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STRATEGIC MARKET PERSPECTIVE

# Federal High Performance Computing

# 1994-1999

**Federal Market Analysis Program**

DECEMBER 1994

# Federal High Performance Computing, 1994-1999

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# Abstract

There have been significant changes in scope and direction of the federal government's High Performance Computing and Communications (HPCC) Program since 1992. This report provides an update to INPUT's 1992 report entitled *High-Performance Computing in the Federal Market.* The government is now integrating high performance computing with the Information Superhighway (National Information Infrastructure [NII] initiatives). This report will highlight the fifth (and new) HPCC program component called the Information Infrastructure Technology and Application (IITA) segment.

This report will describe changes to HPCC program components and federal agency implementation plans. Specific milestones, budgets, program successes and agency concerns, and opportunities for vendors who wish to participate in the program are also discussed.

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***Federal High Performance Computing, 1994-1999***



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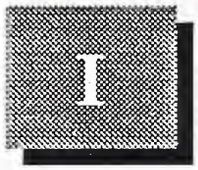


# Introduction and Background

The purpose of this report is to provide an update to the 1992 INPUT report *High Performance Computing in the Federal Market* by describing the government's High Performance Computing and Communications (HPCC) program as follows:

- Basic definitions of the HPCC program goals and objectives
- An Executive Overview of HPCC in Chapter II, which includes INPUT's analysis of program issues and recommendations for information technology vendors who want to take part in the program
- A discussion in Chapter III of each of the five major HPCC components, with goals, status and schedules
- A summary of each federal agency participating in HPCC in Chapter IV, with its planned technical activity, research and procurement activity
- A discussion of funding and technical issues in Chapter V

Other High performance computing requirements, not funded under the HPCC program, are listed in Exhibits IV-5 and IV-6.

## A Methodology

There is a vast amount of information available to the industry and to the general public regarding the HPCC program. INPUT has researched and reviewed much of the available data from the HPCC program office (National Coordination Office - NCO) and from various federal agencies involved in the program. Many of the publications are excellent and are listed in Appendix B.

INPUT also researched and analyzed data from the following sources:

- Federal Agencies FY 1995 Information Technology (IT) Budget submission
- INPUT's Procurement Analysis Reports (PAR)
- Commerce Business Daily (1993 to present)
- OMB Five-Year Information Technology Plans (FY 1996-1999)
- Interviews with HPCC program participants from various agencies

The HPCC program is being executed by a "virtual" organization consisting of participants from ten federal agencies and, as such, is totally dependent on Congress and the Executive Branch for funding and direction. INPUT conducted a survey of selected agency participants, who were, not surprisingly, somewhat reluctant to state opinions on future direction of the program, especially funding.

INPUT's research was conducted during the fourth quarter of 1994, during the mid-term election and the formation of a new Congressional leadership, with its resultant set of new priorities and directions. In late December, 1994, the Executive Branch began to respond with its own new priorities and budget reductions. Agency respondents to the INPUT survey are included where appropriate; other INPUT findings have resulted from discussions with various program participants, agency plans and sources identified in Appendix B.

## B
## Definitions

According to the HPCC National Coordination Office (NCO), high performance computing and communications covers the full range of advanced computing systems including workstations, networks of workstations with servers, scalable parallel systems, vector parallel systems and other more specialized systems.

Parallel processing is the simultaneous processing by more than one processing unit on a single application. Scalable processing means that a system can be made to have more (or less) computational power by configuring it with a larger (or smaller) number of processors, memory, interconnection bandwidth, input/output bandwidth and amounts of mass storage. New, massively parallel processing systems research and development appears to be outpacing and even replacing vector supercomputing, although many of the vector applications still exist in the government and elsewhere. Scalable architectures allow small and

large high performance systems users alike to operate on similar computing problems.

HPCC also addressed scalable input/output interfaces, mass storage and archival storage systems. Included under the program are high performance systems software and software development environments that enable users to view their computer, workstations and the rest of the environment as a unified system.

## 1. History

The HPCC program was created to advance the research, development and usage of future generations of high performance systems throughout the American economy: in the government, industry and the academic world. In the last year, the HPCC program has been tied in with the National Information Infrastructure (NII) program. The NII is known as the "information superhighway". According to the HPCC coordination office, it is the integration of hardware, software, and skills that will make it easy and affordable to connect people with each other, with computers, and with a vast array of services and information resources.

Originally charted in 1991 by President Bush under the High Performance Computing (HPC) Act, the program has had increased attention under the current administration. President Clinton's direction is to connect every classroom, library, clinic and hospital into a "national information superhighway" by the year 2000, as stated in his January 1994 State of the Union address. The capabilities being developed under the HPCC program provide the technology basis for the superhighway: HPCC and the NII are tightly interwoven.

## 2. HPCC Goals

The goals, objectives and overall benefits to be derived from the HPCC program have evolved somewhat since its inception in 1991, and are summarized below in Exhibit I-1.

Exhibit I-1

## HPCC Program

**Goals**

- Extend U.S. technological leadership in high performance computing and computer communications
- Provide wide dissemination and application of technologies to accelerate innovation and to improve national economic competitiveness and productivity, national security, education and health care, and the global environment
- Provide key parts of the foundation for the National Information Infrastructure (NII) and demonstrate selected NII applications

**Benefits**

- Expands scientific and technical knowledge
- Enhances U.S. industrial competitiveness
- Improves quality of life for the public

*Source: "HPCC: Toward a National Information Infrastructure," 1994*

The major goal for 1996 is to advance the development of systems capable of sustained teraflops (trillions of floating point operations per second) performance on large, scalable applications. The other major technological goal is to demonstrate gigabit (billions of bits) per second transmission speeds by 1996, over very large networks for large applications. The HPCC technology areas are summarized in Exhibit I-2.

Exhibit I-2

## HPCC Areas

**Technology**

- Computing Technology:
  - Large-Scale Parallel Systems
  - Vector Systems
  - Hybrid Systems
  - Workstations and Workstation Clusters
  - Networked Heterogeneous Systems
- High Speed Networks
- Software and Algorithms
- Applications Development

**Research**

- Aerospace
- Health
- Library Sciences
- Energy
- Basic Sciences:
  - Astronomy
  - Computers
  - Communications
  - Molecular, Nuclear
  - Earth Sciences
- Military Systems
- Manufacturing
- Education
- Environment

*Source: "HPCC Technology for the National Information Infrastructure," 1994*

These high-level goals are well underway, but they depend heavily on the development of large scale applications which can be shared across the network by program participants and, eventually, by the general public. The general HPCC research areas are also listed in Exhibit I-2.

Some of the very large HPCC applications are "information intensive" and are called National Challenges. These application areas are listed in Exhibit I-3. According to the coordination office, they are fundamental applications that have broad and direct impact on the nation's competitiveness and the quality of life of the American people.

Exhibit I-3

**HPCC Large-Scale Applications**

**National Challenges**

- Crisis and Energy Management
- Digital Libraries
- Education and Life-long Learning
- Electronic Commerce
- Energy Demand and Supply Management
- Health Care
- Design of Manufacturing Processes and Products
- Public Access to Government Information

**Grand Challenges**

- Aircraft and Spacecraft Design
- Computer Sciences
- Energy
- Environment
- Molecular Biology
- Space Sciences
- Product Design

*Source: "HPCC: Toward a National Information Infrastructure," 1994*

Other large scale applications are "computational intensive" and are called Grand Challenges. These very complex applications, which are listed in Exhibit I-3, are fundamental problems in science and engineering with economic and scientific impact. The biggest challenge of the HPCC program is to demonstrate that these applications can be developed in high-performing computing systems, and that they are capable of being scalable, and then becoming accessible over very high speed networks to users across the nation.

INPUT believes that some of the applications will come under close scrutiny during the coming year by the new Congress; some of the work

being done on energy and environmental applications could be redirected to other program areas.

Work on the Grand and National Challenge applications is being performed by the ten participating HPCC departments/agencies listed in Exhibit I-4. Much of the work is also being done at research centers and universities under grants given by the agencies. Chapter IV contains an account of agency plans and activities. The program also has a very detailed account of agency activities described in the HPCC FY 1995 Implementation Plan, listed as Reference 4 in Appendix B.

Exhibit I-4

**Participating HPCC Agencies**

| | |
|---|---|
| DoD | Department of Defense |
| ARPA | Advanced Research Projects Agency |
| DoE | Department of Energy |
| ED | Department of Education |
| EPA | Environmental Protection Agency |
| NASA | National Aeronautics and Space Administration |
| HHS | Health and Human Services |
| NIH | National Institutes of Health |
| DoC | Department of Commerce |
| NIST | National Institute of Standards and Technology |
| NOAA | National Oceanic and Atmospheric Administration |
| NSA | National Security Agency |
| NSF | National Science Foundation |

HPCC technological goals for computer systems, networking, applications and research are organized into five major HPCC components:

- High Performance Computing Systems (HPCS)
  - Accelerated development of scalable computing systems, with associated software, including networks of heterogeneous systems ranging from affordable workstations to large scale high performance systems

  - Technologies to enable the use of advanced component packaging, mass storage and communications technologies for the design of large-scale parallel computers

- National Research and Education Network (NREN)
  - Broadened network connectivity of the research and education communities to high performance computing and research resources
  - Accelerated development and deployment of networking technologies
- Advanced Software Technology and Algorithms (ASTA)
  - Prototype solutions to Grand Challenge problems
  - Improved algorithms, software technologies and software tools for more efficient use of scalable computing systems
  - Deployment of advanced high performance computing systems.
- Information Infrastructure Technology and Applications (IITA)
  - Prototype solutions to National Challenge problems using HPCC enabling technologies
  - Accelerated development and deployment of NII enabling technologies.
- Basic Research and Human Resources (BRHR)
  - Support of research, training, and education in computer science, computer engineering and computational science.

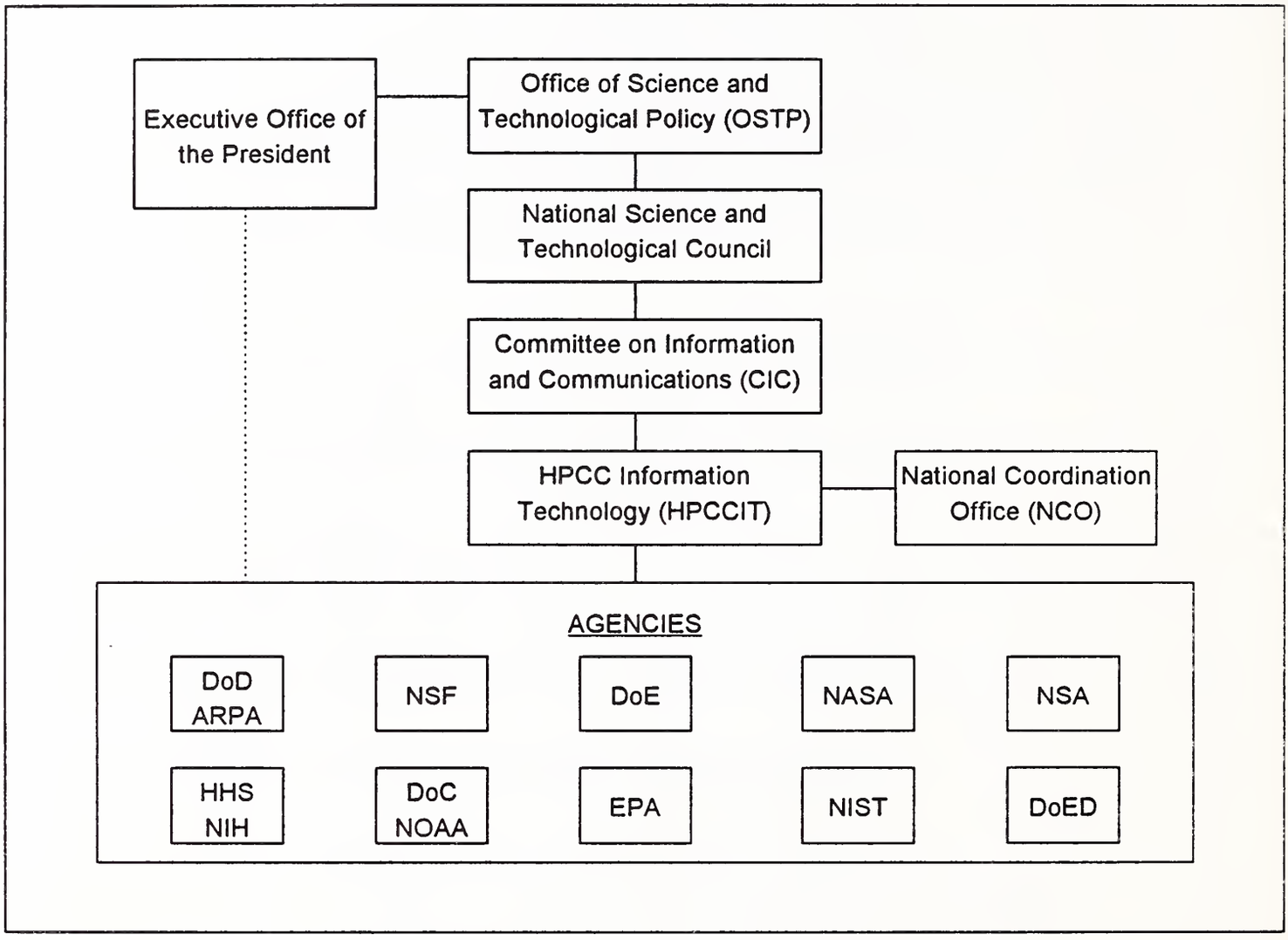
## C
## HPCC Program Organization and Strategies

### 1. Management of HPCC

The HPCC program is a partnership of federal agencies, industry and academia. The program reports to the Director of the Office of Science and Technology Policy (OSTP), part of the Executive Office of the President. Exhibit I-5 shows the organization of the program. Program oversight and budgetary review are provided by the Committee on Information and Communications (CIC), part of the National Science and Technology Council.

Exhibit I-5

## HPCC Management Organization




The HPCC National Coordination Office (NCO) is the central focus of all activities of the agencies and other organizations participating in the program, including Congress, industry, academia, and the public. This is accomplished by a subcommittee called HPCC Information Technology (HPCCIT) which continuously monitors all HPCC programs, coordinates across agencies to ensure common development, selects programs for funding, monitors progress, reports results and interactions, and provides program oversight.

The HPCCIT also establishes working groups and task forces led by representatives from specific agencies, to make various planning recommendations on specific programs. For example, as planning continues for HPCC budgets and programs for FY 1996 and beyond, the subcommittee will be inviting representatives from industry and academia to participate in the planning process. For programs to be

considered relevant, and receive funding, representatives are asked the following questions:

- What technical benefits in HPCC show the greatest promise for benefiting the public and enabling U.S. industrial competitiveness?
- What results would accrue from HPCC and who would benefit?
- What are costs and risks?
- Which agencies are most qualified?
- What is the right mix of participation for industry, government and academia?

Selection and evaluation criteria for program approval on HPCC are summarized in Exhibit I-6.

Exhibit I-6

**Evaluation Criteria for Program Approval**

- Relevance/Contribution
- Technical and Scientific Merit
- Readiness
- Timeliness
- Linkages to other HPCC Programs
- Costs
- Agency Approval

### 2. Management Strategies

INPUT believes that the stated HPCC program strategies in Exhibit I-7 very effectively complement the goals of the program. The strategies need to be understood as companies review HPCC components and agency plans outlined in Chapters III and IV of this report.

Exhibit I-7

## HPCC Program Strategies

- Develop with industry the systems and technology capable of one trillion operations per second performance on large national and grand challenges
- Support HPCC components by expanding and upgrading Internet
- Develop with industry the networks of nationwide gigabit speed
- Demonstrate wide-area gigabit networks to support grand challenges
- Demonstrate grand challenge problems that achieve and exploit one trillion operations per second
- Provide HPCC technologies to collaborations to encourage software and algorithms solutions
- Create an infrastructure of HPCC centers, networks and collaborations for U.S. research and industrial applications
- Work with industry to develop National Information Infrastructure (NII) technologies and national challenge applications
- Train a nation of knowledgeable users by establishing educational programs and fellowships at pre-college, undergraduate and postgraduate levels

"...connect every classroom, library, clinic and hospital in America by the year 2000." - President Clinton, January 1994.

*Source: "HPCC: Technology for the National Information Infrastructure," 1994*

Included in Exhibit I-8 is a list of the HPCC research centers where many of the developments are taking place. Exhibit I-9 shows the types of computing equipment installed at the research centers.

Exhibit I-8

## Major HPCC Research Centers

Department of Energy National Laboratories
- Los Alamos
- Lawrence Livermore
- Oak Ridge

NASA Centers
- Ames Research Center
- Goddard Space Flight Center

National Science Foundation Supercomputer Centers
- Cornell Theory Center
- Pittsburg Supercomputer Center
- San Diego Supercomputer Center
- National Center for Supercomputer Applications

National Science Foundation Science and Technology Centers
- Brown University
- Institute of California Technology
- Cornell University
- University of North Carolina
- University of Utah
- Rice University

Exhibit I-9

## Sample of Computing Brands at HPCC Research Centers

(Over 100 systems now installed)

- Convex - C3880 (8 Vector processors)
- Cray Research - C90 (16 Vector processors)
  - T3D (512 processors)
  - YMP (8 Vector processors)
- Digital Equipment Corp. - Workstation clusters
- Helett-Packard - Workstation Clusters
- IBM - ES 9000/900 (6 Vector processors)
  - PVS
  - SP1, SP2 (512 processors)
  - Workstation clusters
- Intel - IPSC 860 (64 processors)
  - Paragon (512 processors)
- Kendal Square Research - KSR1 (160 processors)
- MasPar - MasPar 2 (16,000 processors)
  - MasPar MP-1 (16,000 processors)
- nCube - nCube 2
- Thinking Machines - CM2 (32,000 processors)
  - CM5 (1,024 processors)
- Sun Microsystems - Workstations

### 3. Program Successes

There have been numerous successful milestones and successes on the HPCC program. These can be reviewed in an excellent document entitled *HPCC Program Successes,* and summarized here in Exhibit I-10.

Exhibit I-10

**HPCC Program Successes in 1994**

- More than 100 scalable High Performance Computing Systems now installed at HPCC Supercomputer Centers, the largest providing 150 gigaflops performance
- Rapid growth of Internet (World Wide Web)
  - 3 million computers
  - 18,000 U.S. networks
  - 13,000 Oconus networks
  - 2,300 colleges and high schools
  - 300 academic libraries
- Growth in gigabit high-capacity network testbeds
  - 24 sites
  - 7 agencies
  - 18 telecommunications carriers
  - 12 universities
- Many Grand Challenges applications being tackled
  - Earth and environmental sciences
  - Design and manufacturing
  - Health care

*Source: "HPCC Program Successes," 1994*

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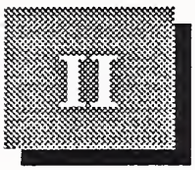


# Executive Overview

The purpose of this report is to provide an update to INPUT's, 1992 report entitled *High Performance Computing in the Federal Market*. This report provides an overview of the HPCC program, program successes, HPCC component overviews, budgets, milestones, and agency plans and concerns in Chapters III through V. Also presented is a summary of activities over the past year, and opportunities for the future for those companies wishing to participate in the HPCC program.

There are bound to be issues and concerns about any program as wide in scope and complexity as HPCC. INPUT feels that HPCC concerns can be overcome with the appropriate funding, management oversight, and additional involvement from the Information Technology industry.

The following INPUT findings and recommendations are presented for those companies who have an interest in the program.

## A
## Findings and Conclusions

The HPCC program is a very important activity, which is receiving the highest level of attention from the White House down to each participating agency. Since it is at the heart of the Nation's information superhighway, it is also justifiably receiving a high level of attention from the telecommunications, information technology and entertainment industries.

HPCC is a well-managed program, for a "virtual" federal agency, which is creating a unique level of cooperation and innovation among all the participating government agencies, universities, research centers and private industry.

Most of the funding for HPCC activity is from the Research & Development budgets of each agency, although some hardware, standard software, and services are procured under the HPCC program. There are

also significant high performance computing resources procured under each agency's information technology budgets. Funding for the HPCC program should continue to grow under the Clinton administration, and through the end of the century, in order to meet the intent of the 1991 High Performance Computing Act.

There has been rapid and significant progress in the development of massively parallel high performance computers, in high speed networks and in the basic research of the HPCC program; there has been slower progress on the development of advanced software and applications. High performance computing and communications is worthless without the effective dissemination and sharing of large amounts of data available to the general public.

The HPCC program needs greater assistance and involvement with private industry in order to speed software development.

The largest opportunity, over time, arising from the HPCC program is in the telecommunications arena, as witnessed in the phenomenal growth in the use of Internet at 10% per month, according the HPCC coordinating office, and other services like Prodigy, America On-line and CompuServe. Telecommunications vendors are well-established in this program as are supercomputing hardware systems vendors. The government appears to acquire computer and telecommunications products directly from the manufacturer, including standard operating software. A large part of the advanced software development is done at the government's research centers and in government-sponsored university environments. The program office is currently trying to encourage industry to increase participation in software development.

Application knowledge or expertise is desirable, but not totally necessary, to be involved in HPCC software development. Algorithm development under ASTA, is the most complex activity on the program.

Many vendors have been willing to share some of the costs in research and development for high performance computing.

There has been little involvement from systems integrators up to now, except at the Department of Defense and NASA. INPUT anticipates that this will change greatly when the prototype locations become operational with new applications in the information infrastructure. There is currently significant opportunity for professional services, analysis and programming, facilities management and maintenance services at most HPCC installations.

## B
## Recommendations

Companies wishing to participate in the HPCC program should adopt some of the following strategies, depending on the level of involvement desired:

Companies should attempt to join the appropriate private sector advisory committees, or industry/university steering groups for the component(s) in which they have an interest. They should attend as many HPCC meetings, symposia, and conferences as possible to form alliances with not only the HPCC federal agencies, but other members of industry and academia. There were well over one thousand enrollees in the technical symposia at the Supercomputing 1994 conference held in Washington, D.C. in November 1994, and many thousands more attending the exhibitions representing hundreds of companies, research centers, universities and others.

Since most HPCC-funded opportunities are considered Research and Development, companies need to access each participating federal agency's bulletin boards and mosaic services on Internet (World Wide Web) for information on funded grants. They should also review traditional sources of acquisition information in the Federal Register and the Commerce Business Daily.

Vendors, for the most part, have to be willing to share some of the costs involved in pursuing HPCC activities. INPUT believes that many vendors in the HPCC community are positioned favorably for future contracts because of their initial involvement in early R & D activities.

Federal agencies normally acquire high performance hardware, systems and standard operating software directly from the original manufacturers. High performance computer manufacturers are very well positioned and have been participating in the program from the very beginning. Telecommunications and networking vendors are likewise very well positioned, and have the most to gain from a successful National Information Infrastructure.

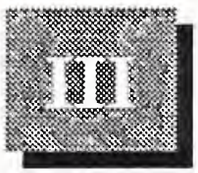
But the largest share of HPCC funding is allocated to advanced software and algorithm development, and application development. This is also where the program is falling behind and needs the most help from industry. The ASTA and IITA components are where all other companies should focus their energies. Companies should review the Grand Challenge and National Challenge application areas, and segment them into elements for development. For example, if the expertise of a company lies in computational intensive applications such as

product/aircraft design, aerospace sciences, energy or the environment, then the focus should be on scientific computing applications under the ASTA, mostly at the National Science Foundation or funded universities and research centers. However, if the company's expertise or interest lies in more "information" intensive computing, such as in electronic commerce, manufacturing, crisis management or connectivity, then the company should pursue the National Challenge applications under the IITA component. Most IITA funding is coordinated by ARPA, although all HPCC agencies are participating in IITA as well as in ASTA.

Systems integrators and software companies should form alliances with the telecommunications and high performance computer manufacturers, which are well established in the HPCC community.

Systems integrators should also focus on several major programs in the Defense Department, such as the Major Shared Resource Center and Defense Research and Engineering Network procurements. They should also investigate various procurements coming up at NASA, Department of Energy and the Environmental Protection Agency (see Exhibit IV-6), although both Energy and Environment may be subject to major cutbacks in 1995.

In addition to advanced software development and applications, there are opportunities for maintenance and other management support services for HPCC installations (see Exhibit IV-6).



# HPCC Program Components

For vendors in the information technology industry who are interested in participating in the HPCC program, it is essential to understand each government agency's planned activities and procurements. These activities are organized under five major HPCC program components. The program components are illustrated in Exhibit III-1.

Exhibit III-1

**HPCC Components**

**High Performance Computing Systems (HPCS) - $181 million**
Future generations of computers, systems design tools, advanced prototype systems, evaluation of early systems

**National Research & Education Network (NREN) - $177 million**
Interagency Internet, gigabit research and development

**Advanced Software Technology & Algorithms (ASTA) - $395 million**
Grand challenge applications, software components and tools, computational techniques, HPCC research centers

**Information Infrastructure Technology & Applications (IITA) - $282 million**
National challenge applications, intelligent interface, information infrastructure services, systems development and support environment

**Basic Research and Human Resources (BRHR) -$120 million**
Research, participation and training, infrastructure, education and curriculum

*Source: "HPCC FY 1995 Implementation Plan," 1994*

Each of the participating federal agencies is contributing to development in the above programs. This chapter will provide a high-level discussion of each program, milestones and objectives. Chapter IV will present HPCC agency plans.

# A
# HPCS - High Performance Computing Systems

## 1. Goal

The goal of HPCS is to extend U.S. technological leadership in high performance computing through the development of scaleable computing systems, with associated software, capable of sustaining at least one trillion operations per second (teraops) performance. Scaleable parallel and distributed computing systems will be able to support the full range of usage from workstations through the largest scale highest-performance systems. Workstations will extend into portable wireless interfaces as technology advances. HPCS consists of four elements:

- Research for future generations
- System design tools
- Advance prototype systems
- Evaluation of early systems.

## 2. Background

ARPA provides most of the funding and management for designing and building prototype systems and supporting design tools for scaleable computing systems, microsystems and integrated command and control technology.

The National Science Foundation and the National Security Agency are contributing efforts in application-specific needs, supercomputing research and engineering. NSF, NSA and other agencies (DoE, NASA, and NIH) acquire and evaluate the early prototype systems for their supercomputing research centers. Exhibits I-8 and I-9 show the HPCC research centers and the types of computers installed.

## 3. Milestones

The two key milestones of the HPCS program are to provide demonstrations of tenth scale teraops systems in 1995, and to have a one (1) teraops system deployed in 1996. More specific objectives for 1995 are to develop embedded systems capable of higher performance using smaller amounts of space (current performance target is 50 to 100 gigaflops/cubic foot), explore new technologies, such as optical computing, superconducting electronics, and wireless computing for use in general-purpose and special-purpose systems, improve design and fabrication tools, and upgrade two systems to larger computational power for medical and energy applications.

The HPCS program has already attained a 100 gigaops system ready for deployment through joint projects with Cray Research, Intel, Kendall Square Research, Thinking Machines and IBM.

Acquisition of prototype systems include Intel Delta and Paragon, Kendall Square KSR-1, and the Thinking Machines CM-5. Some of these will be upgraded later.

## B

## NREN - National Research and Education Network

### 1. Goal

The goal of NREN is to extend U.S. technological leadership in computer communications by a program of research and development that advances the leading edge of networking technology and services. NREN will widen the research and education community's network connectivity to high performance computing and research centers and to electronic information resources and libraries. This will accelerate the development and deployment of networking technologies by the telecommunications industry. It includes nationwide prototypes for terrestrial, satellite, and wireless communications systems, including fiber optics, with common protocol support and applications interfaces.

### 2. Background

NREN has two elements:

- Interagency Internet
- Gigabit Research and Development.

Both elements are encouraging and fostering participation of the private sector in order to maximize the federal funding and return on investment for NREN.

Although NREN is primarily a research and development component, the fastest growing part of the Internet is now in the commercial sector. The underlying strategy of the HPCC Program has been to support the solution of important scientific and technical problems of broad national significance in collaboration with all interested sectors in government, industry and universities. President Clinton's early 1994 commitment to connect all schools, colleges, hospitals and libraries by the year 2000 is at the driving heart of the NREN development. Features of the Interagency Internet NREN component include the use of telephone company facilities, and have the government driving technology while avoiding competition with the private sector.

NREN is the testbed for the National Information Infrastructure (NII), or the Information Superhighway applications and services, such as itemized in the National and Grand Challenge demonstrations listed in Exhibit I-3. This makes it essential that NREN develop connectivity, standards and security capabilities as well as high-speed networks. The NSF coordinates the broad deployment of the Interagency Internet element; NIH, NOAA, and EPA focus on expanding connectivity. NSF, DoE, and NASA will continue to expand connectivity and development of future generations of faster and more robust networks along with ARPA and NIST. The DoD's Defense Research and Engineering Network (DREN) procurement is underway and is listed in Exhibit IV-5.

NREN is ahead of schedule for network connectivity for T1 and lower speed services. However, the Internet is growing at ten percent per month, in terms of the number of computers attached nation and world-wide, according to the HPCC coordinating office. This popularity is creating management and control concerns, but is also an indication of the success of the Internet.

### 3. Milestones

The key milestone for NREN is to create an experimental nationwide network by 1996 which is able to deliver speeds up to 2.4 billion bits per second to individual end user applications. Some other significant, more immediate milestones for 1995 include the design and prototype of ten Gigabits per second (Bb/s) switches for asynchronous transfer mode (ATM), advanced protocols for high speed information transfer over long distances, and the deployment of prototype backbone Internet Protocol (IP) network at 155 Millions of bits per second (Mb/s). NREN also intends to continue privatizing the network, making awards for Regional Network Providers, and developing policy and software and hardware for network integrity, controlling access and protection of data.

## C

## ASTA - Advanced Software Technology and Algorithms

### 1. Goal

ASTA is the most challenging and controversial of the HPCC components and is also the most highly funded. Relevant issues are discussed in Chapter V. The goals of ASTA are to demonstrate prototype solutions to Grand Challenge problems through the development of advanced algorithms and software. Grand Challenge applications are listed in Exhibit I-3. These applications are computationally intensive problems such as forecasting weather, predicting climate, improving environmental monitoring, building more energy-efficient cars and airplanes, designing

better drugs, and conducting basic scientific research. Dramatic improvements in algorithm design and software technology are essential to achieve sustained teraflops computing system performance.

## 2. Background

The key elements of the ASTA component are:

- Support Grand Challenges in fields such as biological sciences, geosciences, engineering, computational mathematics, physical sciences, aeronautics, and energy research.
- Demonstrate large-scale research on distributed systems using the Internet to access distributed files and national software libraries and project performance of applications on teraflops computing systems.
- Establish portable, scaleable libraries, evolving parallel operating systems, and provide high performance computing with scaleable software in desktop class computing systems.
- Improvement and parallelization of algorithms and data structures.
- Increase access to the High Performance Computing Research Centers (HPCRs). Exhibit I-8 lists the HPCC research centers and Exhibit I-9 lists the types of computers installed.

All of the HPCC agencies are involved in the ASTA component. There are varying reports on the success of this activity, but there is a strong push to try to keep up with the steady advances in computing and networking technologies. There are more than 34 scientific teams developing applications. There are over a dozen high performance computer centers serving thousands of users. There is serious doubt, however, by researchers in the HPCC program, that ASTA can meet its objectives without the addition of more funding, people, computers, and other resources from the government and from industry.

## 3. Milestones

Immediate milestones in 1995 include upgrading the supercomputer centers and testbeds with more powerful parallel computing systems to support application development, in areas such as ecological simulations, molecular dynamics, advanced manufacturing, air quality modeling, climate modeling, atmospheric chemistry, digital libraries, combustion, computational chemistry, gene sequencing, and protein structure determination. The program also intends to continue developing software and system support tools for real-time high performance systems and the Internet.

# D
# IITA - Information Infrastructure and Technology Applications

## 1. Goal

IITA is the new HPCC program component created this year which is critical to the development of the National Information Infrastructure (NII). The goal of IITA is to demonstrate prototype solutions to National Challenge problems using HPCC technologies. National Challenges are information intensive applications such as education and lifelong learning, digital libraries, health care, advanced manufacturing, electronic commerce and environmental monitoring. Exhibit I-3 itemizes the National Challenge applications. IITA will support work to integrate technologies, such as services, software, and interfaces to bring HPCC benefits to the general public.

## 2. Background

All of the HPCC agencies are involved in this critical new component, with ARPA receiving the most funding for information enterprises, foundations, health information infrastructure, information sciences, intelligent systems and software and global grid communications. With IITA activities, the government hopes to accelerate industry development of the NII. The General Accounting Office has recommended to Congress that private industry get more involved with the HPCC program and federal HPCC agencies have agreed to work more closely with industry and academia. The objective here is to expand the original HPCC focus of enhancing the nation's computing and communications capabilities to address a broader set of technologies and applications that can have an immediate impact on every individual throughout the U.S., and to enhance quality of life. The IITA component ties all the other components of HPCC together by pointing out and testing the fact that high performance systems, networks, software and algorithms can only be fully exploited by the introduction and sharing of data in extremely large, complex data infrastructures.

Again, ARPA has the major share of IITA funding (see Exhibit IV-4) for national-scale information enterprises, foundations, health information infrastructure, information sciences, intelligent systems and software and global grid communications. Each of the other HPCC agencies is participating in this important component. For example, the National Science Foundation is contributing to the NSF high speed network (NSFNET), research centers and infrastructure, computational mathematics, physical sciences and other programs. The National Institutes of Health is working on applications like health care, biomedical computing and high performance communications for

CancerNet and electronic publishing. The National Institute of Science and Technology is working on development and dissemination of scientific software for the HPCS component, electronic commerce, electronic libraries, manufacturing, and assurance, reliability and integrity of the NREN component.

IITA is a new HPCC program established this year, but is based on many efforts already underway in the last two years. For example, ARPA, NASA and NSF have already been funding virtual reality and telepresence research. Several National Challenge applications already underway are crisis management at ARPA, manufacturing at ARPA, NIST, NASA, and NSF, environmental monitoring at NASA, NOAA, and EPA, health care at NIH and NASA, and energy management at DoE. ARPA, NASA, and NSF are working on digital libraries through 1998.

### 3. Milestones

Specific milestones for 1995 and beyond for IITA include extending research programs to include reliable and high-assurance computing systems and telecommuting services for environmental research and network infrastructure for education. Also, IITA will demonstrate capabilities to disseminate real-time data over the Internet. They will begin providing wide access to government statistics databases for researchers and the general public. Geographical information systems for the NII will be developed and geophysical, satellite imagery and other remote-sensed data will be transmitted. In general, the component will attempt to continue to make the Internet and other networks more easily accessible to the research and general community, and improve the capacity and speed.

## E

## BRHR - Basic Research and Human Resources

### 1. Goal

The goal of the BRHR program is to create a nation of highly educated researchers and scientific personnel. The component supports research, training, and education in computer science, computer engineering, and computational science, and enhances the infrastructure through the addition of HPCC resources. The objective is to increase the flow of innovative ideas and talented people into high performance computing and communications areas, and to address the need for more skilled personnel.

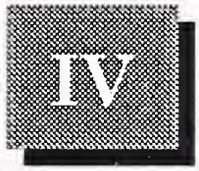
## 2. Background

All HPCC agencies, except NOAA and NIST, participate in BRHR projects, but the National Science Foundation obtains most of the funding (see Exhibit IV-4) for research centers, infrastructure, for software and algorithm research, and grants to universities and schools for education and training.

BRHR has helped in research infrastructure developments in parallel computing, high speed networks, and virtual reality, as well as expanding educational opportunities and training for all academic levels such as "Adventures in Supercomputing", graduate assistantships, and post-doctoral research grants.

## 3. Milestones

BRHR milestones for 1995 and beyond include the continued support for research in virtual manufacturing, networked digital libraries, distributed multimedia systems, and parallel I/O, and continued algorithm and software development for application-specific domains including air quality monitoring, molecular dynamics, and fluid flow.




# HPCC Agency Plans and Opinions

Implementation of HPCC program activities occurs within each of the ten HPCC departments/agencies. The agencies are listed in Exhibit IV-1. A new HPCC agency this year is the National Security Agency (NSA). Please also note that the Department of Education (ED), which was added to the list of participating agencies last year, is an official HPCC agency, but does not obtain funding from the HPCC program.

Exhibit IV-1

**Participating HPCC Agencies**

| | |
|---|---|
| DoD | Department of Defense |
| ARPA | Advanced Research Projects Agency |
| DoE | Department of Energy |
| ED | Department of Education |
| EPA | Environmental Protection Agency |
| NASA | National Aeronautics and Space Administration |
| HHS | Health and Human Services |
| NIH | National Institutes of Health |
| DoC | Department of Commerce |
| NIST | National Institute of Standards and Technology |
| NOAA | National Oceanic and Atmospheric Administration |
| NSA | National Security Agency |
| NSF | National Science Foundation |

Agencies group together projects that are technologically related toward reaching similar goals and objectives. Whereas the HPCC program is broadly described in Chapter III under one of the five major program components (HPCS, NREN, ASTA, IITA, BRHR), the actual program activities at the agencies span multiple components.

## A
## HPCC Funding

In this section, we will list significant activities at each agency. Total Fiscal Year 1995 funding for each agency can be found in Exhibit IV-2.

Exhibit IV-2

**HPCC Agencies & Budgets for FY 1995**
**(In $ Millions)**

| | |
|---|---|
| Advanced Research Projects Agency (ARPA) | $357.40 |
| National Science Foundation (NSF) | $328.62 |
| Department of Energy (DoE) | $125.40 |
| National Aeronautics and Space Administration (NASA) | $124.90 |
| National Institute of Health (NIH) | $81.80 |
| National Institute of Standards and Technology (NIST) | $56.40 |
| National Security Agency (NSA) | $40.13 |
| National Oceanic and Atmospheric Administration (NOAA) | $25.25 |
| Environmental Protection Agency (EPA) | $14.67 |
| **FY95 Total HPCC Budget** | **$1,155 million** |

* The Department of Education (ED), while an HPCC participant, has no FY 1995 budget authority.

*Source: "HPCC: Technology for the National Information Infrastructure," 1994*

Since the beginning of the HPCC program in 1992, there have been significant changes in scope and objectives, with the addition of two new agencies and a re-emphasis on the Information Infrastructure component. The original estimated HPCC funding in FY 1991 totaled $489.4 million. Exhibit IV-3 shows what has happened to the funding profile for agencies since 1991, a growth to $1.155 billion by FY 1995.

Exhibit IV-3

## HPCC Historic Program Funding

| | | |
|---|---|---|
| FY 1991 | Estimated | $498 million |
| FY 1992 | Actual | $638 million |
| FY 1993 | Actual | $728 million |
| FY 1994 | Congressional Action | $936 million |
| FY 1995 | Request | $1.154 billion |

Please refer to Exhibit IV-4 to view the funding across each component within agency.

Exhibit IV-4

## HPCC Agency* FY 1995 Budget Summary by Component
**($ Million)**

| Agency | Total | HPCS | NREN | ASTA | IITA | BRHR |
|---|---|---|---|---|---|---|
| ARPA | 357.40 | 110.70 | 61.10 | 29.60 | 140.80 | 15.20 |
| NSF | 328.62 | 21.70 | 52.86 | 141.23 | 50.64 | 62.19 |
| DoE | 125.40 | 10.90 | 16.80 | 75.50 | 1.20 | 21.00 |
| NASA | 124.90 | 9.70 | 12.70 | 81.20 | 17.50 | 3.80 |
| NIH | 81.80 | 4.90 | 8.40 | 23.80 | 29.10 | 15.60 |
| NSA | 40.13 | 16.10 | 11.80 | 11.80 | 0.23 | 0.20 |
| NIST | 56.40 | 6.75 | 3.65 | 4.60 | 41.40 | N/A |
| NOAA | 25.25 | N/A | 8.70 | 16.05 | 0.50 | N/A |
| EPA | 14.67 | N/A | 0.70 | 11.70 | 0.30 | 1.97 |
| **Total** | 1,154.57 | 180.75 | 176.71 | 395.48 | 281.67 | 119.96 |

* The Department of Education, while an HPCC participant, has no FY 1995 budget authority

*Source: "HPCC: Technology for the National Information Infrastructure, Supplement to the President's FY 1995 Budget"*

INPUT estimates that this growth rate will continue at approximately 20% into FY 1996 - 1998, despite the recent Congressional turnover and threats to reduce funding on the HPCC program. The National Information Infrastructure (NII) and HPCC programs have very good momentum and have exhibited significant successes, considered vital to the nation's economy and quality of life. In any case, the funding should be secure for the duration of the Clinton administration.

# B
# HPCC Funding Sources

Most of the HPCC funding which is available to industry and academia, is contained the each HPCC federal agency's Research and Development (R & D) budgets. Some of this does not appear in the agency's information technology budget submissions as part of their A-11 submissions to the Office of Management and Budget (OMB). Much of the funding will be used for purchases of equipment, software, networks, and information technology services as well as for HPCC pure research and development.

This section lists major activities, by agency, as well as a list of major opportunities for industry participation via the traditional sources of funding. These have been advertised as major procurements, as Commerce Business Daily (CBD) announcements, or in other sources. They show a significant amount of activity over the last year, and into the future.

Exhibit IV-5 lists almost thirty major agency programs contained in INPUT's Procurement Analysis Report (PAR) database, all of which are being tracked by INPUT.

Exhibit IV-5

**Major HPCC Activities - December 1994**

| AGENCY | PAR NUMBER | |
|---|---|---|
| DoE | VI-07-116 | Lawrence Livermore National Lab |
| Massively Parallel High Performance Production Computer Center - Hardware, software, maintenance to enhance National Energy Research Supercomputer Center (NERSC) for Grand Challenge Applications. | | |
| DoE | VI-07-118 | Knolls Atomic Power Lab |
| Scientific Supercomputers - Hardware, software, networks | | |
| DoE | VI-07-073 | Various Energy Sites |
| Class VII Computer Systems - Supercomputers over time for 12 DoE locations | | |
| NASA | VIII-15-109 | Langley Research Center |
| High Performance Mass Storage System - Mass storage for Langley massively parallel supercomputers through the year 2000 | | |
| NASA | VIII-15-154 | Ames Research Center and Various Sites |
| High Performance Local Area Network - All network hardware, software, and support. | | |

Exhibit IV-5 cont.

NASA VIII-15-098 Ames Research Center
Testbed I Computer System - Upgrades to advanced parallel processors

NASA VIII-15-071 Marshall Space Flight Center
Engineering Analysis and Data Systems - Total support for CRAY/NAS/Grumman installations

NASA VIII-15-144 Ames Research Center
Information Sciences Research and Development - 8A Program for R & D services and support

NASA VIII-15-060 Ames Research Center
Support to the CRAY/CSC Supercomputer Center

NASA VIII-15-057 Lewis Research Center
Supercomputer (CRAY) and support

NASA VIII-15-124 Central Computer Facility
Computational Capabilities Resources - Hardware, software, services for Large Scale Applications

NASA VIII-15-161 Ames Research Center
Information and Communications Support Services - Network and information systems support services

NASA VIII-15-119 Ames Research Center
NASA processing System Network - High speed supercomputers, systems, network and services

NASA VIII-15-156 Ames Research Center
Research and Development Support Contract - Scientific computing R & D support services.

NASA VIII-15-151 Goddard Space Flight Center
Data Analysis and Scientific Support - Support for scientific data analysis for NASA Earth Sciences Geodynamics Branch.

NASA VIII-15-159 Johnson Space Center
Information Systems Contract - Hardware, software, and services

NSF VIII-19-003 National Science Foundation Network
Recompetition of the NSFNET support services and network

NOAA VI-06-063 Geophysics Fluid Dynamics Lab
Large Scale Scientific Computing System - Supercomputers and support

Exhibit IV-5 cont.

NOAA VI-06-050 National Weather Service
World Area System - Satellite services to supply meteorological data to world-wide users.

NOAA VI-06-060 Satellite Operations Control Center
Satellite Engineering and Navigation Support Services - Support for meteorological satellite operations.

DoD V-02-120 Department of Defense - Army, Navy, Air Force
Major Shared Resource Center (MSRC) - Complete HPCC systems integration for four major DoD supercomputing sites: hardware, software, connectivity, maintenance, training, under the DoD HPC Modernization Program.

DoD V-04M-001 Forty sites across the DoD
Defense Research and Engineering Network (DREN) - High speed private network over public data networks to connect 40 DoD sites, under the DoD HPC Modernization Program.

DoD V-01-215 Wright Patterson Air Force
Communications and Computer Operations Support Services - Hardware, networks, and services and operations for Air Force Information Systems and Technology Center.

EPA VIII-17-026 National Environmental Supercomputer Center and other locations
National Computer Center Facilities Management - Supercomputers, personnel, networks, services.

EPA VIII-17-021 Various locations
Information Technology Architectural Support - Long term support services for supercomputers at EPA locations

EPA VIII-17-023 Research locations
Systems development and scientific support for Office of Research & Development, including HPCC systems.

ED VII-13-022 Education Community
Sources of materials and research about teaching and learning for improving nationwide education - On-line (NREN) system to deliver information to the education community.

*Source: INPUT PAR Database*

Exhibit IV-6 shows a sample of the over 200 Commerce Business Daily (CBD) announcements for high performance computing hardware, software, services, or research and development. INPUT found that NSA, NIST and NSF do not use the CBD vehicle to any extent to announce HPCC research and development, or other procurement activities related to HPCC.

Exhibit IV-6

## HPCC and Related Activities/Opportunities

**Research and Development Announcements**

| | | |
|---|---|---|
| August 1994 | ARPA | Information Infrastructure Services and Bitways |
| July 1994 | NIS | Engineering Support Services in Intelligent Machines Initiative |
| May 1994 | ARPA | National-Scale Information Enterprises (NIE) |
| March 1994 | NAVY | Long Range Scientific Projects |
| March 1994 | DoE | Applied Research in High Performance Computing and Communications |
| February 1994 | ARPA | Research in Scalable Computing and Microsystems |
| November 1993 | ARPA | Research in High Performance Computing Software and Software Development Environments |
| September 1993 | DoE | Massively Parallel Scientific Computer for the National Energy Research Supercomputer Center |
| July 1993 | DoE | Advanced High-Bandwidth Optoelectronics Technology and applications available for U.S. partnering and collaboration |
| June 1993 | DoE | National Software Exchange |
| June 1993 | NIH | Technical Assistance Services for the National Coordination Office for the HPCC Program |
| June 1993 | NAVY | Management Support Services to support the HPCC Program |
| May 1993 | NIH | Biomedical Applications at National Library of Medicine for the HPCC Program |
| January 1993 | ARPA | Advanced Computing Systems: Software Engineering Science and Technology |

Exhibit IV-6 cont.

**The following announcements are a mixture of Research & Development, General Purpose ADP Equipment, Software, Supplies and Support, Telecommunications Services, and Professional Administrative and Management Support requests.**

| | | |
|---|---|---|
| December 1994 | NASA | Announcement for Technology Cooperation Agreement |
| December 1994 | NASA | Software License Renewal for CRAY supercomputer and others |
| November 1994 | ARMY | Hardware Maintenance |
| October 1994 | NOAA | Large Scale Scientific Computing System |
| October 1994 | ARMY | ADP Maintenance to Cray Research |
| September 1994 | NASA | IMSL Software Licenses for Supercomputers |
| September 1994 | NAVY | Hardware Maintenance of Convex Systems |
| August 1994 | NASA | Dual Technology Cooperation Agreements |
| August 1994 | NASA | Hardware and Software Maintenance for Convex |
| August 1994 | DoD | Technology Transfer Broad Agency Announcements |
| August 1994 | NAVY | Central Computer System Computer Operations |
| August 1994 | ARMY | CRAY-2 Supercomputer Disk Upgrades |
| August 1994 | NASA | Software License Renewal for Supercomputers |
| July 1994 | NAVY | Onsite Maintenance for CDC Equipment |
| July 1994 | USAF | FDDI Network Interface for Convex |
| July 1994 | NASA | Support Services for CRAY Software |
| July 1994 | USAF | CYBER Tape Subsystem Maintenance |
| July 1994 | DoD | Defense Nuclear Agency's Broad Agency Announcement for R & D |
| July 1994 | USAF | Integrated Material-Oriented Molecular Modeling Software |
| July 1994 | ARMY | NASTRAN Software for Cray Supercomputers |
| June 1994 | NAVY | Hydrodynamics/Hydroacoustics Technology Network |
| June 1994 | NASA | Research in Parallel Algorithms and Software for Computational Aerosciences |
| June 1994 | NOAA | Large Scale Scientific Computing System |
| June 1994 | USAF | CYBER Hardware Maintenance |

Exhibit IV-6 cont.

| | | |
|---|---|---|
| May 1994 | NAVY | Maintenance Service for CYBER |
| May 1994 | NASA | Analysis, Programming, Engineering and Maintenance for the Flight Simulation Facility |
| May 1994 | NAVY | Software License for CRAY |
| May 1994 | ARMY | On-site Maintenance for CONVEX |
| May 1994 | ARMY | Contract Modification for CDC CYBER |
| April 1994 | ARMY | CONVEX Supercomputer Maintenance |
| April 1994 | DoD | Purchase of IBM |
| April 1994 | NASA | Software for CRAY Supercomputers |
| April 1994 | NIST | IBM SP Scalable Computer System |
| April 1994 | NASA | CONVEX Hardware and Software Maintenance |
| April 1994 | ARMY | CRAY-2 Supercomputer Disk/Tape Storage |
| March 1994 | ARMY | Purchase of CDSI Hardware and Software |
| March 1994 | USAF | Purchase of Network Interface for CONVEX |
| March 1994 | ARMY | CRAY Maintenance |
| March 1994 | USAF | Software for CRAY |
| March 1994 | NASA | Computational Analysis and Programming Support in CRAY installation |
| March 1994 | NASA | Software for CRAY |
| March 1994 | DoE | Maintenance for CRAY, etc. |
| March 1994 | NASA | Software for CRAY |
| March 1994 | USAF | Systems Engineering Services |
| March 1994 | NASA | Maintenance for CRAY Supercomputer |
| February 1994 | USAF | Teleprocessing/Data Communications Support |
| February 1994 | NASA | Mass Storage Upgrades |
| January 1994 | NASA | Operating System License |
| January 1994 | ARMY | CDC Software Maintenance |
| January 1994 | DoE | High Performance Computer System |
| January 1994 | NAVY | Maintenance of CONVEX |

*Source: Commerce Business Daily (1993-1994)*

INPUT's analysis of the 1994 year-to-date Commerce Business Daily (CBD) activity for high performance computing and communications R & D, and also general purpose information technology activities, are fairly evenly split for supercomputer hardware and peripherals (28 announcements), software (28 announcements), maintenance (24 announcements), Research & Development (27 announcements, some of which include hardware, software, and services), and services (14 announcements). The most activity is at NASA (26 announcements), followed by DoD agencies and Army (18 announcements each), DoE and Navy (14 announcements each), Air Force (11 announcements), NOAA (7 announcements), with little or no activity at NIH, NIST, NSA, ED or NSF. Again, NSF and NSA do not use the CBD process, and the Department of Education has no HPCC funding.

Approximately 90 high performance, computing-related CBD announcements were analyzed for calendar year 1993. Again, the resources being procured cover a wide range of hardware, software and services. There were 29 announcements for supercomputer hardware and peripherals, 8 announcements for pure Research and Development, 17 announcements for software and 14 for other services. The most activity was at the Army (26 announcements), Air Force (20), NASA (20), followed by a fairly even spread at DoE, DoD agencies, EPA, NOAA, NIST and NIH. The vast majority of high performance computing activities took place under each agency's information technology programs, not the HPCC program.

Exhibit IV-7 shows the types of resources being procured by the government. Some of the resources are following the traditional federal procurements for full and open competition. Some can be obtained through unsolicited grants, Cooperative Research and Development Agreements (CRADA), some are single source awards or small business set-aside contracts, or with limited competition.

Exhibit IV-7

## HPCC Funding Opportunities and Resources

**Sources of HPCC Funding Opportunities**

- Major federal HPCC solicitations (RFP) by agency
- Unsolicited research grant applications
- Small Business Administration (SBA)
- Commerce Business Daily (CBD)
- Federal Register

**Types of Resources**

| CBD Section | Category |
|---|---|
| A | Research and development |
| D | ADP and telecommunications |
| R | Professional, administrative and management support services |
| 70 | General purpose ADP - equipment, software, supplies and support |

Also shown on subsequent pages is agency spending of HPCC funds for specific projects. This is included to show the very wide range and scope of HPCC opportunities for the vendor community. Many of the research grants and program activities are in the range of $100,000 to $300,000 level, so the agencies have grouped similar activities into larger categories of similar technology, common goals and objectives.

To access general information online from the HPCC National Coordination Office (NCO), use the following address:

http://www.hpcc.gov/
or
gopher://gopher.hpcc.gov/

# C
# Agency Activities

### 1. Advanced Research Projects Agency (ARPA)

ARPA is the lead Department of Defense (DoD) agency for advanced technology research and is also the lead for the entire department (Army, Navy, Air Force, and DoD agencies) on the HPCC program. ARPA's program is focused on developing scalable high performance technologies (hardware and software) in which a single element can be used as the basis for a workstation, while clustered and arrayed elements yield ever higher performance up to the largest and most powerful systems. ARPA's strategy is to develop the underlying technology base for high performance computing and communications, while the other HPCC agencies apply the technology within the context of their mission-specific application areas. ARPA's activities and current budget are:

| FY 1995 BUDGET $ Millions | ACTIVITY |
|---|---|
| 60.2 | Scalable Computing Systems |
| 46.4 | Microsystems |
| 32.3 | Scalable Software |
| 33.9 | National-scale Information Enterprises |
| 43.1 | Networking |
| 14.0 | Foundations |
| 9.8 | Health Information Infrastructure |
| 21.0 | Information Sciences |
| 72.3 | Intelligent Systems and Software |
| 23.0 | Global Grid Communications |
| 6.0 | Integrated Command and Control |

CONTACT:

ARPA
3701 N. Fairfax Drive
Arlington, Virginia 22203

To contact ARPA online, use the following address:

http://ftp.arpa.mil/

## 2. National Science Foundation (NSF)

The NSF objectives for the HPCC program include developing national research and education networking services and capabilities for connecting universities, libraries, and businesses at speeds of up to one billion bits per second. NSF also is responsible for encouraging industrial partnerships and affiliations to enhance technologies and U.S. competitiveness, and for making advanced computing available to a greater segment of the population for National Challenge applications. They also introduce the new HPCC computers and software to the community to develop solutions to Grand Challenge problems.

| FY 1995 BUDGET $ millions | ACTIVITY |
|---|---|
| 46.2 | NSF Network (NSFNET) |
| 76.4 | Supercomputer Centers |
| 10.5 | Research Centers |
| 20.9 | Research Infrastructure |
| 10.7 | Grand Challenge Applications |
| 20.7 | Computing Systems and Components |
| 25.3 | Software Systems and Algorithms |
| 11.3 | Very High Speed Networks and Optical Systems |
| 11.0 | Human-Machine Interaction & Information Access |
| 11.5 | Biological Sciences |
| 4.2 | Engineering |
| 3.8 | Geosciences |
| 7.6 | Computational Mathematics |
| 9.7 | Physical Sciences |
| 3.0 | Social, Behavioral & Economic Sciences |
| 20.2 | Education and Training |
| 35.2 | IITA Program |

CONTACT:

NSF
4203 Wilson Blvd.
Arlington, Virginia 22230

To contact the NSF online, use the following address:

stis@nsf.gov

### 3. Department of Energy (DoE)

DoE supports a wide range of HPCC activities in a diverse applied mathematical sciences environment from fundamental research to technology development. DoE has a long history in computational research and development with strong industrial and university cooperation. They cover all five program components of HPCC.

| FY 1995 BUDGET $ millions | ACTIVITY |
|---|---|
| 1.0 | Advanced Prototype Systems |
| 9.9 | Evaluation of Early Systems |
| 14.8 | Energy Sciences Network |
| 2.0 | Gigabit Research & Development |
| 9.0 | Enabling Energy Grand Challenges |
| 12.6 | Software Components and Tools |
| 3.4 | Computational Techniques |
| 35.6 | Supercomputer Access |
| 12.9 | HPC Research Centers |
| 2.0 | Global Climate Collaboration |
| 1.2 | Information Services |
| 2.0 | Research Participation & Training |
| 3.0 | Education, Training, and Curriculum |
| 16.0 | Basic Research for Applied Mathematics |

CONTACT:

DoE
Washington, DC 20585

To contact the DoE online, use the following address:

http://www.doe.gov

### 4. National Aeronautics and Space Administration (NASA)

NASA's primary responsibility on the HPCC program is the development of applications software and algorithms for scalable parallel processors, and use of this technology on its Grand Challenge research problems, such as improving the design of aerospace vehicles, enabling people at remote locations to communicate more effectively and share information, and improving the capabilities of advanced spacecraft to explore the Earth and solar system.

| FY 1995 BUDGET $ millions | ACTIVITY |
|---|---|
| 26.4 | Testbeds |
| 55.3 | Grand Challenge Support |
| 9.2 | Systems Software |
| 12.7 | NREN |
| 3.8 | Basic Research |
| 6.8 | Information Infrastructure Technology |
| 8.8 | Information Infrastructure Applications |

CONTACT:

NASA Headquarters, Code RC
Washington, DC 20546-0001

To contact NASA online, use the following address:

http://hypatia.gsfc.nasa.gov/NASA_homepage.html

### 5. National Institutes of Health (NIH)

NIH focuses on biomedical applications of computing and digital communications. NIH's HPCC efforts include research and development and sponsorship via grants and contracts at educational and research institutions. The program includes Grand Challenge research in bimolecular sequence and structure analysis, medical image reconstruction and creation of advanced architecture in those domains.

| FY 1995 BUDGET $ millions | ACTIVITY |
|---|---|
| 37.2 | National Library of Medicine - Various Applications |
| 8.8 | Advanced Software and Algorithms |
| 8.8 | Information Infrastructure Applications |
| 5.0 | Basic Research |
| 11.0 | Biomedical Computing |
| 6.7 | Frederick Biomedical Supercomputing Center |
| 2.0 | High Speed Networking and Distributed Conferencing |
| 0.6 | Communications for CancerNet, etc. |
| 0.7 | National Coordination Office |

CONTACT:

NIH
Bethesda, MD 20892

To contact NIH online, use the following address:

http://www.nih.gov/

### 6. National Security Agency (NSA)

NSA is developing and promoting very high performance computers, storage and networking capabilities in the following areas:

| FY 1995 BUDGET $ millions | ACTIVITY |
|---|---|
| 26.1 | Supercomputing Research |
| 2.0 | Superconducting Research |
| 3.5 | Very High Speed Networking |
| 5.5 | Secure Operating System Development |
| 2.7 | High Speed Data Protection Electronics |
| 0.2 | Technology Based Training |

NSA generally does not fund external research efforts.

### 7. National Institute of Standards and Technology (NIST)

NIST objectives for the HPCC program include accelerating the development and deployment of high performance systems required for the NII, and applying and testing them in a manufacturing environment.

| FY 1995 BUDGET $ millions | ACTIVITY |
|---|---|
| 2.2 | Gigabit Performance Measures |
| 7.6 | Scientific Software for HPCS |
| 2.7 | Electronic Commerce |
| 1.2 | Electronic Libraries and Distributed Multimedia |
| 25.2 | Manufacturing Applications Systems Integration |
| 17.4 | Various Hardware, Software, Network Development |

CONTACT:

NIST
Gaithersburg, MD 20899

To contact NIST online, use the following address:

http://www.nist.gov/

### 8. National Oceanic and Atmospheric Agency (NOAA)

NOAA's research in climate prediction and weather forecasting depends on advances in HPCC technologies. NOAA will increase use of Internet and follow-on networks of the National Information Infrastructure to disseminate large amounts of real-time information.

| FY 1995 BUDGET $ millions | ACTIVITY |
|---|---|
| 16.0 | Advanced Computation |
| 8.7 | Networking Connectivity |
| 0.5 | Information Dissemination Pilots |

CONTACT:

NOAA's HPCC program does not fund research and development. NOAA's Climate and Global Change Program funds some HPCC-related grants which are announced in the Federal Register.

### 9. Environmental Protection Agency (EPA)

EPA's HPCC program is focused on incorporating advances in computing and communications technology into key environmental applications and transferring these tools to state, federal, and industrial users.

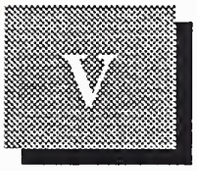
| FY 1995 BUDGET $ millions | ACTIVITY |
|---|---|
| 6.4 | Environmental Modeling |
| 5.2 | Computational Techniques |
| 0.7 | State Network Connectivity |
| 1.9 | Education/Training |
| 0.3 | Public Data Access |

CONTACT:

EPA
Research Triangle Park, NC 27711

To contact EPA online, use the following address:

gopher.epa.gov
134.67.208.112



# HPCC Agency and Program Issues

INPUT has extensively reviewed the HPCC program and surveyed several key agency personnel regarding concerns raised about critical success factors. This chapter will list those issues, and also present a summary of recommendations made in November 1994 by the General Accounting Office for improvements to the program.

While there have been numerous measurable successes in high performance computing and communications, there are two areas of major concern, which contain issues of varying degrees of importance to the program:

- Funding
- Technology Issues

## A Funding

There has been significant growth in HPCC program funding since the FY 1991 inception of the program (see Exhibit IV-3). However, there are major concerns at the agency level, and also in industry, on the future of the program. The newly elected Congress has threatened to drastically reduce, or eliminate, Research and Development funding for HPCC, as well as for the Advanced Technology Program (ATP), both essential elements of the National Information Infrastructure (NII), in order to pay for the tax cuts promised under the Republican Contract with America. The Clinton administration will strongly fight this proposition on the grounds that the HPCC program has gained tremendous momentum and is vital to the nation's economy and well-being.

Also, each HPCC agency has fundamental concerns that they do not have enough funding to meet some of their HPCC objectives. Some agencies

feel that there is enough funding for high performance computers, systems and the network, but not nearly enough for software, algorithms and application development. Essentially, the typical complaint is that the administration set fairly realistic goals and objectives initially, and then increased the scope of HPCC by adding the NII Information Infrastructure Technology Applications (IITA) component without providing any additional funding.

The IITA component is the vital bridge between the HPCC program and the NII. High performance supercomputing and high performance networking technologies are on schedule, and in some cases, even ahead of schedule. Those technologies are only worthwhile if there are effective, large-scale National Challenges applications which can be made accessible to the general public.

INPUT believes that the Administration will find creative ways to retain, and increase funding for this program. For example, in early December the Administration was trying to steer surplus funds, which have been raised from the Federal Communications Commission auctions to private firms on approximately 100 licenses for telephone services nationwide. Congress now mandates competitive bidding on communications licenses, which formerly were provided at no cost. The Administration believes that a $5 billion surplus will be created from the auctions, which could be applied to programs like HPCC, for creating networks linking schools, libraries and hospitals nationwide.

INPUT believes that, because of the Administration's desire for the National Information Infrastructure by the year 2000, and the high level of interest from the general public, and from the information technology, telecommunications, and entertainment industries, that HPCC funding will have sustained growth for the next two years, and probably until the turn of the century. INPUT's assumption is that the Administration will negotiate with the new Congressional leadership on which National Challenges should be funded (Exhibit I-3) and at what level. Some of the National Challenges applications may be considered more politically desirable than others. The new Congressional leadership is generally in favor of the Federal government's investments in Research and Development, but is not necessarily as enthusiastic about some NII applications of certain health care, environmental or energy projects.

# B
# Technology Issues

The common technology problem, or concern, affecting the HPCC program and its participants, is that software (operating software, algorithms, and applications) developments are not keeping up with the advancements in hardware and network technology, and that the software community is constantly having to play "catch-up" with the rest of the program. This concern, and the other issues listed below, seem to be related to the level of available funding, and to the setting of priorities by the management team for HPCC.

### 1. High Performance Computing Systems (HPCS)

- Some amount of funding and prioritization limitations have caused a number of very small prototype systems to be installed, with the intention of being upgraded at a later date. This has limited effective testing of some of the systems for early evaluations, and has reduced the ability to do cross-comparison testing of different systems. It has also limited the ability to measure how effective applications on small prototype systems will be able to "scale up" to larger systems. The overall effect has been to slow down progress in the HPCS component's "Evaluation of Early Systems" element.

- The HPCS component has been consistently ahead of schedule, however.

### 2. National Research & Education Network (NREN)

- The commercial segment of NREN is the fastest growing part of the network. This rapid growth has raised major concerns about manageability and operability for users not highly skilled in maneuvering around the network. There is not an effective accounting and statistical support package, and building a guide to users is a big challenge. However, Microsoft, Prodigy, America On-line, and CompuServe have all announced improved user interfaces to Internet, which should assist the government with Internet usability.

- NREN is also considered ahead of schedule, and is managing to stay ahead of the increased popularity witnessed in the last year. The Internet Protocol (IP) is considered to be able to handle increased growth for the next 6 or 7 years. Upgrading the speed on the Internet has generally slowed, and some grants have been delayed by concerns over funding.

- There is some tension in the community over the "privatization" of the network, but it is proceeding on schedule. In fact, privatization of the network will accelerate in the future.

- Most opinions are that the "data superhighway" is a reachable goal.

### 3. Advanced Software Technology & Algorithms (ASTA)

- Opinions differ on the progress of this component. Generally, progress is behind the other components, largely because of the complexity of the algorithms needed to create the software to effectively run Grand Challenge problems. HPCC participants expressed the opinion that the research centers need far more resources (funding, people, industry involvement, services) to catch up to the rapid progress being made in hardware and network technology. Automated software tools are needed for partitioning and mapping programs onto high performance systems, and more user-friendly platforms are desired.

- This is the HPCC component with the most funding for FY 1995. However, it is felt that even more funding would speed the movement of applications to scaleable architectures. INPUT feels that the HPCC Program must push for greater industry involvement and create additional incentives for industry and academia.

### 4. Information Infrastructure Technology & Applications (IITA)

- This new HPCC component is receiving a lot of attention because it is responsible for bringing National Challenges applications and data to the general public. Again, there have been some funding difficulties in prioritizing some projects, especially at DoE, EPA and NOAA. This has caused some delays in dissemination of data to industry and to some universities.

### 5. Basic Research and Human Resources (BRHR)

- The concerns here involve making sure that HPCC-funded research goes beyond theory and well into practical applications, like those of National Challenges problem solving. There is a need for new evaluation and measurement techniques to assess that new technologies, and their usage, can be accessible by the general public via the NII.

## C

## HPCC Recommendations From the General Accounting Office (GAO)

Please refer to Exhibit V-1 for a summary of the GAO Report on the HPCC Program. The report gives very high praise to the program and its successes.

Exhibit V-1

### GAO Report

**Recent Findings on HPCC Program**

- More focused management approach needed
- HPCC technical agenda could be better defined
- Inconsistent budget information
- Greater industry involvement could help
  - Closer collaboration on NII required
  - More industry involvement in program planning desired
  - Lack of adequate software applications and tools
  - Standards need better support from industry

**Recommendations on HPCC**

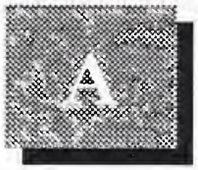
- Develop more explicit HPCC technical agenda along with industry and academia
- Develop more detailed guidelines for preparing HPCC budget
- Appoint advisory committee, including a wide range of industries; sponsor symposia with industry

*Source: U.S. Government Accounting Office (GAO) Report on HPCC, November 1994*

INPUT agrees with most of the conclusions and recommendations of the report. We believe that the HPCC program will implement many of the recommendations, but will not centralize management and funding, which will remain with the HPCC agencies. We agree with the HPCC office that allowing de-centralized management will encourage individual innovation and cooperation for better research and development across the agencies.

The Administration and the HPCC office will institute a new system for prioritizing HPCC projects. This should ensure that high performance hardware and networking technology is not being developed without appropriate software and applications. It should also help alleviate the chronic feeling that the funding level is inadequate.

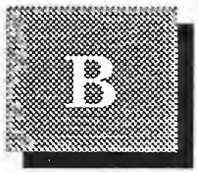
INPUT also agrees that the program would benefit from greater industry involvement, especially in software and algorithm development, and in development of applications under the IITA component for National Challenges. One of the purposes of this report is to encourage industry to become more involved in HPCC conferences, symposia and research and development activities.



# Glossary

| | |
|---|---|
| **ARPA** | Advanced Research Projects Agency |
| **ASTA** | Advanced Software Technology and Algorithms |
| **ATM** | Asynchronous Transfer Mode |
| **BRHR** | Basic Research and Human Resources |
| **CBD** | Commerce Business Daily |
| **CIC** | Committee on Information and Communications |
| **CRADA** | Cooperative Research and Development Agreement |
| **DoC** | Department of Commerce |
| **DoD** | Department of Defense |
| **DoE** | Department of Energy |
| **ED** | Department of Education |
| **DREN** | Defense Research and Engineering Network |
| **EPA** | Environmental Protection Agency |
| **FY** | Fiscal Year |
| **GAO** | General Accounting Office |
| **Gbs** | Gigabits per second |
| **GIGABIT** | Billions of bits |
| **HHS** | Health and Human Services |
| **HPCC** | High Performance Computing and Communications |
| **HPCCIT** | Subcommittee on HPCC Information Technology |
| **HPCS** | High Performance Computing Systems |

| | |
|---|---|
| **IITA** | Information Infrastructure Technology and Applications |
| **INTERNET** | The global, interconnected collection of multiprotocol networks |
| **IP** | Internet Protocol |
| **IT** | Information technology |
| **Mb/s** | Millions of bits per second |
| **NASA** | National Aeronautics and Space Administration |
| **NCO** | National Coordination Office (for HPCC) |
| **NIH** | National Institutes of Health |
| **NII** | National Information Infrastructure |
| **NIST** | National Institute of Standards and Technology |
| **NOAA** | National Oceanic and Atmospheric Administration |
| **NSA** | National Security Agency |
| **NSF** | National Science Foundation |
| **NSFNET** | National Science Foundation Network |
| **OMB** | Office of Management and Budget |
| **OSTP** | Office of Science and Technology Policy |
| **PAR** | INPUT's Procurement Analysis Report |
| **R & D** | Research and Development |
| **RFP** | Request for Proposal |
| **SBA** | Small Business Administration |
| **Teraflops** | Trillions of floating point operations per second |
| **Teraops** | Trillions of operations per second |
| **T1** | Network transmission at 1.5 Mb/s |
| **T3** | Network transmission at 45 Mb/s |



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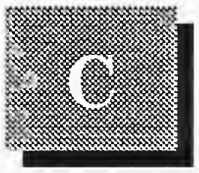


# Related INPUT Reports

*High Performance Computing in the Federal Market, 1992-1997*

*Service to the Citizen - 1994*

*Client/Server Trends in the Federal Market - 1994*

*Business Process Re-engineering in the Federal Government - 1994*

*Federal Imaging Market - 1994*

*Federal Information Systems and Services Market - F 1994 - FY 1999*

*Federal Telecommunications Market - FY 1994 - FY 1999*

*Federal E-Mail Market - FY 1994 - FY 1999*

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