to back up advanced information services by means of a regional LAN system, and to build a central information center ("area management center") to manage individual areas.

3. To develop a system that meets the information needs to implement an advanced system which improves various function sof society, to train knowledge-integrated industries (new media businesses) and to step up already existing industries.

In FY89, the necessary measures for budgeting, financing, and tax structure will be established in order to promote the concept of a future advanced information based city.

Budget: ¥ 860 million (950 million). Financing maintaince of area management facility, Japan Development Bank financing. Tax structure: special repayment policy.

VIII. Promotion of Regional Computerization

In order to facilitate the achievement of a high-level information based society, it is essential to promote the achievement of a nationally balanced computerization level while resolving the differences in information advancement in regional areas.

In order to achieve this, various types of information systems conforming to regional needs will be developed, and the application regions of new media community concept aimed at implementing these systems will be expanded. In addition, regional information systems will be promoted by utilizing the financial system for maintaining basic regional computerization facilities, and for promoting regional information advancement.

A. Application of New Media Community Concept

Regions which implement the model information systems and which make efforts to expand the system are designated as new media community concept implementation regions, and feasibility studies for these regions are performed.

The model information systems which are designed will be standardized and databases will be generated. By implementing this ystem in other areas of the region, the regional computerization efforts will be promoted significantly.

Budget: ¥420 million (450 million).

B. Promotion of Regional Computerizalton Facility (New Media Center) for Private Sector

The Japan Development Bank and others will provide a financing structure for the construction of the main facility of the "new media center" and promote its maintenance. (Japan Development Bank, Hokkaido Tohoku Development Bank financing)

C. Financing for Promotion of Regional Computerization Efforts (Hokkaido Tohoku Development Bank financing)

With the diversification which accompanies computerization, and in order to meet the needs of regions which are achieving a high level of information advancement in terms of diversification, and in order to resolve the differences which exist between the regions in terms of level of advancement, financing will be provided to fund the building of facilities and to cover non-facility needs. The objective is to promote the implementation of advanced and high-level data processing and communication systems.

The systems invovlved are to conform to the promotion of data processing and communications systems of the Japan Development Bank. (See above) Financing: ¥5.3 billion (included in 145 billion figure).

D. Financing for Regional Computerization Base Maintenance (Hokkaido Tohoku Development Bank)

In response to the critical need for regional software development, long-term low interest financing will be provided for software development dealers in the Hokkaid Tohoku region.

Financing: 2.1 billion (included in 145 billion figure).

E. Financing for Promotion of Regional Data Processing Safety Measures (Hokkaido Tohoku Development Bank)

Currently, regional financing and various functions of society depend greatly on computer and information systems. If a computer system breakdown occurs, this will have a serious effect on the regional economy. In order to prevent such an occurrence from happening, low interest financing will be provided for maintenance of a backup system. Financing: ¥4 billion (included in 1450 billion figure).

F. Financing for Foundations That Promote the Basic Technology Research Promotion Center's New Media Community Concept

The basic technology research promotion center will provide funds for foundations which promote the new media community concept. (Included in 19.2 billion figure)

IX. Achievement of Database and Information Services

The database is one of the key elements supporting an information-based society, and is even a prerequisite to the establishment of such a system. However, the Japanese databases are greatly lagging behind other countries in terms of advancement. Establishing these databases is an urgent priority.

For this reason, the building of private databases will be promoted, and public databases will also be promoted and an overall database enactment policy will be accomplished in terms of training distributors, and supplying the private sector with government data.

A. Promotion of Important Database Development

A developmental study will be performed with regard to high priority databases for such advanced technical fields as fine ceramics, new materials, etc.

Budget: ¥470 million (590 million).

B. Promotion of International Databases

A feasibility study pertaining to the building of an international database will be performed to study the needs of Japan, which relies heavily on foreign information sources. In addition, the prospects of maintaining an overseas information supply network will be studied.

Budget: ¥250 million (new).

C. Establishment of Public Database and Increased Supply of Private Government Data

The establishment of public databases (such as technology, patent, intermediate and small business information) will continue to be promoted in order to support international trade and industry.

D. Support for Private Databases

The Japan Development Bank will provide funding and low interest financing for foundations involved in building private databases of significant value.

In addition, the establishment of databases will be supported by means of preparatory funds in order to reduce financial burden.

E. Database Register

A database register showing type, location, contents, etc. will continue to be maintained for various databases which can be utilized in Japan (type, location, contents).

X. Information Advancement of Developing Countries

In order to increase the implementation of international information resources, efforts will continue to be made in cooperating with developing countries and those in the Pacific region.

A. Cooperative Research Efforts for Machine Translation System

In order to promote the exchange of technology and culture between Japan and neighboring countries, and to achieve a higher level of advancement, special efforts will be made to cooperate in the development of a machine translation system with the objective of eliminating the language barrier.

Budget: ¥ 640 million, included in research promotional support and cooperation figure (¥ 330 million).

B. Promotion of International Information Cooperative Center

To promote the information advancement of developing countries, and to contribute to the expansion of local economies and industries, training will be provided to educate engineers, who are the nucleus of information advancement efforts. In addition, Japanese engineers will be dispatched to provided instruction and guidance.

Budget: ¥ 240 million, engineer support (¥ 240 million)

C. Research Cooperation Pertaining to the Advancement of Information Resources in Asia

In order to promote the overall advancement of information resources in Asian countries, a basic study will be performed regarding advanced software generation technology, knowledge-based information processing technology, database construction technology, OSI, and other information processing systems. In addition, this will include the development of the knowledge-based CAI system, which will contribute to the software development environment.

Budget: ¥ 20 million (new).

Subcommittee on Science and Engineering Computing

David B. Nelson, Chair
Department of Energy

James Burrows
National Institute of Standards and Technology

John S. Cavallini
National Oceanographic and Atmospheric Agency

Melyvn Ciment
National Science Foundation

Harlow Freitag
Supercomputer Research Center

Randolph Graves
National Aeronautics and Space Administration

Norman H. Kreisman
Department of Energy

Jacob Maizel
National Institutes of Health

O'Dean Judd
Strategic Defense Initiative Office

C. E. Oliver
Air Force Weapons Laboratory

Anthony L. Pressley
Department of Army

John P. Rignati
Supercomputer Research Center

Paul B. Schneck
Supercomputer Research Center

Jacob Schwartz
Defense Advanced Research Projects Agency

K. Speierman
National Security Agency