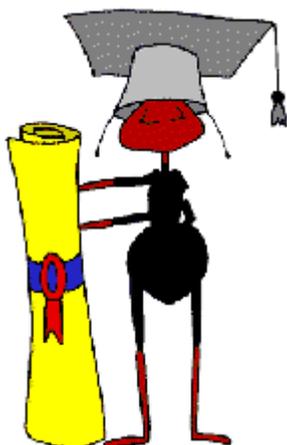


Expanding the Vision of High Performance Computing and Communications: Linking America for



Expanding the Vision of High Performance Computing and Communications: Linking America for the Future

A Report by
the Computer Systems Policy Project

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The Computer Systems Policy Project

The Computer Systems Policy Project (CSPP) is an affiliation of Chief Executive Officers of American computer companies that develop, build and

market information processing systems and related software and services. CSPP was formed in 1989 to provide the CEOs of the industry with a forum to discuss, develop, and advocate public policy positions on trade and technology issues critical to the computer systems industry and country.

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Executive Summary

Over the past year, the Computer Systems Policy Project (CSPP), an affiliation of major U.S. computer systems companies, has reviewed the Administration's High Performance Computing and Communications Initiative (HPCCI), as outlined in Grand Challenges: High Performance Computing and Communications. CSPP believes the HPCCI is a significant, critical and necessary undertaking by the government. As currently designed, the HPCCI will advance research in high performance computing and networking technologies as well as increase the use of high performance computers to solve a range of scientific and engineering "Grand Challenges" -- problems whose solutions are critical to national needs. CSPP believes, however, that the HPCCI can provide the foundation for something even more important: a new national infrastructure to promote America's growth in the 21st century and beyond.

Today, high performance computing and high speed networks are being used at an increasing rate in a wide variety of scientific, engineering, academic, and business settings. The potential benefits of these technologies, however, extend far beyond this country's laboratories, universities, businesses, and supercomputer centers. High performance computing, in conjunction with widely accessible high-speed networks, offers exciting new opportunities to improve the quality of life for all Americans.

To make the most of federal and private research investments in the HPCCI, however, the software, hardware, and networking technologies being developed must be based on the broadest possible vision of what high performance computing and communications can make possible in the future. This requires expanding the current vision of the HPCCI to include Grand Challenges motivated by social and economic needs in areas of interest to the government and general public, such as advances in the delivery of health care and services for senior citizens; improvements in education and opportunities for lifelong learning; enhanced industrial design and intelligent manufacturing technologies; and broad access to public and private databases, electronic mail and other unique resources.

As a major user of computers, the government is appropriately investing in advanced computer technology research through the HPCCI. By leveraging these investments, the government can develop more broadly applicable generic, enabling technologies and stimulate the additional research by the private sector needed to solve the expanded Grand Challenges.

CSPP strongly believes the HPCCI program will have maximum benefit to the country only if the government collaborates more closely with industry and supports the broader vision of the HPCCI; advances the technologies to meet that vision; and implements a stronger management approach. To accomplish this, CSPP recommends the following changes to the current initiative:

- Expand the vision of the HPCCI and include research on generic, enabling technologies to support a wider range of applications;
- Establish a technology and policy foundation for an information and communications infrastructure for the future;
- Improve management and governance of the initiative and increase opportunities for industry participation; and
- Reorder HPCCI budget priorities to achieve a more balanced program.

Working together, the government, industry, and the broader science and technology community can construct an HPCCI program that will contribute to our nation's ability to meet many of the science, engineering, economic and social challenges we face. In addition, by cooperating, we can ensure a better return on the federal R&D investment; promote increased industry investment; and generate productive collaboration between industry, academia, and government.

INTRODUCTION

Linking America for the Future

During the growth of the Industrial Age, America built national transportation links to move people, goods, and raw materials across increasingly greater distances. Just as these interstate highways were crucial to our post-war development, national data links are necessary for growth in the 21st century and beyond. As the United States enters the Information Age, a new national infrastructure is required.

Today, high performance computing is increasingly used in a wide variety of scientific, engineering, academic, and business settings. The potential benefits, however, extend far beyond these current uses. In conjunction with high-speed networks, high performance computing could be the new national infrastructure, offering virtually unlimited opportunities to solve challenges and improve efficiency in ways which directly affect the lives and well-being of all Americans. Among the opportunities are:

- better health care;
- lifelong learning;
- improved services for senior citizens, the disabled, and the housebound;
- enhanced industrial design and intelligent manufacturing technology; and
- broad access to public and private databases, electronic mail, and other unique resources.

Realizing these opportunities requires harnessing the collective energy, talents, and unique resources of industry, academia, the general public,

and the federal government. By enhancing the ability of all Americans to better communicate, share resources and exchange information, the HPCCI can promote a new national infrastructure -- potentially the most powerful tool our nation has ever had to bolster its international economic position and long-term national well-being.

Over the last nine months, the Computer Systems Policy Project (CSPP), an affiliation of chief executives of twelve leading American computer companies, has begun to define this broader vision of high performance computing and communications. If followed, the recommendations offered in this report could help establish the new national infrastructure that would bring the benefits of high performance computing and communications to individual Americans.

Providing the Foundation

In February, 1991, as part of its budget submission to Congress, the Bush Administration released Grand Challenges: High Performance Computing and Communications, summarizing its High Performance Computing and Communications Initiative (HPCCI), a cross-agency research program on computing and networking technologies. The HPCCI is designed to advance research in high performance computing and networking technologies as well as increase the use of high performance computers to solve a range of scientific and engineering "Grand Challenges" -- problems whose solutions are critical to national needs.

CSPP fully supports the goals of the HPCCI and the Administration's program described in Grand Challenges, and commends the Administration for its leadership in designing this important initiative. Similarly, CSPP commends Congress for funding the initiative in Fiscal Year 1992, and for recent legislation that would establish a high performance computing program and National Research and Education Network.

In addition to helping the U.S. maintain its worldwide lead in high performance computing, the HPCCI will lead to specific critical developments in areas such as:

- improving the accuracy of weather forecasts;
- identifying and analyzing cancer-causing genes;
- finding new ways to reduce air pollution; and
- increasing the efficiency of internal combustion engines.

Just as important, however, the HPCCI has the potential to benefit the nation much more broadly by driving important advancements in technologies and policies that will make possible a wide range of future high performance computing and communications applications.

Expanding the Vision

CSPP believes expanding the vision of HPCCI to include a more comprehensive view of what HPCCI technologies can make possible in the future will increase the return on the research investments made in the program. This requires that the HPCCI program include additional Grand Challenges to supplement those already identified by the Administration. Basing federal and private research in software, hardware, and networking technologies on the broadest possible vision will make the most of the foundation provided by the current HPCCI.

CSPP firmly believes that the best means to advance the long-term goals of the HPCCI is for all America to become captivated by the possibilities. The following pages provide just a few examples of what an expanded HPCCI could make possible.

BETTER HEALTH CARE AND MEDICAL SERVICES

- Patients will be linked directly to computers that will not only monitor medical data, but will continuously transmit that information for rapid analysis and ongoing diagnosis by remote experts.
- Interactive video coupled with high capacity networks will deliver medical care, including consultations and diagnoses, to populations without easy access to state of the art medical care and equipment. Besides improving the accuracy of diagnoses, this could reduce the cost of providing medical care throughout the United States by permitting more efficient use of expensive equipment.
- Doctors, patients, and hospitals will be able to confer and consult with specialists in distant cities, sharing high definition video images, audio transmissions, and statistical data from several sources as needed.

LIFELONG LEARNING

- Students will have easy access comprehensive remote databases providing information such as historical and forecasted weather data for their localities. They will be able to compare it with data they collect themselves, analyze the accuracy of predictions, and compare it with data collected by students in other parts of the country through interactive video conferences.
- At home or at school, a student doing research for a homework assignment on Shakespeare will be able to access the Folger Shakespeare Library in Washington, D.C. and consult with experts at the Library of Congress. Portions of plays will be available in video through multimedia information resources.
- Students will take realistic "video field-trips" to Amazon rain forests and Saharan deserts without leaving their classrooms.
- "Lifelong learning" will be a reality through high resolution

interactive video. Schools and businesses will design adult education and training classes tailored to each individual's needs which will be available regardless of a person's schedule.

IMPROVED SERVICES FOR SENIOR CITIZENS, THE DISABLED, AND HOUSEBOUND

- Through advances in speech recognition and other remote control mechanisms, senior citizens, the disabled, and housebound, will become more independent by having access to services and activities that are currently not available to them.
- Enhanced multimedia technology, in conjunction with high performance computers and communications, will enable personal and direct interaction with friends and family in distant places, as well as with health care professionals and social service providers.
- More direct access to critical government services will also be available, as will health monitoring systems enabling help to be sent quickly and automatically in the event of an emergency.

ENHANCED INDUSTRIAL DESIGN AND INTELLIGENT MANUFACTURING TECHNOLOGY

- Industries will use high performance computing for advanced design, simulation, and testing. This will be particularly beneficial in manufacturing, including sheet-metal forming, rolling, welding, and casting; emissions control technologies; engine design; light materials design; and pharmaceutical design.
- High performance computers and networks will enhance capabilities in distributed manufacturing, including just-in-time manufacturing, automated inventory control and resupply, and scheduling; concurrent design, engineering, and manufacturing.
- The availability of high performance computing and communications in conjunction with sophisticated databases of important government information, will enable small and large manufacturing companies to quickly conduct automated patent searches and apply for patents electronically, significantly speeding the current process.

BROAD ACCESS TO PUBLIC AND PRIVATE DATABASES, ELECTRONIC MAIL, AND OTHER UNIQUE RESOURCES

- A farmer in South Dakota will be able to easily access the latest crop predictions and satellite soil analyses from the Department of Agriculture, and long-range weather forecasts from the Department of Commerce, enabling adjustment of planting and harvesting plans.
- A small business owner will be able to respond electronically to a government request for proposal on a contract, receive more rapid feedback on the proposal, and track the award of contracts, enabling instant identification of subcontracting opportunities.

- Individuals will have immediate access to legislative proposals and will be able to provide their legislators with instant electronic feedback on specific bills.
- With government information available and easily accessible on line, individuals who live near waste dump sites will be able to conduct searches of Environmental Protection Agency data to find out whether the waste is toxic and what actions are being taken to clean it up.

RECOMMENDATION #1

Expand the Vision of the HPCCI and Include Research on Generic, Enabling Technologies To Solve a Wider Range of Grand Challenges

To expand the vision of the HPCCI, federal agencies, such as the Departments of Education, Health and Human Services, and Commerce, should work with industry to identify additional Grand Challenges in social and economic areas of direct interest to the government, such as those described on the previous pages.

To make the new vision a reality, the HPCCI must include research on the generic, enabling technologies and the computing and communications architectures needed to enable a wide variety of applications. These include technologies needed for development of open, scalable platforms and systems, from high performance workstations to parallel vector, heterogeneous and massively parallel systems. The current HPCCI will address a range of technologies, including, for example, the following:

- new computer architectures that will permit high-capacity information processing;
- advanced microelectronic technologies, including packaging;
- compression and decompression techniques;
- broadband networks and protocols;
- improved techniques for mass data storage and retrieval to permit storage of complex images;
- improved technologies and algorithms for accessing large databases;
- innovative user interface technologies;
- new algorithms for massively parallel machines, heterogeneous computers and workstations, and other platforms and applications;
- advanced database technology, including tools and services to tie together the users, the applications, the systems technology and the operating systems; and
- enhanced multimedia technologies and capabilities.

These technologies, while useful in solving the science and engineering Grand Challenges, can help to do more. The national investment in the HPCCI research program can be enhanced by designing it in such a way that the technologies also support solving the additional social and economic Grand Challenges.

CSPP companies are already pursuing these and other necessary technologies individually. Moreover, we are prepared to invest in collaborative work with the government. In fact, we are developing a computer industry model

Cooperative Research and Development Agreement (CRADA) with the Department of Energy designed to increase industry/laboratory interaction.

Throughout implementation of the program, it is critical that the government collaborate with both the user and computer systems industries to be sure the HPCCI research and development priorities will support the development of the hardware, software and networking tools needed to solve the expanded Grand Challenges. It is equally critical that new insights, knowledge, and technology developments generated by the HPCCI be quickly transferred to the private sector for actual development, production, and deployment.

CSPP also urges that the Library of Congress and the many government agencies that generate and maintain large amounts of useful information be included in the HPCCI to help lay the research foundation for a National Digital Library. The participation of agencies such as the departments of Agriculture, Transportation, Interior, and the Environmental Protection Agency, for example, is necessary to most efficiently develop the technologies needed to make databases easily accessible over a network.

RECOMMENDATION #2

Establish a Technology and Policy Foundation for an Information and Communications Infrastructure for the Future

Developing the most efficient, effective and broad-reaching communications and information infrastructure for the future requires that near-term research and policy decisions be made with an eye toward the long-term. As it is described in Grand Challenges, the National Research and Education Network (NREN) will provide a basic infrastructure for research and education. However, the NREN offers the foundation for something broader and more exciting.

Through an expanded HPCCI research agenda, there is an opportunity to lay the technology and policy foundation to support a much more comprehensive electronic communications and information infrastructure. Such an infrastructure, to be developed and deployed by the private sector, will consist of a number of interconnected networks that will not only connect research hubs across the country, but will bring educational, health, social, business, and entertainment services to households, schools, hospitals, and offices across the United States. This "network of networks" will provide all Americans with access to unique resources, public and private databases, and other individuals throughout the country.

To make this possible, government and industry must work together to address the following.

1. NETWORK POLICY CONSIDERATIONS -- As a broad communications and information infrastructure develops, many important policy and network management issues will need to be addressed, including, for example:

- how to ensure security and privacy of widely accessible networks and the communications transmitted over them, including methods for ensuring privacy of data and files identifiable to individuals;
- protection of copyright licensing and royalty rights;
- allocation of radio and broadcast spectrum for networking purposes;
- the role of the FCC with respect to networks; and
- how to develop and implement flexible and fair standards applicable to high-capacity networks.

CSPP urges the Administration to ensure the HPCCI serves as a stepping stone to a broader future information infrastructure by beginning to address these and other network-related issues now. This will require expanding the activities under the NREN component of the HPCCI to include research and development on the technologies needed to support broadly accessible and affordable networks.

2. ENSURING NETWORK INTEROPERABILITY -- The future information infrastructure is expected to be a network of today's many separate regional, local, private, and public networks. To be able to send information around such a network of networks, each must connect physically and logically with the others, a concept known as interoperability.

To ensure interoperability, the multitude of commercial and research networks in the U.S. and around the world must be built on a harmonized set of coding schemes and protocols. Because government policies and programs will have a significant effect on the protocols used in future networks, they must be coordinated to meet the goal of network interoperability.

3. ENSURING BROADEST POSSIBLE ACCESS -- In the past, the federal government has been the sole convener and principal funding source for research and education networks. Today and into the future, however, more and more of the funding for these and other networks, even experimental networks, will come from the private sector.

While market forces must be allowed to operate to assure full competition in the provision of networks and services, an expanded HPCCI must include a plan for ensuring the widest possible access to the infrastructure as existing networks are upgraded and broadened. The federal government should also work with foreign governments to ensure equitable access and use of foreign networks, as well as the ability of U.S. information providers to compete abroad.

RECOMMENDATION #3

Improve Management and Governance of the Initiative and Increase Opportunities for Industry Participation

CSPP is concerned that the current HPCCI management approach is not strong enough to guarantee effective results. In particular, it does not take sufficient advantage of existing industry expertise in implementing similar systems.

The HPCCI is a complex project which is being undertaken by at least eight federal agencies, each with separate needs for high performance computing and networking activities. With the exception of the National Science Foundation, the agencies are focused primarily on pursuing agency missions and objectives. At this time, there is no unified vision of the HPCCI or any ultimate point of responsibility for ensuring the overall program goals are met.

If the HPCCI is to move forward effectively and efficiently, CSPP believes there must be explicit coordination and accountability, as well as a clear mechanism, which draws on industry expertise, to coordinate, manage and govern the implementation of the initiative. CSPP is willing to work with the government to help identify an appropriate lead body within the Executive Branch that would:

- develop and support a national vision for the HPCCI;
- develop a coordinated research and public policy agenda designed to make the national vision for HPCCI a reality;
- identify the government's role in accomplishing and overseeing the vision and the necessary computing and communications architecture;
- develop a set of measures and checkpoints against which progress toward the ultimate goals of the initiative can be measured;
- develop a mechanism to ensure that industry, academia, and other parties with expertise to offer can interact with the government and directly contribute to the design and implementation of the HPCCI; and
- develop a system to ensure the efficient transfer of government-developed technology under the HPCCI to the private sector for product development and application.

CSPP is particularly interested in working with the government to ensure close and continuing involvement with user industries and the computer and telecommunications industries.

RECOMMENDATION #4

Reorder HPCCI Budget Priorities to Achieve a More Balanced Program

Following a series of meetings and interviews with the relevant agencies, CSPP has concluded that in general, the research planned under the HPCCI will address the technology areas needed to lay the foundation for a world-class high performance computing and communications infrastructure. However, CSPP believes, in addition to broadening the vision for the HPCCI as described on the previous pages, the following shifts in current priorities will maximize the relevance of the program to both the government and the private sector, thereby increasing the likelihood that the program's

overall goals will be successfully achieved in the near future.

- First, the focus of the HPCCI research should include research on multiple high performance hardware and software configurations, across a broad performance range. In other words, the program should balance research on massively parallel architectures with development and application of other high performance computing tools including open, scalable platforms and systems, from high performance workstations to parallel vector, heterogeneous and massively parallel systems.
- Second, the proposed budget, especially the Advanced Software Technology and Algorithms subcomponent, includes relatively large expenditures on equipment and facilities in addition to software research activities. CSPP recommends that the Administration investigate whether the proportion of funds allocated to software research can be increased, perhaps by using or improving existing facilities.
- Third, CSPP considers the activities planned under the Basic Research and Human Resources (BRHR) component crucial to the success of the HPCCI. OMB and the participating agencies must ensure these activities are also given high priority. Without trained personnel and a basic research infrastructure, none of the advances made in the other three program components can be successfully implemented or used.
- Finally, successfully achieving the goals of the HPCCI will require a balance between advancing key technologies and applying those technologies to solve complex problems affecting our society. These problems cannot be solved, nor the benefits distributed, without leaps in a broad range of technologies. However, planned HPCCI activities seem to focus on advancing key computer technologies, while applying and disseminating the technologies to solve critical problems is given a secondary role. CSPP recommends balancing these two goals to ensure both are adequately addressed.



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