# HIGH PERFORMANCE COMPUTING and COMMUNICATIONS

## FY 1998

## Implementation Plan

**September 3, 1998**

National Coordination Office for Computing, Information, and Communications
Executive Office of the President
National Science and Technology Council

National Coordination Office for Computing, Information, and Communications

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September 3, 1998

Dr. Neal Lane
Assistant to the President for Science and Technology
Executive Office of the President
Old Executive Office Building
Washington, DC 20500

Dear Dr. Lane:

I am pleased to forward to you the FY 1998 Implementation Plan for the High Performance Computing and Communications (HPCC) Program. This Plan provides a detailed description of FY 1997 HPCC accomplishments and FY 1998 HPCC plans as reflected in the President's FY 1998 HPCC budget proposal. The planning, accomplishment, and budget material in this document was prepared by the National Coordination Office for Computing, Information, and Communications (NCO/CIC) and the twelve agencies that are members of the Subcommittee on Computing, Information, and Communications Research and Development (CIC R&D).

This Implementation Plan includes FY 1998 plans for the President's Next Generation Internet (NGI) initiative, which is reported here under the Large Scale Networking Program Component Area. The Federal investments made in this initiative and associated industry investments are creating the foundation for the networks of the 21st century. Our FY 1999 Implementation Plan, which will be published later this year, will detail impressive FY 1998 accomplishments toward the NGI goals.

The format and contents of this Implementation Plan are similar to previous years' plans and were determined through substantial interaction with the Office of Management and Budget. This document will be made available to the public in printed form and can also be accessed via our NCO Web site, http://www.ccic.gov/. The Supplement to the President's FY 1998 Budget, "Computing, Information, and Communications: Technologies for the 21st Century," published in November 1997, is a companion to this document and can also be accessed via our Web site.

The Subcommittee on CIC R&D and the NCO staff look forward to working with you to assure continued U. S. leadership in computing, information, and communications technologies.

Respectfully yours,

Kay Howell
Director

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## Appendix B

**High Performance Computing and Communications Program**

**FY 1998 Implementation Plan**

## 1. Executive Summary

This document presents the FY 1998 Implementation Plan (IP) for the Federal High Performance Computing and Communication (HPCC) Program. This highly successful Program builds upon decades of Federal HPCC R&D and receives bipartisan Congressional support. The IP is based on the President's FY 1998 HPCC budget request of $1.1037 billion and the FY 1998 HPCC Program's Supplement to the President's Budget entitled Computing, Information, and Communication: Technologies for the 21st Century. This Plan provides a detailed description of FY 1997 HPCC accomplishments and FY 1998 HPCC plans as reflected in the President's FY 1998 HPCC budget proposal to the U. S. Congress to be carried out by the twelve participating Federal agencies. The FY 1998 budget figures derive from a base of $489 million in place at the beginning of the HPCC Program in FY 1992.

As the 21st Century approaches, the rapid convergence of computing, communications, and information technology promises unprecedented opportunities for scientific discovery, industrial progress, and societal benefit. The development of ever more powerful high-performance computers and effective low-cost computers, advanced networking technologies, and evolving software technologies are enabling unparalleled advances in science and engineering, as well as facilitating the integration of the information technology into the mainstream of American life. Federal R&D programs detailed in this document are key driving forces for advancing these technologies and their application to a more secure and better life in 21st Century America.

To meet many of the challenges of this new century, under the direction of National Science and Technology Council's (NSTC) Committee on Technology (CT), the Federal Computing, Information, and Communications (CIC) programs are investing in long-term R&D to advance computing, information, and communications in the United States. The HPCC Program is a part of the CIC programs. The National Coordination Office for Computing, Information, and Communications (NCO) provides a central focus for interagency R&D activities and coordinates the activities of the HPCC and CIC agencies. The Subcommittee on CIC R&D is divided into five Working Groups that are responsible for focusing on specific technical and high priority Program Component Areas (PCAs). The five CIC R&D PCA Working Groups and their overall goals are:

**High End Computing and Computation (HECC):** The goal of HECC R&D is to provide the foundation for U.S. leadership in computing through investments in systems hardware and software innovations, in algorithms and software for modeling and simulation needed for computation- and information-intensive science and engineering applications, and in the research infrastructure required to carry out this R&D.

**Large Scale Networking (LSN):** The goal of LSN R&D is to further U.S. leadership in network communications through advances in high performance network components; technologies that enable wireless, optical, mobile, and wireline communications; large scale network engineering, management, and services; and systems software and program development environments for network-centric computing.

**High Confidence Systems (HCS):** The goal of HCS R&D is to develop technologies that provide high levels of security, protection of privacy and data, reliability, and restorability of information services.

**Human Centered Systems (HuCS):** The goal of HuCS R&D is to make computing and networking more useful through collaboratories, technologies that provide knowledge from distributed repositories, multi-modal interactive systems, and virtual reality environments.

**Education, Training, and Human Resources (ETHR):** The goal of ETHR R&D is to support research that advances education and training technologies, including technologies that support lifelong and distance learning, information-based learning tools, and curriculum development.

FY 1998 research directions for the five PCAs include the following:

HECC R&D focuses on algorithms and software for modeling and simulation needed for computation- and information-intensive science and engineering applications including the Grand Challenges and the infrastructure that supports computational science research. In FY 1998 more attention will be given to system software technologies for high performance systems—especially scalable clusters of shared memory processors. There is also a new emphasis on research on fundamental computing technologies based on quantum, optical, and biological phenomena.

In LSN R&D, emphasis is on the Next Generation Internet initiative, as well as research on smart packet networks, "active networks," mobile networking and computing, multi-wavelength network management, faster networks, connectivity, IP/ATM interconnect, class of service, resource contention, and remote sensing applications.

In HCS R&D, agencies focus on the high performance aspects of system reliability, provability, and privacy of sensitive unclassified data, with emphasis on information security. Additional R&D activities are in computer-based patient records, electronic commerce, and emergency management. The HCS working group is developing a strategic implementation plan, planned for completion before the close of this fiscal year.

In HuCS R&D, emphasis is on human-computer interaction techniques, including interactive problem-solving, software development technology, speech and document understanding, digital library technologies, collaboratories, virtual reality applications in telemedicine, remote operation of expensive and unique equipment, and technologies for remote collaboration.

ETHR R&D activities, such as graduate and postdoctoral support for high performance computing research, distribution of K-12 curriculum products, demonstration of results of mature digital library projects, and training biomedical scientists to use technology efficiently and effectively.

## 2. Introduction

With broad bipartisan support, Congress authorized the High Performance Computing and Communications (HPCC) Program in the High Performance Computing Act of 1991 (Public Law 102-194), signed on December 9, 1991. The eight Federal agencies supporting the original Program have grown to twelve. This Plan provides a detailed description of these agencies' FY 1997 HPCC accomplishments and FY 1998 HPCC plans.

HPCC and computing, information, and communication activities are coordinated by the Subcommittee on Computing, Information, and Communications (CIC) R&D of the Committee on Technology (CT), one of the five committees of the National Science and Technology Council (NSTC). In FY 1991, before the start of the formal Program, the HPCC-related activities by the original eight agencies totaled approximately $489 million—the Program's base level. The Program goals justified annual funding levels that were expected to grow to approximately $1,500 million over five years. While the funding did not grow to that level, the Program has remained a healthy and vital mechanism for R&D in the enabling technologies required for computing, information, and communications.

The overall funding profile for the HPCC Program and CIC programs, is as follows:

| **Fiscal Year (Number of Agencies)** | **Original Eight Agencies (Dollars in Millions)** | **Change from Previous Year for Original Eight** | **Participating Agencies (Dollars in Millions)** | **Change from Previous Year for Twelve Agencies** |
|---|---|---|---|---|
| FY 1991 Base (Eight agencies) | $ 489.4 | | $489.4 | |
| FY 1992 Actual (Eight agencies) | $ 655 | +33.9% | $ 655 | +33.9% |
| FY 1993 Actual (Ten agencies) | $ 783 | +19.5% | $ 795 | +21.4% |
| FY 1994 Actual (Ten agencies, IITA added) | $ 925 | +18.1% | $ 938 | +18.0% |
| FY 1995 Actual (Twelve agencies) | $ 1,019 | +10.2% | $ 1,129 | +20.4% |
| FY 1996 Actual (Twelve agencies) | $ 949 | –6.9% | $ 1,043 | –7.6% |
| FY 1997 Estimate (Twelve agencies) | $ 931 | -1.9% | $ 1,009 | –3.3% |
| FY 1998 President's Request[1] (Twelve agencies) | $ 1,002 | +7.6% | $ 1,104 | +9.4% |

[1] The published FY 1998 President's HPCC Budget also includes funding for the Department of Transportation, which is not a part of the FY 1998 HPCC Program.

## 3. Program Overview

Through their goals and objectives, the HPCC Program and the CIC programs provide the focus for the member agencies' planning, implementation, and management of these activities. Through collaborative coordination, the participating agencies seek to leverage each other's activities wherever possible and to minimize redundancy in activities. However, funding for each agency's HPCC and CIC activities flows directly to the agency, and each agency has its own mechanisms to select and evaluate projects funded under this Program. Published reports, workshops, meetings, and continuously updated World Wide Web sites are used to distribute the results of HPCC and CIC research and to evaluate overall Program progress.

### 3.1. Goals and Objectives

The HPCC Program goals are to:

*Extend U.S. technological leadership in high performance computing and computer communications*

*Provide wide dissemination and application of these technologies to speed the pace of innovation and improve national economic competitiveness, national security, education, health care, and the environment*

*Provide key enabling technologies for the National Information Infrastructure (NII) and demonstrate selected NII applications*

These goals are consistent with the goals of the CIC R&D programs, and will be realized by focusing the HPCC and CIC activities within each of the participating Federal agencies and coordinating those activities among the participants. Throughout the life of the HPCC Program, many key applications in Government, academia, and industry have required far greater computing capability than was available at the time, and that remains true today. These applications can be subdivided into Grand Challenges (GC) and National Challenges (NC). The Grand Challenges are those efforts that focus on computationally intensive problems in science and engineering with broad economic and scientific impacts, whose solution can be advanced by HPCC techniques and resources. Typical examples of GC include parallel ocean modeling, computational structural biology, massively parallel atmospheric modeling, and global climate modeling. National Challenges on the other hand focus on efforts that are informationally intensive, have broad and direct impact on the Nation's competitiveness, well-being of its citizens, and that can benefit from the application of the HPCC technologies and resources. Some examples of NC include digital libraries, electronic commerce, education and life-long learning, and healthcare.

The HPCC and CIC programs will continue to accelerate the development of scalable computing systems that will have the capability (in terms of computational cycles) and capacity (in terms of memory and communication speed) to address more of these critical applications. It will also accelerate development of the supporting technologies, such as file storage systems, computing environments, and network communications required for effective use of these systems. The Administration's vision for a National Information Infrastructure (NII) makes unprecedented demands for network connectivity, capacity, database availability, information management, access security, and ease of use. The HPCC and the CIC programs will continue to work with industry to create key elements of the technology base needed for a universally accessible NII and will use this technology to develop and demonstrate prototype NC-class applications. All of these activities depend on inventing more cost-effective approaches to developing and maintaining scalable algorithms and software. Progress requires that the Government support the development of a cadre of highly-trained professionals capable of developing and using these advanced computing systems and networks.

### 3.2. Definition of Program Component Areas (PCAs)

The HPCC and the CIC programs are organized into five Program Component Areas (PCAs) that cover a broad spectrum of computing, information, and communications technology R&D supported by the Federal Government. The PCAs are areas of high priority investments by the Federal agencies that participate in the coordinated R&D

programs. The PCAs are defined, briefly, in the following. More extensive definitions and characteristics are given in section 4.

**High End Computing and Computation (HECC):**
HECC R&D is focused on continued U.S. leadership in high performance computing and computation. Investments concentrate on leading-edge innovations in hardware and software such as storage and data technologies for high-end computing systems; experimentation with new devices; development of system software technologies; advanced simulation techniques; and fast, efficient algorithms for simulation and modeling. In addition, HECC research supports exploration of advanced computing concepts in quantum, biological, and optical computing at both the hardware and software levels. At the high end, these technologies enable distributed, multidisciplinary computation- and information-intensive, scientific and engineering applications. Scalable systems allow effective deployment of these technologies to the workplace, school, and home.

**Large Scale Networking (LSN):**
LSN R&D will assure U.S. technological leadership in communications through R&D that advances the leading edge of networking technologies and services. This includes advanced network components and technologies for engineering and management of large-scale networks, both for scientific and engineering R&D and for other purposes. Areas of particular focus include: (1) technologies and services that enable wireless, optical, mobile, and wireline communications; (2) networking software that enables information to be disseminated to individuals, multicast to select groups, or broadcast to an entire network; (3) software for efficient development and execution of scalable distributed applications; (4) software components for distributed applications, such as electronic commerce, digital libraries, and health care; and (5) R&D infrastructure support and testbeds.

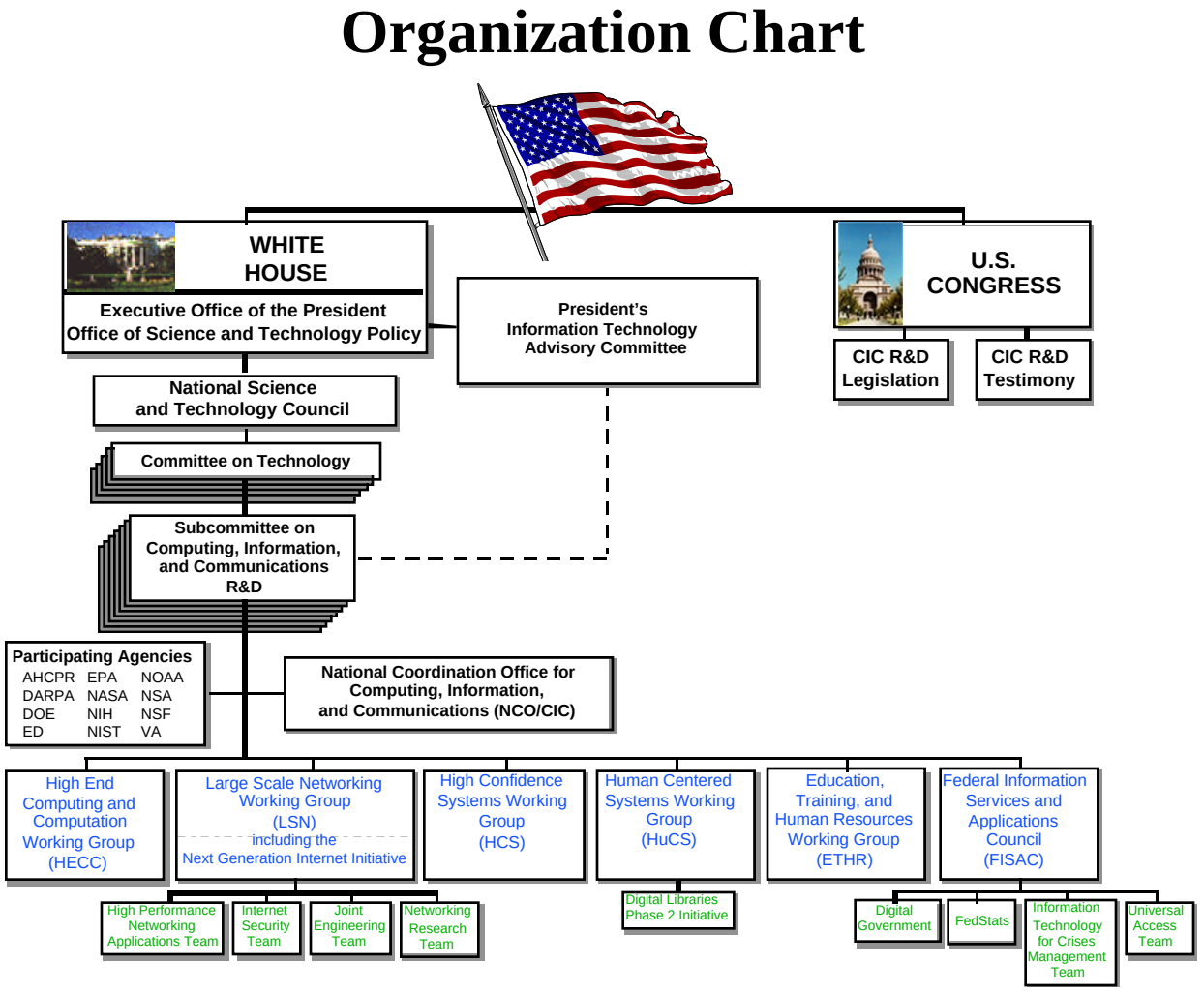
**High Confidence Systems (HCS):**
HCS R&D will provide users with the technologies necessary to achieve high levels of security, protection, reliability, and restorability of information services. Such systems are resistant to system failure and malicious penetration or damage and readily adapt or respond to interference. These systems include both physical components, wired and wireless technologies, the data they contain and transmit, and the software that manipulates these data. HCS R&D focuses on (1) system reliability (such as management of networks under load, failure, or intrusion; emergency response; firewalls; secure enclaves; and formal methods), (2) security and privacy (including personal identification, access control, authentication, encryption and other privacy assurance techniques, public key infrastructures, and trusted agents for secure distributed computing), and (3) testing and evaluation. Key applications include national security, law enforcement, life- and safety-critical requirements, personal privacy, and protection of critical elements of the NII.

**Human Centered Systems (HuCS):**
HuCS R&D makes computing systems and communications networks more easily accessible to and usable by a wide range of user communities. These communities include scientists and engineers, educators and students, the workforce, and the general public. Technologies enabling such systems include: (1) “knowledge repositories” and “information agents” for managing, analyzing, and presenting massive amounts of multimedia and multi-source information; (2) “collaboratories” that provide access to knowledge repositories and that facilitate knowledge sharing, group authorship, and control of remote instruments; (3) systems that enable multi-modal human system interactions including speech, touch, and gesture recognition and synthesis; and (4) virtual reality environments and their application to fields including scientific research, health care, manufacturing, and training.

**Education, Training, and Human Resources (ETHR):**
The focus of ETHR R&D is on advancing education and training technologies. The goals of this education and training are to produce (1) researchers and students in high performance computing, communications, information technologies, and their application, and (2) a citizenry with the skills to compete and prosper in the 21$^{st}$ Century's information age. ETHR includes curriculum development, fellowships, and scholarships for computational, computer, and information sciences and engineering. It includes the application of interdisciplinary research to learning technologies, and R&D in information-based learning tools, lifelong learning, and distance learning for people in remote locations.

### 3.3. HPCC and CIC Management, Planning, and Organization

The HPCC Program and CIC programs are implemented as a partnership among Federal agencies, with strong involvement by U.S. academia and industry. Program oversight and budgetary review are provided by the Committee on Technology (CT) through its Subcommittee on CIC R&D. The National Coordination Office for Computing, Information, and Communications (NCO) provides a central focus for interagency R&D activities. Preparation of planning, budget, assessment of the documents, development of inter-agency CIC programs, and coordination of the various activities of the HPCC and CIC agencies are additional NCO activities. The NCO also provides an interface to Congress, academia, industry, and the public. The NCO Director, who reports to the Director of the Office of Science and Technology Policy (OSTP), Executive Office of the President, serves as the Chair of the Subcommittee on CIC R&D.




The CIC R&D Subcommittee meets quarterly to coordinate agency HPCC and CIC programs through information exchanges, development of interagency programs, and the review of individual agency plans and budgets. The CIC R&D Subcommittee charters a Working Group for each PCA to coordinate activities in specific areas.

The Federal Information Services and Applications Council (formerly the Applications Council) facilitates partnerships between Federal R&D and non-R&D communities to promote early application of advanced computing, information, and communications technologies within the Federal Government, in particular efforts that involve multiple agencies and disciplines. The FISAC has no budget allocation.

### 3.4. Selecting Projects for Funding

The CIC R&D Subcommittee works with the agencies to minimize redundancy, coordinate interagency programs, and encourage adequate funding. The mechanisms used to evaluate and fund activities differ among the twelve agencies that support R&D conducted by agency staff and researchers in universities, industry, and national laboratories. Agencies in general have a program to review and fund competitive, merit-based awards consistent with the agency's mission. Calls for proposals for these grants and contracts may be in the form of Broad Area Announcements (BAAs), Requests for Proposals (RFPs), Cooperative Research and Development Agreements (CRADAs), Cooperative Agreement Notices (CANs), etc. These receive wide distribution, including both electronic means (e.g., electronic bulletin boards and World Wide Web sites on the Internet) and traditional media (e.g., Commerce Business Daily). R&D projects are normally subjected to peer review to aid in selection of the highest quality work and to ensure active participation by the research community.

### 3.5. Measurement of Progress

The Federal HPCC and CIC programs provide the stimulation and coordination essential to accelerate progress in R&D in high performance computing, communications, and information technology. Success is measured using both quantitative metrics, which characterize the capabilities of the technologies in these areas, and qualitative characteristics, which attempt to capture the impact of using new information technologies in the Federal Government, academia, industry, and by the general public.

One method for measuring progress is the establishment and subsequent review of yearly milestones described in the next section. This document reports on milestones for three Fiscal Years. The FY 1996 milestones are those that were accomplished by the end of that year. The FY 1997 milestones reported herein are the expected accomplishments for last year, based on Congressional appropriations. FY 1998 milestones describe anticipated accomplishments, assuming Congressional appropriations at the President's requested level. Achievement of these milestones depends on specific program activities that take place within the agencies. The successful completion of these activity-specific milestones across all agencies will meet the HPCC and CIC goals and objectives.

One aspect of HPCC and CIC research is to identify and use effective measures of progress. HPCC and CIC objectives and agencies' project activity milestones are the primary measures of progress when success can be measured quantitatively. When progress cannot be measured quantitatively, qualitative measures are used. Whether quantitative or qualitative, both HPCC and CIC work with program managers and technical reviewers to assess progress.

### 3.6. Reporting Results and Interactions

At the individual project level, investigators present their results in workshops, conferences, and journal publications and rely on electronic means to share and distribute software tools. At the agency level, periodic reports summarize the results of HPCC and CIC activities. In addition, HPCC agencies' Web sites provide direct access to the results of their research projects. The NCO's *http://www.ccic.gov/* and *http://www.ngi.gov/* Web sites are linked to all of the agency-level sites.

In FY 1997, the CIC R&D Subcommittee and its Working Groups sponsored the following outreach conferences and workshops:

- "Next Generation Internet Initiative Workshop" (January 1997)
- "Petaflop Algorithms Workshop, PAL 97" (April, 1997)
- "Next Generation Internet Initiative Workshop" (May 1997)
- "Workshop on R&D Opportunities in Federal Information Services" (May 1997)

### 3.7. Program Publications

HPCC and CIC publications for FY 1997, include:

- "Technologies for the 21st Century, Supplement to the President's FY 1998 Budget"
- "Advancing the Frontiers of Information Technology," Supplement to the President's FY 1997 Budget
- "Federal HPCC FY 1997 Implementation Plan," which details HPCC plans and budget crosscut
- "Computing, Information, and Communications Technologies for the 21st Century," a brochure and a separate report that is the Supplement to the President's FY 1998 Budget
- A four-page flier that documents five years of HPCC and CIC accomplishments.

These publications are available in print from the NCO and on-line at the NCO's Web site, *http://www.ccic.gov/*.

### 3.8. Assessment and Review

In February 1997, the President established an Advisory Committee on High Performance Computing, and Communications, Information Technology, and Next Generation Internet consisting of non-Federal members from the research, education, and library communities; network providers; and industry. The President's Information Technology Advisory Committee (PITAC) advises the Administration on the CIC R&D efforts and its progress. The Committee members are specially qualified to provide independent assessment, advice, and information on high performance computing and communications. In addition, representatives from academia, industry, and professional associations have conferred with and advised the CIC R&D Subcommittee in several public sessions.

### 3.9. Agency Program Oversight

Individual agencies review programs in detail via their management review structures, including official advisory committees. This section highlights current oversight and review activities and describes existing review mechanisms within each of the larger agencies.

The **Defense Advanced Research Projects Agency (DARPA)** reviews its HPCC and CIC efforts at many different levels to ensure consistent program evaluation in a dynamic R&D environment. Projects produce reports on a regular basis that are reviewed by program managers. An annual process of updating accomplishments, milestones, and project plans is tied to the incremental funding process. DARPA staff fulfill their program management responsibilities through site visits, project meetings, principal investigator meetings, and regular interactions over the Internet. In addition, DARPA contracting agents work regularly on details with program managers as part of the contract management process. Office directors and program managers develop plans and milestones that are approved by senior management during the planning and budget cycle. New programs and ideas are proposed during this process. In conjunction with yearly funding decisions by DARPA and the Department of Defense (DoD), senior DARPA technical management critically review program areas, plans, and accomplishments. Guidance is provided to reflect programmatic, technical, and funding directions. At the DoD level, programs are described through a formal process that requires agency, DARPA Comptroller, DoD Comptroller, senior DARPA management, and senior DoD approvals. Once approved, these descriptions become part of the Defense budget submitted to Congress for approval. In addition to other internal Federal reviews, there are Congressional briefings, agency crosscuts, technical working groups, DoD advisory panels, and several National Academy of Science studies that contribute to the planning process.

The **National Science Foundation (NSF)** defines its HPCC and CIC projects so as to reach its long-term objectives and reviews its projects in that context. The Foundation sets long-term goals in consultation with committees such as the National Science Board, panels and committees commissioned to study and recommend program activities, and external advisory committees. Consistent with long-term goals, the NSF HPCC and CIC programs develop specific goals and objectives for each of the activities within the programs. The program uses several means to help it define specific objectives, implementation mechanisms, and evaluation measures and actually to perform evaluations: external peer review (mail reviews, panel reviews, and site visits), workshops for developing research agendas, committees of visitors, technical oversight teams, ongoing site visits by program staff and outside experts, program

officer review of final project reports, and the bodies of opinion held by the community of researchers themselves as captured in publications and their review.

The **Department of Energy (DOE)** HPCC and CIC programs focus is on basic mathematics and computational research and on developing and delivering technology for use by other scientists and engineers in DOE and associated U.S. universities and industry. Performance evaluation is an integral part of these programs. Because of this focus, external review by prospective users of the technology is a critical component of measuring performance. In previous years this has been most explicitly present in the use of committees of users such as the ESnet (Energy Sciences network) Steering Committee and the ER (Energy Research) Supercomputer Users Group to evaluate the effectiveness of the access and networking programs. Many of the education programs established under the DOE HPCC and CIC programs have built-in evaluation procedures. In software technology, employing prospective users of technologies as reviewers has ensured that the technology developed is that required by users. DOE further formalized these procedures to include program-wide reviews of the basic technology components of the program by significant prospective users of those technologies. These include reviews of effectiveness in all categories as well as of progress in reaching specific numerical targets. Also included from the Office of Defense Programs (DP) is the Advanced Strategic Alliances Program from the Accelerated Strategic Computing Initiative (ASCI).

The **National Aeronautics and Space Administration (NASA)** evaluates HPCC and CIC programs at several levels. At the agency level, the NASA Advisory Council has established the Ad Hoc Task Force on Supercomputing, which completed a review and report on the NASA HPCC program. NASA expects to charter other such bodies permanently under the Aeronautics Advisory Committee to advise the NASA HPCC program. Within the program, annual comprehensive reviews are conducted for each of the projects. In addition to appropriate NASA personnel, representatives from other Federal agencies, academia, and industry may be invited to participate. Annual independent reviews of program progress and plans are also conducted with the participation of the NASA HPCC Executive Committee. In addition, the program managers, the Associate Administrator of Aeronautics, and the Director of NASA's Ames Research Center conducts quarterly reviews of the NASA HPCC program. As new research is funded under the HPCC projects, the proposals undergo a peer review to ascertain the applicability of the research to NASA’s needs, the innovativeness of the research, the quality of the science, and the adequacy of the requested funding.

The **National Institutes of Health (NIH)** HPCC and CIC program goals are enhancements of existing NIH program missions to support biomedical science and expand biomedical knowledge. Program objectives are developed by Institute Directors, advisory bodies, and senior program staff, and are peer reviewed for determination of merit. Each of the participating NIH components has one or more standing external advisory committees that review new and existing programs. These include the National Library of Medicine (NLM) Board of Regents, NLM Board of Scientific Counselors, National Center for Research Resources (NCRR) Advisory Council, NCRR Biomedical Research Technology Review Committee, the National Cancer Advisory Board, the National Cancer Institute (NCI) Division of Cancer Biology and Diagnosis Board of Scientific Counselors, and the Center for Information Technology (CIT) Advisory Council. The final decision regarding individual HPCC and CIC programs within each of the participating Institutes rests with the Director of that Institute. Within each of the participating NIH Institutes, mechanisms exist to ensure objective evaluation of progress and results and identification of possible new activities.

The **National Security Agency (NSA)** reviews its HPCC support efforts on a yearly basis in several separate reviews. A steering group composed of senior managers from the technical components provides high level guidance prior to the formal budget process. The steering group receives individual project assessments from the project managers and determines whether any major shifts or changes are needed. Senior management has the flexibility to sponsor HPCC efforts in several budget reviews. Individual projects are proposed and budgeted within the technical components and are constantly evaluated by the project managers. Monthly status reports are evaluated and meetings held with the project staff to ensure that the correct focus is maintained. During the budget review cycle, the projects are evaluated and terminated or retained based on their performance, importance relative to other initiatives, and priority based on the steering group guidance. New projects can be proposed by the technical components each year during the NSA Technology Program review process.

The **National Institute of Standards and Technology (NIST)** has the National Academy of Science review annually all the programs and activities of each operating unit, as part of its normal operation. Assessment includes relevance to Institute goals and missions, performance measures, and achievements. Programs and activities that are a part of the Federal HPCC and CIC programs are subject to review and comments of an external panel of experts from academia and industry. Such panels report in writing to the Director of NIST, the Administration, and Congress. Selection of individual projects and subsequent progress reviews are conducted by program managers. The activities are further reviewed by an inter-operating unit panel composed of senior managers for relevance to agency mission, the HPCC and the CIC programs, and for continued acceptable performance.

The **National Oceanic and Atmospheric Administration (NOAA)** HPCC and CIC programs support and enhance NOAA programs in environmental prediction and stewardship. Comprehensive NOAA science reviews of these programs are held periodically. Quarterly reviews of HPCC and CIC progress are conducted as an integral part of NOAA-wide quarterly reviews by the Administrator and other NOAA senior line and program managers. Overall HPCC and CIC goals and plans are reviewed annually as part of the NOAA strategic planning process.

The **Environmental Protection Agency (EPA)** HPCC and CIC programs are focused on incorporating advances in computing and communications technology into critical environmental assessment applications and transferring those advanced tools to key state, Federal, and industrial users. EPA senior management officials review the EPA HPCC and CIC programs annually to assess their relevance to the agency mission and program achievements. Agency guidelines require an external peer review of the EPA HPCC and CIC programs every two years. The external review panel is composed of representatives from other Federal agencies, academia, and industry. Within the program, each major project is reviewed at least twice a year to evaluate progress toward the program objectives.

### 3.10. HPCC and CIC Planning Beyond FY 1998

The CIC R&D Subcommittee will continue to seek input and comment from academia, industry, other segments of the Government, and the public through a wide range of interchanges. A variety of workshops with technical experts and potential users of HPCC and CIC technologies will assess options and benefits that derive from continued efforts to stimulate computing and communications technologies. In FY 1997, the workshops listed in Section 3.6 were part of that process. As an additional part of this process, the Subcommittee and the NCO will actively seek comments on Implementation Plans such as this.

Computing, communications, and information technologies continue to be strategic enabling technologies for national security, the economy, education, and healthcare. The HPCC and CIC programs provide additional stimulation to accelerate progress in developing these technologies and in benefiting from their use. Through broad debate both within and outside the Federal government, the CIC R&D Subcommittee continues to develop and refine its long-term R&D plan as well as detailed implementation proposals that evolve naturally into a budget planning process.

## 4. HPCC and CIC FY 1998 Budget Overview by PCAs

This section presents an HPCC and CIC overview by agency by year by PCA. The presentation begins with the proposed agency-level funding on which the planned activities are based. The following summary information is presented for each PCA:

- Description of the types of activities included
- Status report describing changes from FY 1997 and their potential effects
- List of milestones expected to be accomplished in FY 1998
- Table of the agency activities supporting the area

### 4.1. Budget Planning Assumptions by PCA

Table 1 summarizes the HPCC and CIC financial planning information prepared by each agency for this Implementation Plan. The “FY 1996 Actual” column refers to the actual funds appropriated for that year. The “FY

1997 Pres." and "FY 1998 Pres." columns refer to the funds requested by the President in his budget request to Congress for those two years. The "FY 1997 Est." column estimates the funds each agency has been authorized to spend on HPCC and CIC as a result of Congressional appropriations. The last five columns break down the FY 1998 Presidential Request into the planned spending levels for each of the five PCAs. These breakdowns are subjective, since an activity may span several PCAs.

Table 1A provides a comparison by PCA of funding in FY 1997 and FY 1998. Both tables are obtained from a database that the NCO updates as new information is obtained from the agencies about Congressional action, agency funding redirections, etc.

Tables 2-6 include comparisons for each PCA of activities in FY 1996, 1997, and 1998.

In Appendix A, the FY 1996 milestones identify actual accomplishments, and the FY 1997 milestones assume the FY 1997 estimated funding level for each agency. The FY 1998 milestones assume the FY 1998 Presidential Request funding level in each agency. All discussions of program status also assume these budget numbers.

## Table 1: HPCC FY 1998 IP - Budget Summary

| Agency | Budget (BA, $ M) | | | | FY 1998 President's Request by HPCC PCAs | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | FY 96 Actual | FY 97 Pres. Req. | FY 97 Est. | FY 98 Pres. Req. | HECC | LSN | HCS | HuCS | ETHR |
| DARPA | 302.41 | 325.52 | 292.69 | 321.30 | 84.80 | 89.23 | 9.40 | 137.87 | |
| NSF | 291.10 | 279.51 | 279.51 | 294.13 | 132.90 | 79.20 | 0.90 | 60.17 | 20.96 |
| DOE | 109.69 | 121.46 | 119.18 | 152.53 | 90.80 | 48.79 | | 9.94 | 3.00 |
| NASA | 126.60 | 110.10 | 114.40 | 128.40 | 90.10 | 25.00 | 2.80 | 2.20 | 8.30 |
| NIH | 79.75 | 86.21 | 87.22 | 91.71 | 23.74 | 28.19 | 4.13 | 29.28 | 6.38 |
| NSA | 40.03 | 36.73 | 41.23 | 35.80 | 26.42 | 2.18 | 7.20 | | |
| NIST | 23.51 | 23.51 | 23.51 | 26.51 | 3.99 | 5.46 | 3.40 | 13.66 | |
| VA | 21.93 | 14.55 | 14.55 | 22.00 | | 7.45 | 5.35 | 9.20 | |
| ED | 28.93 | 18.01 | 18.01 | 12.00 | | | | 12.00 | |
| NOAA | 6.50 | 9.50 | 7.50 | 7.50 | 4.30 | 2.70 | | 0.50 | |
| EPA | 9.38 | 7.18 | 6.18 | 6.18 | 5.38 | | | 0.80 | |
| AHCPR | 3.20 | 4.20 | 4.20 | 5.50 | | | | 5.50 | |
| **Totals** | **1043.03** | **1036.48** | **1008.18** | **1103.56** | **462.43** | **288.19** | **33.18** | **281.12** | **38.64** |

## Table 1A: HPCC Budget Comparisons between FY 1998 and FY 1997

| | HPCC Program Component Areas by 1998 President's Request | | | | | | FY 1997 Estimated Budget by HPCC Program Component Areas | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **AGENCY** | **TOTAL 98** | HECC 98 | LSN 98 | HCS 98 | HuCS 98 | ETHR 98 | **TOTAL 97** | HECC 97 | LSN 97 | HCS 97 | HuCS 97 | ETHR 97 |
| DARPA | **321.30** | 84.80 | 89.23 | 9.40 | 137.87 | | **292.69** | 72.68 | 106.36 | 10.00 | 103.65 | |
| NSF | **294.13** | 132.90 | 79.20 | 0.90 | 60.17 | 20.96 | **279.51** | 129.17 | 72.26 | 1.21 | 57.76 | 19.11 |
| DOE | **152.53** | 90.80 | 48.79 | | 9.94 | 3.00 | **119.18** | 86.00 | 14.79 | | 14.89 | 3.50 |
| NASA | **128.40** | 90.10 | 25.00 | 2.80 | 2.20 | 8.30 | **114.40** | 88.00 | 14.60 | 1.60 | 4.50 | 5.70 |
| NIH | **91.71** | 23.74 | 28.19 | 4.13 | 29.28 | 6.38 | **87.22** | 23.40 | 26.52 | 4.17 | 27.25 | 5.88 |
| NSA | **35.80** | 26.42 | 2.18 | 7.20 | | | **41.23** | 30.43 | 3.50 | 7.30 | | |
| NIST | **26.51** | 3.99 | 5.46 | 3.40 | 13.66 | | **23.51** | 3.99 | 2.46 | 3.40 | 13.66 | 0.00 |
| VA | **22.00** | | 7.45 | 5.35 | 9.20 | | **14.55** | 1.00 | 9.45 | 2.30 | 1.80 | |
| ED | **12.00** | | | | 12.00 | | **18.01** | | | | 11.40 | 6.61 |
| NOAA | **7.50** | 4.30 | 2.70 | | 0.50 | | **7.50** | 4.30 | 2.70 | | 0.50 | |
| EPA | **6.18** | 5.38 | | | 0.80 | | **6.18** | 5.58 | | | 0.60 | |
| AHCPR | **5.50** | | | | 5.50 | | **4.20** | | | | 4.20 | |
| **Totals** | **1103.56** | **462.43** | **288.19** | **33.18** | **281.12** | **38.64** | **1008.18** | **444.55** | **252.64** | **29.98** | **240.21** | **40.80** |

### 4.2. High End Computing and Computation (HECC)

#### 4.2.1. HECC Definition

HECC R&D provides the foundation for U.S. leadership in computing through investments in hardware and software innovations; in algorithms for physical, chemical, and biological modeling and simulation of these processes in complex systems; and in information-intensive science and engineering applications. HECC research also explores advanced concepts in quantum, biological, and optical computing.

HECC R&D investments are made in four key science and technology areas:

1. System software technology focuses on improving the usability and effectiveness of teraflops-scale systems across a wide range of Government, industry, and academic applications.
2. Leading-edge research for future generations computing focuses on research and technology necessary for petaflops-scale computation and exabyte-level mass storage.
3. Incorporation of technology into agency applications focuses on first use of HECC technologies in agency applications, the practice of high performance computational science, and the required underlying algorithms.
4. Infrastructure for research in HECC focuses on computational facilities dedicated to research, large scale test systems, and high performance networks to maintain a state-of-the-art infrastructure for HECC R&D.

Investments in all four R&D areas will enable development of the distributed, computation-intensive applications required to meet future scientific, engineering, economic competitiveness, and national security needs.

## HECC Goals

The medium range technology development (three to five years) goals are to achieve major improvements in the usability and effectiveness of teraflops-scale systems across a wide range of applications. Longer range goals (more than five years) include the understanding of the device technology, algorithms, and software required for petaflops-level computation and exabyte-level mass storage.

**1. System Software Technology**

This thrust includes fostering the development of parallel software tools for operating systems, program development environments, and performance monitoring that can be used on a variety of distributed, scalable systems. These tools and system software will improve scalability, throughput, speed, portability, and programmability. A key activity is support for parallel systems software, such as innovative languages and their compilers, debuggers, performance monitors, scalable operating systems and input/output (I/O), program development environments, scientific visualization, and data management. Large-scale data management requires the development of technology for a new storage hierarchy, from exabyte tape robots to large, fast, on-chip memories.

**2. Leading-edge Research for Future Generations Computing**

HECC will support research and technology necessary for petaflops-level (i.e., a thousand-fold increase over today's capability) computation and exabyte-level mass storage through innovative technologies on architecture, hardware, and software components. The thrust will focus on innovative technologies, including software, device components, models of computation, and laboratory demonstration of prototypes. Research based on the shared-memory programming model must create techniques to overcome memory latency through multi-threading, better caching algorithms, or other means. The research will also focus on portable software technologies that scale the symmetric multiprocessor systems currently available (with several to hundreds of processors) to systems with very large numbers (tens of thousands) of processors. Concepts in the research stage include logic circuits based on semiconducting and other new materials such as low and high temperature superconductors, and on quantum mechanical devices such as rapid single-flux quantum (RSFQ) devices, used for logic circuits and memories. Research is carried out on the algorithmic, architectural, and technological foundations for amorphous computing

with programmable materials. Other promising concepts are on- and off-chip interconnections based on guided optics that employ wavelength division multiplexing (WDM), and massive holographic optical memory devices for mass storage concepts. Basic research must continue on innovative logic devices, based on nanotechnology and biological materials, that may exploit the information contained in large molecules such as deoxyribonucleic acid (DNA).

**3. Incorporation of HECC Technologies into Agency Applications**

This thrust involves incorporating HECC technologies into agency applications. Researchers must develop the practice of high performance computational science techniques and the use of underlying algorithms to ensure that key applications will run at full potential.

Many agencies support scientific mission-driven applications projects requiring large scale computation-intensive or data-intensive operations. These projects span the spectrum of scientific problems, with spatial and temporal scales from cosmology to global climate modeling to short range weather prediction to protein folding to quantum chromodynamics. R&D is needed to make advances in fast, efficient algorithms for computational sciences addressing emerging computational challenges, including very large sparse matrix-based problems, searching, sorting, and pattern matching. Research on algorithms with large amounts of concurrency, fault tolerance, and latency hiding is crucial to the use of high end computational systems of the future.

**4. Infrastructure for Research**

The goal of this thrust is to realize the full potential of research computational facilities, large scale test systems, and high performance networks by designing and coordinating the implementation and maintenance of a state-of-the-art infrastructure for HECC R&D. This will help to ensure a balanced infrastructure, including what is available through HPCC-supported centers, that has maximum computational strength and network bandwidth upon which large scale computation-intensive problems depend.

### 4.2.2. HECC Status

Proposed FY 1998 funds to support HECC activities total approximately $462 million. This is an increase of 3.6 percent over the FY 1997 estimated budget of $446 million.

NSF initiated the Partnerships for Advanced Computational Infrastructure (PACI) to provide access to high performance computing for the academic research community at a performance level of two orders of magnitude greater than that available today at a typical major research university. NSF will continue to support broad academic research in computing systems. This includes “Knowledge Networking,” an initiative focused on the next generation of interconnected networks and associated database and collaborative technologies. It also supports interdisciplinary research in computer and information science and engineering focused on problems requiring scientific advances across multiple computational science and engineering topics.

DOE will support the development of large applications software that can be executed in environments ranging from networks of workstations to the highest performance massively parallel processors available, based on strategies evaluated in FY 1997. DOE plans to introduce advanced tools for parallel program diagnosis and tuning in production versions. The DOE 2000 Program focuses on developing solutions for DOE’s increasingly complex scientific problems. A primary thrust is the Advanced Computational Testing and Simulation (ACTS) Toolkit, which will provide an integrated set of algorithms, software tools, and environments to accelerate the adoption and use of advanced computing by DOE programs for mission-critical problems. The Scientific Template Library project, along with DOE laboratories and university developers, has initiated research in this area. The Toolkit will be used by scientists working on DOE Grand Challenge Projects. DOE will begin developing ACTS-enabled applications in compressible fluid dynamics, combustion, environmental chemistry, and materials sciences. (This effort is coordinated with DOE Defense Programs development of ACTS-enabled applications in weapons hydrodynamics and materials characterization and aging.) DOE will support the self-sustaining operation of mission-related scientific applications programs combining massively parallel, advanced vector, and symmetric

multiprocessor computers. This will require integrating supercomputer file systems using the High Performance Storage System. The program will also support the training of DOE users in software development using new tools for efficient use of the new HPC architectures and in procedures for effectively using mass storage and other National Energy Research Scientific Computing center (NERSC) technologies.

In DARPA, the Scalable Systems and Software component has been reorganized into three subcomponents: Scalable Computing, which addresses very high performance systems; UltraScale Computing, which examines new breakthrough models and mechanisms; and Quorum, which focuses on high-performance, distributed computing. In FY 1998, DARPA plans to demonstrate highly efficient parallel nodes, auto-parallelization performance of file I/O from the Scalable I/O Consortium, the first node-level performance of ultra-low-power systems, performance of new backplane networks supporting security, and hardware-accelerated distributed shared-memory performance on workstation clusters. DARPA will support the design and modeling of a quantum-to-silicon hardware and software interface, including development of a language for expressing amorphous algorithmic computations. DARPA projects will develop tools and mechanisms to build bioelectronic systems, develop formal complex system design semantics for common intermediate format and extend arithmetic verification of complex system design to floating point. DARPA plans to complete architecture designs using configurable component technology for low-power, hybrid, reduced overhead prototypes and develop a high-level language to demonstrate an adaptive template-matching software prototype showing auto runtime remapping. DARPA's system environment effort will demonstrate an order of magnitude reduction in design time with experimental scalable applications, experimental scalable application versions of new iterative solvers for radar cross-section modeling, and languages and runtime services supporting parallel applications such as Advanced Distributed Simulation, and HPC++ languages and runtime services supporting both task and data parallelism.

NASA will support long-term HECC projects in high performance computing systems research and high performance systems software and technologies, in coordination with DARPA, NSF, and DOE. NASA's Earth and Space Sciences (ESS) scalable testbed will achieve 50 gigaFLOPS sustained on ESS investigator codes. In support of this effort, NASA will develop pre-competitive prototype systems software that provides high availability and portability demonstrated in a large-scale production environment with the objective of eventual commercial availability. NASA's Computational AeroSciences (CAS) 100-250 gigaFLOPS sustained scalable testbed will achieve 100 gigaFLOPS sustained on CAS investigator codes.

NIH organizations NLM, NCRR, DCRT, NCI, and National Institute of General Medical Sciences (NIGMS) will refine new methods developed for *ab initio* structure prediction for use in the pharmaceutical industry. NIH/NCRR will further improve computational technologies for larger simulations of protein, DNA, and membrane complexes in water environments. The Institutes will enhance methods to access and use parallel computing systems for biochemistry, molecular biology, and cellular biology applications. These approaches will emphasize use of Web browsers to access supercomputers, large databases, and other resources. Such access enables complex receptor site simulations for drug design. NIH organizations will integrate 3-D graphics software with other software tools, such as tools for magnetic resonance spectroscopy data analysis and molecular structure determination, to provide new structure-based drug design capabilities. NCRR will further improve methods for predicting protein-drug binding energies, and support new investigator-initiated research to further develop high performance computing methods and technologies for biomedical applications. NCI provides state of the art capabilities in a fully integrated high performance computing center, will evaluate new scalable parallel architectures for biomedical applications, and will continue to apply high performance parallel computing and communication methods to biomedical applications.

NSA will flight test MARQUISE (the embedded High Performance Computer) on Air Force and Navy aircraft. The agency will continue research on a miniaturized spray cooled embedded diamond power supply and on embedded scalable nodes (follow-on architecture to MARQUISE) for mission scenarios. NSA will continue joint NSA/University of Maryland research on microelectronics applied to high speed computing, including very high speed (many Gb/s) optoelectronic devices and systems using 1.5 micron WDM interconnect technology. The program supports research on new electronic (Si) structures for future very high speed, high density very large scale integration (VLSI) with feature sizes well below 0.1 micron and supports research in silicon surface science. Research also includes synthetic diamond packaging technology, all-optical switching, and optoelectronic integrated

circuit (IC) packaging technology. Expected FY 1998 accomplishments include point-of-use power conversion (for power reduction), area array I/O design studies for low power implementations of high performance multichip module (MCM), and studying and prototyping very high level programmable accelerator plug-ins for standard architectures. FY 1998 efforts will continue research in quantum computing in association with NIST, DOE laboratories, and other research agencies.

NIST will evolve mathematical software repositories into problem-solving environments, complete object-oriented libraries for basic linear algebra and related capabilities, and demonstrate capabilities on distributed systems.

NOAA plans to continue algorithm development on a scalable system to achieve 5 to 10 km resolution in mesoscale atmospheric models. The agency will explore the design of next-generation environmental observing systems using HECC to test data assimilation needs for optimizing future forecast systems and will develop software tools to facilitate converting software from traditional shared-memory machines to scalable systems. NOAA will continue and enhance scientific experiments running on high performance computing systems at NOAA/Geophysical Fluid Dynamics Laboratory (GFDL), and evaluate performance of the Eta model at various grid resolutions and assess its potential for operational forecast purposes.

EPA will award grants for research on object oriented numerical methods for environmental models and on parallel algorithms for linear and non-linear optimization processes to support pollution control strategy optimization and risk assessment.

### 4.2.3. HECC FY 1998 Expected Milestones

The following are some of the individual agency FY 1998 HECC milestones from Appendix A.

- Demonstrate 256-component addressed array of molecular computational mechanisms and a computational paradigm mechanism in an engineered living cell, and evaluate surface patterning mechanisms for culturing neural components on silicon.
- Demonstrate order of magnitude improvement in operating systems/network interface of translucent system and local area network (LAN)-based quality-of-service performance assurance for Quorum Prototype No. 1.
- Demonstrate scalability beyond 128 nodes of parallel design environment, scalable, parallel-processing, and symbolic simulation linked with hardware emulation for complex system design.
- Demonstrate order of magnitude reduction in design time with experimental scalable application versions of new iterative solvers for radar cross-section modeling, languages, and runtime services supporting parallel applications such as advanced distributed simulation, and HPC++ languages, and runtime services supporting both task and data parallelism.
- Demonstrate symbolic simulation linked with hardware emulation for complex design technology.
- Complete the experimental evaluation of design technology for high performance computational prototyping of systems, supporting both task and data parallelism for scalable software library technology.
- Demonstrate a computational model using UltraScale computing techniques.
- Demonstrate integrating testbed architecture incorporating advanced distributed simulation, advanced distributed collaboration, advanced communications and control, and advanced human computer interfaces.
- Demonstrate initial capabilities of intelligent information services architecture with multiple mechanisms for describing resource capabilities and with a uniform interface to hybrid search methods for resource retrieval.
- Demonstrate portable scalable programming and runtime environment for Grand Challenge applications on a teraFLOPS scalable system.
- Demonstrate interim progress towards FY 1999 goal to demonstrate 200-fold improvements over FY 1992 baseline in time to solution for Grand Challenge applications on teraFLOPS testbeds.
- Demonstrate the utility of new protein potential functions to provide the accuracy required for applications in the biotechnology industry, such as synthesizing models of protein receptors for structure-based drug design.
- Complete and distribute algorithms and associated software to (1) predict the folded structure of proteins, (2) select from the small molecule database inhibitors for therapeutically important enzymes and receptors, and (3) determine the structure of biological macromolecules containing up to 1,600 atoms by direct methods.

- Demonstrate the impact of advanced packaging techniques to greatly decrease the size and weight (by up to a factor of four) of a commercial high performance computer.
- Design, model, and assess quantum-to-Si hardware and software interface and a language for expressing amorphous algorithmic computations.
- Create a prototype for a powerful, mobile, front-end processor that supports high capacity I/O, high performance computing, high utilization of peak processor performance (50 to 80 percent), and is programmable in a high level language such as C or C++.
- Develop a multi-gigabit per second crossbar switch for supercomputer and data transfer applications. This work is to demonstrate a 128x128 crossbar switch with 2.5 Gb/s per port data rate and a latency less than 10 ns. The device technology is cryogenic superconductive digital circuits. The final system components will be selected and assembly begun during FY 1997 and continue through FY 1998 for an FY 1999 delivery of:
    - An operational 128 X 128 superconductive crossbar switch
    - A 100 Gb/s serial to parallel device with clock recovery
    - Two types of 16 Kb subnanosecond access-time memory chips—one room temperature and one superconductive.

## Table 2: Summary of HECC FY 1998 Presidential Budget

| Agency / Program Activity<br>High End Computing and Computation | FY 98<br>Pres. Req.<br>(BA $M) | FY 97<br>Est.<br>(BA $M) | FY 96<br>Est.<br>(BA $M) |
|---|---|---|---|
| **DARPA** TOTAL | **84.80** | **72.68** | **77.96** |
| Scalable Systems and Software | 35.20 | 26.90 | 32.63 |
| Microsystems | 15.90 | 14.29 | 16.25 |
| System Environments | 12.70 | 15.50 | 18.28 |
| Defense Technology Integration and Infrastructure | | | 8.20 |
| Embeddable Systems | 15.00 | 11.90 | |
| Information Sciences | 6.00 | 4.09 | 2.60 |
| **NSF** TOTAL | **132.90** | **129.17** | **140.32** |
| Supercomputer Centers | 53.17 | 57.73 | 69.36 |
| Computing Systems | 51.02 | 45.95 | |
| Applications | 28.71 | 25.49 | |
| Research Centers | | | 6.30 |
| Research Infrastructure | | | 8.64 |
| Grand Challenge Applications Groups | | | 7.32 |
| Computing Systems and Components | | | 17.20 |
| Software Systems and Algorithms | | | 26.66 |
| Engineering (non-NC/GC) | | | 1.65 |
| Geosciences (non-NC/GC) | | | 3.19 |
| **DOE** TOTAL | **90.80** | **86.00** | **84.49** |
| Advanced Computational Testing and Simulation Research | 33.74 | 33.00 | 31.81 |
| Grand Challenge Applications | 9.00 | 8.00 | 10.00 |
| DOE2000 ACTS | 5.00 | 2.50 | |
| National Energy Research Scientific Computing Center | 26.50 | 26.50 | 30.30 |
| High Performance Computing Resource Providers | 16.56 | 16.00 | 12.39 |
| **NASA** TOTAL | **90.10** | **88.00** | **75.55** |
| Testbeds | 24.50 | 13.70 | 12.91 |
| Grand Challenge Support | 48.60 | 48.10 | 52.62 |
| Systems Software | 17.00 | 14.20 | 10.02 |
| Information Infrastructure Technology & Applications | | 12.00 | |
| **NIH** TOTAL | **23.74** | **23.40** | **22.40** |
| NCRR Biomolecular Computing | 6.30 | 6.30 | 5.80 |
| NCRR Software Tools for Receptor-Based Drug Design | 2.20 | 2.20 | 2.20 |
| NCRR Modeling/Simulation | 4.50 | 4.50 | 4.50 |

## Table 2: Summary of HECC FY 1998 Presidential Budget

| Agency / Program Activity<br>High End Computing and Computation | FY 98<br>Pres. Req.<br>(BA $M) | FY 97<br>Est.<br>(BA $M) | FY 96<br>Est.<br>(BA $M) |
|---|---|---|---|
| DCRT High Performance Biomedical Computing Program | 6.12 | 6.10 | 6.10 |
| NCI Frederick Biomedical Supercomputing Center | 3.91 | 3.60 | 3.60 |
| NCI High Speed Networking and Distributed Conferencing | 0.20 | 0.20 | 0.20 |
| NIGMS HPCC Extramural Activities | 0.51 | 0.50 | |
| **NSA** TOTAL | **26.42** | **30.43** | **29.48** |
| Supercomputing Research | 24.20 | 27.93 | 27.48 |
| Superconducting Research | 2.22 | 2.50 | 2.00 |
| **NIST** TOTAL | **3.99** | **3.99** | **3.59** |
| Information Technology Metrology, Testing, and Applications | 3.99 | 3.99 | |
| Development and Dissemination of Scientific Software for HPCS | | | 2.37 |
| Infrastructure for Information Technology | | | 1.22 |
| **VA** TOTAL | | **1.00** | **3.00** |
| VA Hybrid Open Systems Technology (VA HOST) | | 1.00 | 3.00 |
| **NOAA** TOTAL | **4.30** | **4.30** | **3.30** |
| Advanced Computation | 4.30 | 4.30 | 3.30 |
| **EPA** TOTAL | **5.38** | **5.58** | **8.70** |
| Environmental Modeling | 3.25 | 3.45 | 5.53 |
| Computational Techniques | 2.13 | 2.13 | 3.17 |
| HECC FY 1998 Total | **462.43** | **444.55** | **448.79** |

## 4.3. Large Scale Networking (LSN)

### 4.3.1. LSN Definition

LSN R&D will assure U.S. technological leadership in communications through R&D that advances the leading edge of networking technologies, services, and performance. This includes advanced network components and technologies for engineering and management of large scale networks for scientific and engineering R&D and for other purposes. Areas of particular focus include:

- Technologies and services that enable wireless, optical, mobile, and wireline communications
- Networking software that enables information to be disseminated to individuals, multicast to select groups, or broadcast to an entire network
- Software for efficient development and execution of scalable distributed applications
- Software components for distributed applications, such as electronic commerce, digital libraries, and health care
- Infrastructure support and testbeds

This advanced networking R&D agenda will lead to new and more capable solutions to support Federal agency missions and will provide the foundation as well as the economic benefits for the continued evolution of the National Information Infrastructure.

The research and education communities need access to high performance data networks in order to carry out projects and educate the citizenry. To support these needs and provide leading edge network infrastructure for computational research activities, advanced Federal networks connect researchers and educators to computational and information resources and to scientific facilities. In addition, these networks support advanced networking research activities such as gigabit testbeds, optical fiber networks, adaptive networks, and packetized video and voice.

The Next Generation Internet (NGI) initiative will be the dominant focus of LSN R&D beginning in FY 1998. This initiative is possible only because of the very strong agency programs that are currently underway. Some effects are already evident as agencies shift their focus to better accomplish the goals laid out for the initiative.

The NGI initiative, together with R&D programs from academia and industry and investments by Federal agency information technology and R&D programs, will create a foundation for these more powerful and versatile networks of the 21st Century. It will foster partnerships among academia, industry, and Government that will keep the U.S. at the cutting edge of information and communications technologies. It will accelerate the introduction of new networking services for our homes, schools, and businesses.

As a first goal, the initiative will develop and test new network services and technologies. These will include advances such as transaction security, ease-of-use, quality of service, and tools for network monitoring, management, and accounting. Many of these new network services and technologies already exist as individual components, but substantial system integration and testing at sufficient scale will be required for them to provide seamless support for advanced applications.

As a second goal, the initiative will develop prototype high performance network testbeds to provide system-scale testing of advanced network technologies and services and to support testing of advanced applications that enable new paradigms. These testbeds will emphasize end-to-end performance to the user. Therefore, significant upgrades of local infrastructure within participating sites will be needed as well as high-performance links among sites; the NGI initiative supports individual universities and works with the university-based Internet 2 project to upgrade the academic networking infrastructure. Advanced technologies and services will be key to the success of these testbeds and their overall utility in delivering applications.

The most important part of a network is what people do with it—their applications, which require adequate network infrastructure and services. The NGI initiative will conduct research that spans all three areas: (1) services, (2) infrastructure, and (3) applications. The NGI initiative will enable advanced education, environmental, health, and

science applications. These applications will be selected from the missions of the participating agencies and other Government organizations and will be carried out in partnerships with the initiative and other programs. The role of applications in the initiative will be to demonstrate the value of advanced networking and to test advanced networking technologies and services.

### 4.3.2. LSN Status

Proposed FY 1998 funds to support LSN activities total approximately $288 million. This includes approximately $85 million for the Next Generation Internet in the budgets of DoD/DARPA, NSF, NASA, NIST, and NIH/NLM. This is an increase of 13.8 percent over the FY 1997 estimated budget of $253 million.

To achieve the goals of the NGI initiative, Federal agencies will construct high performance collaborative testbeds in partnership with the telecommunications industry, Internet service providers, and major Federal research organizations. Such networks will be built on the foundation of existing Federal networks including NSF's very high performance backbone network services (vBNS) DOE's ESnet, the DARPA-led Advance Technology Demonstration network (ATDnet), and NASA's Research and Education Network (NREN). Building on these networks, universities, Federal research organizations, and industry will conduct research and develop the advanced services, protocols, and functionality necessary to support next generation applications. These activities will create an open technology transfer environment, continuing a strategy that determined much of the success of the original Internet.

The initiative is planned to last five years. The Administration has made an initial three-year $300 million funding commitment of $100 million per year, and will seek bipartisan Congressional support in its budget submissions. Built on the base of current Federally-funded R&D, the initiative will also call on substantial matching funds from private sector partners, as well as seek commitments from major applications developers.

*The U. S. Congress appropriated no funds for DOE participation in the NGI initiatives for FY 1998.*

DARPA plans to complete and release a specification language for network engineering elements and management systems. In high performance networking, they will demonstrate enhanced Asynchronous Transfer Mode (ATM)-switching and demonstrate scalability in a defense application. In active networks, DARPA plans to implement a prototype of Enhanced Networking Services using composable modules. DARPA will continue analysis and report on economics of multi-wavelength network architecture and technology for local area optical networks.

NSF will increase support for experimental activities demonstrating high performance networking applications and support experimental projects that integrate research and education through the use of high speed networking. NSF will continue to support a broad academic research program in networking, communications, and the convergence of computing and communications. NSF will support Knowledge Networking, an initiative focused on the next generation of interconnected networks and associated database and collaborative technologies. NSF and DOE, for example, are working together to ensure that their high performance networks, vBNS and Esnet respectively, can work together seamlessly.

DOE will expand its native ATM-connected sites to enable effective remote experimentation and simulation applications. DOE will further develop high speed advanced interagency and internetwork peering and interconnection points, continue the development and deployment of network traffic analysis and measurement tools, and pursue evolving protocols and tools that address congestion caused by Web traffic (e.g., reliable multicast). DOE will adopt applications, via libraries and Application Programming Interfaces (APIs), to use Quality of Service (QoS) and to better use network management capabilities. DOE will enhance Internet Protocol (IP) and ATM network management capabilities, and provide multimodal support of production and network research traffic on the same infrastructure.

NASA will establish NGI exchange facilities designed to connect university-based Grand Challenge principal investigators to NASA high performance resources.

NSA will continue its very high speed networking R&D by applying the latest technologies to inter-agency testbeds that can be migrated to deployment. Enabling technologies such as materials and photonics research are being studied for new capabilities to speed processing power and enhance sensitivity. In FY 1998, NSA expects to have in place all the parts necessary for a truly Gb/s Internet, capable of supporting multiple individual data streams, each at 2.4 Gb/s, over ATM and IP. Installation of all-optical networks will begin. The Washington, DC, area ATDnet will act as a public network capable of interconnection with an all-optical (crossbar) network, acting as a DoD private network, as well as use individual wavelengths for support of "legacy" ATM networks.

NIH will fund approximately 50 grants to connect U.S. health care institutions to the Internet. Expansion of the Internet and the availability of higher-bandwidth connections will lead to significantly greater user load for text retrieval, sequence analysis, and 3-D structure comparisons. To accommodate computing demands, NIH will architect clusters of low-cost compute servers for parallelizing repetitive database searches. Additional demand will result from expansion of scientific literature database (PubMed project) with increased linkage between the literature and experimental databases. NLM will continue to develop and deploy new capabilities for automatic source selection and for retrieving and sorting information from multiple databases both within Internet Grateful Med and the Unified Medical Language Systems (UMLS) Information Sources Map and by replacing its retrieval engine. R&D for computer-based patient records and public health applications of the NII will receive special emphasis. DCRT will continue to develop ATM network, multimedia workstation, and parallel computing technologies for medical imaging and scientific visualization.

NIST will integrate a network performance evaluation chip with the Pardyn system (joint with the University of Maryland) and install it on NIST's ATM heterogeneous distributed testbed. NIST will provide remote Internet access to both the IPv6 interoperability testbed and the Integrated Services Packet Switched Network testbed. NIST plans to develop tests and test tools that promote interoperability. NIST will develop interface protocols enabling integration of Web-based scientific and engineering reference data with manufacturing applications and processes.

NOAA will exploit Web software technologies for advanced dissemination and visualization of NOAA environmental information. NOAA will implement an integrated view of environmental data across NOAA Web servers. NOAA will explore the use of advanced communications technologies such as ATM for environmental data dissemination. NOAA will explore strategies to make use of the Internet more robust, and test and evaluate collaborative desktop technologies.

The Department of Veteran's Affair's (VA) plans to expand testing of its nationwide authentication, authorization and encryption services to allow secure transmission of medical data across unsecured telecommunication links such as the Internet, public networks, and phone systems. VA will expand its Intranet initiative. VA will evaluate the needs for increased bandwidth for three gateways between VA wide area network (WAN) and the Internet.

### 4.3.3. LSN 1998 Expected Milestones

The following are some of the individual agency LSN milestones from Appendix A.

- Complete composite protocol prototype implementation of execution environment and of a fast compiler for SmartPacket Methods.
- Initiate operation of wide area Active Network on composite prototype platforms.
- Demonstrate the prototype System of Systems: Phase 1.
- Develop prototype information transformer application and evaluate the mediated link information transformer on a LAN/WAN.
- Demonstrate the semantic component of a mediated link information transformer on a LAN/WAN/Mobile.
- Demonstrate application support services for adapting mobile application support to changing infrastructure resources; and robust mobile networking based on packet radio algorithms.
- Demonstrate multi-wavelength network management and control in local area testbeds.
- Demonstrate 40 billion bits per second cross-connect switching and 32 channel transceiver chip.

- Demonstrate integration of digital library technologies with remote sensing demonstrations.
- Demonstrate completed Remote Sensing Database Applications over the Internet.
- Demonstrate 100 times increased capability to access NASA high performance resources by its Grand Challenge community.
- Connect two to four DOE labs at 155 Mbps via the ESnet.
- Connect at least two DOE sites to the Gigabit/Terabit DARPA-led testbeds.
- Develop high-speed gigabit end-system interfaces and test equipment.
- Deploy class of service support.
- Demonstrate bandwidth-adaptive multimedia node for mobile computing.
- Demonstrate transparent application relocation within a mobile environment.
- Initiate the development of secure resource contention admission control mechanisms.

## Table 3: Summary of LSN FY 1998 Presidential Budget

| Agency / Program Activity<br>Large Scale Networking | FY 98<br>Pres. Req.<br>(BA $M) | FY 97<br>Est.<br>(BA $M) | FY 96<br>Est.<br>(BA $M) |
|---|---|---|---|
| **DARPA** TOTAL | **89.23** | **106.36** | **96.04** |
| Networking Systems | 32.00 | 24.30 | 28.72 |
| Defense Technology Integration and Infrastructure | 10.70 | 35.10 | 24.19 |
| Global Mobile Infosystems | 16.90 | 15.60 | 16.30 |
| Global Grid Communications | 29.63 | 31.36 | 26.83 |
| **NSF** TOTAL | **79.20** | **72.26** | **104.47** |
| NSFNET | 44.50 | 41.64 | 44.04 |
| Networking, Communications and the Convergence of Computing & Comm. | 26.05 | 19.92 | |
| Applications | 8.65 | 8.20 | |
| Education and Training | | 2.50 | 2.50 |
| Research Centers | | | 0.68 |
| Research Infrastructure | | | 2.48 |
| Ubiquitous Computing and Communication | | | 14.44 |
| Human-Machine Interaction & Information Access | | | 5.29 |
| Biological Sciences (non-NC/GC) | | | 12.42 |
| Engineering (non-NC/GC) | | | 1.38 |
| Geosciences (non-NC/GC) | | | 1.47 |
| Computational Mathematics (non-NC/GC) | | | 2.67 |
| Physical Sciences (non-NC/GC) | | | 6.41 |
| Social, Behavioral & Economic Sciences (non-NC/GC) | | | 2.14 |
| National Challenges | | | 8.55 |
| **DOE** TOTAL | **48.79** | **14.79** | **12.64** |
| ESnet | 13.79 | 14.79 | 12.64 |
| Next Generation Internet | 35.00 | | |
| **NASA** TOTAL | **25.00** | **14.60** | **27.45** |
| Grand Challenge Support | | | 6.60 |
| NREN | 25.00 | 14.60 | 20.85 |
| **NIH** TOTAL | **28.19** | **26.52** | **22.39** |
| NLM Medical Connections Program | 1.47 | 1.47 | 0.82 |
| NLM Biotechnology Informatics | 7.31 | 6.71 | 4.69 |
| NLM IAIMS grants | 2.00 | 2.00 | 2.00 |
| NLM Intelligent Agent DB searching | 9.97 | 8.85 | 7.39 |
| NLM HPCC Health Care Applications | 2.35 | 2.48 | 2.48 |

## Table 3: Summary of LSN FY 1998 Presidential Budget

| Agency / Program Activity<br>Large Scale Networking | FY 98<br>Pres. Req.<br>(BA $M) | FY 97<br>Est.<br>(BA $M) | FY 96<br>Est.<br>(BA $M) |
|---|---|---|---|
| NCRR Biomolecular Computing | 0.20 | 0.20 | 0.20 |
| NCRR Modeling/Simulation | 0.10 | 0.10 | 0.10 |
| DCRT High Performance Biomedical Computing Program | 2.30 | 2.30 | 2.30 |
| NCI Frederick Biomedical Supercomputing Center | 1.39 | 1.39 | 1.39 |
| NCI High Speed Networking and Distributed Conferencing | 0.72 | 0.72 | 0.72 |
| NCI High Perf. Comms for PDQ, CancerNet, and Electronic Publishing | 0.38 | 0.30 | 0.30 |
| **NSA** TOTAL | **2.18** | **3.50** | **3.00** |
| Very High Speed Networking | 2.18 | 3.50 | 3.00 |
| **NIST** TOTAL | **5.46** | **2.46** | **1.70** |
| Information Technology Metrology, Testing, and Applications | 3.46 | 2.46 | |
| Systems Integration for Manufacturing Applications | 2.00 | | |
| Development and Dissemination of Scientific Software for HPCS | | | 0.50 |
| Infrastructure for Information Technology | | | 1.20 |
| **VA** TOTAL | **7.45** | **9.45** | **14.13** |
| Computerized Patient Record and Telemedicine | 2.50 | 1.20 | 0.80 |
| Clinical Workstations and Medical Imaging | 0.75 | 2.00 | 4.00 |
| Improve Telecommunications Infrastructure and Internet Connectivity | 1.70 | 0.50 | 0.18 |
| VA Hybrid Open Systems Technology (VA HOST) | 1.50 | 4.75 | 8.50 |
| VA/DoD Sharing | 1.00 | 1.00 | 0.65 |
| **NOAA** TOTAL | **2.70** | **2.70** | **2.70** |
| Networking Connectivity | 2.70 | 2.70 | 2.70 |
| LSN FY 1998 Total | **288.19** | **252.64** | **284.52** |

## 4.4. High Confidence Systems (HCS)

### 4.4.1. HCS Definition

HCS R&D focuses on the technologies necessary to achieve high levels of availability, protection, reliability, restorability, and security of information services. Systems using these technologies will be resistant to component failure and malicious manipulation and will respond to damage or perceived threat by immediate adaptation or reconfiguration. High confidence technologies can be applied to any element of a system, including the computing system, the network, and the information in the network, and may involve content, procedures, or protocols used to create, store, transmit, route, reconfigure, receive, aggregate, or display data.

HCS applications include law enforcement, life-and safety-critical systems, national security, personal privacy, and the protection of critical elements of the National Information Infrastructure. Systems for automated surgical assistants, banking, medical implants, power generation and distribution, telecommunications, and transportation are some of the critical systems that also require reliable computing and telecommunications technologies.

HCS R&D facilitates interagency collaborations in Federal high confidence systems programs, addresses gaps in systems technologies by fostering Federal research efforts, and provides mechanisms for Federal cooperation with academia and industry.

### 4.4.2. HCS Status

Proposed FY 1998 funds to support HCS activities total approximately $33 million. This is an increase of 10 percent over the FY 1997 estimated budget of $30 million.

DARPA will develop quality-of-service negotiation protocols, Quorum, for performance architecture attributes and adaptive resource discovery protocols. The agency will also demonstrate an order of magnitude improvement in operating systems/network interface of translucent systems and LAN-based quality-of-service performance assurance.

NSA will demonstrate solutions to high assurance configurable security architectures. NSA will continue constructing prototypes to enable the efficient replacement of security policies and security mechanisms with minimal impact on system service or assurance. Research solutions will be integrated into future commercial technology via collaboration with various research labs. This effort will include: integration of security research results into advanced operating system technologies; creation of system framework for flexible authentication services; and securing computing related to distributed and mobile computing. NSA will continue development of functional devices including core cryptographic processors, numeric processors, high speed memories, and test and characterization devices. It will also explore related silicon technologies that employ high speed, low power characteristics.

NIST will enhance laboratory facilities for automated testing and integrated software engineering, and broaden industry and standards bodies involvement in support of the development, specification, validation, and testing of standards and interoperation of conforming products.

NIH/NLM will continue funding projects promoting the application of HPCC technologies to health care, the evaluation of telemedicine, the testing of methods for protecting the privacy of electronic health data, and continuing progress toward integrating academic information management by U.S. medical centers. R&D for computer-based patient records and public health applications of the NII will receive special emphasis.

VA will expand testing of its nationwide authentication, authorization, and encryption services to allow secure transmission of medical data across unsecured telecommunication links such as public networks, phone systems, and the Internet. VA plans to enhance and test its computerized patient record (CPR) system, enhance and test the integration of its telemedicine systems with the CPR, and expand development of its clinical repository and controlled vocabulary.

NSF will continue to support a broad academic research program in computing systems; support knowledge networking, an initiative focused on the next generation of interconnected networks and associated database and collaborative technologies; and support interdisciplinary research in computer and information science and engineering focused on problems requiring scientific advances across multiple subdivisions of computational science and engineering.

### 4.4.3. HCS 1998 Expected Milestones

The following are some of the individual agency HCS milestones from Appendix A.

- Demonstrate the first node-level performance of ultra-low-power systems.
- Complete composite protocol prototype implementation of an execution environment and a fast compiler for SmartPacket Methods.
- Demonstrate the performance of new backplane networks supporting security.
- Develop architectures for high-speed key management processors or servers.
- Complete and release a specification language for network engineering elements and management system.

## Table 4: Summary of HCS FY 1998 Presidential Budget

| Agency / Program Activity<br>High Confidence Systems | FY 98<br>Pres. Req.<br>(BA $M) | FY 97<br>Est.<br>(BA $M) | FY 96<br>Est.<br>(BA $M) |
|---|---|---|---|
| **DARPA** TOTAL | **9.40** | **10.00** | **10.00** |
| Scalable Systems and Software | 5.00 | 5.00 | 5.00 |
| Networking Systems | 4.40 | 5.00 | 5.00 |
| **NSF** TOTAL | **0.90** | **1.21** | |
| Computing Systems | 0.90 | 1.21 | |
| **NASA** TOTAL | **2.80** | **1.60** | |
| Grand Challenge Support | 2.80 | 1.60 | |
| **NIH** TOTAL | **4.13** | **4.17** | **3.80** |
| NLM Biotechnology Informatics | 1.14 | 1.05 | 0.68 |
| NLM IAIMS grants | 0.50 | 0.50 | 0.50 |
| NLM HPCC Health Care Applications | 2.35 | 2.48 | 2.48 |
| NCI Frederick Biomedical Supercomputing Center | 0.14 | 0.14 | 0.14 |
| **NSA** TOTAL | **7.20** | **7.30** | **7.40** |
| Secure Operating System Development | 4.50 | 4.50 | 4.70 |
| High Speed Data Protection Electronics | 2.70 | 2.80 | 2.70 |
| **NIST** TOTAL | **3.40** | **3.40** | **4.20** |
| Information Technology Metrology, Testing, and Applications | 3.40 | 3.40 | |
| Infrastructure for Information Technology | | | 4.20 |
| **VA** TOTAL | **5.35** | **2.30** | **2.90** |
| Computerized Patient Record and Telemedicine | 1.50 | 0.20 | 0.20 |
| Clinical Workstations and Medical Imaging | 0.85 | 0.60 | 1.20 |
| Improve Telecommunications Infrastructure and Internet Connectivity | 0.75 | 0.25 | |
| VA Hybrid Open Systems Technology (VA HOST) | 1.75 | 1.00 | 1.50 |
| VA/DoD Sharing | 0.50 | 0.25 | |
| HCS FY 1998 Total | **33.18** | **29.98** | **28.30** |

## 4.5. Human Centered Systems (HuCS)

### 4.5.1. HuCS Definition

HuCS R&D leads to increased accessibility and usability of computing systems and communications networks. Scientists, engineers, educators, students, the workforce, and the general public are potential beneficiaries of HuCS technologies. Examples of these technologies are:

- "Knowledge repositories" and "information agents" for managing, analyzing, and presenting massive amounts of multimedia and multi-source information
- "Collaboratories" that provide access to knowledge repositories and that facilitate knowledge sharing, group authorship, and control of remote instruments
- Systems that enable multi-modal human-system interactions including speech, touch, and gesture recognition and synthesis
- Virtual reality environments and their application to fields including scientific research, health care, manufacturing, and training.

"Knowledge repositories" are huge electronic databases that are being created for access by all users. The content is multimedia (text, voice, images, and video), and the data reside on distributed heterogeneous computing systems that use different data management software. There is a critical need for tools to manage these repositories, as well as for "information agents" to analyze the data and effectively present the results.

Collaboratories, which permit geographically distant people to work together and to use remote resources as if there were no geographical separation, build upon knowledge repositories and information agents. Collaboratories also require new technologies for creating multimedia information, such as the middleware for advanced collaboration across very large distributed systems, and for controlling remote instruments that will enable researchers to access scarce and expensive research resources from their desktops.

HuCS R&D includes those elements of information technologies that address the usability of information and services and the augmentation of human performance. Such systems facilitate human collaboration and interaction with knowledge resources and in virtual environments via multiple modalities of human communication. They also augment, with intelligent assistance, human abilities individually or in groups to process information, or to interact with objects of very large or very small scale, or at remote sites.

HuCS R&D activities will focus on collaboration among Federal departments and agencies, which will continue to develop their human-centered systems programs principally to address their unique mission needs while collaborating in areas of common interest. HuCS will identify gaps in research and technology development and ensure that these are addressed by individual agencies or through collaborations. HuCS activities will include collaboration with U.S. industry and a coordination role for Federally-approved international collaboration in human-centered systems technology beyond that reserved to individual departments, agencies, or other governmental entities.

### 4.5.2. HuCS Status

Proposed FY 1998 funds to support HuCS activities total approximately $281 million. This is an increase of 17.1 percent over the FY 1997 estimated budget of $240 million.

DARPA will develop formal complex system design semantics for a common intermediate format and extend arithmetic verification of complex system design to floating point. DARPA will develop algorithms to effectively search collections of documents for words used only in restricted senses and will design query and preferences languages incorporating similarity and value filtering. DARPA will integrate several manufacturing automation and design engineering (MADE) design computation tools to demonstrate robust multidisciplinary design. DARPA will develop initial prototypes for multi-language text extraction and audio transcription where performance is baselined against that of human operators. The agency plans to develop modular human language technologies to support easy, low-cost, rapid technology transfer and application development for document understanding, machine

translation, and speech understanding. The agency will develop tools and techniques to enable the rapid construction of information fusion, aggregation, and summarization software to filter, access, and integrate information from hundreds of disparate, heterogeneous, distributed data sources.

NSF, NASA, and DARPA will initiate Phase 2 of the Digital Library Initiative (DLI) in FY 1998. Its broad goal is to advance the methods used to collect, store, organize, and use widely distributed knowledge resources that contain diverse types of information and contents stored in a variety of electronic forms. Six university-led DLI projects are pursuing this goal in partnership with libraries, museums, publishers, schools, and computing and communication companies.

NSF will continue support of a broad academic research program in human centered systems. The Foundation will support Knowledge Networking, an initiative focused on the next generation of interconnected networks and associated database and collaborative technologies. NSF will support a program of interdisciplinary research in computer and information science and engineering focused on problems requiring scientific advances across multiple subdivisions of computational science and engineering. NSF will continue to develop high capability applications for the individual which are focused on societal needs and are enabled by universal, easy to use and access paradigms.

DOE will specify and begin building a scalable standards-based software infrastructure to support collaborative environments. DOE will integrate existing collaborative tools into its Virtual Laboratory Framework and will implement advanced technologies for information security to support flexible administration of resources. DOE plans on production deployment of remote access software to a number of experimental groups and plans to address issues of navigation and context in a virtual laboratory. DOE will begin preparing one additional experimental facility for remote access.

NASA, working collaboratively with other Federal agencies whose primary focus is HuCS, will continue investments using expertise from its Information Technology Center of Excellence. These investments will be through some of NASA's more traditional efforts such as computational aerosciences.

NIH will continue its telemedicine and Visible Human programs and will develop and test a graphical user interface for an existing medical imaging system. NIH/NLM will begin projects for the full object identification of the Visible Human data sets. NLM will continue projects in applying CIC technologies to health care, the evaluation of telemedicine, and the testing of methods for protecting the privacy of electronic health data. There will also be a special emphasis on R&D for computer-based patient records and public health applications of the NII. NIH/NCRR will continue to develop and use virtual environments for scientific instruments. Such environments will enable users to use chemical probes on the tips of atomic force microscopes to investigate and modify biological processes. NCRR also plans to extend cognitive neuroscience research capabilities to simulate human memory circuits leading to a model of human working memory with the potential to affect all aspects of learning. NIH/NCI will improve systems of visual and voice interactions between biomedical computing researchers and projects.

NIST will develop methods for evaluating image quality effects of optical character recognition (OCR) and test sample models. NIST will demonstrate an intelligent systems architecture for manufacturing system and machine control in Advance Manufacturing and Networking Testbed (AMSANT) facilities. NIST will demonstrate remote operator interfaces for machine and production system monitoring and control, and distributed design, planning, and production application integration using object-based interfaces in AMSANT and remote partner facilities. The program will demonstrate integration of planning and simulation applications using process data models and will demonstrate collaboratory environment use by Government and industry partners in development and validation of manufacturing integration specifications.

VA will enhance and test its computerized patient records (CPR) system and enhance and test the integration of its CPR and telemedicine systems. VA will continue developing and testing a graphical user interface to CPRs and will support standardization of nomenclature for health care records.

The Department of Education's (ED) National Institute on Disability and Rehabilitation will continue funding of 15 continuing Rehabilitation Engineering Research Centers (RERCs) and one new center.

NOAA will investigate emerging programming paradigms for presenting NOAA data and information through more useful, understandable methods, merging these with advanced visualization techniques to expand the universe of information available to the public.

EPA will award grants for research on data access techniques in a distributed heterogeneous environment.

The Agency for Health Care Policy and Research (AHCPR) will accelerate the development of information standards essential for integrating clinical information systems with knowledge based servers. AHCPR will test the use of such standards in pilot projects across medical settings to determine their contribution to both the medical effectiveness and cost effectiveness of clinical decision support systems. AHCPR will test the confidentiality and privacy protection of computer-based patient record security measures.

### 4.5.3. HuCS 1998 Expected Milestones

The following are some of the individual agency HuCS milestones from Appendix A.

- Demonstrate translingual search aids for military type documents in English, Korean, and a European language; electronic document management with access controls; statistical co-occurrence techniques for texture classification of images; and semi-automatic generation of metadata.
- Demonstrate order of magnitude improvement in operating systems/network interface of translucent system and LAN-based quality-of-service performance assurance for Quorum Prototype No.1.
- Demonstrate initial capabilities of intelligent information services architecture with multiple mechanisms for describing resource capabilities and with a uniform interface to hybrid search methods for resource retrieval.
- Demonstrate symbolic simulation linked with hardware emulation for complex design technology.
- Demonstrate a reduction by a factor of five in early design trade-off time by combining qualitative and quantitative models.
- Complete the experimental evaluation of design technology for high performance computational prototyping of systems, supporting both task and data parallelism for scalable software library technology.
- Demonstrate the results of mature digital library technology projects.
- Demonstrate the languages and runtime services in defense applications, and complete the scalable software library technology demonstration.
- Demonstrate feasibility of utilizing an advanced software environment that supports composition tools for composing software, integration, and software development and testing using animation techniques in military environment.
- Complete standardized readings of National Health and Nutrition Examination Survey (NHANES) II and III images and begin general access to integrated database consisting of NHANES II and III text and images as a beta test.
- Demonstrate collaboratory environment use by Government and industry partners in development and validation of manufacturing integration specifications.

## Table 5: Summary of HuCS FY 1998 Presidential Budget

| Agency / Program Activity<br>Human Centered Systems | FY 98<br>Pres. Req.<br>(BA $M) | FY 97<br>Est.<br>(BA $M) | FY 96<br>Est.<br>(BA $M) |
|---|---|---|---|
| **DARPA** TOTAL | **137.87** | **103.65** | **112.17** |
| Microsystems | 17.90 | 14.23 | 17.05 |
| System Environments | 2.00 | 2.18 | 3.68 |
| Defense Technology Integration and Infrastructure | 26.20 | | 9.01 |
| Information Sciences | 13.01 | 22.33 | 20.50 |
| Intelligent Systems and Software | 78.76 | 64.91 | 61.93 |
| **NSF** TOTAL | **60.17** | **57.76** | **15.28** |
| Human Centered Systems | 50.07 | 48.10 | |
| Applications | 10.10 | 9.66 | |
| Research Infrastructure | | | 4.78 |
| Human-Machine Interaction & Information Access | | | 6.80 |
| Engineering (non-NC/GC) | | | 1.70 |
| Computational Mathematics (non-NC/GC) | | | 2.00 |
| **DOE** TOTAL | **9.94** | **14.89** | **8.56** |
| National Collaboratory Research | 3.94 | 8.89 | 8.38 |
| DOE2000 NC | 6.00 | 6.00 | 0.18 |
| **NASA** TOTAL | **2.20** | **4.50** | |
| Systems Software | 1.90 | 4.20 | |
| BRHR | 0.30 | | |
| Information Infrastructure Technology & Applications | | 0.30 | |
| **NIH** TOTAL | **29.28** | **27.25** | **24.05** |
| NLM Biotechnology Informatics | 0.69 | 0.63 | 0.45 |
| NLM Electronic Imaging | 2.25 | 2.25 | 1.93 |
| NLM IAIMS grants | 0.90 | 0.90 | 0.90 |
| NLM Intelligent Agent DB searching | 3.33 | 2.95 | 2.10 |
| NLM HPCC Health Care Applications | 9.41 | 9.90 | 11.25 |
| NCRR Biomolecular Computing | 0.80 | 0.80 | 0.60 |
| NCRR Modeling/Simulation | 0.70 | 0.70 | 1.20 |
| NCRR Virtual Reality/Environments | 9.70 | 7.70 | 4.20 |
| DCRT High Performance Biomedical Computing Program | 0.50 | 0.50 | 0.50 |
| NCI Frederick Biomedical Supercomputing Center | 0.28 | 0.28 | 0.28 |
| NCI High Speed Networking and Distributed Conferencing | 0.34 | 0.34 | 0.34 |
| NCI High Perf. Comms for PDQ, CancerNet, and Electronic Publishing | 0.38 | 0.30 | 0.30 |

## Table 5: Summary of HuCS FY 1998 Presidential Budget

| Agency / Program Activity<br>Human Centered Systems | FY 98<br>Pres. Req.<br>(BA $M) | FY 97<br>Est.<br>(BA $M) | FY 96<br>Est.<br>(BA $M) |
|---|---|---|---|
| **NIST** TOTAL | **13.66** | **13.66** | **14.02** |
| Information Technology Metrology, Testing, and Applications | 3.00 | 3.00 | |
| Systems Integration for Manufacturing Applications | 10.66 | 10.66 | 10.66 |
| Development and Dissemination of Scientific Software for HPCS | | | 0.50 |
| Infrastructure for Information Technology | | | 2.86 |
| **VA** TOTAL | **9.20** | **1.80** | **1.90** |
| Computerized Patient Record and Telemedicine | 3.00 | 0.40 | 0.40 |
| Clinical Workstations and Medical Imaging | 0.65 | 0.40 | |
| Improve Telecommunications Infrastructure and Internet Connectivity | 1.30 | | |
| VA Hybrid Open Systems Technology (VA HOST) | 3.25 | 1.00 | 1.50 |
| VA/DoD Sharing | 1.00 | | |
| **ED** TOTAL | **12.00** | **11.40** | **11.40** |
| Regional Education Laboratory Program | 2.00 | | |
| National Institute on Disability and Rehabilitation Research | | 11.40 | 11.40 |
| Regional Technology in Education Consortia | 10.00 | | |
| **NOAA** TOTAL | **0.50** | **0.50** | **0.50** |
| Information Dissemination Pilots | 0.50 | 0.50 | 0.50 |
| **EPA** TOTAL | **0.80** | **0.60** | **0.60** |
| Public Data Access | 0.80 | 0.60 | 0.60 |
| **AHCPR** TOTAL | **5.50** | **4.20** | **3.20** |
| Computer-Based Patient Records | 5.50 | 4.20 | 3.20 |
| HuCS FY 1998 Total | **281.12** | **240.21** | **191.68** |

## 4.6. Education, Training, and Human Resources (ETHR)

### 4.6.1. ETHR Definition

ETHR R&D supports research to advance education and training technologies. Research areas include curriculum development, fellowships, and scholarships for computational, computer, and information scientists, and engineers. ETHR includes the application of interdisciplinary research to learning technologies, as well as R&D in information-based learning tools, lifelong learning, and distance learning. Applications flowing from leading edge R&D in HECC and LSN will prove difficult to implement if today's students and professionals are not receiving continuous or updated training to augment existing skills for exploiting these developments. ETHR technologies improve the quality of science and engineering education and lead to a more knowledgeable and productive citizenry.

Information technologies will have a profound impact on all forms and levels of education in the 21st Century, ranging from the use of geographically dispersed learning centers using virtual environment technologies, to the extension of learning beyond abstract presentation to experiential learning through advanced simulation and visualization techniques.

Research in learning technologies has direct implications for achieving the national goal of a technologically literate citizenry. Such research is needed to enable use of the Nation's information infrastructure to provide the resources for efficient and effective education and training. Indeed, the training of the next generation of citizens skilled in the development and use of information technologies is critical to the national health.

One of the primary focal points of ETHR R&D involves engineering applications in the classroom. This includes new curriculum and course development in high performance computing and communication and information processing, and provides research opportunities in high performance computing and communications for undergraduates.

ETHR R&D is also concentrating efforts on creating collaborative tools for R&D in learning, creativity, and productivity. This area supports techniques to develop the technologies and tools that will enable scientists and engineers to easily collaborate across geographic boundaries and to interact cooperatively in common problem solving and experimental activities.

ETHR also supports high-level university training with grants for graduate and postdoctoral CIC R&D research. Programs in education and training are focused on increasing the pool of people with the knowledge, skills, and insights to lead research in the science and technology required to make high performance computing and information technologies easier to use, and to apply those developments in the pursuit of fundamental knowledge in all disciplines of science and engineering.

In addition to providing research opportunities for university students, scientists, and professionals, ETHR R&D provides training and information services for students, teachers, and faculty in computing, networking, and computational science in grades K-12.

### 4.6.2. ETHR Status

Proposed FY 1998 funds to support ETHR activities total approximately $39 million. This is a decrease of 4.9 percent over the FY 1997 estimated budget of $41 million.

NSF will support a broad spectrum of applications that stress high performance computing and communications and/or that demonstrate the potential impact of high performance computing and communications on particular science or engineering disciplines. NSF will continue support of activities that advance education and training in high performance computing and communications at all levels. NSF will promote a collaborative research and development agenda to advance understanding of learning, creativity, and productivity. The NSF Postdoctoral

Research Associates program, for example, supports postdoctoral training in computational science and engineering and experimental computer science. NSF plans to increase support of learning technologies to enable information technologies to help transform education in the 21st Century.

NASA will distribute mature K-12 curriculum products over the NII. NASA also focuses on the development of the next generation of computer and computational scientists. Additionally, NASA supports research institutes and centers of excellence engaged in computer science and computational science, and funds small university grants on CIC R&D topics at the individual principal investigator level.

NIH/NLM will continue individual and program grants for HPCC training for health professionals. NLM is expanding its successful pre-doctoral and post-doctoral grants program for career training in medical informatics, both for research and application, and in providing HPCC-in-medicine fellowship training support. NCRR will continue hands-on training programs and science education projects. NCRR provides training in high performance computing mainly through its research resource centers that focus on the use of this technology. This training, which is generally integrated with the research and development activities of the resource centers, can involve undergraduate and graduate students, postdoctoral fellows, and established scientists from within and outside of the host institution. NCRR will implement a National Research Service Act (NRSA) awards program, not limited to NCRR resource centers, to train biomedical scientists to use HPC technology efficiently and effectively.

In DOE's Advances in Supercomputing (AiS) program, the number of state sites will be reduced from five to the original three. DOE will encourage state and local school systems to adopt the successful educational technology programs developed under the AiS and Model Nets Programs. DOE will work with community colleges and vocational schools on education and training programs in computing and networking that prepare students for school and job opportunities and encourage colleges and universities to adopt curricula and instructional material developed in the Undergraduate Computational Engineering and Sciences Program. The Computational Science Graduate Fellowship Program supports over 50 doctoral students in computational science and engineering at select universities. Participating fellows spend at least one summer working at a DOE laboratory in the area of their dissertation.

### 4.6.3 ETHR 1998 Expected Milestones

The following are some of the individual agency ETHR milestones from Appendix A.

- Provide graduate and postdoctoral support for high-performance computing research.
- Distribute mature K-12 curriculum products over the NII.
- Demonstrate results of mature digital library projects.
- Implement an NRSA awards program, not limited to NCRR resource centers, to train biomedical scientists to use HPC technology efficiently and effectively.

## Table 6: Summary of ETHR FY 1998 Presidential Budget

| Agency / Program Activity<br>Education, Training, and Human Resources | FY 98<br>Pres. Req.<br>(BA $M) | FY 97<br>Est.<br>(BA $M) | FY 96<br>Est.<br>(BA $M) |
|---|---|---|---|
| **DARPA** TOTAL | | | **6.24** |
| Health Information Infrastructure | | | 6.24 |
| **NSF** TOTAL | **20.96** | **19.11** | **31.03** |
| Applications | 12.39 | 11.86 | |
| Education and Training | 8.57 | 7.25 | 14.12 |
| Research Centers | | | 4.40 |
| Research Infrastructure | | | 2.30 |
| Human-Machine Interaction & Information Access | | | 3.60 |
| Computational Mathematics (non-NC/GC) | | | 3.52 |
| Physical Sciences (non-NC/GC) | | | 3.09 |
| **DOE** TOTAL | **3.00** | **3.50** | **4.00** |
| Advanced Computational Testing and Simulation Research | 3.00 | 3.50 | 4.00 |
| **NASA** TOTAL | **8.30** | **5.70** | **23.60** |
| Grand Challenge Support | | | 0.62 |
| BRHR | 8.30 | 1.10 | 3.98 |
| Information Infrastructure Technology & Applications | | 4.60 | 19.00 |
| **NIH** TOTAL | **6.38** | **5.88** | **7.11** |
| NLM HPCC Training Grants | 4.04 | 3.54 | 3.04 |
| NCRR HPCC Training | 1.80 | 1.80 | 3.50 |
| NCI Frederick Biomedical Supercomputing Center | 0.49 | 0.49 | 0.49 |
| NCI High Speed Networking and Distributed Conferencing | 0.05 | 0.05 | 0.08 |
| **NSA** TOTAL | | | **0.15** |
| Technology Based Training | | | 0.15 |
| **ED** TOTAL | | **6.61** | **17.53** |
| AskERIC Service | | 1.00 | 0.34 |
| OERI Institutional Communications Network (INET) | | 1.90 | 0.93 |
| Regional Education Laboratory Program | | 1.50 | 1.50 |
| Teacher Networking Project | | | 13.21 |
| National Parents Information Network | | 0.23 | 0.20 |
| ERIC Clearinghouses | | 1.98 | 1.35 |
| **EPA** TOTAL | | | **0.08** |
| Education/Training | | | 0.08 |

**Table 6: Summary of ETHR FY 1998 Presidential Budget**

| Agency / Program Activity<br>Education, Training, and Human Resources | FY 98<br>Pres. Req.<br>(BA $M) | FY 97<br>Est.<br>(BA $M) | FY 96<br>Est.<br>(BA $M) |
|---|---|---|---|
| ETHR FY 1998 Total | **38.64** | **40.80** | **14.20** |

## Glossary

| | |
|---|---|
| ACTS | Advanced Computational Testing and Simulation |
| ADL | Alexandria Digital Library |
| AHCPR | Agency for Health Care Policy and Research |
| AiS | Advances in Supercomputing |
| AMSANT | Advanced Manufacturing Systems and Networking Testbed |
| ARPANet | Advanced Research Projects Agency Network |
| API | Applications Programming Interface |
| ASCI | Accelerated Strategic Computing Initiative |
| ATDNet | Advanced Technology Demonstration Network |
| ATM | Asynchronous Transfer Mode |
| BAA | Broad Area Announcement |
| CAN | Cooperative Agreement Notice |
| CAS | Computational AeroSciences |
| CIC | Computing, Information, and Communications |
| CIM | Computer Integrated Manufacturing |
| CMOS | complementary metal oxide semiconductor |
| COTS | Commercial off-the-shelf |
| CPR | Computerized Patient Records |
| CPU | Central Processing Unit |
| CRADA | Cooperative Research and Development Agreement |
| CT | Committee on Technology |
| DARPA | Defense Advanced Research Projects Agency |
| DCRT | Division of Computer Research and Technology |
| DLI | Digital Libraries Initiative |
| DNA | Deoxyribonucleic Acid |
| DOD | Department of Defense |
| DOE | Department of Energy |
| DP | Defense Programs, a part of DOE |
| DSM | Distributed Shared Memory |
| ED | Department of Education |
| EPA | Environmental Protection Agency |
| ER | Energy Research, a part of DOE |

| | |
|---|---|
| ERIC | Education Resources Information Center |
| ESnet | DOE's Energy Sciences Network |
| ESS | Earth and Space Sciences |
| ETHR | Education, Training, and Human Resources |
| FY | Fiscal Year |
| FISAC | Federal Information Services and Applications |
| GaAs | Gallium Arsenide |
| GAMS | Guide to Available Mathematical Software |
| GC | Grand Challenge |
| GFDL | NOAA's Geophysical Fluid Dynamics Laboratory |
| GSA | General Services Administration |
| HCS | High Confidence Systems |
| HECC | High End Computing and Computation |
| HPCC | High Performance Computing and Communications |
| HuCS | Human Centered Systems |
| IC | Integrated Circuit |
| I/O | Input/Output |
| IP | Implementation Plan |
| LAN | Local Area Network |
| LSN | Large Scale Networking |
| MADE | Manufacturing Automation and Design Engineering |
| MBONE | Multicast Backbone |
| MCM | Multichip Module |
| MPP | Massively Parallel Processor |
| NASA | National Aeronautics and Space Administration |
| NC | National Challenge |
| NCAR | National Center for Atmospheric Research |
| NCBI | National Center for Biotechnology Information |
| NCI | National Cancer Institute |
| NCO | National Coordination Office |
| NCRR | National Center for Research Resources |
| NERSC | National Energy Research Scientific Computing |
| NGI | Next Generation Internet |
| NHANES | National Health and Nutrition Examination Survey |
| NIGMS | National Institute of General Medical Sciences |
| NIH | National Institutes of Health |

| | |
|---|---|
| NII | National Information Infrastructure |
| NIST | National Institute of Standards and Technology |
| NLM | National Library of Medicine |
| NOAA | National Oceanic and Atmospheric Administration |
| NPACI | National Partnership for Advanced Computational Infrastructure |
| NREN | NASA Research and Education Network |
| NRSA | National Research Service Act |
| NSA | National Security Agency |
| NSF | National Science Foundation |
| NSTC | National Science and Technology Council |
| OCR | Optical Character Recognition |
| OMB | Office of Management and Budget |
| ORNL | Oak Ridge National Laboratory |
| OSTP | Office of Science and Technology Policy |
| PACI | Partnerships for Advanced Computational Infrastructure |
| PCA | Program Component Area |
| PITAC | President's Information Technology Advisory Committee |
| QoS | Quality of Service |
| R&D | Research and Development |
| RERC | Rehabilitation Engineering Research Center |
| RFP | Requests for Proposal |
| RSFQ | Rapid Single-Flux Quantum devices |
| UMLS | Unified Medical Language Systems |
| U. S. | United States |
| VA | Department of Veterans Affairs |
| vBNS | very high performance Backbone Network Services |
| VLSI | Very Large Scale Integration |
| WAN | Wide Area Network |
| WDM | Wavelength Division Multiplexing |
| WWW | World Wide Web |

**Appendix A. Agency Accomplishments and Plans**

Implementation of the CIC R&D programs, including the HPCC Program, takes place within each of the twelve participating agencies, where the final decisions are made on the funding, management, and evaluation of program activities. This section organizes these activities by agency to reflect the operational structure of the funding. The level of information does not reflect individual projects.

Each agency section contains four parts:

- Brief overview of the agency's perspective on CIC and HPCC R&D efforts
- Table summarizing financial data and collaborative ties for its program activities
- Table comparing financial data for this year's program activities with last year's
- For each program activity, a one-page form, describing that activity and its milestones.

The individual program activity form contains some fields that require explanation:

- The "Budget Code" field is an internal label used by some agencies to track funding. The budget fields provide actual spending (Act.), estimated spending based on Congressional appropriations and rescissions (Est.), and Presidential requests (Pres.) for relevant fiscal years. The numbers below the CIC/HPCC component labels estimate the breakdown of the FY 1998 request into the five PCAs.

- The "Agency Ties" section of the form permits two labels. A "Partner" label indicates that the corresponding agency participates in this activity as a funding and research partner. Note that two different agencies may view partnering differently (e.g., developing a scalable system for DARPA would be HECC, but its use for National Challenges could be inside LSN for NIST or NOAA). A "User" label indicates that the corresponding agency needs the results of this program activity for another, related activity.

- The large field in the center of the form gives an overview description of each activity. The remaining fields provide highlights of major accomplishments and milestones planned for future years. These entries highlight significant objectives and results; they should not be viewed as complete descriptions of any activity.

# Defense Advanced Research Projects Agency

DARPA is the lead DoD agency for advanced technology research, and has the leadership responsibility for the HPCC program within DoD. This is based on DARPA's history of technical innovations in computer architecture, integrated circuits, networking, and system software. DARPA's strategy is to focus on developing the underlying technology base for high performance computing and communications while other agencies apply these technologies within the context of their mission-specific application focus.

The High-End Computing and Computation (HECC) activity focuses on developing high performance technologies (both hardware and software) for computing. Computing elements of the program are aimed at producing scalable software and architectures to meet defense computing requirements.

The Large Scale Networking (LSN) activity focuses on distributed services over broadly based, large scale interconnections of networks. Efforts are aimed at information management, secure transaction support, and integrated testbeds including special defense applications. The network elements are aimed at interoperability, mobility, and high performance systems.

The Human-Centered Systems (HuCS) activity includes language understanding, knowledge representation, intelligent systems and human computer interaction. Virtual environments addresses distributed design environments, languages, and experimental applications.

The Education, Training, and Human Resources (ETHR) activity addresses intelligent software systems for combat casualty care.

The High Confidence Systems (HCS) activity addresses technologies for increasing systems reliability and recoverability under conditions of load, failure and intrusion.

# Defense Advanced Research Projects Agency

## FY 1998 President's Request by Program Component Area

| Program Activity | Budget Account Code | Partner/User Agencies | Budget (BA, $ M) | | | | HPCC PCAs by 1998 Pres. Request | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | FY 96 Actual | FY 97 Pres. | FY 97 Est. | FY 98 Rqst. | HECC | LSN | HCS | HuCS | ETHR |
| Scalable Systems and Software | ST-19 | NSF, DOE, NASA, NSA | 37.63 | 32.17 | 31.90 | 40.20 | 35.20 | | 5.00 | | |
| Scalable Systems and Software (continued) | ST-19 | NSF, DOE, NASA, NSA | | | | | | | | | |
| Microsystems | ST-19 | NSF, NASA, NSA | 33.30 | 32.50 | 28.52 | 33.80 | 15.90 | | | 17.90 | |
| System Environments | ST-19 | All HPCC Agencies | 21.96 | 17.68 | 17.68 | 14.70 | 12.70 | | | 2.00 | |
| Networking Systems | ST-19 | NSF, DOE, NASA, ... | 33.72 | 33.76 | 29.30 | 36.40 | | 32.00 | 4.40 | | |
| Defense Technology Integration and Infrastructure | ST-19 | NSF, DOE, NASA | 41.40 | 56.71 | 35.10 | 36.90 | | 10.70 | | 26.20 | |
| Defense Technology Integration and Infrastructure (continued) | ST-19 | NSF, DOE, NASA | | | | | | | | | |
| Embeddable Systems | ST-19 | NASA, NSA | | | 11.90 | 15.00 | 15.00 | | | | |
| Global Mobile Infosystems | ST-19 | NSF, NASA | 16.30 | 17.58 | 15.60 | 16.90 | | 16.90 | | | |
| Health Information Infrastructure | MPT-07 | NIH | 6.24 | 7.51 | | | | | | | |
| Information Sciences | CCS-02 | NSF, NASA | 23.10 | 23.35 | 26.42 | 19.01 | 6.00 | | | 13.01 | |
| Information Sciences (continued) | CCS-02 | NSF, NASA | | | | | | | | | |
| Intelligent Systems and Software | ST-11 | | 61.93 | 72.14 | 64.91 | 78.76 | | | | 78.76 | |
| Intelligent Systems and Software (continued) | ST-11 | | | | | | | | | | |
| Global Grid Communications | EE-45 | NSA | 26.83 | 32.12 | 31.36 | 29.63 | | 29.63 | | | |
| Totals: | | | 302.41 | 325.52 | 292.69 | 321.30 | 84.80 | 89.23 | 9.40 | 137.87 | |

# Defense Advanced Research Projects Agency

## Comparison of FY 1997 and FY 1998 by Program Component Area

| Program Activity | Budget (BA, $ M) | | | | HPCC PCAs by 1998 President's Request | | | | | HPCC PCAs by 1997 Estimated | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | FY 96 Actual | FY 97 Pres. | FY 97 Est. | FY 98 Rqst. | HECC | LSN | HCS | HuCS | ETHR | HECC | LSN | HCS | HuCS | ETHR |
| Scalable Systems and Software | 37.63 | 32.17 | 31.90 | 40.20 | 35.20 | | 5.00 | | | 26.90 | | 5.00 | | |
| Scalable Systems and Software (continued) | | | | | | | | | | | | | | |
| Microsystems | 33.30 | 32.50 | 28.52 | 33.80 | 15.90 | | | 17.90 | | 14.29 | | | 14.23 | |
| System Environments | 21.96 | 17.68 | 17.68 | 14.70 | 12.70 | | | 2.00 | | 15.50 | | | 2.18 | |
| Networking Systems | 33.72 | 33.76 | 29.30 | 36.40 | | 32.00 | 4.40 | | | | 24.30 | 5.00 | | |
| Defense Technology Integration and Infrastructure | 41.40 | 56.71 | 35.10 | 36.90 | | 10.70 | | 26.20 | | | 35.10 | | | |
| Defense Technology Integration and Infrastructure (continued) | | | | | | | | | | | | | | |
| Embeddable Systems | | | 11.90 | 15.00 | 15.00 | | | | | 11.90 | | | | |
| Global Mobile Infosystems | 16.30 | 17.58 | 15.60 | 16.90 | | 16.90 | | | | | 15.60 | | | |
| Health Information Infrastructure | 6.24 | 7.51 | | | | | | | | | | | | |
| Information Sciences | 23.10 | 23.35 | 26.42 | 19.01 | 6.00 | | | 13.01 | | 4.09 | | | 22.33 | |
| Information Sciences (continued) | | | | | | | | | | | | | | |
| Intelligent Systems and Software | 61.93 | 72.14 | 64.91 | 78.76 | | | | 78.76 | | | | | 64.91 | |
| Intelligent Systems and Software (continued) | | | | | | | | | | | | | | |
| Global Grid Communications | 26.83 | 32.12 | 31.36 | 29.63 | | 29.63 | | | | | 31.36 | | | |
| Totals: | 302.41 | 325.52 | 292.69 | 321.30 | 84.80 | 89.23 | 9.40 | 137.87 | | 72.68 | 106.36 | 10.00 | 103.65 | |

| DARPA | **Scalable Systems and Software** | Budget Code | ST-19 |
|---|---|---|---|

The Scalable Systems and Software component develops software and hardware technologies leading to a secure scalable computing and communications technology base for systems configured over a wide performance range, from mobile handheld devices to desktop workstations to the largest-scale, highest performance systems.

In 1997 and beyond, the Scalable Systems and Software component has been reorganized into three subcomponents: Scalable Computing, which addresses very high performance systems; UltraScale Computing, which examines new breakthrough models and mechanisms; and Quorum, which focuses on activities in high-performance, distributed computing.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 37.63 |
| FY 97 Pres | 32.17 |
| FY 97 Est. | 31.90 |
| FY 98 Rqst. | 40.20 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | 26.90 | 35.20 |
| LSN | | |
| HCS | 5.00 | 5.00 |
| HuCS | | |
| ETHR | | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Demonstrated user-extensible microkernel operating system technology, integrating compiler and run-time support services; computing node architectures that dramatically increase internal memory and communications bandwidths; and I/O enhancements to a scalable operating system that overcomes identified bottlenecks leading to significant improvements in throughput. | *Scalable Computing*<br>Demonstrate integration of parallel communication and processing; of scalable, MAGIC-based, system prototype and operational protocols; and performance of distributed shared-memory hardware supporting several commodity processors.<br>*UltraScale Computing*<br>Design UltraScale quantum architecture model that addresses error-correction, computation in a noisy environment, and multispin entanglements; and develop and exercise computing simulator computation model to evaluate parallel behavior and performance structure.<br>*Quorum*<br>Define an integrated architecture, and develop quality-of-service specification language.<br>Demonstrate order of magnitude performance improvement of translucent system layers using network-attached secure disks. | *Scalable Computing*<br>Demonstrate highly efficient, parallel nodes; auto-parallelization performance of file I/O from Scalable I/O Consortium; first node-level performance of ultra-low-power systems; performance of novel backplane networks supporting security; and hardware-accelerated, distributed, shared-memory performance on workstation clusters.<br>*UltraScale Computing*<br>Design, model, and assess quantum-to-Si hardware and software interface; and language for expressing amorphous algorithmic computations.<br>Develop tools and mechanisms to build bioelectronic systems.<br>Demonstrate 256-component addressed array of molecular computational mechanisms; and a computational paradigm mechanism in an engineered living cell, and evaluate surface patterning mechanisms for culturing neural components on silicon.<br>(continued) |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | Partner |
| DOE | Partner |
| NASA | Partner |
| NIH | |
| NSA | Partner |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| DARPA | **Scalable Systems and Software (continued)** | Budget Code | ST-19 |
|---|---|---|---|

| Milestone Changes | |
|---|---|

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| | | (continued)<br>*Quorum*<br>Develop quality-of-service negotiation protocols for performance architecture attributes and adaptive resource discovery protocols.<br>Demonstrate order of magnitude improvement in operating systems/network interface of translucent system and LAN-based quality-of-service performance assurance for Quorum Prototype No. 1. |

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | |
| FY 97 Pres | |
| FY 97 Est. | |
| FY 98 Rqst. | |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | | |
| HCS | | |
| HuCS | | |
| ETHR | | |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | Partner |
| DOE | Partner |
| NASA | Partner |
| NIH | |
| NSA | Partner |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| DARPA | **Microsystems** | Budget Code | ST-19 |
|---|---|---|---|

The Microsystems component develops design tools, environments, and design infrastructure to support the research and development of advanced scalable parallel computing components and embedded computing systems. Microsystems is the incubator and delivery mechanism of future generation defense advanced information systems components. Microsystems is the critical bridge that leverages other DARPA technology in low-power processes, advanced packaging, materials, and electronic componentry to develop the critical architecture and building blocks of the most advanced defense computing and communication systems.

In 1997 and beyond, the Microsystems component has been restructured into two subcomponents: Microsystems Design, which incorporates activities in design tools, environments, and design infrastructure; and Adaptive Computing Systems, which focuses the microarchitecture efforts on configurable architecture designs and prototypes.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 33.30 |
| FY 97 Pres | 32.50 |
| FY 97 Est. | 28.52 |
| FY 98 Rqst. | 33.80 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | 14.29 | 15.90 |
| LSN | | |
| HCS | | |
| HuCS | 14.23 | 17.90 |
| ETHR | | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Performed early demonstration of parallel, fully-hierarchical Automatic Test Generation for both combinational and sequential circuits.<br>Demonstrated fault-tolerant and reliability design tools supporting large-scale HPC systems developments; distributed computing architectures based on low-cost, low-latency switching technology; and integrated module-level synthesis capability.<br>Prototyped emulation-enhanced system simulation capabilities for microsystems design.<br>Developed highest performance open interconnect component for embedded defense systems, future demos in various systems, missiles and satellites.<br>Designed message-passing/shared-memory hybrid architecture protocol accelerator component. | *Microsystems Design*<br>Release comprehensive complex system design benchmark suite.<br>Draft specifications for common descriptive format for complex system design hardware verification.<br>Demonstrate multi-site parallel processing design collaboratory; formal methods for early complex system design microprocessor verification; sequential complex system design processor verification; and integrated environment spanning of advanced parallel processing microcomponents.<br>Develop complex system design functional error modeling and test generation.<br>*Adaptive Computing Systems*<br>Develop 1 million gate standard form factor boards and hybrid system prototypes using configurable component technology; automatic process of template design and integration (for ATR library templates).<br>Demonstrate 10x performance improvement of user-level software on challenge problems. | *Microsystems Design*<br>Develop formal complex system design semantics for common intermediate format and extend arithmetic verification of complex system design to floating point.<br>Verify complex system, in-order execution superscalar processors and automate complex system error modeling and test generation.<br>Demonstrate scalability beyond 128 nodes of parallel design environment; scalable, parallel-processing; and symbolic simulation linked with hardware emulation for complex system design.<br>*Adaptive Computing Architectures*<br>Complete architecture designs using configurable component technology for low-power, hybrid, reduced overhead prototypes.<br>Develop high-level language and demonstrate adaptive template matching concept software prototype showing auto runtime remapping. |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | Partner |
| DOE | |
| NASA | Partner |
| NIH | |
| NSA | Partner |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| DARPA | System Environments | Budget Code | ST-19 |
|---|---|---|---|

The Systems Environments component develops scalable software which is tailored toward easing the use of systems by application programmers. This includes languages, run-time services, scalable software library technologies, and experimental applications.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 21.96 |
| FY 97 Pres | 17.68 |
| FY 97 Est. | 17.68 |
| FY 98 Rqst. | 14.70 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | 15.50 | 12.70 |
| LSN | | |
| HCS | | |
| HuCS | 2.18 | 2.00 |
| ETHR | | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Evaluated first generation of fully scalable operating system software and programming environments on small-scale versions of teraops computing systems.<br>Defined second generation of High Performance Fortran with extensions for task parallelism and support for scalable Input/Output (I/O).<br>Demonstrated extensions of portable scalable libraries to incorporate object-oriented technology and a broader set of applications.<br>Enhanced and experimentally evaluated advanced software environment that supports composition tools. | Enable scalable structural dynamics applications using scalable software library technology for sparse symmetric Eigen problem.<br>Demonstrate experimental, scalable Advanced Distributed Simulation applications enabling STOW-97 to utilize 50,000 entities; and automatic optimization of data movement across the memory hierarchy in distributed shared memory systems using languages and runtime services.<br>Define HPC++ languages and runtime services with extensions for data and task parallel exploitation of concurrency. | Demonstrate order of magnitude reduction in design time with experimental scalable applications; experimental scalable application versions of new iterative solvers for radar cross-section modeling; and languages and runtime services supporting parallel applications such as Advanced Distributed Simulation; and HPC++ languages and runtime services supporting both task and data parallelism. |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | Partner |
| DOE | Partner |
| NASA | Partner |
| NIH | Partner |
| NSA | Partner |
| NIST | Partner |
| NOAA | Partner |
| EPA | Partner |
| ED | |
| AHCPR | |
| VA | |

| DARPA | **Networking Systems** | Budget Code | ST-19 |
|---|---|---|---|

The Networking component develops high performance networking technologies and associated network management capabilities. Research is coordinated with network technology and Service deployments made by DoD, NASA, and other federal agencies.

In 1997 and beyond, the Networking Systems component has been reorganized into three subcomponents: Network Engineering, which addresses the problems of analysis, design and management for large-scale networks; High Performance Networks, which focuses on order of magnitude increases in performance; and Active Networks, which focuses on breakthrough technologies for a new networking environment.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 33.72 |
| FY 97 Pres | 33.76 |
| FY 97 Est. | 29.30 |
| FY 98 Rqst. | 36.40 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | 24.30 | 32.00 |
| HCS | 5.00 | 4.40 |
| HuCS | | |
| ETHR | | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Prototyped networks at greater than 40-gigabit-per-second speed using optical technologies; experimentally validated scalable network protocols at the higher speeds; and secure nomadic computing architecture integrated into existing wide area networks.<br>Deployed reference implementation of protocol-independent, multicast-capable infrastructure as basis for development of advanced services.<br>Demonstrated robust and secure network-level infrastructure protocols to include directory services and resource allocation; and technology for autonomous, node-level network management. | *Network Engineering*<br>Develop plan for Network Engineering and Management Program, and manage large-scale scalable network engineering technology.<br><br>*High Performance Networking*<br>Demonstrate high performance networking systems for coordinating sets of workstations as a single computing system, and test high-performance subsystem.<br><br>*Active Networks*<br>Define Enhanced Networking Services Architecture for routing, multicast, location aware, and proxy services.<br>Develop definition and protocols of SmartPacket Format, and of Execution Environment. | *Networking Engineering*<br>Complete and release specification language for network engineering elements and management system.<br><br>*High Performance networking*<br>Demonstrate additional high performance networking systems, and enhanced ATM-switching, high-performance, networking technology.<br>Test subsystem in a testbed and demonstrate subsystems scalability in a defense application.<br><br>*Active Networks*<br>Implement prototype of Enhanced Networking Services utilizing composable modules.<br>Complete composite protocol prototype implementation of execution environment; of fast compiler for SmartPacket Methods; and of basic switch functions.<br>Initiate operation of wide area Active Network on composite prototype platforms. |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | Partner |
| DOE | Partner |
| NASA | Partner |
| NIH | Partner |
| NSA | Partner |
| NIST | Partner |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| DARPA | **Defense Technology Integration and Infrastructure** | Budget Code | ST-19 |
|---|---|---|---|

Defense Technology Integration and Infrastructure combines state-of-the-art computing and information technologies focused on critical defense applications. These include developing embeddable systems based upon scalable technologies, and projects which accelerate technology transition of advanced research to intelligence, command and control, and other major DARPA and DoD programs. Technologies addressed include: information management, integration of systems, real-time, multimedia collaboration and visualization and application adaptivity.

In 1997 and beyond, the Embeddable Computing component is presented as a separate component. The remaining portion of the Defense Technology Integration and Infrastructure component has been reorganized into three subcomponents: Prototype System of Systems, which addresses high-performance, integrated testbed activities; Information Management, which addresses the technologies needed to manage very large-scale, distributed information environments; and Intelligent Collaboration and Visualization, which includes the middleware for advanced collaboration across very large distributed systems.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 41.40 |
| FY 97 Pres | 56.71 |
| FY 97 Est. | 35.10 |
| FY 98 Rqst. | 36.90 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | 35.10 | 10.70 |
| HCS | | |
| HuCS | | 26.20 |
| ETHR | | |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | Partner |
| DOE | Partner |
| NASA | Partner |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Developed and provided experimental testbed services employing advanced high performance computing technologies for defense users; and prototype distributed, object-oriented architecture for scalable, interoperable, multimedia digital library repositories.<br>Prototyped embedded computing system modules with scalability concepts containing memory hierarchy and power on a single unit of replication.<br>Performed integration tests in key defense applications such as advanced distributed simulation, advanced distributed collaboration, advanced communications and control, and advanced human computer interfaces.<br>Demonstrated first fine-grained high performance embedded and scalable computer system; graphical program environments for embedded systems;<br>(continued) | *Prototype System of Systems: Phase 1*<br>Develop prototype Mediated Link application.<br>Evaluate the experimental Mediated Link on a LAN.<br>Evaluate Phase II feasibility and cost; and complete Phase II Program Plan.<br>*Information Management*<br>Deploy net-accessible prototype demonstrating vocabulary switching and object categorization; deploy operational prototype with active references to technical literature to licensed institutions.<br>Develop scalable information value framework to characterize prior use of objects; and testbed for electronic deposit, registration and recordation of digital objects.<br>Demonstrate agent architecture for cross-collection search and results fusion.<br>(continued) | *Prototype System of Systems: Phase 1*<br>Develop prototype information transformer application; and semantic component application.<br>Evaluate the mediated link information transformer on a LAN/WAN; and integrated system of mediated link information transformer, and semantic component on a LAN/WAN/Mobile.<br>*Information Management*<br>Develop algorithms to effectively search collections of documents for words used only in restricted senses; and design query and preferences languages incorporating similarity and value filtering.<br>Demonstrate translingual search aids for military type documents in English, Korean and a European language; electronic document management with access controls; statistical co-occurrence techniques for texture classification of images; and semi-automatic generation of metadata.<br>(continued) |

| Milestone Changes | |
|---|---|

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| (continued)<br>prototype toolkits supporting development of applications adaptive to changes in the computing and communication environment; and prototype of information services through a testbed incorporating information management and secure transactions. | (continued)<br>*Intelligent Collaboration and Visualization*<br>Develop initial design of collaboration architecture; definition of candidate approaches to represent self-describing objects; and initial specification of evaluation approach and benchmarking of performance measures.<br>Demonstrate multimedia annotation for graphical representations, shown through a collaborative application where a user can attach multimedia comments to objects in a 2-D/3-D graphical space and where collaborating users can review and add to these annotations. | (continued)<br>*Intelligent Collaboration and Visualization*<br>Develop initial software library of critical collaboration middleware for data sharing, coupling and coordination.<br>Demonstrate the meaning of machine-assisted structuring using an irregular information space; mutually-enhancing views, shown by a collaborative application; and real-time multimedia ad hoc collaboration applications with automated setup. |

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | |
| FY 97 Pres | |
| FY 97 Est. | |
| FY 98 Rqst. | |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | | |
| HCS | | |
| HuCS | | |
| ETHR | | |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | Partner |
| DOE | Partner |
| NASA | Partner |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| DARPA | **Embeddable Systems** | Budget Code | ST-19 |
|---|---|---|---|

The Embeddable Systems component is developing embeddable systems based on scalable technologies and Defense-required properties of real-time, fault-tolerant performance. The program is accelerating technology transition into intelligence, command and control, and other major DOD problems.

Before 1997, this component was part of the Defense Technology Integration and Infrastructure component. In 1997 and beyond, it is presented as a separate component.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | |
| FY 97 Pres | |
| FY 97 Est. | 11.90 |
| FY 98 Rqst. | 15.00 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | 11.90 | 15.00 |
| LSN | | |
| HCS | | |
| HuCS | | |
| ETHR | | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| | Demonstrate first DoD lab coordinated flight technology; 100 gigaops/cu. ft.; and heterogeneous architectures.<br>Integrate support for instrumentation and visualization of real-time operating systems; ability to monitor performance of realtime systems and interact in-situ; and system and application software technologies.<br>Fabricate and test digital signal processing(DSP) chips for advanced vision systems.<br>Develop first prototype accelerator module: Alacron, Westinghouse/ASI for advanced vision systems; signaling technology, Signaling Workshop; and initial set of visualization tools for cpu and memory. | Demonstrate missile application technology; in-system, high-speed, reconfigurable advanced vision switches; HPC portable/scalable instantiations of domain-specific tools and middleware; and UUV technology.<br><br>Develop hard realtime/operating systems with security; systems tools and middleware with adaptive scheduling tasks; and wrapper generator for encapsulating advanced vision systems. |

**Agency Ties**

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|---|---|
| DARPA | |
| NSF | |
| DOE | |
| NASA | Partner |
| NIH | |
| NSA | Partner |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| DARPA | **Global Mobile Infosystems** | Budget Code | ST-19 |
|---|---|---|---|

Global Mobile Information Systems effort deals with the activities required for defense-based mobile systems, including modal architectures, adaptive extensions, changing resources and robust mobile services.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 16.30 |
| FY 97 Pres | 17.58 |
| FY 97 Est. | 15.60 |
| FY 98 Rqst. | 16.90 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | 15.60 | 16.90 |
| HCS | | |
| HuCS | | |
| ETHR | | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Developed initial prototype of adaptive extensions; and untethered node hardware/software architectures.<br>Demonstrated design environments supporting simulation and synthesis of wireless systems.<br>Completed the experimental evaluation of the integration of multiple advanced intelligent systems. | Demonstrate location-transparent computing relocation and data access within a mobile application support environment.<br>Develop adaptive networking extensions to Internet services in support of mobility; and prototypes of untethered node architectures for mobile computing. | Demonstrate application support services for adapting mobile application support to changing infrastructure resources; and robust, mobile networking based on packet radio algorithms. |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | Partner |
| DOE | |
| NASA | Partner |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| DARPA | **Health Information Infrastructure** | Budget Code | MPT-07 |
|---|---|---|---|

Healthcare Information Infrastructure is one of two components comprising the DARPA Combat Casualty Care Program. The development of an advanced Healthcare Information Infrastructure supports the entire trauma care technology base. Medical information must flow seamlessly and transparently on all levels of patient care. For this to occur, a platform-independent medical record system, such as the electronic theater medical record (ETMR), will ensure immediate continuity, distribution, and accessibility of medical information from the forward battlefield to the rear echelon support in U.S. based medical centers. This information will be achieved in multimedia heterogeneous databases of laboratory studies, radiologic and pathologic images, inpatient medical records, and be available over a world wide telecommunication system for real-time interactive collaboration among physicians. In addition, the infrastructure will provide a clinical associate system which is an intelligent system that assists physicians, nurses, corpsmen and paramedics in assessing and treating patients.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 6.24 |
| FY 97 Pres | 7.51 |
| FY 97 Est. | |
| FY 98 Rqst. | |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | | |
| HCS | | |
| HuCS | | |
| ETHR | | |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | |
| DOE | |
| NASA | |
| NIH | Partner |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Integrated models of combat doctrine and knowledge-based decision support tools (combat casualty protocols and guidelines) in support of combat medics and physicians.<br>Demonstrated hands-free capture of patient data under battlefield conditions.<br>Demonstrated integration of battlefield electronic patient record with peacetime care systems. | | |

| DARPA | **Information Sciences** | Budget Code | CCS-02 |
|---|---|---|---|

This project supports the scientific study and experimentation that is the basis for more advanced knowledge and understanding in information sciences technology areas such as software foundations and environments, intelligent systems, human computer interface, language technology, microelectronic science, and high performance computing related to long-term national security requirements.

In the area of software technology: advanced concepts are developed for methods and tools to produce high assurance software; language concepts that facilitate the rapid specification and evolution of systems; and techniques to manage shared complex structured data objects in larger heterogeneous, distributed information systems. The intelligent systems technology focus is on advanced techniques for knowledge representation, reasoning, and machine learning, which enables computer understanding of spoken and written language and images. Also included is advanced methods for planning, scheduling, and resource allocation. The focus in the human computer interaction technology area is design methods and enabling technology for more natural interaction between people and computers. Lastly, the high performance computing (HPC) focus is on science generated concepts and methods for validating and verifying design components, and unique approaches to rapidly develop high performance libraries across multiple HPC architectures.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 23.10 |
| FY 97 Pres | 23.35 |
| FY 97 Est. | 26.42 |
| FY 98 Rqst. | 19.01 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | 4.09 | 6.00 |
| LSN | | |
| HCS | | |
| HuCS | 22.33 | 13.01 |
| ETHR | | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Developed complex software languages and tools to integrate architecture-level representations of software systems and used these representations for analysis and testing.<br>Enhanced advanced information processing methods in spoken language understanding, written language understanding and automated planning systems.<br>Experimentally evaluated tool kits for interactive, dialogue-based human computer interaction.<br>Refined and began experimental evaluation of design technology to include high performance computational prototyping of systems.<br>Demonstrated utility of scalable libraries for defense tasking; completed basic research effort in scalable operating systems and runtime services; initiated Quorum architecture definition; and demonstrated adaptive computing systems for defense applications.<br>(continued) | Complete the development of the tools and tool kits for development and evaluation of highly interactive, agent and dialogue-based human computer interactions.<br>Advance the capabilities of spoken and written language understanding to solve real-world problems and provide widely usable functionality.<br>Experimentally evaluate design technology for high performance computational prototyping of systems.<br>Experimentally support software evolution by integrating numerous formal and informal information sources in a "hyperweb"; enhance formal notations for software design to include both syntactic and semantic information; and demonstrate multi-language architecture definition and analysis tools.<br>Continue the experimental evaluation of supporting both task and data parallelism for scalable software library technology, and the utility of adaptive computing systems for defense applications.<br>(continued) | Demonstrate symbolic simulation linked with hardware emulation for complex design technology.<br>Complete the experimental evaluation of design technology for high performance computational prototyping of systems, supporting both task and data parallelism for scalable software library technology.<br>Develop robust spoken and text language technologies with emphasis on affordable dialog grammars and understanding in spite of noise; all technology developed in response to systems experiments focused on critical military needs.<br>Demonstrate a computational model using UltraScale computing techniques.<br>Evaluate the quality of service specifications relative to the Quorum architecture.<br>Demonstrate the languages and runtime services in defense applications, and complete the scalable software library technology demonstration. |

**Agency Ties**

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|---|---|
| DARPA | |
| NSF | Partner |
| DOE | |
| NASA | Partner |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| DARPA | **Information Sciences (continued)** | Budget Code | CCS-02 |
|---|---|---|---|

| Milestone Changes | |
|---|---|

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| (continued)<br>Experimentally evaluated planning and decision aids prototypes for heterogeneous, distributed software system architectures and tools to support construction and maintenance of advanced intelligent systems. | (continued)<br>Demonstrate the feasibility of using UltraScale computing techniques to store and retrieve information.<br>Define Quorum architecture and validate findings, and define and validate the next generation of languages and runtime services for supporting parallel task applications. | |

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | |
| FY 97 Pres | |
| FY 97 Est. | |
| FY 98 Rqst. | |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | | |
| HCS | | |
| HuCS | | |
| ETHR | | |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | Partner |
| DOE | |
| NASA | Partner |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| DARPA | **Intelligent Systems and Software** | Budget Code | ST-11 |
|---|---|---|---|

This project develops new information processing technology concepts that lead to fundamentally new software and intelligent systems capabilities. This will enable advanced information systems to more effectively accomplish decision-making tasks in stressful, time sensitive situations and create efficient software systems supporting computer and software intensive defense systems. Major areas of technical emphasis are: (a) intelligent systems (artificial intelligence) including autonomous systems, image understanding, interactive problem solving and intelligent integration of information from heterogeneous sources; (b) software development technology including languages, algorithms, data and object bases, domain specific software architectures, software prototype technology, software design tools, software reuse, and advanced software engineering environments; (c) manufacturing automation and design engineering (MADE), including the development of advanced software systems which support sharing of engineering knowledge, advanced product and process design representations, integrated product and process design, software tools for design process management, manufacturing process planning, manufacturing process control and demonstrations; (d) Text Video Speech (TVS) technology focusing on the integration and application of emerging language understanding technology for both C4I and Intelligence community needs; and (e) organizing resources to obtain access to multiple systems and decision aids that provide logistical information when and where it is needed.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 61.93 |
| FY 97 Pres | 72.14 |
| FY 97 Est. | 64.91 |
| FY 98 Rqst. | 78.76 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | | |
| HCS | | |
| HuCS | 64.91 | 78.76 |
| ETHR | | |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | |
| DOE | |
| NASA | |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Demonstrated and evaluated advanced reconnaissance, surveillance, and target acquisition algorithms on unmanned ground vehicle; installed baseline RADIUS Site Monitoring System at National Photographic Interpretation Center; delivered first version image understanding environment.<br>Experimentally evaluated implementations for human-aided machine language translation, document understanding, and robust speech understanding in adverse acoustic conditions.<br>Experimentally evaluated implementations of real-time planning and control algorithms.<br>Evaluated knowledge-based planning and decision aids to support the rapid construction of multiple crisis action plans in an operational exercise.<br>Developed new techniques for intelligently locating, filtering, accessing, and integrating information from disparate, heterogeneous, distributed information sources and demonstrated the use of those techniques in accessing information for air campaign planners, logistics planners, satellite imagery users, weapon system engineers, and others.<br>(continued) | Continue development of human-computer interaction, heterogeneous testbed products and insertion. Test, evaluate and demonstrate enhancements to the developer and user communities.<br>Experimentally evaluate methods for building information detection filters from text, and baseline topic concept recognition from radio news broadcasts.<br>Evaluate distributed design tools and demonstrate multi-agent systems for capture of collaborative design history.<br>Develop modular Human Language Technologies to support easy, low-cost, rapid technology transfer and application development for Document Understanding, Machine Translation, and Speech Understanding.<br>Extend Architecture Description Language for complex systems to include performance and context information.<br>Initial implementation of distributed dynamic language and real-time dynamic language.<br>Initial web-structure configuration management capability.<br>(continued) | Integrate several MADE design computation tools to demonstrate robust multi-disciplinary design.<br>Demonstrate a 5X reduction in early design trade-off time by combining qualitative and quantitative models.<br>Develop initial prototypes for multi-language text extraction and audio transcription where performance is baselined against that of human operators.<br>Continue development of human-computer interaction, heterogeneous testbed products and insertion. Test, evaluate and demonstrate enhancements to the developer and user communities.<br>Develop modular Human Language Technologies to support easy, low-cost, rapid technology transfer and application development for Document Understanding, Machine Translation, and Speech Understanding.<br>Develop, in the Intelligent Integration of Information area, tools and techniques to enable the rapid construction of information fusion, aggregation, and summarization software to filter, access, and integrate information from 100's of<br>(continued) |

| DARPA | Intelligent Systems and Software (continued) | Budget Code | ST-11 |
|---|---|---|---|

| Milestone Changes | |
|---|---|

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| (continued)<br>Developed an initial library of knowledge base components to support the creation and maintenance of High Performance Knowledge Bases in military command and control.<br>Developed planning and control algorithms for tasking multiple homogeneous assets in support of small unit operations.<br>Integrated Artificial Intelligence based research technologies with numerical simulations and CAD Models, and demonstrated a three fold reduction in trade-off analysis and collaborative design optimization.<br>Continued the human computer interaction heterogeneous testbed product development and insertion. Tested, evaluated, and demonstrated enhancements to the user community.<br>Defined consensus Architecture Description Language and Interactive Architecture Synthesis Tools and initiated development of tools for complex system design.<br>Developed and demonstrated multi-echelon, collaborative logistical support tools that integrate planning, execution, monitoring and decisions support systems to achieve real time logistical reallocation and redeployments within and between commands. | (continued)<br>Develop new image understanding technologies for image exploitation, automatic population of geospatial databases, and video surveillance and monitoring to enhance battlefield awareness.<br>Perform university research toward development of automated target recognition technologies that operate effectively under difficult circumstances involving obscuration, camouflage, and urban settings.<br>Develop, in the Intelligent Integration of Information area, tools and techniques to enable the rapid construction of information filtering, accessing, and integration software to enable the dynamic management of massive amounts of battlefield information.<br>Develop a library of knowledge base components, composition tools, and an initial integrated development environment to support the creation and maintenance of High Performance Knowledge Bases in battlefield awareness and military command and control.<br>Develop site-monitoring technology and testbed for evaluating utility of automated tools for image analysts. | (continued)<br><br>disparate, heterogeneous, distributed data sources.<br>Demonstrate use of web to integrate rationale, system models and implementation.<br>Initial demonstration of ability to incrementally reanalyze a system using propagation bounding.<br>Release of real-time dynamic language to demo team.<br>Continue to develop, demonstrate, and evaluate image understanding technologies for image exploitation, automatic population of geospatial database, video surveillance and monitoring, and automatic target recognition to enhance battlefield awareness.<br>Use unified knowledge representations in tools for focused knowledge acquisition, extend learning methods, and add new, high-performance, problem-solving methods to the High Performance Knowledge Base library. |

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | |
| FY 97 Pres | |
| FY 97 Est. | |
| FY 98 Rqst. | |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | | |
| HCS | | |
| HuCS | | |
| ETHR | | |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | |
| DOE | |
| NASA | |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| DARPA | **Global Grid Communications** | Budget Code | EE-45 |
|---|---|---|---|

This program develops and demonstrates advanced communications technologies needed for defense and intelligence operations for the 21st century. The program will develop advanced information processing concepts to support a geographically dispersed staff for crisis management. Services for an enhanced information infrastructure to support command and control will be developed and demonstrated to be applicable to advanced, high performance networks. This program will demonstrate that commercial communications resources and technologies can be integrated with advanced optical components developed in this program as well as DoD tactical and satellite technologies developed elsewhere.

The key elements are: 1) Applications such as intelligent decision aids, that enable a geographically distributed planning staff to develop and analyze a course of action; 2) Advanced services such as scalable file systems, databases, and distributed computing support that are integrated with high performance computing, and free applications from the necessity to work down to the raw data transport level; 3) Demonstration networks that validate the research and development and enable early application development and technology transition into DoD efforts such as Defense Information System Networks; 4) Develop network controls pertaining to management, and security software technologies to enable sensor-to-shooter applications combining all network media; and 5) Develop advanced optoelectronic network component technology and network architecture for scalable and modular networks. The aggregate network bandwidth will be in the range of terabits per second and the network will handle multi-media service for both digital and analog signals.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 26.83 |
| FY 97 Pres | 32.12 |
| FY 97 Est. | 31.36 |
| FY 98 Rqst. | 29.63 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | 31.36 | 29.63 |
| HCS | | |
| HuCS | | |
| ETHR | | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Demonstrated high bandwidth operation of critical multi-wavelength components.<br>Field tested local area network application of multi-wavelength analog and digital signal transmission.<br>Developed multi-wavelength network management software and control algorithms. | Identify control and protocol issues for operation of multi-wavelength networks.<br>Demonstrate advance integrated optoelectronic network component operations.<br>Complete multi-wavelength network architecture and control planning; and initiate field-trial network deployment for long-distance and wide area applications. | Demonstrate multi-wavelength network management and control in local area testbeds.<br>Demonstrate 40 billion bit per second cross-connect switching and 32 channel transceiver chip.<br>Continue analysis and report on economics of multi-wavelength network architecture and technology for local area optical networks. |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | |
| DOE | |
| NASA | |
| NIH | |
| NSA | Partner |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

# National Science Foundation

NSF supports and elaborates upon the Federal HPCC Program goals of extending U.S. technological leadership in high performance computing and communications, accelerating wide dissemination and application of technologies to speed the pace of innovation and to serve the national interests in many critical areas, and spurring gains in U.S. productivity and industrial competitiveness through the use of high performance computing and networking technologies. Program objectives, as the term is used here, refers to more specific ends, the attainment of which signals a major step toward achieving programmatic goals. For NSF, the objectives include:

Developing national research and education networking services and capabilities for connecting universities, high schools, research laboratories, libraries, and businesses at speeds of up to one billion bits per second;

Providing early access to new generations of scalable parallel high performance computers and software technologies in order to achieve performance of one trillion computer calculations per second on application areas representing Grand Challenges;

Generating fundamental knowledge with the potential for radically changing the state of high performance computing and communications;

Creating a cadre of scientists, engineers, and technical personnel knowledgeable in the ideas, methods, and value of computational science and engineering and prepared to take advantage of these new capabilities;

Encouraging industrial partnerships and affiliations to enhance innovation, technology transfer and U.S. productivity and industrial competitiveness;

Making advanced computing and communications information infrastructure available to a larger segment of the society to solve information intensive National Challenges and advance education.

The NSF strategy for meeting its goals and objectives consists of balanced programs of support for:

Individual investigators performing long-term curiosity-driven research;

Small group research teams studying single, broader problems;

Grand Challenge Applications Groups working on complex problems requiring multidisciplinary teams;

Science and Technology Centers, targeted on major and significant research areas;

Deployment of infrastructure, including general availability of networking services, access to specialized high performance computing capabilities, and provision of local small-scale state-of-art computing instrumentation; and

Developing new opportunities and technologies for enhancing science and engineering education.

For FY 1997, NSF has restructured its program into activities that reflect recommendations incorporated in reports such as the CIC Strategic Implementation Plan 'America in the Age of Information' and the National Research Council report 'Evolving the High Performance Computing and Communications Initiative to Support the Nation's Information Infrastructure.' This restructuring reflects both the Strategic Focus Areas of the CIC plan and the structure of the NSF. The new organization of the program is reflected in the following seven activity sheets; the original seventeen activities are included to capture past accomplishments and to help elucidate the transition.

# National Science Foundation

## FY 1998 President's Request by Program Component Area

| Program Activity | Budget Account Code | Partner/User Agencies | Budget (BA, $ M) | | | | HPCC PCAs by 1998 Pres. Request | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | FY 96 Actual | FY 97 Pres. | FY 97 Est. | FY 98 Rqst. | HECC | LSN | HCS | HuCS | ETHR |
| NSFNET | | All HPCC Agencies | 44.04 | 41.64 | 41.64 | 44.50 | | 44.50 | | | |
| Supercomputer Centers | | DARPA, NASA, NIH | 69.36 | 57.73 | 57.73 | 53.17 | 53.17 | | | | |
| Computing Systems | | | | 47.16 | 47.16 | 51.92 | 51.02 | | 0.90 | | |
| Human Centered Systems | | | | 48.10 | 48.10 | 50.07 | | | | 50.07 | |
| Networking, Communications and the Convergence of Computing &Comm. | | DARPA,DOE,NASA | | 19.92 | 19.92 | 26.05 | | 26.05 | | | |
| Applications | | DARPA,NASA,... | | 55.21 | 55.21 | 59.85 | 28.71 | 8.65 | | 10.10 | 12.39 |
| Education and Training | | DARPA,NASA,... | 16.62 | 9.75 | 9.75 | 8.57 | | | | | 8.57 |
| Research Centers | | | 11.38 | | | | | | | | |
| Research Infrastructure | | | 18.20 | | | | | | | | |
| Grand Challenge Applications Groups | | ARPA, EPA | 7.32 | | | | | | | | |
| Computing Systems and Components | | | 17.20 | | | | | | | | |
| Software Systems and Algorithms | | | 26.66 | | | | | | | | |
| Ubiquitous Computing and Communication | | ARPA, DOE, NASA | 14.44 | | | | | | | | |
| Human-Machine Interaction & Information Access | | ARPA | 15.69 | | | | | | | | |
| Biological Sciences (non-NC/GC) | | | 12.42 | | | | | | | | |
| Engineering (non-NC/GC) | | | 4.73 | | | | | | | | |
| Geosciences (non-NC/GC) | | NASA, NOAA | 4.66 | | | | | | | | |
| Computational Mathematics (non-NC/GC) | | | 8.19 | | | | | | | | |
| Physical Sciences (non-NC/GC) | | NIST | 9.50 | | | | | | | | |
| Social, Behavioral & Economic Sciences (non-NC/GC) | | | 2.14 | | | | | | | | |
| National Challenges | | ARPA, NASA | 8.55 | | | | | | | | |
| Totals: | | | 291.10 | 279.51 | 279.51 | 294.13 | 132.90 | 79.20 | 0.90 | 60.17 | 20.96 |

# National Science Foundation

## Comparison of FY 1997 and FY 1998 by Program Component Area

| Program Activity | Budget (BA, $ M) | | | | HPCC PCAs by 1998 President's Request | | | | | HPCC PCAs by 1997 Estimated | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | FY 96 Actual | FY 97 Pres. | FY 97 Est. | FY 98 Rqst. | HECC | LSN | HCS | HuCS | ETHR | HECC | LSN | HCS | HuCS | ETHR |
| NSFNET | 44.04 | 41.64 | 41.64 | 44.50 | | 44.50 | | | | | 41.64 | | | |
| Supercomputer Centers | 69.36 | 57.73 | 57.73 | 53.17 | 53.17 | | | | | 57.73 | | | | |
| Computing Systems | | 47.16 | 47.16 | 51.92 | 51.02 | | 0.90 | | | 45.95 | | 1.21 | | |
| Human Centered Systems | | 48.10 | 48.10 | 50.07 | | | | 50.07 | | | | | 48.10 | |
| Networking, Communications and the Convergence of Computing & Comm. | | 19.92 | 19.92 | 26.05 | | 26.05 | | | | | 19.92 | | | |
| Applications | | 55.21 | 55.21 | 59.85 | 28.71 | 8.65 | | 10.10 | 12.39 | 25.49 | 8.20 | | 9.66 | 11.86 |
| Education and Training | 16.62 | 9.75 | 9.75 | 8.57 | | | | | 8.57 | | 2.50 | | | 7.25 |
| Research Centers | 11.38 | | | | | | | | | | | | | |
| Research Infrastructure | 18.20 | | | | | | | | | | | | | |
| Grand Challenge Applications Groups | 7.32 | | | | | | | | | | | | | |
| Computing Systems and Components | 17.20 | | | | | | | | | | | | | |
| Software Systems and Algorithms | 26.66 | | | | | | | | | | | | | |
| Ubiquitous Computing and Communication | 14.44 | | | | | | | | | | | | | |
| Human-Machine Interaction & Information Access | 15.69 | | | | | | | | | | | | | |
| Biological Sciences (non-NC/GC) | 12.42 | | | | | | | | | | | | | |
| Engineering (non-NC/GC) | 4.73 | | | | | | | | | | | | | |
| Geosciences (non-NC/GC) | 4.66 | | | | | | | | | | | | | |
| Computational Mathematics (non-NC/GC) | 8.19 | | | | | | | | | | | | | |
| Physical Sciences (non-NC/GC) | 9.50 | | | | | | | | | | | | | |
| Social, Behavioral & Economic Sciences (non-NC/GC) | 2.14 | | | | | | | | | | | | | |
| National Challenges | 8.55 | | | | | | | | | | | | | |
| Totals: | 291.10 | 279.51 | 279.51 | 294.13 | 132.90 | 79.20 | 0.90 | 60.17 | 20.96 | 129.17 | 72.26 | 1.21 | 57.76 | 19.11 |

| NSF | NSFNET | Budget Code | |
|---|---|---|---|

The purpose of the NSFNET program activity is to provide for the high performance data networking needs of the U.S. research and education community.

The new very high speed network backbone service (the 'vBNS') links NSF-supported high performance computing centers, and links are being established competitively to research institutions with scientific applications that demand the performance available. This is expected to improve greatly the networking support for science, engineering, and education today while developing applications and technology for the Internet of the future.

For less demanding, general-purpose networking needs of the community, this activity supplies funds to regional networks --most of which have their roots in regional university consortia, and, under the Connections Program, to individual academic institutions needing Internet connectivity. Together with networking programs in other Federal agencies, the NSFNET program activity participates in funding administrative functions of the Internet, and collaborates in provisioning international Internet links. The NSFNET activity also supports technical development in such areas as database access and bibliographic protocols, routing and addressing, security and privacy, and network management.

More than 1,100 U.S. colleges and universities have been connected to the Internet through the NSFNET program activity, and several thousand high schools have had their connection facilitated. Libraries, medical schools, and public health facilities have also been connected. The program activity has directly stimulated the emergence of a vigorous and highly competitive private-sector industry in Internet hardware, software, and connectivity in which the U.S. is a world leader with an overwhelmingly positive balance of trade.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 44.04 |
| FY 97 Pres | 41.64 |
| FY 97 Est. | 41.64 |
| FY 98 Rqst. | 44.50 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | 41.64 | 44.50 |
| HCS | | |
| HuCS | | |
| ETHR | | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Continue to expand connection of qualifying scientific applications to the vBNS.<br>Participate with other Federal agencies and the private sector in implementing new network-layer protocol on the Internet.<br>Support connection of 50 additional institutions to the Internet.<br>Pilot deployment of emerging privacy and security tools for the Internet. | As a result of ongoing privatization, reduce support of commodity-level network services to educational institutions, and increase support of very high bandwidth services which focus on experimental applications of high bandwidth networks and international networking.<br>Among the applications areas targeted for emphasis are distributed high performance computing, information based learning technologies, remote visualization and imaging, and tele-collaboration. | Increase support for experimental activities demonstrating high performance networking applications.<br>Support experimental projects that integrate research and education through the use of high speed networking. |

**Agency Ties**

| | |
|---|---|
| DARPA | Partner |
| NSF | |
| DOE | Partner |
| NASA | Partner |
| NIH | Partner |
| NSA | User |
| NIST | User |
| NOAA | User |
| EPA | User |
| ED | User |
| AHCPR | User |
| VA | User |

| NSF | **Supercomputer Centers** | Budget Code | |
|---|---|---|---|

Under the NSF Supercomputer Centers Program, the four centers are:
1. Cornell National Supercomputer Facility at Cornell University;
2. National Center for Supercomputing Applications at the University of Illinois;
3. Pittsburgh Supercomputing Center at Carnegie Mellon University, University of Pittsburgh,and Westinghouse;
4. San Diego Supercomputer Center at the University of California at San Diego.

They represent major activities that serve the computational needs of all NSF science and engineering disciplines by providing over 6,600 users from all 50 States access to state-of-the-art high performance computing resources. Additional activities at the Centers include: information on and access to emerging technologies; software tools for high performance computing; support for Grand Challenge applications and data intensive applications; and education, training, and outreach at all levels. The Centers have pioneered partnerships with the private sector working to introduce HPC technologies into national industries to solve design and manufacturing problems. They are also involved in testing the next generation network capabilities, including developing tools for ease of network navigation.

The Supercomputer Centers Program is being replaced by the Partnerships for Advanced Computational Infrastructure Program whose goals are to:

Provide, facilitate, and enhance access to state of the art high performance computational infrastructure for the academic community;
Promote vigorous early use of experimental and emerging high performance computational and associated communications technologies;
Enable the effective use of such infrastructure and technologies through education, training, consulting, and related support services;
Foster interdisciplinary research in science and engineering;
Facilitate the development of the intellectual capital required to maintain world leadership in computational science and engineering; and
Broaden the base for the nation's advanced computational and communications infrastructure.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 69.36 |
| FY 97 Pres | 57.73 |
| FY 97 Est. | 57.73 |
| FY 98 Rqst. | 53.17 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | 57.73 | 53.17 |
| LSN | | |
| HCS | | |
| HuCS | | |
| ETHR | | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Renew Supercomputer Centers cooperative agreements.<br>Establish National Metacenter as a seamless national computing environment across all four NSF Centers and other affiliates.<br>Establish parallel computing as production method in computational research.<br>Provide access to computer systems with capacity approaching a teraFLOP.<br>Support demonstration of National Challenge applications.<br>Release announcement for the Partnerships for Advanced Computational Infrastructure Program competition. | Complete competition of Partnerships for Advanced Computational Infrastructure Program and initiate awards in order to provide access to high performance computing for the academic research community at a level of one to two orders of magnitude greater than that typically available at a major research university. | Complete transition of Supercomputer Centers Program to Partnerships for Advanced Computational Infrastructure Program. |

**Agency Ties**

| | |
|---|---|
| DARPA | Partner |
| NSF | |
| DOE | |
| NASA | Partner |
| NIH | Partner |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| NSF | **Computing Systems** | Budget Code | |
|---|---|---|---|

Computing Systems Research is concerned with developing a fundamental understanding of computing systems, including their design and implementation,and the evaluation of novel computing and information processing systems and architectures with respect to their design criteria, usually involving high levels of performance. Computing Systems deals with computer architecture, hardware implementation, system software(compilers, operating systems), interconnection networks, storage and I/O architectures, and novel computing structures and technologies that hold the promise for radically new computer systems of the next century. A unifying 'systems' focus is the development and demonstration of balanced, scalable, parallel systems that can gracefully scale across a wide range of underlying numbers of processor nodes and interconnection structures.

TECHNOLOGY: (1) design and evaluation of instruction set architectures and the organization of central processing units; (2) memory systems; (3) computer system interfaces to communications networks and other high speed peripherals; (4) multilevel storage structures; (5)interconnection structures among processors, memories, and input/output channels; (6)compilers; (7) operating systems; (8) parallel algorithms; (9) fault tolerant and redundant hardware structures; and (10) high-performance input/output systems.

FOUNDATIONS: Development of a fundamental understanding of architectural design,interconnection structures, computational complexity, programming language semantics, and models of computation, with current emphasis on parallel and distributed algorithms and systems.

EXPERIMENTAL: Design, construction, and evaluation of high performance computing systems.

INFRASTRUCTURE: Access to high performance networks and computing systems for teams of university researchers.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | |
| FY 97 Pres | 47.16 |
| FY 97 Est. | 47.16 |
| FY 98 Rqst. | 51.92 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | 45.95 | 51.02 |
| LSN | | |
| HCS | 1.21 | 0.90 |
| HuCS | | |
| ETHR | | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| These are reported under Computing Systems and Components and Software Systems and Algorithms for FY 96. | Continue an initiative, begun in FY 1996, to explore problem-solving environments for computation in science, through a multi-disciplinary approach.<br>Begin a new initiative on improved methods for software engineering, making use of powerful, mathematically-based techniques for analysis and synthesis of software systems.<br>Begin a new, inter-disciplinary initiative to apply massively parallel computing using biological materials, including DNA.<br>Determine whether and how the understanding that enabled the VLSI revolution might be reapplied to the design of electromechanical systems.<br>Continue support of research that can enable more effective compilers for both tightly coupled and loosely distributed parallel systems.<br>Enable rapid advances in design for nano-manufacturing by supporting research to determine how formal, automated design techniques can be utilized.<br>Initiate a new program in experimental software systems to exploit previously supported research of a more conceptual or theoretical nature. | Continue support of a broad, academic research program in computing systems.<br>Support Knowledge Networking, an initiative focused on the next generation of interconnected networks and associated database and collaborative technologies.<br>Support a program of interdisciplinary research in computer and information science and engineering focused on problems requiring scientific advances across multiple subdivisions of computational science and engineering. |

**Agency Ties**

| | |
|---|---|
| DARPA | Partner |
| NSF | |
| DOE | |
| NASA | |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| NSF | **Human Centered Systems** | Budget Code | |
|---|---|---|---|

Human-centered Systems research is concerned with improving the interactions among humans, computing systems, and information resources. Among the research issues addressed are data capture; information store, management and access; knowledge representation, delivery and distribution; intelligent human and computer interfaces; group and organizational interactions; determination of usability and adaptability; and programming paradigms and software environments tailored to problem domains and task specifications. The key challenge in this research is how to harness new information technologies for the benefits of diverse end users.

TECHNOLOGY: (1) Intelligent sensors and input/output devices; (2) Database and knowledge processing technology for data capture and store, knowledge acquisition and representation, information management and retrieval, and knowledge mining; (3) Human-system interfaces, including speech recognition, natural language understanding, and other modalities of human/machine communication; (4) Multi-media information technologies; (5)Machine learning technology, enabling the system to adapt its operations and interactions to human preferences; (6) Collaboration technology; (7) Virtual environments, including both the advanced simulation and modeling technology and the virtual enterprise technology enabling the restructuring of businesses and corporations in the distributed workplace; (8) End-user enhancement technology, including large-scale robotics and very small-scale, embedded systems.

FOUNDATIONS: Development of the fundamental theories and models required to understand basic aspects of human/computer interactions.

EXPERIMENTAL: Design, construction, and evaluation of systems to support human/computer interactions and to validate models and theories for that interaction.

INFRASTRUCTURE: Access to high performance networks and computing systems for teams of university researchers and development of sharable data resources to support experimental work and large scale user evaluation.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | |
| FY 97 Pres | 48.10 |
| FY 97 Est. | 48.10 |
| FY 98 Rqst. | 50.07 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | | |
| HCS | | |
| HuCS | 48.10 | 50.07 |
| ETHR | | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| These are reported under Human-Machine Interaction and Information Access. | Continue the Digital Library projects, a joint research initiative with DARPA and NASA, and support related new work in very large databases and knowledge repositories.<br>As part of a long-term goal to enable better and more facile access to information and computing resources by ordinary citizens emphasize research including virtual environments,multi-modal human-computer communications and human-language technology.<br>Increase support for research in information-based learning technologies with the potential to transform education at all levels in the 21st century and form a new enabler for the integration of research and education.<br>Initiate the multi-agency program, STIMULATE: Speech, Text, Image, and MUltimedia Advanced Technology Effort, in order to understand multimodal human communication and apply it to computer technology. | Continue support of a broad, academic research program in human centered systems.<br>Support Knowledge Networking, an initiative focused on the next generation of interconnected networks and associated database and collaborative technologies.<br>Support a program of interdisciplinary research in computer and information science and engineering focused on problems requiring scientific advances across multiple subdivisions of computational science and engineering.<br>Increase support of Learning Technologies to enable information technologies to help transform education in the 21st century. |

**Agency Ties**

| | |
|---|---|
| DARPA | Partner |
| NSF | |
| DOE | |
| NASA | |
| NIH | |
| NSA | Partner |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| NSF | **Networking, Communications and the Convergence of Computing & Comm.** | Budget Code | |
|---|---|---|---|

The overall goal is to facilitate access to information and computing in order to overcome effectively and efficiently distance and time barriers. Networking research focuses on architecture, protocols, and performance of different types of networks including high band-width networks with multiple qualities of service guarantees, as well as wireless and all-optical networks. Communications research focuses on improving communication over optical and electromagnetic channels and the systems that enable that communication and on developing new approaches to digital storage systems. It is increasingly important to explore communications, computing, and networking as a single system. This convergence is emerging as computers become more universal and integrated parts of networked environments, communication becomes mostly digital, distributed databases become networked, the demand for interactive and on-demand multimedia services increases, and on-demand remote computing becomes available.

TECHNOLOGY: (1) Network access and control protocols; (2) Network management tools& techniques; (3) Wireless networks; (4) Mobile computing; (5) Optical systems; (6) Software to support distributed computing; (7) Software to support resource discovery and access to networked resources; (8) I/O devices & subsystems.

FOUNDATIONS: Theoretically based techniques for the design, specification, analysis,implementation, testing, maintenance, and modification of architectures and protocols for networks and on-demand remote computing systems.

EXPERIMENTAL: Design, construction, and evaluation of networking, communications,and on-demand remote computing systems.

INFRASTRUCTURE: Multiple levels ranging from laboratory optical networks to wide area, complex, high speed networks; from wireless systems to widely distributed databases and network storage devices, and networks of workstations to networks of supercomputers. The gigabit testbeds are examples of infrastructure that supports research integrating communications, networking and computing. The vBNS is another example of infrastructure that will support several classes of research activity.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | |
| FY 97 Pres | 19.92 |
| FY 97 Est. | 19.92 |
| FY 98 Rqst. | 26.05 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | 19.92 | 26.05 |
| HCS | | |
| HuCS | | |
| ETHR | | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| These are reported under Software Systems and Algorithms and Ubiquitous Computing and Communication. | Support software systems research to enable the seamless convergence of computing and communications leading to a transparent information processing system.<br>Support new applications of very high bandwidth communications demonstrating the integration of research and education.<br>Increase emphasis on wireless communications and wireless network access, and on very broadband networks including optical networks.<br>Initiate a new experimental program in networking and communications focused on projects that address the convergence of computing, communications, and information. | Continue support of a broad, academic research program in networking, communications and the convergence of computing and communications.<br>Support Knowledge Networking, an initiative focused on the next generation of interconnected networks and associated database and collaborative technologies. |

**Agency Ties**

| | |
|---|---|
| DARPA | Partner |
| NSF | |
| DOE | User |
| NASA | User |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| NSF | **Applications** | Budget Code | |
|---|---|---|---|

Societal goals and the pursuit of fundamental knowledge in science and engineering identify the applications to be pursued. These applications fall into the following three categories:

High Performance Applications for Science and Engineering: These applications are intended to push the envelope of computational capabilities in order to enable new discoveries in science and engineering. Thus they require access to the highest performance computing systems available, interconnected by high speed networks. The Grand Challenge problems fall into this category.

High Confidence Applications for Dynamic Enterprises: These applications are intended to push the envelope of information processing in order to demonstrate and advance new technologies in the Information Age. Improvements in integration, privacy, security, and reliability of information flows within and across organizations are a consequence of pursuing these applications. Some of the National Challenge problems are examples of this type of application.

High Capability Applications for the Individual: These applications are focused on societal needs and are enabled by universal, easy to use access to information resources, powerful methods of presenting information for ease of understanding, and customization of 'information space' for personal use. National Challenges such as digital libraries and medical information servers are examples of this type of application.

These applications have one or both of the following attributes. They will drive and stress the enabling research areas outlined in the descriptions of Computing Systems, Human Centered Systems, and Networking, Communications, and the Convergence of Computing &Communications given elsewhere in this document; they will lead to a paradigm shift in the application area involving a fundamentally different way of solving an important class of problems. The applications come from the physical and biological sciences, geosciences, social and behavioral sciences, and engineering.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | |
| FY 97 Pres | 55.21 |
| FY 97 Est. | 55.21 |
| FY 98 Rqst. | 59.85 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | 25.49 | 28.71 |
| LSN | 8.20 | 8.65 |
| HCS | | |
| HuCS | 9.66 | 10.10 |
| ETHR | 11.86 | 12.39 |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| These are reported under Grand Challenges Applications Groups,Biological Sciences, Engineering, Geosciences, Computational Mathematics, Physical Sciences,Social, Behavioral, and Economic Sciences, and National Challenges. | Continue support of the Grand Challenges and National Challenges initiated in FY 1993, FY 1994, and FY 1995.<br>Continue to support the paradigm shift involving increased use of high performance computing to enhance or replace the experimental phase of the scientific method.<br>Continue the Digital Library projects, a joint research initiative with DARPA and NASA, and support related new work in very large databases and knowledge repositories. | Continue support of a broad spectrum of applications that stress high performance computing and communications and/or that demonstrate the potential impact of high performance computing and communications on particular science or engineering disciplines. |

**Agency Ties**

| | |
|---|---|
| DARPA | Partner |
| NSF | |
| DOE | |
| NASA | Partner |
| NIH | |
| NSA | |
| NIST | Partner |
| NOAA | Partner |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| NSF | **Education and Training** | Budget Code | |
|---|---|---|---|

The program in education and training is focused on increasing the pool of people with the knowledge, skills and insights to lead research in the science and technology required to make high performance computing and information processing more easily utilized, and to apply those developments in the pursuit of fundamental knowledge in all disciplines of science and engineering. A secondary goal is to increase the percentage of the populace with an understanding of the power of and opportunities for high performance computing and information processing in the 21st century. Example activities include:

MOSIS - An activity training students and providing research infrastructure for the design and manufacture of custom VLSI chips.

Undergraduate Education - An activity which provides funding for new course and curriculum development in high performance computing and communication and information processing.

Research Experiences for Undergraduates - Opportunities for undergraduates to perform research in high performance computing and communication and information processing.

Postdoctoral Research Associates - Postdoctoral training in computational science and engineering and experimental computer science.

Pilot Educational Networks - Develop networks to develop, implement, test, and evaluate applications of computer and communications to education.

Network Infrastructure for Education - A joint CISE-EHR activity that addresses issues of large-scale networking for education.

Collaborative Research on Learning Technologies - A multi-directorate activity involving CISE, ENR, ENG, and MPS that addresses the integration of technology with learning at all levels of education.

| Milestone Changes | The new program in Learning Technologies previously planned for initiation in FY 1997 was actually begun in FY 1996. |
|---|---|

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Evaluate and analyze ongoing educational networking projects to create a base of knowledge for successful user-driven model transfer and expansion.<br>Support large-scale models for educational applications of Digital Libraries.<br>Monitor and evaluate existing projects that demonstrate scalability, cost/benefits, policy, effective applications and other characteristics of successful user-driven models of computer networking in education.<br>Develop plans for technology transfer of networked-based educational materials.<br>Initiate a new program in Learning Technologies that will combine human centered information systems research with research in education to provide the basis for the next generation of technologies for education. | Increase support for the incorporation of research findings into the undergraduate curriculum.<br>Increase support for the integration of research and education through supplements to existing research awards and through the initiation of new programs.<br>Expand the program in Learning Technologies that combines human centered information systems research with research in education to provide the basis for the next generation of technologies for education.<br>Support research projects that integrate technology with learning.<br>Support at least one real or virtual Center for Collaborative Research on Learning Technologies. | Continue support of activities that advance education and training in high performance computing and communications at all levels.<br>Promote a collaborative research and development agenda to advance understanding of learning, creativity and productivity. |

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 16.62 |
| FY 97 Pres | 9.75 |
| FY 97 Est. | 9.75 |
| FY 98 Rqst. | 8.57 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | 2.50 | |
| HCS | | |
| HuCS | | |
| ETHR | 7.25 | 8.57 |

**Agency Ties**

| | |
|---|---|
| DARPA | Partner |
| NSF | |
| DOE | |
| NASA | |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| NSF | **Research Centers** | Budget Code | |
|---|---|---|---|

The HPCC program provides support for four Science and Technology Centers. These centers share several important characteristics: a unifying, cross-disciplinary intellectual focus; an emphasis on knowledge-transfer and linkages with private sector organizations; and significant education and outreach components. The centers and their focus are:

Center for Research in Parallel Computation, CRPC, at Rice University -- making parallel computers as easy to use as conventional computers;

Center for Computer Graphics and Scientific Visualization, CG & SV, at the University of Utah -- building and displaying models that are visually and measurably indistinguishable from real world entities;

Center for Discrete Mathematics and Theoretical Computer Science, DIMACS, at Rutgers University -- applying discrete mathematics and theoretical computer science to the solution of fundamental problems in science and engineering;

Center for Cognitive Science at the University of Pennsylvania -- human cognition, perception, natural language processing, and the application of parallel computation.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 11.38 |
| FY 97 Pres | |
| FY 97 Est. | |
| FY 98 Rqst. | |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | | |
| HCS | | |
| HuCS | | |
| ETHR | | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Build models that are visually and measurably indistinguishable from real-world entities.<br>Provide universal Fortran-based language for which vendors can provide efficient compilers and which will assure program portability.<br>Identify and exploit applications areas where discrete mathematics and theoretical computer science developments can lead to more accurate and efficient computations.<br>Begin a special year on Logic and Algorithms at DIMACS focused on the relationship between mathematics and computational algorithms. | This activity is now incorporated into the activities described under Computing Systems and Human-Centered Systems. | |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | |
| DOE | |
| NASA | |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| NSF | **Research Infrastructure** | Budget Code | |
|---|---|---|---|

The Research Infrastructure activity aids in the establishment,enhancement, and operation of major experimental facilities and in the acquisition of equipment such as workstations in order to support research activities in the areas of computer and information science, computer engineering, or computational science. In general, support is provided for equipment, maintenance, technical support staff, and other appropriate costs. The groups supported range from single researchers requiring workstations to cross departmental or cross institutional groups requiring access to special purpose instrumentation.

The largest part of the activity is the Institutional Infrastructure Program. The program activity supports both the acquisition of Scalable Parallel computers for research in parallel computing and computational science and engineering and the acquisition of facilities for experimental research.

The Research Instrumentation program, a smaller activity, supports experimental research with awards for workstations for experimental facilities and also for smaller Scalable Parallel computers.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 18.20 |
| FY 97 Pres | |
| FY 97 Est. | |
| FY 98 Rqst. | |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | | |
| HCS | | |
| HuCS | | |
| ETHR | | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Conduct formal evaluation of existing programs to adjust to the infrastructure needs of experimental research in computing disciplines supporting HPCC.<br>Develop infrastructure support for basic research necessary for educational uses of the NII.<br>Continue infrastructure support for virtual manufacturing, and other applications of information infrastructure technologies<br>Increase participation in the NIE program. | This activity is now incorporated into the activities described under Computing Systems, Human-Centered Systems, Networking, Communications and the Convergence of Computing and Communications, and Applications. | |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | |
| DOE | |
| NASA | |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| NSF | **Grand Challenge Applications Groups** | Budget Code | |
|---|---|---|---|

This activity supports multidisciplinary groups of scientists, engineers, mathematicians, and computer scientists to apply emerging high performance computing and communications systems to advance the solution of fundamental problems in science and engineering. These activities will generate significant new research in mathematics, computer science, engineering, and other scientific disciplines. The groups are listed below.

High Performance Computing for Learning--Massachusetts Institute of Technology
High Performance Computing for Land Cover Dynamics--University of Maryland
Black Hole Binaries: Coalescence and Gravitational Radiation--University of Texas
High Performance Imaging in Biological Research--Carnegie Mellon University
Earthquake Ground Motion Modeling in Large Basins--Carnegie Mellon University
Computational Biomolecular Design--University of Houston
Adaptive Coordination of Predictive models with Experimental Observations--Stanford University
The Formation of Galaxies and Large-Scale Structure--Princeton University
High Performance Computational Methods for Coupled Field Problems and GAFD Turbulence--University of Colorado at Boulder
Radio Synthesis Imaging: An HPCC Application--University of Illinois at Champaign-Urbana
High Capacity Atomic-Level Simulations for Design of Materials Modeling--Carnegie Mellon University
A Distributed Computational System for Large Scale Environmental Modeling--California Institute of Technology
Parallel I/O Methodologies for I/O-Intensive Grand Challenge Applications--California Institute of Technology
Understanding Human Joint Mechanics Through Advanced Computational Models--Rensselaer Polytechnic Institute
Massively Parallel Simulation of Large Scale, High Resolution Ecosystem Models Determination, University of Illinois

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Extend face recognition system to larger data sets including recognition in groups.<br>Release of Scientist's Visual Workbench to astronomers, with development versions of interactive, distributed visualization and remote rendering of very large images.<br>Demonstrate effectiveness of Archimedes, a special purpose compiler for unstructured mesh computations, through simulation of the seismic response of Los Angeles Basin.<br>Enhance the CM-5 watershed simulation model with hydrological/ecological relationships to demonstrate increased realism within reasonable run times.<br>Begin work with industry to produce an affordable, stand- alone successor to AIM, with specialized high performance computing hardware built in. | This activity is now incorporated into the activity described under Applications. | |

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 7.32 |
| FY 97 Pres | |
| FY 97 Est. | |
| FY 98 Rqst. | |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | | |
| HCS | | |
| HuCS | | |
| ETHR | | |

**Agency Ties**

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|---|---|
| DARPA | Partner |
| NSF | |
| DOE | |
| NASA | |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | User |
| ED | |
| AHCPR | |
| VA | |

| NSF | **Computing Systems and Components** | Budget Code | |
|---|---|---|---|

Advances in computing systems and components requires that prototype systems be built quickly and cheaply, and new kinds of design tools need to be developed for this to take place. Prototype systems allow evaluation of new application-driven and technology-driven systems by 'exercising' them with real applications that provide realistic tests of novel ideas and performance.

Included in this activity is research on:

Systems architecture, including application-specific systems and memory hierarchy;

Early prototyping and evaluation of hardware and software systems;

New tools for systems level automated design and prototyping;

Distributed design and intelligent manufacturing capabilities; and

Optical communications systems and devices.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 17.20 |
| FY 97 Pres | |
| FY 97 Est. | |
| FY 98 Rqst. | |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | | |
| HCS | | |
| HuCS | | |
| ETHR | | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Start projects to integrate high-performance memory hierarchies into low-power machines for ubiquitous computing.<br>Develop new research areas in high performance computing guided by progress in FY 1994 and FY 1995 and by workshops. | This activity is now incorporated into the activity described under Computing Systems. | |

**Agency Ties**

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| DARPA | |
| NSF | |
| DOE | |
| NASA | |
| NIH | |
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| NIST | |
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| EPA | |
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| AHCPR | |
| VA | |

| NSF | **Software Systems and Algorithms** | Budget Code | |
|---|---|---|---|

Research emphasizes the development of scalable parallel algorithms and software technologies, and the development of problem solving environments. Areas of research include:

Parallel languages and optimizing compilers;
Parallel operating systems;
Performance evaluation and prediction;
High performance systems for numeric and symbolic computations;
Parallel algorithms and data structures;
Algorithms for biological applications;
Problem solving environments;
Software engineering;
Computer graphics;
Computational geometry; and
Real-time systems.

In addition, a significant fraction of the activity is devoted to fundamental research, with potential impact on high performance computing, in areas such as the theory of computing,software engineering, and theoretical aspects of computer systems and operating systems.

The activity also includes a postdoctoral program for interdisciplinary computational scientists.

**Budget ($ M)**

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|---|---|
| FY 96 Act | 26.66 |
| FY 97 Pres | |
| FY 97 Est. | |
| FY 98 Rqst. | |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | | |
| HCS | | |
| HuCS | | |
| ETHR | | |

**Agency Ties**

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|---|---|
| DARPA | |
| NSF | |
| DOE | |
| NASA | |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Increase the support for compiler and operating systems research focused on heterogeneous, geographically distributed collections of computing systems.<br>Introduce a sabbatical program to support scientists and engineers to become more proficient in applying parallel computing technology to their disciplines.<br>Initiate a program to bring promising computer science research to a point of maturity that will permit evaluation by the user community.<br>Identify and exploit applications areas where discrete mathematics and theoretical computer science developments can lead to more accurate and efficient computations.<br>Extend ongoing research in parallel and distributed computing to address problems for universal services including heterogeneity, interoperability, and real-time operating systems. | This activity is now incorporated into the activities described under Computing Systems and Networking, Communications and the Convergence and Computing and Communications. | |

| NSF | **Ubiquitous Computing and Communication** | Budget Code | |
|---|---|---|---|

The focus of this program activity is basic research on technology for the transfer of information from one point in space to another (transmission and networking) and/or one point in time to another (information storage and retrieval) including multiple access techniques to enable effective collaborative access to information resources. Research issues include: the efficient utilization of spectral bandwidth for wireless and wired systems; new architectures and multiple access techniques for lightwave systems; optical technologies; reliable and secure transmission or storage of information in local and in multiple access environments; and fundamental aspects of the characterization, control, and management,of information networks.

Areas of currently funded research include:

Gigabit testbed research;
Design and analysis of gigabit switching systems;
Protocols and software structures for network management;
Resource discovery among collaborative information spaces in large, decentralized environments;
Network information theory;
Multi-sender and multi-receiver network security;
Modulation, detection, and coding of reliable information storage and retrieval;
All optical networks; and
Optical technologies for computing and communications.

| Milestone Changes | The name of this activity has been changed from Very High Speed Networks and Communications in the previous Implementation Plan to reflect the broader nature of the program. |
|---|---|

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Build on new gigabit research infrastructure by funding research aimed at more effective utilization of large information resources; specifically, enabling access to, distribution of, and effective interactions with these resources.<br>Hold competitive program solicitation and make awards for wireless access testbeds.<br>Continue collaboration with ARPA in 10 Gb/s testbed initiated under the Technology Reinvestment Program.<br>Continue basic research in coding and coded modulation relevant to challenges in wireless access such as mobility management and channels of widely and rapidly fluctuating capacity.<br>Examine convergence of computing, entertainment, and telecommunications from the standpoint of the Internet experience and the Open Bearer Service. | This activity is now incorporated into the activity described under Networking, Communications and the Convergence of Computing and Communications. | |

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 14.44 |
| FY 97 Pres | |
| FY 97 Est. | |
| FY 98 Rqst. | |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | | |
| HCS | | |
| HuCS | | |
| ETHR | | |

**Agency Ties**

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|---|---|
| DARPA | Partner |
| NSF | |
| DOE | User |
| NASA | User |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| NSF | **Human-Machine Interaction & Information Access** | Budget Code | |
|---|---|---|---|

The focus of research in the area of human-machine interaction and information access is to advance the underlying scientific knowledge and technologies for creating and inserting an intelligent service layer that will significantly broaden the base of information providers, developers, and consumers, while reducing the existing barriers to accessing and using information and computing resources for real world applications.

Work supported in this area includes:

Human Language Technology--development of technologies for speech recognition, text understanding, multi-lingual language processing, including machine aided language translation;

Multi-modal Human-computer interfaces--image processing and computer vision, integrated with sound, text, and gesture recognition;

Very Large Knowledge Repositories--technologies for storing, accessing, and using large amounts and different varieties of data and information;

Virtual Environments/Collaboration Technology--sharable computing and communications environments which many can access, interact with, and use effectively across time/geographical and physical/artificial boundaries.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 15.69 |
| FY 97 Pres | |
| FY 97 Est. | |
| FY 98 Rqst. | |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | | |
| HCS | | |
| HuCS | | |
| ETHR | | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Initiate new and extend ongoing research in user-centered design,including models, interfaces, and programming tools for rapid prototyping.<br>Demonstrate results of research in coordination theory, collaboration technology, and group-oriented software tools.<br>Initiate new and extend ongoing research in novel modalities of human-computer communications (e.g., face and gesture recognition and sensor-motor control), modeling and simulation, virtual reality, and problem-solving environments.<br>Accelerate development of techniques to capture, store, access, refine, search distribute,preserve, and interactively use complex information over high capacity communication channel sin very large knowledge repositories. | This activity is now incorporated into the activity described under Human-Centered Systems. | |

**Agency Ties**

| | Partner |
|---|---|
| DARPA | |
| NSF | |
| DOE | |
| NASA | |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
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| NSF | **Biological Sciences (non-NC/GC)** | Budget Code | |
|---|---|---|---|

Many areas of both basic and applied biology require the use of computational tools to resolve significant questions. HPCC has had a dramatic impact on many of these areas. Three examples are mentioned below. Each one must analyze experimental results, construct detailed theory and then interrelate the two. They must also develop database systems to handle heterogeneous databases and to develop networking technologies to link various databases. This program activity supports the development of necessary computational tools: software; optimization techniques; and large volume data accessing, storage and managing techniques. In addition, the activity supports modeling of biological phenomena on new computer architectures, which will allow new questions to be posed and answered in these areas. In many cases projects are supported that involve multidisciplinary groups of investigators.

Structural Biology: The challenge is to determine macromolecular structure, and to relate structure to function. Determining structure of a molecule directly from experimental data or inferring it through comparison with known structures are computationally intensive problems that will not be solved without HPCC systems. The impact of solving these problems will be felt in both basic and applied biology, e.g., rational drug design, as well as biomaterials.

Neuroscience: The challenge is to understand how networks of neurons work, and ultimately how the entire nervous system operates, from sensory systems to learning and memory. New HPCC architectures allow for explorations of these questions. The impact of further understanding of experimental and theoretical systems will be felt in the areas of health care (neuropharmacology, psychotherapy), artificial intelligence, and robotics.

Ecology: The challenge is to understand the relationship of individuals that interact at various scales, both spatial -- from microorganisms to higher organisms, from populations to entire ecosystems, ultimately to global scale -- and temporal -- from nanoseconds to geological time. The complexity of the data and of the relationships requires computational solutions. Impact of advances in this area will be felt on issues of global change, biodiversity, and the environment.

| Milestone Changes | Several Milestones listed below contribute to and benefit from other NSF themes such as Ubiquitous Computing and Communication and Human-Machine Interaction & Information Access. |
|---|---|

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Develop prototype information workplace of the 21st century including tools for use and accessibility of heterogeneous (multimedia) distributed databases.<br>Develop search tools for databases of images.<br>Develop postdoctoral and training programs in the use of high performance computing and information technology.<br>Begin partnerships with other agencies regarding information infrastructure support and maintenance, e.g., the Network of Networks.<br>Continue development of the Center for Ecological Analysis and Synthesis, and of models and tools to make computer simulations of biological phenomena more realistic over temporal and spatial scales. | This activity is now incorporated into the activity described under Applications. | |

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 12.42 |
| FY 97 Pres | |
| FY 97 Est. | |
| FY 98 Rqst. | |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | | |
| HCS | | |
| HuCS | | |
| ETHR | | |

**Agency Ties**

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|---|---|
| DARPA | |
| NSF | |
| DOE | |
| NASA | |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| NSF | **Engineering (non-NC/GC)** | Budget Code | |
|---|---|---|---|

The ENG Directorate supports fundamental engineering research by individual investigators and small groups that contribute to three components of the HPCC initiative: ASTA, BRHR, and IITA.

(1) Software tools and algorithms are developed and applied to the solution of computationally complex engineering problems utilizing parallel and distributed computing environments. Support is also provided for engineering groups addressing Grand Challenge problems, under NSF's Grand Challenge Application Groups initiative.

(2) Basic research is conducted on optical and optoelectronic technologies that are at the cutting edge for future advances in ultra-high-capacity computing and connectivity environments, and on the implementation of wireless network architectures and their interface to optical networks. Emphasis is on integration at the interface of devices, and on system level research that can help accelerate the implementation of these technologies.

(3) The basic tools, methodology, and information technologies are developed that underlie an expanded National Information Infrastructure. Support is also provided for multidisciplinary groups of engineers, computer scientists, and educators to integrate critical information systems under NSF's IITA initiative on National Challenges, such as in health care delivery, civil infrastructure systems, advanced manufacturing, environmental research, and engineering education.

| Milestone Changes | This activity supports other NSF themes such as Ubiquitous Computing and Communication and Human-Machine Interaction & Information Access. |
|---|---|

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Develop the basic tools, methodology, and information technologies in engineering that underlie an expanded National Information Infrastructure<br>Continue support of innovative approaches to computationally-complex engineering problems.<br>Initiate research in wireless network architectures and their interface with optical networks for ultra-high-capacity computing and connectivity environments.<br>Continue research at the device and systems level of advanced optical and optoelectronic technologies.<br>Continue interagency support for US users in US/Japan Joint Optoelectronics Project. | This activity is now incorporated into the activity described under Applications. | |

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 4.73 |
| FY 97 Pres | |
| FY 97 Est. | |
| FY 98 Rqst. | |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | | |
| HCS | | |
| HuCS | | |
| ETHR | | |

**Agency Ties**

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|---|---|
| DARPA | |
| NSF | |
| DOE | |
| NASA | |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| NSF | **Geosciences (non-NC/GC)** | Budget Code | |
|---|---|---|---|

Geosciences and the Office of Polar Programs HPCC activities build on a substantial infrastructure within the directorate. Incremental funds are used to enhance present activities and to synergistically integrate existing efforts into a geosciences program and the Global Change Research Program that is responsive and effective in using emerging technologies. The acquisition and testing (using Geoscience codes) of parallel computers of various architectures is being carried out to determine which technology offers the most promising capabilities. This initial work will guide the acquisition of a massively parallel machine in the FY 95-97 time frame.

Software that effectively uses parallel computers for geoscience problems is being developed and enhanced, including parallel algorithms to be used in models such as the Community Climate, global atmospheric chemistry, and eddy-resolving global ocean circulation models.

Extended activities are carried out to provide access to unique scientific and informational resources by connecting the Antarctic science facilities to the Internet for high speed data transmission (especially during the southern hemisphere winter) of global data,images from telescopes, and general interactive tele-science from remotely located experimental centers.

The education and training of geoscientists in high performance computing and communication is being addressed through a broad spectrum of courses ranging from program son a parallel computer to effective visualization techniques. These courses are offered at NCAR and the other NSF supercomputer centers. Graduate assistantships and postdoctoral positions that focus on HPCC activities are established at NCAR.

Technologies are being developed for Internet distribution of real-time geophysical data that have multiple sources at separate locations. Geoscience data necessary for monitoring global change is widely distributed with total databases anticipated to grow to 10's of petabytes. The development of services, standards, tools, and user interfaces for storing, finding, transmitting,manipulating, displaying, comparing, and analyzing three dimensional historical and near real-time geophysical data is a major activity. It is the aim of this effort to allow a university user transparent access to petabytes of geosciences data located at several centers from which data of interest can be selected.

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Replace shared memory computer at NCAR and upgrade MPP machines.<br>Complete final development phase of Earth Simulation models running on different computers.<br>Establish preliminary Volcano Network and fully implement geophysical data distribution.<br>Establish an HPCC graduate and postdoctoral program for geosciences and revise exiting postdoctoral program to add HPCC thrust. Six to eight people will be supported.<br>Enhance Mass Store software to effectively work with high performance MPP computers.<br>Bring to operation 1.5Mbps link at Palmer Station, Antarctica using ACTS satellite. | This activity is now incorporated into the activity described under Applications. | |

**Budget ($ M)**

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|---|---|
| FY 96 Act | 4.66 |
| FY 97 Pres | |
| FY 97 Est. | |
| FY 98 Rqst. | |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | | |
| HCS | | |
| HuCS | | |
| ETHR | | |

**Agency Ties**

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|---|---|
| DARPA | |
| NSF | |
| DOE | |
| NASA | Partner |
| NIH | |
| NSA | |
| NIST | |
| NOAA | Partner |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| NSF | **Computational Mathematics (non-NC/GC)** | Budget Code | |
|---|---|---|---|

Mathematics plays a central role in the drive to produce faster and more accurate algorithms that, in tandem with hardware advances, produce state-of-the-art simulations across the wide spectrum of the sciences. Research supported under this activity satisfies at least one of the following criteria:

Use of high performance computer systems and architectures as a testbed for research;
Innovative approaches to development of new algorithms, especially involving parallel and distributed, heterogeneous environments;
Information-intensive activities, such as wide-area data exchanges, interaction services, and electronic collaborations;
Unusual developments involving symbolic and numeric computation;
Mathematical questions involving the preparation of suitable tools for visualization.

This activity supports other NSF themes such as Software Systems and Algorithms,Ubiquitous Computing and Communication and Human-Machine Interaction & Information Access.

**Budget ($ M)**

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|---|---|
| FY 96 Act | 8.19 |
| FY 97 Pres | |
| FY 97 Est. | |
| FY 98 Rqst. | |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | | |
| HCS | | |
| HuCS | | |
| ETHR | | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Expand activities in algorithm research and development.<br>Expand development of computational tools exploiting new HPCC technologies.<br>Support development of, access to, and transmission of large complex databases, and development of specialized electronic libraries.<br>Enhance and disseminate software for geometric visualization and analysis.<br>Develop new algorithms blending statistical and geometric features to solve partial differential equations arising from problems with moving interfaces. | This activity is now incorporated into the activity described under Applications. | |

**Agency Ties**

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| DARPA | |
| NSF | |
| DOE | |
| NASA | |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| NSF | **Physical Sciences (non-NC/GC)** | Budget Code | |
|---|---|---|---|

This activity provides support for research on fundamental problems in Astronomy, Chemistry, Material Science, and Physics using state of the art vector supercomputers or emerging massively parallel systems. The emphasis is on developing models and solution techniques that provide for qualitative and quantitative improvements in the simulations. From these more accurate simulations the researchers are able to gain new insights into the nature of the physical phenomena being simulated. In addition, this activity broadens the base of users of advanced computing systems by exposing graduate students and postdoctoral researchers to the benefits of computational science as an intrinsic part of the scientific method.

This activity supports other NSF themes such as Software Systems and Algorithms,Ubiquitous Computing and Communication, and Human-Machine Interaction & Information Access.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 9.50 |
| FY 97 Pres | |
| FY 97 Est. | |
| FY 98 Rqst. | |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | | |
| HCS | | |
| HuCS | | |
| ETHR | | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Working parallelized versions of GAUSSIAN, CHARM, or other molecular dynamics codes will be available for public use at all of the NSF Supercomputer Centers.<br>Through the Supercomputer Centers and the parallelized versions of codes supported for public use, strengthen the ties between academic researchers and industrial affiliates.<br>As appropriate, establish interactions between NSF and NIST in applications of HPCC to computational modeling of materials.<br>Expand the CARM program to include computation for materials engineering problems.<br>Develop rapid, open, and widespread access to electronic preprints over a broad spectrum of physics, chemistry, astronomy, and materials science. | This activity is now incorporated into the activity described under Applications. | |

**Agency Ties**

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|---|---|
| DARPA | |
| NSF | |
| DOE | |
| NASA | |
| NIH | |
| NSA | |
| NIST | partner |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| NSF | **Social, Behavioral & Economic Sciences (non-NC/GC)** | Budget Code | |
|---|---|---|---|

The Division of Social, Behavioral and Economic Research(SBER) was created at the beginning of 1993, by amalgamation of many existing programs. SBER is currently engaged in the development of a general plan for computing in the social and behavioral sciences, and it is examining how best to contribute to the HPCC component, IITA. There are five program clusters in SBER, and each one has held a workshop on aspects of high performance computing that relate to its disciplines:

Cognitive, Psychological, and Language Sciences cluster: 'Cognitive Science' workshop;
Anthropological and Geographic Sciences cluster: 'Computational Geography' workshop;
Economics, Decision and Management Sciences cluster: 'Computational Economics' workshop;
Social and Political Sciences cluster: Artificial Social Intelligence' workshop; and
Science, Technology and Society cluster: 'Electronic Networks' workshop.

SBER will be heavily involved in the IITA component, because its goals are close to the social and behavioral sciences.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 2.14 |
| FY 97 Pres | |
| FY 97 Est. | |
| FY 98 Rqst. | |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | | |
| HCS | | |
| HuCS | | |
| ETHR | | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Launch new competition for multi-disciplinary research groups to conduct research in advanced computing for the social, behavioral, and economic sciences.<br>Support work on software and mathematical tools for the National Information Infrastructure.<br>Develop Cognitive Science activity in a partnership of the programs in Linguistics and in Human Cognition and Perception. | This activity is now incorporated into the activity described under Applications. | |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | |
| DOE | |
| NASA | |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| NSF | National Challenges | Budget Code | |
|---|---|---|---|

National Challenges are information intensive applications that have broad and direct impact on the Nation's well-being and economic competitiveness. The IITA component supports the use and integration of component technologies developed in other parts of HPCC to seek solutions to such applications. The research needed to accelerate these solutions will span a spectrum of activities from concept demonstrations and experimental testbeds to the actual delivery of application systems in specific domains. Areas identified for focus include:

Digital Libraries;
Advanced Manufacturing;
Education, Training, and Lifelong Learning;
Health Care;
Civil Infrastructure Systems;
Physical, Biological, and Geological Network Centers;
Government Information Delivery;
Environmental Monitoring;
Electronic Commerce;
Crisis Management;
Energy Management.

Initially, the NSF program will focus on the first seven activities.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 8.55 |
| FY 97 Pres | |
| FY 97 Est. | |
| FY 98 Rqst. | |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | | |
| HCS | | |
| HuCS | | |
| ETHR | | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Demonstrate preliminary results of research and the experimental testbeds developed under the Digital Libraries initiative.<br>Demonstrate results of research from National Challenges through workshops and symposia.<br>Initiate new research to accelerate development of enabling technologies (e.g., wireless,lightwave) for the NII to help provide universal access to diverse bitways, including high speed networks.<br>Expand programs in National Challenges. | This activity is now incorporated into the activity described under Applications. | |

**Agency Ties**

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|---|---|
| DARPA | Partner |
| NSF | |
| DOE | |
| NASA | Partner |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

# Department of Energy

DOE faces unprecedented challenges challenges as it approaches the 21st century. DOE is committed to:reducing the global nuclear danger through its national security and nonproliferation activities; replacing underground nuclear testing with science; understanding and dealing with risks associated with environmental problems resulting from nuclear weapons production during the Cold War; promoting clean and efficient supply of energy; ensuring continuing US world leadership in science and technology research; and maintaining U.S. global competitiveness through leadership in environmentally-conscious materials, technologies, and industrial processes.

The DOE High Performance Computing Program is focused on providing DOE with tools to address these challenges. It is a forefront, diverse applied mathematical sciences, high performance computing, communications and information infrastructure program which spans the spectrum of activities from strategic fundamental research to technology development and demonstration. The diverse activities supported by this program are integrated to support two major strategic thrusts: National Collaboratories (NC) and Advanced Computational Testing and Simulation (ACTS).

The thrust in National Collaboratories is developing a set of tools and capabilities which will permit scientists and engineers working at different DOE and other facilities to collaborate on solving problems as easily as if they were in the same building.

The thrust in Advanced Computational Testing and Simulation is developing an integrated set of algorithms, software tools and infrastructure which will enable computer simulation to be used in place of experiments when real experiments are too dangerous, expensive, inaccessible, or politically infeasible. These two strategic thrusts support the underlying mathematical concepts and information technology needs of all Department of Energy (DOE) mission areas (e.g., Defense, Energy Efficiency, Environmental and Fossil programs, etc.) and the efforts in these areas are closely coordinated with related activities supported by Defense Programs.

The DOE program also supports and responds to the Energy Policy Act (EPACT) and to the High Performance Computing Act of 1991 (also known as the Gore Bill) and provides supercomputer access and advanced communication capabilities (through the ESnet computer network) to scientific researchers. Finally, the this program also serves as an advocate within the Department to formulate and coordinate the Department's National Information Infrastructure (NII) initiative, especially to promote economically beneficial energy-related 'National Challenges' applications such as energy demand and supply management and to develop the underlying technologies to enable these applications.

**NOTE:**
Although this agency plan contains NGI related program activities, they solely represent the President’s request for funding. The U.S. Congress appropriated no funds for DOE participation in the NGI initiatives for FY 1998.

# Department of Energy

## FY 1998 President's Request by Program Component Area

| Program Activity | Budget Account Code | Partner/User Agencies | Budget (BA, $ M) | | | | HPCC PCAs by 1998 Pres. Request | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | FY 96 Actual | FY 97 Pres. | FY 97 Est. | FY 98 Rqst. | HECC | LSN | HCS | HuCS | ETHR |
| Advanced Computational Testing and Simulation Research | KJ0101, KJ3501 | | 35.81 | 35.49 | 36.50 | 36.74 | 33.74 | | | | 3.00 |
| Advanced Computational Testing and Simulation Research (continued) | KJ0101, KJ3501 | | | | | | | | | | |
| Grand Challenge Applications | KJ0101, KJ3501 | | 10.00 | 9.75 | 8.00 | 9.00 | 9.00 | | | | |
| Grand Challenge Applications (continued) | KJ0101, KJ3501 | | | | | | | | | | |
| National Collaboratory Research | KJ0102, KJ3501 | | 8.38 | 7.78 | 8.89 | 3.94 | | | | 3.94 | |
| National Collaboratory Research (continued) | KJ0102, KJ3501 | | | | | | | | | | |
| DOE2000 ACTS | KJ0101 | | | 4.88 | 2.50 | 5.00 | 5.00 | | | | |
| DOE2000 NC | KJ0102 | | 0.18 | 4.88 | 6.00 | 6.00 | | | | 6.00 | |
| National Energy Research Scientific Computing Center | KJ0102, KJ3501 | | 30.30 | 29.02 | 26.50 | 26.50 | 26.50 | | | | |
| National Energy Research Scientific Computing Center (continued) | KJ0102, KJ3501 | | | | | | | | | | |
| ESnet | KJ0102, KJ3501 | | 12.64 | 14.42 | 14.79 | 13.79 | | 13.79 | | | |
| ESnet (continued) | KJ0102, KJ3501 | | | | | | | | | | |
| High Performance Computing Resource Providers | KJ0102, KJ3501 | | 12.39 | 15.24 | 16.00 | 16.56 | 16.56 | | | | |
| Next Generation Internet | | DARPA. NSF, NASA, NSA, NIST | | | | 35.00 | | 35.00 | | | |
| Totals: | | | 109.69 | 121.46 | 119.18 | 152.53 | 90.80 | 48.79 | | 9.94 | 3.00 |

# Department of Energy

## Comparison of FY 1997 and FY 1998 by Program Component Area

| Program Activity | Budget (BA, $ M) | | | | HPCC PCAs by 1998 President's Request | | | | | HPCC PCAs by 1997 Estimated | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | FY 96 Actual | FY 97 Pres. | FY 97 Est. | FY 98 Rqst. | HECC | LSN | HCS | HuCS | ETHR | HECC | LSN | HCS | HuCS | ETHR |
| Advanced Computational Testing and Simulation Research | 35.81 | 35.49 | 36.50 | 36.74 | 33.74 | | | | 3.00 | 33.00 | | | | 3.50 |
| Advanced Computational Testing and Simulation Research (continued) | | | | | | | | | | | | | | |
| Grand Challenge Applications | 10.00 | 9.75 | 8.00 | 9.00 | 9.00 | | | | | 8.00 | | | | |
| Grand Challenge Applications (continued) | | | | | | | | | | | | | | |
| National Collaboratory Research | 8.38 | 7.78 | 8.89 | 3.94 | | | | 3.94 | | | | | 8.89 | |
| National Collaboratory Research (continued) | | | | | | | | | | | | | | |
| DOE2000 ACTS | | 4.88 | 2.50 | 5.00 | 5.00 | | | | | 2.50 | | | | |
| DOE2000 NC | 0.18 | 4.88 | 6.00 | 6.00 | | | | 6.00 | | | | | 6.00 | |
| National Energy Research Scientific Computing Center | 30.30 | 29.02 | 26.50 | 26.50 | 26.50 | | | | | 26.50 | | | | |
| National Energy Research Scientific Computing Center (continued) | | | | | | | | | | | | | | |
| ESnet | 12.64 | 14.42 | 14.79 | 13.79 | | 13.79 | | | | | 14.79 | | | |
| ESnet (continued) | | | | | | | | | | | | | | |
| High Performance Computing Resource Providers | 12.39 | 15.24 | 16.00 | 16.56 | 16.56 | | | | | 16.00 | | | | |
| Next Generation Internet | | | | 35.00 | | 35.00 | | | | | | | | |
| Totals: | 109.69 | 121.46 | 119.18 | 152.53 | 90.80 | 48.79 | | 9.94 | 3.00 | 86.00 | 14.79 | | 14.89 | 3.50 |

| DOE | **Advanced Computational Testing and Simulation Research** | Budget Code | KJ0101, KJ3501 |
|---|---|---|---|

This activity has three fundamental research components: Applied Mathematics, Computer Science, and Software Tools. In addition, this activity supports education activities which are focused on educating the next generation of computational scientists.

The applied mathematics research component develops theory, algorithms, and tools for enabling the solution of large scientific and engineering problems. This component supports leading-edge research at ten DOE laboratories and over 30 universities. Applied mathematicians and computational scientists supported by the basic research program are also active in Grand Challenge projects and other multidisciplinary research projects. Supported laboratory and university researchers meet every two years at a workshop designed to foster collaborations and idea exchanges.

The computer science and software tools component of this effort focuses on developing advanced software to facilitate the use of high performance systems to scientific problems. Efforts range from efficient operating systems and I/O software for MPP's, to frameworks for isolating application codes from the underlying hardware details, to tools for monitoring the performance of scientific applications. In addition, this component supports efforts to improve the management, visualization, and understanding of the results of high end computations.

The education programs focus on engaging and training students, teachers, and faculty from middle and high school through graduate school in computing, networking, and computational science, by leveraging the large DOE investment in these areas at universities and the national laboratories.

The Computational Science Graduate Fellowship (CSGF) Program supports over 50 doctoral students in computational science and engineering at selected universities. Participating fellows spend at least one summer working at a DOE laboratory in the area of their dissertation.
(continued)

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 35.81 |
| FY 97 Pres | 35.49 |
| FY 97 Est. | 36.50 |
| FY 98 Rqst. | 36.74 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | 33.00 | 33.74 |
| LSN | | |
| HCS | | |
| HuCS | | |
| ETHR | 3.50 | 3.00 |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Relocated the Lawrence Livermore National Laboratory (LLNL) applied mathematics group to Lawrence Berkeley National Laboratory (LBNL) as part of the NERSC relocation.<br>Computational scientists at Los Alamos National Laboratory (LANL) and LBNL, working with university partners and a commercial combustion firm, released a code based on adaptive mesh refinement techniques that simulates 3D combustion phenomena in complex geometries, with radiation effects included, accurately enough for the code to be used in the design of commercial low NOx burners.<br>Applied mathematicians at Argonne National Laboratory (ANL), in partnership with researchers at nearby Northwestern University, set up the Optimization Technology Center (OTC) at Northwestern, in order to enhance laboratory/university collaborations.<br>On-line services at the OTC enable researchers around the country to access software for solving large-scale optimization and programming problems.<br>Oak Ridge National Laboratory (ORNL) researchers developed and distributed improved codes for sparse matrix calculations that enabled progress on various Grand Challenge problems. (continued) | Reduce support for the Ames Laboratory and Brookhaven National Laboratory applied mathematics programs as part of an overall redirection of funds into more computationally intensive areas.<br>LBNL and LANL computational combustion researchers, along with their university partners, will initiate simulations of internal combustion engines, in collaboration with industry partners.<br>Continue collaboration between ANL applied mathematicians and the DOE Office of Integrated Analysis and Forecasting on improving the predictive capabilities of the National Energy Modeling System.<br>Initiate research at LANL on the predictability of catastrophic events such as wildfires and earthquakes through the development of modeling and simulation tools.<br>Strengthen collaborative ties between laboratory and university researchers working on Grand Challenge problems and other multidisciplinary projects important to the DOE mission. Establish interoperability of MUSE and CAVE virtual reality technologies to explore domains of most advantageous use of these two technologies.<br>Deploy advanced scientific data management technologies to scientific users. (continued) | Discontinue support of the Ames Laboratory and Brookhaven National Laboratory applied mathematics programs.<br>Initiate computational materials science program within the ORNL applied mathematics group in order to strengthen related activities of the ORNL High Performance Computing and Research Center and the ORNL Materials Science Division.<br>Increase support of Sandia National Laboratory's program in computational biology that focuses on developing and implementing algorithms for genome sequencing and protein folding.<br>Large applications software packages produced that can be executed in environments ranging from networks of workstations to the highest performance massively parallel processors available based on strategies evaluated in FY 97.<br>Introduce advanced tools for parallel program diagnosis and tuning in production versions.<br>Prototype deployment of first new software tools which are designed around the Advanced Computational Testing and Simulation Toolkit interface definitions.<br>(continued)<br>.. |

**Agency Ties**

| | |
|---|---|
| DARPA | Partner |
| NSF | Partner |
| DOE | |
| NASA | Partner |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| DOE | **Advanced Computational Testing and Simulation Research (continued)** | Budget Code | KJ0101, KJ3501 |
|---|---|---|---|

(continued)

The Adventures in Supercomputing (AiS) Program trains middle and high school students and their teachers in the use of computers and networks and provides computers and curricular materials to participating schools. AiS encourages the participation of women and under represented minorities.

The Undergraduate Computational Engineering and Science (UCES) Program develops curricular materials and application-based modules for undergraduate computational science courses, tests this material at selected universities, and sponsors workshops and conferences for faculty and students. he UCES Program was expanded to involve the participation of selected HBCU's in teaching demonstrations and the development of curricula and instructional materials.

Model Nets, a networking technology assessment project to determine appropriate educational technology tools and curricula in a variety of school systems, was completed. A catalog of effective technologies for use by teachers, administrators, and local and state education officials is now available in electronic and printed formats.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | |
| FY 97 Pres | |
| FY 97 Est. | |
| FY 98 Rqst. | |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | | |
| HCS | | |
| HuCS | | |
| ETHR | | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| (continued)<br>Advances in modeling and asymptotic techniques allowed LBNL applied mathematicians to correct long-standing errors in commonly-used turbulence formulas for viscous flows near solid boundaries.<br>LANL computational physicists, in partnership with SUNY Stony Brook applied mathematicians, extended the ability of front tracking codes to simulate interfacial phenomena of importance in fusion and weapons research.<br>Transfer improved operating systems and message passing models to U.S. computer vendors.<br>Investigate scalability of existing performance analysis tools and deliver beta versions of high performance scalable I/O libraries.<br>Develop plan to integrate scalable I/O with distributed and archival file and data systems.<br>Evaluated the quality of the first and second group of CSGF fellows as they enter the professional computational science career path.<br>Made general releases of updated graduate and undergraduate computational science texts available.<br>The AiS Program extended its computing and networking activities to middle school students at selected sites. | (continued)<br>Evaluate strategies for producing large applications software packages that can be executed in environments ranging from networks of workstations to the highest performance massively parallel processors available.<br>Introduce advanced tools for parallel program diagnosis and tuning in preproduction versions.<br>Begin development of software tools which are designed around the Advanced Computational Testing and Simulation Toolkit interface definitions.<br>Prototype integrated, distributed multimedia scientific visualization environment for DOE researchers. Continue evaluation of the effectiveness of the CSGF Program.<br>Complete electronic computational science text projects through commercialization.<br>Replace Macintosh computers used in the AiS Program with PC's running LINUX software, in order to enhance local computing capabilities and train students in distributed computing.<br>Initiate follow-on program to the Model Nets Project that focuses on training in-service teachers and administrators to use and maintain local- and wide-area networks in their schools. | (continued)<br>Adjust support for the CSGF, AiS, and UCES Programs to meet outyear budget targets.<br>Encourage state and local school systems to adopt the successful educational technology programs developed under the AiS and Model Nets Programs.<br>Consider working with community colleges and vocational schools on education and training programs in computing and networking that prepare students for school and job opportunities.<br>Encourage colleges and universities to adopt curricula and instructional material developed in the UCES Program. |

**Agency Ties**

| | |
|---|---|
| DARPA | Partner |
| NSF | Partner |
| DOE | |
| NASA | Partner |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| DOE | **Grand Challenge Applications** | Budget Code | KJ0101, KJ3501 |
|---|---|---|---|

In FY 1992, DOE initiated nine Phase I Grand Challenge projects (GCs) crucial to energy issues. All projects are co-funded by other DOE programs and by industrial partners or other agencies. Participants include DOE laboratories, universities, industry and other HPCC agencies. These projects address the Grand Challenges through the development of advanced algorithms and software and the use of HPCC resources. The selection of these projects was made by a panel including DOE program managers and other HPCC agency participants. Each project undergoes periodic reviews to assess research progress and future plans for continued funding. The projects are:

1. Computational Chemistry (CC) -- parallelize key chemistry codes that permit researchers to study environment problems, using techniques such as self-consistent field (SCF), second order many-body perturbation theory (MP2), and Configuration Interaction (CI) codes;
2. Computational Structural Biology -- develop methods for modeling components of genomes and a parallel programming environment for structural biology;
3. Mathematical Combustion Modeling (MCM) -- develop adaptive parallel algorithms for computational fluid dynamics and apply these methods to key problems in commercial burner design;
4. Quantum Chromodynamics Calculations -- develop lattice gauge algorithms on massively parallel machines for high energy and particle physics applications;
5. Oil Reservoir Modeling -- construct efficient algorithms for parallel systems to model fluid flow through permeable media for better oil recovery methods from wells;
6. The Numerical Tokamak Project -- develop and integrate particle and fluid plasma models on MPPs as part of a study of Tokamak fusion reactors;

(continued)

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 10.00 |
| FY 97 Pres | 9.75 |
| FY 97 Est. | 8.00 |
| FY 98 Rqst. | 9.00 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | 8.00 | 9.00 |
| LSN | | |
| HCS | | |
| HuCS | | |
| ETHR | | |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | |
| DOE | |
| NASA | |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

Milestone Changes

### FY 1996 Actual Milestones

Some representative research accomplishments of Phase I GCs in FY_1996 are:

CC -- developed scalable approaches for evaluation of multi-configuration wave functions like Multi-configuration SCF and CI.

Developed parallel algorithms for analytic SCF second derivatives and MP2 gradients. Integrated scalable input/output techniques into the codes.

GCM -- demonstrated successful coupling of atmospheric-ocean-sea ice models on MPPs. GCT -- 3D front-tracking and simple fracture modeling were incorporated into the GCT code in the Groundwater Remediation Grand Challenge. This permitted studies of three-phase flow in fractured regimes and the role of geostatics to obtain bounding calculations for uncertainties of remediation strategies.

Classical Molecular Dynamics, Tight- Binding Molecular Dynamics, ab initio Pseudopotential, and Large Scale Multiple Scattering codes were ported to the Intel Paragon XP/S 150.

Unified graphical pre- and post-processing tools for major codes were developed.

(continued)

### FY 1997 Estimated Milestones

Evaluate results from completed Phase I GC projects.

Complete Phase II GC applications review and make new awards.

The number of projects supported will be reduced to provide funding of the initiative in 'Advanced Computational Testing and Simulation.'

Funding of computational infrastructural component at the DOE's High Performance Computing Resource Centers (HPCRCs) will be coordinated with this activity.

### FY 1998 Agency Request / Expected Milestones

Phase II GC projects will be monitored for progress more closely because of the direct involvement of the HPCRCs: this will allow quick remedial action to improve their productivity.

| DOE | Grand Challenge Applications (continued) | Budget Code | KJ0101, KJ3501 |
|---|---|---|---|

(continued)
7. Global Climate Modeling (GCM) -- develop and implement versions of large-scale atmosphere and ocean general circulation models for MPPs;
8. Groundwater Transport and Remediation (GTR) -- design and implement a multiphase groundwater transport code with interface tracking, fracture flow, microtransport; and
9. First Principles Simulation of Materials Properties -- develop scalable parallel algorithms for performing local density approximation simulations of materials to novel properties for the Materials Properties Grand Challenge (MPGC).

At the end of FY 1996, Phase I of the GC program was terminated. An RFP was published for Phase II of the program with project starts early in FY 1997. The intent and grant procedures of Phase II are similar to Phase I but the projects now incorporate a infrastructural component to insure that the projects have the computational resources to complete their proposed goals.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | |
| FY 97 Pres | |
| FY 97 Est. | |
| FY 98 Rqst. | |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | | |
| HCS | | |
| HuCS | | |
| ETHR | | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| (continued)<br>MCM -- Incorporated radiation effects into codes that simulate the behavior of low NOx commercial burners and design algorithms for simulating high speed combustion processes in realistic 3D geometries.<br>RFP published for Phase II Grand Challenge Projects and technical review was begun. Thirty-six applications were submitted. | | |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | |
| DOE | |
| NASA | |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| DOE | National Collaboratory Research | Budget Code | KJ0102, KJ3501 |
|---|---|---|---|

The National Collaboratory Research is structured to develop the technologies and tools that will enable scientists and engineers to easily collaborate across geographic boundaries and to interact cooperatively in common problem solving and experimental activities. Elements of this research address the basic technology and services that underlie a number of national challenge applications including energy demand management and remote environmental monitoring.

Information Infrastructure technology R&D is conducted in information navigation and analysis tools, in hierarchical distributed information storage, advanced collaborative multimedia environments and in information surety.

Networking research activities include security (such as providing secure information retrieval and search mechanisms and interoperable authentications realms), secure software distribution intelligent user interfaces for accessing the network, interoperable interactive multimedia systems, high speed LANs and WANs, telepresence, protocols and services to support energy demand and supply management as well as collaborative work environments.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 8.38 |
| FY 97 Pres | 7.78 |
| FY 97 Est. | 8.89 |
| FY 98 Rqst. | 3.94 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | | |
| HCS | | |
| HuCS | 8.89 | 3.94 |
| ETHR | | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Defined a security architecture that provides transparent and easily administered security services.<br>Software developed to allow remote access to Advanced Light Source (ALS) experiments across ESnet was deployed in version 1.0 release.<br>Developed a prototype system for monitoring power quality over the Internet and for providing associated energy services. | Integrate existing collaborative tools into the National Collaboratory Framework. Virtual reality advancement to allow a CAVE to CAVE interaction of at least twenty minutes.<br>Generalize and package the components developed for the on-line access of the ALS for general use in remote collaborative access of facilities and instruments.<br>First release of LabSpace software--an integrated media server for providing hypermedia indexing and information navigation and discovery, n-way multipoint media services and parallel interactive serving.<br>Prototype a system allowing multiple commercial building monitoring and operations from a single remotely-sited control room.<br>Prototype, on a small scale, residential energy demand management using information infrastructure (i.e., the Internet).<br>(continued) | Specify and begin building a scalable standards-based software infrastructure to support collaborative environments.<br>Further investigate and develop immersive environment use of high speed low latency networks and protocols.<br>Further evaluation and use of ATM capabilities to support advanced applications as well as provide interagency collaborative environments. |

**Agency Ties**

| | |
|---|---|
| DARPA | Partner |
| NSF | Partner |
| DOE | |
| NASA | |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| DOE | National Collaboratory Research (continued) | Budget Code | KJ0102, KJ3501 |
|---|---|---|---|

| Milestone Changes | |
|---|---|

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| | (continued)<br>Make the adaptive secure high speed communications library for hi-end systems available for evaluation and use.<br>Further investigate and develop immersive environment (e.g., CAVE) use of high speed low latency networks and protocols.<br>Further evaluation and use of ATM capabilities (e.g.,quality of service, signaling) to support advanced applications as well as provide interagency collaborative environments.<br>Prototype the Secure Software distribution system. | |

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | |
| FY 97 Pres | |
| FY 97 Est. | |
| FY 98 Rqst. | |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | | |
| HCS | | |
| HuCS | | |
| ETHR | | |

**Agency Ties**

| | |
|---|---|
| DARPA | Partner |
| NSF | Partner |
| DOE | |
| NASA | |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| DOE | DOE2000 ACTS | Budget Code | KJ0101 |
|---|---|---|---|

The DOE2000 focused program in Advanced Computational Testing and Simulation is developing an integrated set of algorithms, software tools, and infrastructure that will enable computer simulation to be used in place of experiments when real experiments are too dangerous, expensive, inaccessible, or politically infeasible.

This program is focused on defining and producing an ACTS toolkit composed of tools for representing complex geometries, advanced numerical techniques, tools for integrating other physics models, parallelism and software backplane, tools for data assimilation, management, understanding, advanced software framework which can be used to accelerate progress in critical DOE applications.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | |
| FY 97 Pres | 4.88 |
| FY 97 Est. | 2.50 |
| FY 98 Rqst. | 5.00 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | 2.50 | 5.00 |
| LSN | | |
| HCS | | |
| HuCS | | |
| ETHR | | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| | Coordinated definition (with DOE Defense Programs) of the interfaces which allow new ACTS tools to be incorporated into a unified ACTS toolkit.<br><br>Begin Scientific Template Library project with multiple labs working on common numerics, software frameworks, and portable runtime support. | Integrate most critical existing software tools into ACTS framework.<br>Begin development of ACTS-enabled applications development in compressible fluid dynamics/combustion, environmental chemistry, and materials sciences. (This effort is coordinated with parallel development in DOE Defense Programs of ACTS-enabled applications in weapons hydrodynamics and materials characterization and aging).<br>Deploy VR technologies to scientific users in a number of disciplines for evaluation. |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | |
| DOE | |
| NASA | |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| DOE | DOE2000 NC | Budget Code | KJ0102 |
|---|---|---|---|

The DOE2000 focused program in National Collaboratories is developing a set of tools and capabilities which will permit scientists and engineers working at different DOE and other facilities to collaborate on solving problems as easily as if they were in the same building. The program supports research in the tools which a virtual laboratory requires: Collaborative tools; Information surety (authentication + security), and High-performance networking and one pilot implementations of these tools in partnership with other DOE programs.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 0.18 |
| FY 97 Pres | 4.88 |
| FY 97 Est. | 6.00 |
| FY 98 Rqst. | 6.00 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | | |
| HCS | | |
| HuCS | 6.00 | 6.00 |
| ETHR | | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Conduct workshop on DOE2000 NC technologies and initiate planning for integrated technology development program and pilot projects. | Initiate R&D efforts in critical NC technologies.<br>Select 2 NC pilot projects from partnership prospectuses from other Offices in DOE: Diesel Combustion Collaboratory and the Materials MicroCharacterization Collaboratory<br>Held Joint meeting with DARPA on Collaboratory Technologies | Integrate existing collaborative tools into Virtual Laboratory Framework;<br>Implement advanced technologies for information security to support flexible administration of resources.<br>Production deployment of remote access software to a number of experimental groups; Address issues of navigation and context in a virtual laboratory.<br>Continue NC pilot projects. |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | |
| DOE | |
| NASA | |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| DOE | **National Energy Research Scientific Computing Center** | Budget Code | KJ0102, KJ3501 |
|---|---|---|---|

This activity provides funding for equipment and personnel for the Scientific Applications effort at the National Energy Research Scientific Computing Center (NERSC). This effort provides high performance computing resources for investigators supported by the Energy Research often through collaboration with the NERSC staff. Mission areas of Energy Research include: Material Sciences; Chemistry; Geosciences; Biosciences; Engineering; Health and Environmental Research; High Energy and Nuclear Physics; Fusion Energy; and Mathematical, Information and Computational Science.

The Center serves more than 4,000 users working on about 700 projects, of which about 30% are university based, 65% are in National Laboratories, and 5% in industry. In FY 1996 NERSC operated 4 CRAY computers: a C-90 with 16 processors, with 256 Million words (Mw) of memory, a CRAY-2 with 8 processors with 128 Mw, a CRAY 2 with 4 processors and 128 Mw, and a J-90 with 32 processors and 512 Mw, and the National Education Supercomputer, a single processor CRAY XMP donated by Cray Research, which is available over the Internet to high schools for educational programs.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 30.30 |
| FY 97 Pres | 29.02 |
| FY 97 Est. | 26.50 |
| FY 98 Rqst. | 26.50 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | 26.50 | 26.50 |
| LSN | | |
| HCS | | |
| HuCS | | |
| ETHR | | |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | |
| DOE | |
| NASA | |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

Milestone Changes

### FY 1996 Actual Milestones

While successfully delivering 600,000 Computer Resource Units (CRUs) in FY 1996 (more than in FY 1995 ) and an additional 3 Terabytes of archival storage to ER programs, the operating philosophy of NERSC was rewritten, the Center was recompeted, moved, and rebuilt at Lawrence Berkeley National Laboratory in response to a directive to operate the Center in a self sustaining mode for 20% less funding. The operating philosophy is not to continue to operate NERSC as a first class production computing facility as it successfully has for the last two decades, but to an interactive Center whose staff will collaborate with DOE/ER scientists and engineers to enable them to accomplish their missions through effective use of the Centers new computing systems with novel architectures.

In FY 1996, the Center also acquired new computing systems that are not classical vector Supercomputers. (continued)

### FY 1997 Estimated Milestones

Continue to rebuilt the Center to effectively operate within the new philosophy primarily by hiring scientists and engineers trained in the mission disciplines of DOE Energy Research to work interactively with Energy Research users of the Center .

Install new computing and mass storage systems, bring into operation, and train and otherwise aid Energy Research investigators in effective use of the new Center.

Expand the efforts of the Center to assess and use new computing, collaborating and communications technologies important to Energy Research.

### FY 1998 Agency Request / Expected Milestones

Self-sustaining operation of scientific applications program combining massively parallel, advanced vector, and symmetric multiprocessor computers.

Integrate file systems of supercomputers in access center using High Performance Storage System.

Training of ER users in code development using new tools for efficient use of the new HPC architectures and in operating procedures for effective use of mass storage and other NERSC technology.

| DOE | National Energy Research Scientific Computing Center (continued) | Budget Code | KJ0102, KJ3501 |
|---|---|---|---|

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | |
| FY 97 Pres | |
| FY 97 Est. | |
| FY 98 Rqst. | |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | | |
| HCS | | |
| HuCS | | |
| ETHR | | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| (continued)<br>These systems, J90s with a shared-memory multi-processor architecture and a T3E with a massively parallel architecture, will be acquired from SGI's Cray Research Division providing certain performance benchmarks are met.<br>The new systems will increase the computational resources at the Center by more than 400% before the end of FY 1997.<br>Also acquisitions of Mass Storage will improve this component of the Center's system by an order of magnitude in the same time span. | | |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | |
| DOE | |
| NASA | |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| DOE | **ESnet** | Budget Code | KJ0102, KJ3501 |
|---|---|---|---|

The large scale networking activity provides leading edge network infrastructure for the high performance computational research activities and funds the gigabit and advanced networking research activities that include gigabit testbed activities and R&D pilot projects such as HiPPI, ATM, National Storage Lab, and On-line Electronic Telescope. It also includes R&D for packetized video and voice, next-generation IP deployment. The network infrastructure, ESnet, is an integral part of the National Information Infrastructure (NII) and the global internet supporting basic research. It provides worldwide access to Energy Research facilities, including: Advanced Light Sources, Neutron Sources, Particle Accelerators, Fusion Reactors, Spectrometers, High Performance Computing Resource Providers (HPCRP), Genome Centers, Data banks, and other leading-edge science instruments and facilities. Planned upgrades will facilitate remote experimentation and `national collaboratory` access to these facilities.

The ESnet project, using laboratory-industry partnerships, provides advanced services through the early acquisition and testing of commercially-supplied communications and network services. Funding covers acquisition of services and advanced network capabilities and integration of these with other services, primary rate ISDN for video, video multiport/services, hardware to expand network capabilities (routers, international links), personnel to develop tools for network use (e.g., communication, authentication, privacy protocols), advanced network information services, and maintenance. Funding may be provided for research and development on ATM issues with regard to High Performance Parallel Interface (HiPPI), standards implementation, interfaces, and LAN to WAN ATM interoperability.
(continued)

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 12.64 |
| FY 97 Pres | 14.42 |
| FY 97 Est. | 14.79 |
| FY 98 Rqst. | 13.79 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | 14.79 | 13.79 |
| HCS | | |
| HuCS | | |
| ETHR | | |

Milestone Changes

### FY 1996 Actual Milestones

Integration of ATM into the infrastructure was successful. Ten ATM ports are in production mode with speeds ranging from 4 to 155 Mbps. Additional sites have been integrated using frame relay-to-ATM connections or N times T1 connections where cost effective. Two ports are active at OC3c ATM service. Implemented a successful Internet Transition Strategy. Statistics show ESnet to be reliable and consistent and customer service remains high. Support was provided for Defense Programs activities by supporting unclassified and end-to-end encrypted data.

A transatlantic ATM pilot project was initiated to provide 5 to 10 Mbps ATM links to overseas collaborators in Europe. Initiated the standards process for HiPPI-6400, the gigabit speed system are network protocol successor of HiPPI.

Developed Class Based Queuing (CBQ) IP gateways that control congestion as well as allow link sharing.

Developed a Pentium PC based ATM long link error simulator. Finalized the Real Time Protocol (RTP) standard and reference implementation.
(continued)

### FY 1997 Estimated Milestones

Maintain existing sites and upgrade ESnet bandwidth services, subject to budget constraints, to support Advanced Computational Testing and Simulation applications.

Provide increased connectivity and bandwidth to Europe and Japan. Connect the supercomputers at Sandia National Laboratory and Oak Ridge National Laboratory via a native ATM circuit. Deploy RED and CBQ in operational networks.

Make available to others the PC based ATM simulator.

Further develop high speed advanced interagency and internetwork peering and interconnection points.

Prototype the Secure Software distribution system.

Design and prototype a HiPPI-6400 switch and tester, as well as advance the standard.

Continue the development and deployment of network traffic analysis and measuring tools.

Develop a strategy, protocols, and tools that address congestion caused by WWW traffic (e.g.,. reliable multicast).

### FY 1998 Agency Request / Expected Milestones

Expand the native ATM connected sites to enable effective remote experimentation and simulation applications.

Further develop high speed advanced interagency and internetwork peering and interconnection points.

Continue the development and deployment of network traffic analysis and measuring tools.

Continue development of protocols and tools that address congestion caused by WWW traffic (e.g., reliable multicast).

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | |
| DOE | |
| NASA | |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| DOE | ESnet (continued) | Budget Code | KJ0102, KJ3501 |
|---|---|---|---|

(continued)

Funding may also be used to investigate the network resource reservation and management for isochronous traffic. With additional funding work is needed in identifying the real issues with inter-network peering and routing. Research on routing and addressing (e. g., end system identifiers, network versus geographical addressing, automatic host configuration, multi-level peering, etc.) for the growth of the Internet on a multi-protocol dimension must be conducted.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | |
| FY 97 Pres | |
| FY 97 Est. | |
| FY 98 Rqst. | |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | | |
| HCS | | |
| HuCS | | |
| ETHR | | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| (continued)<br>Successful management and deployment of IWAY for SC '95.<br>Development of Random Early Detection (RED) gateways for congestion control and resource management on IP networks.<br>Demonstrated successful remote control of a robot from a CAVE over high speed networks.<br>Enhanced audio/video (e.g.,. VIC, VAT) collaborative tools and released reference implementations.<br>Demonstrated a geographically distributed joint site immersive environment (CAVEs) using an OC-3 ATM network.<br>Developed an initial design for a heterogeneous secure software distribution system.<br>Initial development of advanced IP network analysis tools and techniques.<br>Development of Real time protocol (RTP) and Multicast (Mtrace) tools.<br>Initiated a set or ER-DP security workshops with the goal of identifying common security R&D as well as operational challenges. | (continued)<br>Develop a strategy, protocols, and tools that address congestion caused by WWW traffic (e.g.,. reliable multicast). | |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | |
| DOE | |
| NASA | |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| DOE | **High Performance Computing Resource Providers** | Budget Code | KJ0102, KJ3501 |
|---|---|---|---|

Support the operation of High Performance Computing Resource Providers which provide critical resources for enabling Grand Challenge applications. To this end, the HPCRP's acquire large, full-scale, high performance computers exploiting a variety architectures for use by computational scientists working on Grand Challenge applications. The centers integrate these early high-performance computing systems into prototype heterogeneous computing configurations and make them available through the NREN. This allows for a wide spectrum of experiments for scalability studies, as well as an opportunity to provide Grand Challenge researchers access to the largest possible advanced systems.

The range of architectures includes Intel Paragon, IBM SP2, Cray T3E, and advanced networks of SMP's

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 12.39 |
| FY 97 Pres | 15.24 |
| FY 97 Est. | 16.00 |
| FY 98 Rqst. | 16.56 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | 16.00 | 16.56 |
| LSN | | |
| HCS | | |
| HuCS | | |
| ETHR | | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Continue funding for advanced prototype systems at:<br>1. Argonne National Laboratory as part of a cooperative effort to implement a standard reference message passing interface;<br>2. Ames Laboratory for use in developing performance measurements and benchmarking capabilities; and<br>3. Oak Ridge National Laboratory as part of the HPCRC supporting a number of the DOE Grand Challenges teams. | Coordinate HPCRP funding to optimize productivity of grand challenge application teams. Special concern to balancing CPU speed with memory, I/O, etc. | Trials of DSM models in GCA's running on networks of SMP's |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | |
| DOE | |
| NASA | |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| DOE | **Next Generation Internet** | Budget Code | |
|---|---|---|---|

DOE will leverage its highly successful experience in managing production and research networks, as well as its specialized skills in networking research and technology, coupled with its great strength in mission-driven applications and in system integration to attain the NGI goals of advanced experimental network infrastructure, network technology and services research and development, and next generation applications. The ESnet program will be expanded to provide end-to-end 155 Mbps NGI connectivity to 10 to 12 DOE sites as well as promote high speed interconnects with the other agency NGI networks, as well as collaborate with NSF to further university NGI connectivity. DOE will also continue its work on gigabit to terabit network technologies and interfaces and connect at least 2 DOE Labs to the DARPA led gigabit/terabit testbeds.

DOE's goals on network research are aimed at not only to supporting higher speeds (i.e., end to end gigabits), but also to support more efficient, smarter, and secure use of network resources. Therefore, DOE will extend its work in areas relevant to the use and support of QoS capabilities (admission control, scheduling, management, prioritization, accounting, bidding, costing, etc.) at the network, operating system, and application layers, as well as further its efforts in IP and ATM multicast, network management, and flow and congestion control. It is intended that the network research activities will be concurrently developed on and incorporated into DOE's NGI 100x production quality infrastructure. DOE's applications (e.g., Diesel Combustion Collaboratory, Materials Microcharacterization Collaboratory, Accelerated Strategic Computing Initiative, the Oak Ridge/Sandia Distributed Computing Project, Data Access and Analysis of Massive Datasets for High-Energy and Nuclear Physics) will be adapted to make use of the new services (e.g., QoS) and utilize DOE's high speed NGI virtual networks. This will include secure and adaptive cross layer capabilities and APIs for the applications to utilize.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | |
| FY 97 Pres | |
| FY 97 Est. | |
| FY 98 Rqst. | 35.00 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | | 35.00 |
| HCS | | |
| HuCS | | |
| ETHR | | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| | Lead NGI planning activities via co-chairmanship of LSN WG.<br>Sponsor DOE participation in Joint Engineering Team. | Connect 10-12 DOE Labs at 155 Mbps via the ESnet program supported virtual NGI network.<br>Provide IP and ATM interconnection of DOE's NGI virtual network with other agency NGI networks.<br>Transfer $13 million of NGI funds to NSF to connect Universities to the NGI.<br>Connect at least 2 DOE sites to the Gigabit/Terabit DARPA led testbeds.<br>Develop high speed gigabit end-system interfaces and test equipment.<br>Deploy class of service support .<br>Initiate the development of secure resource contention admission control mechanisms.<br>Adopt applications, via libraries and APIs, to use QOS and to better utilize network management capabilities.<br>Enhance IP and ATM network management capabilities.<br>Provide multimodal support of production and network research traffic on the same infrastructure. |

**Agency Ties**

| | |
|---|---|
| DARPA | Partner |
| NSF | Partner |
| DOE | |
| NASA | Partner |
| NIH | |
| NSA | Partner |
| NIST | Partner |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

# National Aeronautics and Space Administration

As a key participant of the Federal Program, the primary purpose of NASA's HPCC Program is to extend U.S. technological leadership in high-performance computing and communications for the benefit of NASA stakeholders: the U.S. aeronautics, Earth and space sciences, and spaceborne research communities. As international competition intensifies and as scientists push back the frontiers of knowledge, leading-edge computational science becomes more critical.

The NASA HPCC Program is structured to contribute to broad Federal efforts while addressing agency-specific computational problems called Grand Challenges. There are four HPCC projects:Computational Aerosciences (CAS), Earth and Space Sciences (ESS), Remote Exploration and Experimentation (REE) and Learning Technologies (LT). The Learning Technologies project is the core educational technologies that was supported in the former Information Infrastructure Technology and Application project.

The NASA centers responsible for these projects are Ames Research Center, which manages CAS, LT and NREN; Goddard Space Flight Center, which leads ESS; and Jet Propulsion Lab, which heads REE. These centers are working toward accomplishing six specific objectives: (1) Develop algorithm and architecture testbeds that are able to fully utilize high-performance computing and networking concepts and increase end-to-end performance; (2) Develop high-performance computing architectures scalable to sustained TeraFLOPS performance; (3) Develop high-performance networking architectures scalable to enable Gigabits per second aggregate applications traffic; (4) Demonstrate HPCC technologies on U.S. aeronautics, Earth and space science, and spaceborne community research problems; (5) Develop services, tools, and interfaces essential to the distribution of technologies to the American public; (6) Conduct pilot programs in education and the public use of remote sensing data that demonstrate innovative distribution of technologies.

Working on these Grand Challenges are teams composed of researchers from NASA centers, industry and universities who cover a wide spectrum of science and engineering.

There are a variety of reasons why NASA invests in the development of tools to solve Grand Challenges. One reason is that the science and engineering requirements inherent in NASA Grand Challenge applications require at least three orders of magnitude improvement in computing capabilities over that which existed at the beginning of the NASA HPCC Program. A second reason is the need in computational science to address competition from abroad. A third reason is that a growing number of national computing challenges in the U.S. require extreme simulations such as the computational modeling of the magnetosphere and of an aircraft engine. Without an accelerated development program, this required improvement may not be available for 15 to 20 years.

# National Aeronautics and Space Administration

## FY 1998 President's Request by Program Component Area

| Program Activity | Budget Account Code | Partner/User Agencies | Budget (BA, $ M) | | | | HPCC PCAs by 1998 Pres. Request | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | FY 96 Actual | FY 97 Pres. | FY 97 Est. | FY 98 Rqst. | HECC | LSN | HCS | HuCS | ETHR |
| Testbeds | 509,234,536 | ARPA, NSF, DOE | 12.91 | 15.39 | 13.70 | 24.50 | 24.50 | | | | |
| Grand Challenge Support | 509,505,535-538,212,232,233,306,656 | NSF, DOE, NOAA, EPA | 59.84 | 57.75 | 49.70 | 51.40 | 48.60 | | 2.80 | | |
| Systems Software | 509 | EPA, NOAA, NSA, NIH, .... | 10.02 | 10.96 | 18.40 | 18.90 | 17.00 | | | 1.90 | |
| NREN | 509,428.538 | DOE, DARPA, ED, NOAA, EPA, NSF | 20.85 | 15.30 | 14.60 | 25.00 | | 25.00 | | | |
| BRHR | 509, 233 | NSF, NIH, NOAA, EPA | 3.98 | 3.20 | 1.10 | 8.60 | | | | 0.30 | 8.30 |
| Information Infrastructure Technology & Applications | 509 | NOAA, EPA, ED | 19.00 | 7.50 | 16.90 | | | | | | |
| Totals: | | | 126.60 | 110.10 | 114.40 | 128.40 | 90.10 | 25.00 | 2.80 | 2.20 | 8.30 |

# National Aeronautics and Space Administration

## Comparison of FY 1997 and FY 1998 by Program Component Area

| Program Activity | Budget (BA, $ M) | | | | HPCC PCAs by 1998 President's Request | | | | | HPCC PCAs by 1997 Estimated | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | FY 96 Actual | FY 97 Pres. | FY 97 Est. | FY 98 Rqst. | HECC | LSN | HCS | HuCS | ETHR | HECC | LSN | HCS | HuCS | ETHR |
| Testbeds | 12.91 | 15.39 | 13.70 | 24.50 | 24.50 | | | | | 13.70 | | | | |
| Grand Challenge Support | 59.84 | 57.75 | 49.70 | 51.40 | 48.60 | | 2.80 | | | 48.10 | | 1.60 | | |
| Systems Software | 10.02 | 10.96 | 18.40 | 18.90 | 17.00 | | | 1.90 | | 14.20 | | | 4.20 | |
| NREN | 20.85 | 15.30 | 14.60 | 25.00 | | 25.00 | | | | | 14.60 | | | |
| BRHR | 3.98 | 3.20 | 1.10 | 8.60 | | | | 0.30 | 8.30 | | | | | 1.10 |
| Information Infrastructure Technology & Applications | 19.00 | 7.50 | 16.90 | | | | | | | 12.00 | | | 0.30 | 4.60 |
| Totals: | 126.60 | 110.10 | 114.40 | 128.40 | 90.10 | 25.00 | 2.80 | 2.20 | 8.30 | 88.00 | 14.60 | 1.60 | 4.50 | 5.70 |

| NASA | **Testbeds** | Budget Code | 509,234,536 |
|---|---|---|---|

The objective of this activity is to encourage and accelerate U.S. commercial development of high performance computing systems that will support Grand Challenges. To accomplish this, NASA encourages:

- the commitment to early acquisition, access, and placement of advanced systems by acquiring advanced prototype and early production high performance computing systems for use and evaluation;
- providing network access to Grand Challenge applications on TeraFLOPS systems;
- providing a testbed control environment to assist in the collection of data about testbed operations;
- developing a set of parallel benchmark codes based directly on the Grand Challenge applications to evaluate disparate architectures; and
- performing research and development activities in ground and flight-based testbeds to be used for demonstration, evaluation, and validation of performance and scalability of both high performance and ultra low power prototypes.

To compare different approaches to TeraFLOPS systems on a common basis, NASA develops these parallel benchmarks to reflect the computational demands of the various Grand Challenge areas. All benchmarks developed are scalable and used on HPCC testbeds.

High performance computing research facilities are established to accelerate transition to new generations of high performance computing technology. These facilities include access to the NASA Research and Education Network, early systems or prototype storage subsystems, and state-of-the-art visualization applications.

| Milestone Changes | 50-100 GigaFLOPS testbed originally scheduled for FY 1996, but budget cuts delayed full configuration until FY 1997. |
|---|---|

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| | Install 50-100 GigaFLOPS sustained scalable testbed achieving a minimum of 50 GigaFLOPS on benchmarks and demonstrating a maximum scalable configuration of at least ten times the installed testbed.<br>Demonstrate cost effective high-performance computing at performance and reliability levels equivalent to 1994 Vector Supercomputers at 25% of the capital cost. | Install a 100-250 GigaFLOPS sustained, scalable TeraFLOPS testbed. |

## Budget ($ M)

| | |
|---|---|
| FY 96 Act | 12.91 |
| FY 97 Pres | 15.39 |
| FY 97 Est. | 13.70 |
| FY 98 Rqst. | 24.50 |

## Program Component Areas

| | FY 97 | FY 98 |
|---|---|---|
| HECC | 13.70 | 24.50 |
| LSN | | |
| HCS | | |
| HuCS | | |
| ETHR | | |

## Agency Ties

| | |
|---|---|
| DARPA | Partner |
| NSF | Partner |
| DOE | User |
| NASA | User |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| NASA | **Grand Challenge Support** | Budget Code | 509,505,535-538,212,232,233,306,656 |
|---|---|---|---|

This research area develops and enhances techniques for the multidisciplinary modeling and simulation of Grand Challenge problems. Computational AeroSciences (CAS) research focuses on understanding the high performance computing environment and how it can be used to solvea range of problems in aerospace engineering at a cost that represents the value, flexibility, and short cycle time required by the aerospace community. CAS research is focused on nationally important aerospace design problems such as High Speed Technology, Advanced Subsonics Technology, and Rotorcraft.

Earth and Space Sciences (ESS) research covers two critical scientific areas: the coupling of advanced discipline models into scalable global simulations providing realistic global change understanding; and the integration of models and analysis algorithms for processing, analyzing and understanding the enormous volumes of data expected from scientific missions. ESS research focuses on: large scale structure and galaxy formation; cosmology and accretion astrophysics; convective turbulence and mixing in astrophysics; solar activity and heliospheric dynamics; Earth system models; four-dimensional data assimilation; climate models, and knowledge discovery in geophysical databases and satellite data.

Collaborative groups including discipline scientists, software and systems engineers, professional software developers and algorithm designers share computational and experimental facilities. Researchers develop application-specific codes for innovative high-performance computing systems, design and analysis of algorithms, and architecture and performance assessment of specific applications.

NASA research products are made available to system vendors as quickly as possible. Results in design and theory of algorithms are as important to breaking down computational scaling barriers as are performance improvements in computing hardware. NASA develops algorithms for common techniques, such as multidimensional FFTs, Fast Poisson solvers, multigrid methods, Reimann solvers, sparse matrix methods, singular value decomposition, matrix factorization methods, and spectral methods on a variety of architectures, in order to understand how architecture affects efficiency and algorithm design.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 59.84 |
| FY 97 Pres | 57.75 |
| FY 97 Est. | 49.70 |
| FY 98 Rqst. | 51.40 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | 48.10 | 48.60 |
| LSN | | |
| HCS | 1.60 | 2.80 |
| HuCS | | |
| ETHR | | |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | Partner |
| DOE | Partner |
| NASA | User |
| NIH | |
| NSA | |
| NIST | |
| NOAA | User |
| EPA | User |
| ED | |
| AHCPR | |
| VA | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Demonstrated multidisciplinary applications on 10-50 GigaFLOPS testbeds demonstrating logarithmic scalability at or better than 50% of ideal with portability to all current testbeds while maintaining 10 GigaFLOPS performance. | Demonstrate end-to-end reductions in cost and time to solution for aerospace design applications on heterogeneous systems. These demonstrations included at least a 25% cost reduction in time to solution for 5 applications and a 5 to 1 reduction in time to solution equal to baseline for combustor design application.<br>Demonstrate integrated, multidisciplinary applications on TeraFLOPS scalable testbeds.<br>Demonstrated logarithmic scalability at or better than 50% of ideal with portability to all current testbeds while maintaining 50 or GigaFLOPS performance or 50x baseline. | |

| NASA | **Systems Software** | Budget Code | 509 |
|---|---|---|---|

There are common needs in many areas of software technology including programming environments for code development and adaptation, techniques for improving portability between parallel computer systems and architectures, advanced compiler technology, tools for optimization and parallelization, data management and interoperability, analysis and performance measurements, user interaction and visualization, and debugging and instrumentation. Advances in these generic software technology areas have broad national impact. This results from the united efforts of NASA, other Federal agencies, academia, and industry.

Research is conducted in the development of program debugging tools and in instrumentation facilities for developing new techniques for monitoring and presenting the state of concurrent program execution in a coherent and user-friendly manner. Studies include evaluating the scalability of these utilities.

Research is also conducted in the design of data management software needed to support the development and use of Grand Challenge based applications on future highly parallel systems. Techniques are explored to control efficient, high performance I/O in parallel computer systems. The structures that are used heavily in multidisciplinary design applications may be object-oriented. Dynamic resource management methods are prototyped and evaluated. NASA researches the portability of these methods to various high performance systems.

Human interfaces are developed to permit users to observe and manipulate the huge amounts of 3D temporal input and result data from the multidisciplinary simulation, analysis, and optimization processes in a manageable, coherent fashion, and to allow for the analysis of the discrete physics through visualization, manipulation, and comparisons with other experimental or computational data.

NASA ensures that new systems software technology and algorithm developments are available to many potential users. To accomplish this, NASA leads the HPCC effort to maintain and further a National HPCC Software Exchange (NHSE). NHSE provides the infrastructure that encourages software reuse and the sharing of software modules across organizations through an interconnected set of software repositories.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 10.02 |
| FY 97 Pres | 10.96 |
| FY 97 Est. | 18.40 |
| FY 98 Rqst. | 18.90 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | 14.20 | 17.00 |
| LSN | | |
| HCS | | |
| HuCS | 4.20 | 1.90 |
| ETHR | | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Demonstrated portability and scalability of software components and tools to TeraFLOPS systems.<br>Demonstrated 3 tools and components with full portability to all testbeds and full scalability. | Provide a production system software environment that integrates distributed workstations with scalable TeraFLOPS machines achieving 98% availability and portability to all testbeds. | Demonstrate a portable, scalable programming and runtime environment for Grand Challenge applications on a TeraFLOPS scalable system.<br>Demonstrate that the applications scale logarithmically with the number of processors and are portable to all current testbeds. |

**Agency Ties**

| | |
|---|---|
| DARPA | Partner |
| NSF | Partner |
| DOE | Partner |
| NASA | User |
| NIH | User |
| NSA | User |
| NIST | Partner |
| NOAA | User |
| EPA | User |
| ED | User |
| AHCPR | User |
| VA | User |

| NASA | **NREN** | Budget Code | 509,428.538 |
|---|---|---|---|

The NASA Research and Education Network (NREN) is a network testbed. The NREN will establish standards and provide working models for commercial communications infrastructure deployment. NASA's role is to deploy the advanced communications required by the Grand Challenge investigators in a manner that satisfies the immediate needs of researchers while simultaneously guiding commercial infrastructure development for the nation. NASA works with NSF, DOE, DARPA, and other agencies to enhance the national network infrastructure by coordinating the development and implementation of enhanced network technologies and services: integrated voice, video, and computer data transmission; network management and operations tools; protocol standards; routers and switches; security management; and emerging high-performance user services including provision of advanced network services for multi-media communications.

NASA is providing additional NREN resources in cooperation with other Federal agencies to promote the Next Generation Internet. This project will provide for the future technologies and momentum for improved Internet connectivity in the United States.

NASA has deployed 622 Mb/s network testbeds between five NASA centers significantly improving communications between investigators of CAS and ESS testbeds. An acquisition for advanced telecommunications services on an early availability basis brings telecommunication and computational standards together to provide a low-cost computer network infrastructure over vendor facilities ultimately targeted at commercial availability. This takes advantage of the latest telecommunications technologies, such as Asynchronous Transfer Mode (ATM) over Synchronous Optical Network Transmission (SONET) services. Research collaboration with the DoD's Application Technology Demonstration Network (ATDnet) supports interoperability between independently managed networks that are based on ATM technology supplied by multiple vendors.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 20.85 |
| FY 97 Pres | 15.30 |
| FY 97 Est. | 14.60 |
| FY 98 Rqst. | 25.00 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | 14.60 | 25.00 |
| HCS | | |
| HuCS | | |
| ETHR | | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Demonstrated interoperability between independently managed NREN networks based on ATM technology supplied by multiple vendors achieving a performance level of 149 Mbps with 2 independent networks. | Demonstrate 100 times end-to-end performance improvement of Grand Challenge and/or NASA mission applications across NASA NREN testbeds over 155 Mbps wide area network.<br>Use five demonstrations to show 100-fold or more in end-to-end performance improvement over FY 1996 baseline. | Establish Next Generation Internetwork exchange for NASA to connect Grand Challenge universities' principal investigators to NASA high performance resources.<br>Demonstrate 100 times increased capability to access NASA high performance resources by Grand Challenge community. |

**Agency Ties**

| | |
|---|---|
| DARPA | Partner |
| NSF | Partner |
| DOE | Partner |
| NASA | User |
| NIH | |
| NSA | |
| NIST | |
| NOAA | User |
| EPA | User |
| ED | User |
| AHCPR | |
| VA | |

| NASA | **BRHR** | Budget Code | 509, 233 |
|---|---|---|---|

Effective integration of new high performance computing technology into the U.S. mainstream requires a sustained research effort across the spectrum of computing technology. Areas included are: computer architectures; fundamental algorithms; computational complexity; networked and distributed computation; numerical analysis, and application specific algorithms.

NASA concentrates at the graduate and post-doctoral level to find resources, covering the baccalaureate degree and junior professor levels. For example, the ESS-sponsored NASA Summer School in High Performance Computational Physics has been held each summer at GSFC for Ph.D. candidates who have been selected through a national search.

In addition, new mechanisms for supporting students and faculty applying HPCC technology on NASA's applications have been initiated. These mechanisms include funding students directly at their institutions if they have an advisor interested in NASA applications. NASA is expanding on the NASA Graduate Student Researchers Program at NASA centers. This initiative will reflect the diversity of students in the nation, with better recruitment work within socially and economically disadvantaged groups, historically underrepresented in science and engineering.

As of FY 1998, BRHR also includes the technology in education efforts that formerly were included in the now-complete and phenomenally successful Information Infrastructure Technology and Applications project. These activities include NASA Center-based efforts in application of educational tools and aeronautics related educational projects.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 3.98 |
| FY 97 Pres | 3.20 |
| FY 97 Est. | 1.10 |
| FY 98 Rqst. | 8.60 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | | |
| HCS | | |
| HuCS | | 0.30 |
| ETHR | 1.10 | 8.30 |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Provided annual graduate and postdoctoral support for high performance computing research. | Provide annual graduate and postdoctoral support for high performance computing research. | Provide graduate & postdoctoral support for high-performance computing research.<br>Distribute mature K-12 curriculum products over the National Information Infrastructure.<br>Demonstrate results of mature digital library projects. |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | Partner |
| DOE | |
| NASA | |
| NIH | User |
| NSA | |
| NIST | |
| NOAA | User |
| EPA | User |
| ED | |
| AHCPR | |
| VA | |

| NASA | **Information Infrastructure Technology & Applications** | Budget Code | 509 |
|---|---|---|---|

Information Infrastructure Technology and Applications is a combination of the formerly reported "Information Infrastructure Technology" and "Information Infrastructure Applications". This combination reflects the diminishing role of the activities within NASA's HPCC program as the activities complete in FY 1997. A few remaining projects core to NASA's technology outreach efforts will be continue in a new "Learning Technologies" component of HPCC starting in FY 1998 and reported within NASA's BRHR activities.

NASA promoted the development and deployment of digital libraries within the National Information Infrastructure in partnership with other Federal agencies. NASA's approach in pursuing this objective was based on unique NASA requirements and technology contributions, as well as on the more general advanced technology requirements of National Challenge applications.

NASA developed and provided access to databases of remote sensing images and supportive software over the Internet. Such databases are accessible to both public and private institutions, promoting the dissemination of taxpayer-funded Federal information. The information contained within these databases can also be used by the educational and library communities to fulfill their needs and goals. The programmatic goal provides broad public access to remote sensing data to traditionally under-served communities. These data are NASA and other federally funded data provided to the application communities. Providing the access to remote sensing data has promoted gains in education, quality of life and economic growth.

NASA built on its HPCC program, its aeronautics and space science research and engineering missions, and its existing education outreach infrastructure to facilitate the general development of the National Information Infrastructure to support mathematics, science, and engineering education in the K-12 levels.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 19.00 |
| FY 97 Pres | 7.50 |
| FY 97 Est. | 16.90 |
| FY 98 Rqst. | |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | 12.00 | |
| LSN | | |
| HCS | | |
| HuCS | 0.30 | |
| ETHR | 4.60 | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Demonstrated interim results of remote sensing database applications achieving hundreds of thousands of accesses per day peak use of the applications. | NASA's IITA Project will terminate at the end of FY 1997. Activities with funding schedules beyond FY 1997 will transition into the Learning Technologies (LT) Project.<br>A majority of RSD and DLT grants will be terminating during FY 1997. Education activities will be transferred to LT. These activities will become the basis of NASA's post-FY 1997 investment in the Federal CIC's Education, Training, and Human Resources Program Focus Area. | |

**Agency Ties**

| | |
|---|---|
| DARPA | Partner |
| NSF | Partner |
| DOE | Partner |
| NASA | Partner |
| NIH | User |
| NSA | |
| NIST | User |
| NOAA | Partner |
| EPA | Partner |
| ED | User |
| AHCPR | |
| VA | User |

# National Institutes of Health

The National Institutes of Health (NIH) Computing, Information, and Communications Research and Development (CIC R&D) programs are an integral part of the NIH biomedical research mission to develop basic knowledge for the diagnosis, treatment, understanding and prevention of human disease. The scientific activities include the analysis of biomolecular sequences and structures, the application of software tools for receptor-based drug design, the processing and visualization of biomedical images, and the modeling and simulation of living systems. The health care-related activities include the development of test bed networks linking hospitals, clinics, libraries, and medical schools, the development of computerized patient records and telemedicine technologies, and the creation of virtual environments to assist in medical diagnosis. The NIH CIC R&D programs make available to biomedical researchers the benefits of high performance computing and communication systems including advanced computing architectures and high speed network connections. The NIH pursues its CIC R&D goals through the funding of grants and contracts to support research conducted at universities and Research institutions throughout the Nation, as well as through research conducted at the NIH's intramural laboratories. These programs are administered by the National Library of Medicine (NLM), the National Center for Research Resources (NCRR), the Division of Computer Research and Technology (DCRT), the National Cancer Institute (NCI), and the National Institute of General Medical Sciences (NIGMS).

# National Institutes of Health

## FY 1998 President's Request by Program Component Area

| Program Activity | Budget Account Code | Partner/User Agencies | Budget (BA, $ M) | | | | HPCC PCAs by 1998 Pres. Request | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | FY 96 Actual | FY 97 Pres. | FY 97 Est. | FY 98 Rqst. | HECC | LSN | HCS | HuCS | ETHR |
| NLM Medical Connections Program | | | 0.82 | 1.22 | 1.47 | 1.47 | | 1.47 | | | |
| NLM Biotechnology Informatics | | | 5.82 | 6.17 | 8.39 | 9.14 | | 7.31 | 1.14 | 0.69 | |
| NLM Electronic Imaging | | | 1.93 | 1.44 | 2.25 | 2.25 | | | | 2.25 | |
| NLM Electronic Imaging (continued) | | | | | | | | | | | |
| NLM HPCC Training Grants | | | 3.04 | 3.04 | 3.54 | 4.04 | | | | | 4.04 |
| NLM IAIMS grants | | | 3.40 | 3.40 | 3.40 | 3.40 | | 2.00 | 0.50 | 0.90 | |
| NLM Intelligent Agent DB searching | | | 9.49 | 8.57 | 11.80 | 13.30 | | 9.97 | | 3.33 | |
| NLM HPCC Health Care Applications | | | 16.21 | 20.86 | 14.86 | 14.11 | | 2.35 | 2.35 | 9.41 | |
| NCRR Biomolecular Computing | | | 6.60 | 7.30 | 7.30 | 7.30 | 6.30 | 0.20 | | 0.80 | |
| NCRR Software Tools for Receptor-Based Drug Design | | | 2.20 | 2.20 | 2.20 | 2.20 | 2.20 | | | | |
| NCRR Modeling/Simulation | | | 5.80 | 5.30 | 5.30 | 5.30 | 4.50 | 0.10 | | 0.70 | |
| NCRR Virtual Reality/Environments | | | 4.20 | 7.70 | 7.70 | 9.70 | | | | 9.70 | |
| NCRR HPCC Training | | | 3.50 | 1.80 | 1.80 | 1.80 | | | | | 1.80 |
| DCRT High Performance Biomedical Computing Program | | | 8.90 | 8.90 | 8.90 | 8.92 | 6.12 | 2.30 | | 0.50 | |
| NCI Frederick Biomedical Supercomputing Center | | | 5.90 | 5.90 | 5.90 | 6.21 | 3.91 | 1.39 | 0.14 | 0.28 | 0.49 |
| NCI High Speed Networking and Distributed Conferencing | | | 1.34 | 1.31 | 1.31 | 1.31 | 0.20 | 0.72 | | 0.34 | 0.05 |
| NCI High Perf. Comms for PDQ, CancerNet, and Electronic Publishing | | | 0.60 | 0.60 | 0.60 | 0.75 | | 0.38 | | 0.38 | |
| NIGMS HPCC Extramural Activities | | | | 0.50 | 0.50 | 0.51 | 0.51 | | | | |
| Totals: | | | 79.75 | 86.21 | 87.22 | 91.71 | 23.74 | 28.19 | 4.13 | 29.28 | 6.38 |

# National Institutes of Health

## Comparison of FY 1997 and FY 1998 by Program Component Area

| Program Activity | Budget (BA, $ M) | | | | HPCC PCAs by 1998 President's Request | | | | | HPCC PCAs by 1997 Estimated | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | FY 96 Actual | FY 97 Pres. | FY 97 Est. | FY 98 Rqst. | HECC | LSN | HCS | HuCS | ETHR | HECC | LSN | HCS | HuCS | ETHR |
| NLM Medical Connections Program | 0.82 | 1.22 | 1.47 | 1.47 | | 1.47 | | | | | 1.47 | | | |
| NLM Biotechnology Informatics | 5.82 | 6.17 | 8.39 | 9.14 | | 7.31 | 1.14 | 0.69 | | | 6.71 | 1.05 | 0.63 | |
| NLM Electronic Imaging | 1.93 | 1.44 | 2.25 | 2.25 | | | | 2.25 | | | | | 2.25 | |
| NLM Electronic Imaging (continued) | | | | | | | | | | | | | | |
| NLM HPCC Training Grants | 3.04 | 3.04 | 3.54 | 4.04 | | | | | 4.04 | | | | | 3.54 |
| NLM IAIMS grants | 3.40 | 3.40 | 3.40 | 3.40 | | 2.00 | 0.50 | 0.90 | | | 2.00 | 0.50 | 0.90 | |
| NLM Intelligent Agent DB searching | 9.49 | 8.57 | 11.80 | 13.30 | | 9.97 | | 3.33 | | | 8.85 | | 2.95 | |
| NLM HPCC Health Care Applications | 16.21 | 20.86 | 14.86 | 14.11 | | 2.35 | 2.35 | 9.41 | | | 2.48 | 2.48 | 9.90 | |
| NCRR Biomolecular Computing | 6.60 | 7.30 | 7.30 | 7.30 | 6.30 | 0.20 | | 0.80 | | 6.30 | 0.20 | | 0.80 | |
| NCRR Software Tools for Receptor-Based Drug Design | 2.20 | 2.20 | 2.20 | 2.20 | 2.20 | | | | | 2.20 | | | | |
| NCRR Modeling/Simulation | 5.80 | 5.30 | 5.30 | 5.30 | 4.50 | 0.10 | | 0.70 | | 4.50 | 0.10 | | 0.70 | |
| NCRR Virtual Reality/Environments | 4.20 | 7.70 | 7.70 | 9.70 | | | | 9.70 | | | | | 7.70 | |
| NCRR HPCC Training | 3.50 | 1.80 | 1.80 | 1.80 | | | | | 1.80 | | | | | 1.80 |
| DCRT High Performance Biomedical Computing Program | 8.90 | 8.90 | 8.90 | 8.92 | 6.12 | 2.30 | | 0.50 | | 6.10 | 2.30 | | 0.50 | |
| NCI Frederick Biomedical Supercomputing Center | 5.90 | 5.90 | 5.90 | 6.21 | 3.91 | 1.39 | 0.14 | 0.28 | 0.49 | 3.60 | 1.39 | 0.14 | 0.28 | 0.49 |
| NCI High Speed Networking and Distributed Conferencing | 1.34 | 1.31 | 1.31 | 1.31 | 0.20 | 0.72 | | 0.34 | 0.05 | 0.20 | 0.72 | | 0.34 | 0.05 |
| NCI High Perf. Comms for PDQ, CancerNet, and Electronic Publishing | 0.60 | 0.60 | 0.60 | 0.75 | | 0.38 | | 0.38 | | | 0.30 | | 0.30 | |
| NIGMS HPCC Extramural Activities | | 0.50 | 0.50 | 0.51 | 0.51 | | | | | 0.50 | | | | |
| Totals: | 79.75 | 86.21 | 87.22 | 91.71 | 23.74 | 28.19 | 4.13 | 29.28 | 6.38 | 23.40 | 26.52 | 4.17 | 27.25 | 5.88 |

| NIH | **NLM Medical Connections Program** | Budget Code | |
|---|---|---|---|

The Medical Connections grant program provides `jump start` funding to academic medical centers, community hospitals, and other health care organizations to allow them to connect to NREN. Funding by the National Library of Medicine is provided to offset the costs of digital communications equipment, digital circuits linking medical centers with academic and commercial mid-level networks, and personnel and services necessary to connect to the NREN. Special emphasis is given to linking medical libraries with health care delivery organizations and networked databases so that high speed telecommunications can support delivery of timely and accurate information for clinical decision making. The program also supports distribution of Internet capability within an institution, and creation of regional consortia of health care institutions for sharing of medical information.

| Milestone Changes | Due to funding limitations, 1996 grant targets were reduced from 50 to 25. |
|---|---|

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Twenty-five grants were awarded. | Approximately 40 grants will be awarded. Overall program goal is to contribute to the task of connecting health care institutions in the U.S. onto the NREN. | Approximately 50 grants will be awarded. Overall program goal is to contribute to the task of connecting health care institutions in the U.S. onto the NREN. |

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 0.82 |
| FY 97 Pres | 1.22 |
| FY 97 Est. | 1.47 |
| FY 98 Rqst. | 1.47 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | 1.47 | 1.47 |
| HCS | | |
| HuCS | | |
| ETHR | | |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | |
| DOE | |
| NASA | |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| NIH | **NLM Biotechnology Informatics** | Budget Code | |
|---|---|---|---|

The NLM's National Center for Biotechnology Information (NCBI) has the legislative mandate to create automated systems for storing and analyzing the vast and growing volume of data related to molecular biology, biochemistry, and genetics. This field, which has come to be known as bioinformatics, is an essential component of genome research, protein engineering and drug design through its use of analytical and predictive methods to identify key molecular patterns associated with health and disease. Within a distributed database architecture, the NCBI collects sequence data from researchers worldwide and incorporates them into GenBank, the NIH DNA sequence databank which is a key data resource of the Human Genome Project. NCBI has produced an integrated database system consisting of GenBank, the genetic scientific literature in Medline, taxonomy, and 3-D molecular structures. This database is accessed daily through the Internet by over 10,000 different sites. Basic research on efficient data analysis techniques and large-scale genome analysis is conducted within NCBI's Computational Biology Branch and has been a key factor in gene discovery. The Biotechnology Informatics program administered through NLM's Extramural Program also supports investigator-initiated research in computational biology via peer reviewed grants.-

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 5.82 |
| FY 97 Pres | 6.17 |
| FY 97 Est. | 8.39 |
| FY 98 Rqst. | 9.14 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | 6.71 | 7.31 |
| HCS | 1.05 | 1.14 |
| HuCS | 0.63 | 0.69 |
| ETHR | | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Automated sequencing technology accelerates pace of input to database, from the current rate of doubling every 20 months. High throughput from cDNA sequencing may doubles size of database in less than one year. NCBI began distribution of human genetic disease database (OMIM) produced at Johns Hopkins. Increased user and network demands for sequence search and retrieval, approaches 40,000 queries per day, will require upgrading server software and hardware. | Increase in the number of funded genome centers will increase sequence data output to greater than 600,000 sequences per year. Increased demand for retrieval services due to growth in Internet and the World Wide Web and the availability of complete genome from several organisms.<br>NCBI will continue participation with publishers of online journals in a WWW project linking the GenBank sequences and MEDLINE abstracts to the full text of scientific articles (PubMed project). Immensity and complexity of genomic data will drive development of tools for synthesizing and summarizing data into higher level interactive views. NCBI will begin organizing physical and genetic map information for human genome and model organisms. | Based on reliable predictions for genome-scale sequencing projects, daily input rate of DNA sequences should quadruple. In addition, raw sequence information will be increasingly linked to large-scale physical maps which NCBI is compiling.<br>Expansion of Internet and availability of higher-bandwidth connections will lead to significantly greater user load on services: text retrieval, sequence analysis, 3-D structure comparisons. To accommodate computing demands, will be architecting clusters of low cost compute servers for parallelizing repetitive database searches. Additional demands will result from expansion of scientific literature database (PubMed project) with increased linkage between literature and experimental databases.- |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | |
| DOE | |
| NASA | |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| NIH | NLM Electronic Imaging | Budget Code | |
|---|---|---|---|

Images are an important part of biomedical knowledge. New computer based technologies are providing an unprecedented opportunity to supplement the traditional two dimensional images of medicine and biology with dynamic, three dimensional images that can be viewed, rotated, and reversible dissected in a manner analogous to the physical objects they represent.

Visible Human Project: The National Library of Medicine has undertaken steps to build and evaluate digital image libraries of anatomical structures of the human body. Full use and understanding of the biological structures depicted in such libraries will exploit the integration of advance computer and communications technologies, with medical imaging systems for computer tomography (CT), and magnetic resonance (MR)imaging. The combinations of these technologies with efficient algorithms to efficiently render anatomic data into photo realistic images which are easily manipulable by students, researchers, or health care providers will offer new tools for health education, research and clinical practice.

DPXNET Program: The NLM is the technical lead agency in a collaborative project in electronic imaging with the National Center for Health Statistics (NCHS) and the National Institute of Arthritis and Musculoskeletal and Skin Diseases (NIAMS). The NCHS conducts nationwide surveys and collects a broad range of medical, demographic and other health related data in addition to x rays. This project has succeeded in digitizing and archiving about 17,000 cervical and lumbar spine x-ray films acquired as part of the second National Health and Nutrition Examination Survey (NHANES II) to create an electronic archive of this unique and nationally important collection.

(continued)

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 1.93 |
| FY 97 Pres | 1.44 |
| FY 97 Est. | 2.25 |
| FY 98 Rqst. | 2.25 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | | |
| HCS | | |
| HuCS | 2.25 | 2.25 |
| ETHR | | |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | |
| DOE | |
| NASA | |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| A subset for the color data were mapped with anatomical labels and graphical outlines to serve as a data structure model for object identification of the full male and female image data sets; a prototype image database was designed to house the 2D and 3D data sets.<br>Continue research into automated image classification, and linkage of structural data with semantic labels. The design of a portable standardized readings workstations for deployment on the Internet was initiated; began readings of all cervical and lumbar spine images, and incorporated this data with the digital images and other NHANES II collateral data; completed general access client workstations for Internet access by universities, government agencies, research institutions and a broad array of independent investigators.<br>Began an effort to incorporate image compression and high speed transmission techniques to optimize the distribution of the Visible Human and digital x-ray images. The multi socket transmission technique algorithms were tested on image samples from both collections. | Implement the prototype for the complete image data base; start full object identification of the Visible Human data sets; mount the prototype Visible Human Subset Database on line for user alpha testing.<br>Begin standardized readings of NHANES II and III images; design test for general access to integrated database consisting of NHANES II and III collateral text and images; expand general access workstations to access other image/text databases.<br>Identify the compression technique and specific parameters for maximum compression of images consistent with required quality standards; encode the multi socket transmission technique for use in server/client systems. | Expand the data set, consisting of the thorax of the visible human male specimen, to include additional records of the male and female anatomical structures; release an alpha test model of the prototype visualization subsystem to process and display image subsets retrieved from the visible human image database.<br>Complete standardized readings of NHANES II and III images; begin general access to integrated database consisting of NHANES II and III text and images as a beta test.<br>Complete a lossless compression technique for the archiving of ISTO image set; begin the development of a lossy high compression ratio technique/system using wavelet transform, scalar or vector quantization and entropy coding. |

| NIH | **NLM Electronic Imaging (continued)** | Budget Code | |
|---|---|---|---|

(continued)

The third survey, NHANES III, has generated an additional 10,000 x-rays of the hands, wrists and knees. Accomplishments include: the development of high performance imaging workstations for quality control and standardized readings; the development of an electronic store implemented by a 144-platter optical disk jukebox and a RAID system accessible over the Internet; the development of client/server software for general access to the images and collateral data over the Internet; initiating the design of an electronic radiologic atlas and training set for the cervical and lumbar spine; began the development of an integrated database with image and collateral data for general access over the Internet and begin the development of a general access workstation.

ISTO Project: The large size of the Visible Human image set and other medical images offer an enormous challenge to storage and transmission. The full set of Visible Human images would require a capacity of over 100 CDROMs, an impractical distribution option. The NLM therefore is investigating advanced compression and communication techniques to minimize the required storage capacity and maximize transmission speed over the Internet.-

| Milestone Changes | |
|---|---|

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| | | |

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | |
| FY 97 Pres | |
| FY 97 Est. | |
| FY 98 Rqst. | |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | | |
| HCS | | |
| HuCS | | |
| ETHR | | |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | |
| DOE | |
| NASA | |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| NIH | NLM HPCC Training Grants | Budget Code | |
|---|---|---|---|

Currently, there are too few professionals in biomedical fields who have had training in the use of modern computer and telecommunications systems. There is a need both for biomedical professionals cross-trained in Informatics and for persons from computer and information sciences and engineering who have had doctoral or post doctoral training in the application of these technologies to health problems. Medical centers that wish to modernize and network efficiently their institution-wide information services have found it difficult to identify and recruit senior professionals with this kind of education and training. Training in health information management skills is critical. NLM is expanding its successful pre-doctoral and post-doctoral grants program for career training in Medical Informatics, both for research and application, and in providing an HPCC-in-medicine fellowship training support.

| Milestone Changes | NLM's awards to selected universities to develop and operate training programs for informatics are currently being recompeted because the five year grants made in FY 1992 expire next year. The nineteen applications that have been received include all of the ten institutions supported by the expiring grants |
|---|---|

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Continued support for existing programs continued. | Continuing individual and program grants for HPCC training for health professionals. | Continuing individual and program grants for HPCC training for health professionals. |

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 3.04 |
| FY 97 Pres | 3.04 |
| FY 97 Est. | 3.54 |
| FY 98 Rqst. | 4.04 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | | |
| HCS | | |
| HuCS | | |
| ETHR | 3.54 | 4.04 |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | |
| DOE | |
| NASA | |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| NIH | **NLM IAIMS grants** | Budget Code | |
|---|---|---|---|

Academic Medical Centers are the backbone of the American biomedical research enterprise. These 120-plus institutions are comprised of health profession schools, their associated teaching and research hospitals, clinics and laboratories. Information related to patient care, research, education, and administration is the life blood of these complex centers; increasingly this information is in electronic form: databases of bibliographic and factual information, molecular databases, patient records, laboratory and clinical data. Currently, these electronic information sources (databases) are largely disconnected and isolated from one another, and communications among the various computerized systems in academic medical centers is primitive or non existent. The focus of the IAIMS program, initiated in 1984, is the development of the technical and organizational infrastructure necessary to link and retrieve conceptually related information from many disparate sources within the medical center, and to link medical centers. The administrative, clinical, educational, and research databases should be able to communicate, and to appear as one database to the user. The goal of the program is the development, testing, and implementation of generalizable systems of information flow management within university health science centers or major teaching hospitals. The expected outcomes of this program are greater research productivity, improved access to patient data for technology assessment and health outcomes research, and more efficient patient care leading to increased efficiency in the use of health care resources. The work is expected eventually to benefit all health delivery organization, including community hospitals and outpatient services.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 3.40 |
| FY 97 Pres | 3.40 |
| FY 97 Est. | 3.40 |
| FY 98 Rqst. | 3.40 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | 2.00 | 2.00 |
| HCS | 0.50 | 0.50 |
| HuCS | 0.90 | 0.90 |
| ETHR | | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| In addition to continuation of active awards, five new planning grants were awarded. As usual, emphasis on sharing of information via the NREN is a central focus of the program. | Continuing progress toward integration of academic information management by American medical centers. | Continuing progress toward integration of academic information management by American medical centers. |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | |
| DOE | |
| NASA | |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| NIH | **NLM Intelligent Agent DB searching** | Budget Code | |
|---|---|---|---|

With the large and rapidly growing number of computerized data base resources and services offering bibliographic, full text and factual data via the Internet, it is difficult for the user to locate and process needed information. One may not know where -- in which data base -- to look, and the user must deal with the structured and unforgiving access protocols and retrieval languages that differ from one data base service to the next. An especially vexing problem arises if the user needs to search across several data bases or services containing information in multiple formats. In biomedicine, the disparity in the biomedical terminology used to describe related concepts in different machine readable files also prevents practitioners and researchers from retrieving and integrating relevant biomedical information from separate sources, such as the biomedical literature, clinical records, medical data banks, and expert knowledge bases. NLM's approach to these problems is to develop intelligent gateways among data base services, using a Unified Medical Language System (UMLS) to compensate for the dissimilarity in the ways related information is classified in different automated systems. Intelligent-agent-mediated gateways will provide users with a single point of access to needed information and free the user as much as possible from having to know the peculiarities of the various information sources. The UMLS will function as an electronic Rosetta Stone, making the myriad of classifications of medical knowledge invisible to the user and enabling retrieval of related biomedical information from many sources.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 9.49 |
| FY 97 Pres | 8.57 |
| FY 97 Est. | 11.80 |
| FY 98 Rqst. | 13.30 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | 8.85 | 9.97 |
| HCS | | |
| HuCS | 2.95 | 3.33 |
| ETHR | | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Made Internet Grateful Med generally available to provide intelligent agent-mediated multi-database searching to all NLM users with Internet access.<br>Deployed Internet-based tools for creation of descriptions of Internet accessible biomedical information resources and for intelligent source selection, as part of NLM's UMLS Information Sources Map development. | Deploy new capabilities for automatic source selection and for retrieving and sorting information from multiple databases both within the Internet Grateful Med and UMLS Information Sources Map context and from replacement of the retrieval engine. | Continue to develop and deploy new capabilities for automatic source selection and for retrieving and sorting information from multiple databases both within the Internet Grateful Med and UMLS Information Sources Map context and from replacement of the retrieval engine. |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | |
| DOE | |
| NASA | |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| NIH | NLM HPCC Health Care Applications | Budget Code | |
|---|---|---|---|

Through a variety of mechanisms, the NLM is promoting the application of HPCC technologies to health care. The program supports research and development projects in each of the following IITA areas:

1. Test bed networks for linking hospitals, clinics, doctor's offices, medical schools, medical libraries, and universities to enable health care providers and researchers to share medical data and imagery;
2. Software and technology for visualizing the human anatomy and analyzing imagery from X-rays, CAT scans, PET scans, and other diagnostic tools;
3. Virtual reality technology for simulating operations and other medical procedures;
4. Telemedicine or collaborative technology to allow several health care providers in remote locations to provide real-time treatment to patients;
5. Database technology to provide health care providers with access to relevant medical information and literature; and
6. Database technology for storing, accessing, and transmitting patients' medical records while protecting the accuracy and privacy of those records.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 16.21 |
| FY 97 Pres | 20.86 |
| FY 97 Est. | 14.86 |
| FY 98 Rqst. | 14.11 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | 2.48 | 2.35 |
| HCS | 2.48 | 2.35 |
| HuCS | 9.90 | 9.41 |
| ETHR | | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Initiated and expanded HPCC health care applications, with special emphasis on evaluation of impact of telemedicine and testing of best practices for protecting privacy of health data.<br>Continued funding of twelve HPCC BAA awards and 8 (5.5 NLM; 2.5 AHCPR) cooperative agreements. | Continue funding projects promoting the application of HPCC technologies to health care, the evaluation of telemedicine, and the testing of methods for protecting the privacy of electronic health data. There will also be a special emphasis on R&D for computer-based patient records and public health applications of the NII. | Continue funding projects promoting the application of HPCC technologies to health care, the evaluation of telemedicine, and the testing of methods for protecting the privacy of electronic health data. There will also be a special emphasis on R&D for computer-based patient records and public health applications of the NII. |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | |
| DOE | |
| NASA | |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | Partner |
| VA | Partner |

| NIH | **NCRR Biomolecular Computing** | Budget Code | |
|---|---|---|---|

Biomolecular computing using high performance computing involves extensive, often complex calculations to determine or predict:
1) The structure of biologically relevant macromolecules, e.g., proteins;
2) Their structural and functional changes due to interactions with other molecules or drugs;
3) How they are made in the cell and how they fold;
4) How they interact with water and biological membranes; and
5) Especially for drugs, the energetics of molecules going into solution.

Achieving meaningful results in a reasonable timeframe requires powerful, high end computers and efficient software and algorithms. Hardware, including massively parallel processors, are available to several NCRR resource centers through a partnership with the NSF. Investigators at these resource centers develop the algorithms and software to address these important and difficult research problems.

| Milestone Changes | FY 96 goal of predicting protein structure from sequence will not be achieved. Significantly improved models for predicting protein folding are expected in FY 97. |
|---|---|

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| New methods for predicting secondary structure and tertiary structure of proteins using statistical information from protein databases have been developed. A large set of existing molecular models for proteins have been tested against accurate quantum mechanical calculations for a four amino acid peptide and the results demonstrate that all of the potential functions in current use have substantial inaccuracies, rendering them inadequate for quantitative protein modeling. Six resource centers can support computational technology capable of simulating very large complexes of proteins, DNA, and membranes in water environments. Several new investigator-initiated research project grants were undertaken in this area. | Methodology to predict protein structure from sequence and NMR data should be ready for commercialization. Improved methods for predicting final protein structure from its amino acid sequence will be developed. More accurate methods to determine potential functions will become available for use in quantitative protein modeling.<br>Continued improvements in computational technologies are anticipated which will permit increasingly larger complexes of proteins, DNA, and membranes to be simulated in water environments. Support of investigator-initiated research project grants will be continued. | Refine new methods developed for ab initio structure prediction for use in the pharmaceutical industry.<br>Demonstrate the utility of novel protein potential functions to provide the accuracy required for applications in the biotechnology industry, such as synthesizing models of protein receptors for structure-based drug design.<br>Further improve computational technologies for larger simulations of protein, DNA, and membrane complexes in water environments.<br>Continued support of investigator-initiated research grants to further develop high performance computer methods and technologies related to biomedical applications. |

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 6.60 |
| FY 97 Pres | 7.30 |
| FY 97 Est. | 7.30 |
| FY 98 Rqst. | 7.30 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | 6.30 | 6.30 |
| LSN | 0.20 | 0.20 |
| HCS | | |
| HuCS | 0.80 | 0.80 |
| ETHR | | |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | Partner |
| DOE | |
| NASA | |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| NIH | NCRR Software Tools for Receptor-Based Drug Design | Budget Code | |
|---|---|---|---|

The goal of this activity is to develop computational methodologies for use in the design of drugs. This endeavor includes the establishment of high performance computer-based environments that:
1) accurately and efficiently estimate electrostatic forces among molecular and atomic interactions;
2) effectively use core computer technologies to calculate drug-protein binding energies with quantum mechanics, statistical mechanics and simulation techniques; and
3) strive to attain dramatic improvements in performance of molecular dynamics programs to permit theoretical and experimental studies to be executed in similar time frames.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 2.20 |
| FY 97 Pres | 2.20 |
| FY 97 Est. | 2.20 |
| FY 98 Rqst. | 2.20 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | 2.20 | 2.20 |
| LSN | | |
| HCS | | |
| HuCS | | |
| ETHR | | |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | Partner |
| DOE | |
| NASA | |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Use of high performance resources accessible through high speed networks are becoming available to support structure-based design of drugs by university research centers and the pharmaceutical industry.<br>Design of new molecule-drug combinations using capability to predict protein-drug binding energies.<br>Work on calculation of solvation energies should uncover overestimates in certain binding energies, e.g., hydrogen binding. New potential functions will need to be developed for biomolecular modeling to become quantitative.<br>Support new investigator initiated research project grants.- | Continue use of high performance computer resources accessible through high speed networks to support structure-based drug design.<br>Improve methods to efficiently and accurately predict protein-drug binding energies.<br>Enhance simulations of complex protein drug interactions on/in cellular membranes.<br>Deployment of novel 3-D graphics software for interactive selection, display, and manipulation of macromolecules, such as proteins and nucleic acids, and `docking` of drugs and receptors.<br>Support new investigator-initiated research project grants. | Provide enhanced methods to access and use powerful parallel computer applications in the area of biochemistry, molecular biology, and cellular biology. These approaches will emphasize use of Web-based browsers, such as Netscape, to access supercomputers and other resources such as large databases.<br>Provide over the Internet the ability to conduct complex simulations related to receptor sites and other aspects of drug design. Integrate 3-D graphics software with other software tools, such as tools for magnetic resonance spectroscopy data analysis and molecular structure determination, to provide powerful new capabilities for addressing structure-based drug design.<br>Further improve the methodology to predict protein-drug binding energies. Support new investigator-initiated research project grants. |

| NIH | **NCRR Modeling/Simulation** | Budget Code | |
|---|---|---|---|

As scientists strive to understand increasingly more complex biomedical processes, the computer requirements, both hardware and software, needed to model and simulate these processes increase in performance and complexity. These requirements extend to network capabilities which will be required to carry increasingly more data per unit time. Network response time is a barrier to carrying this out in real time. The research resource centers are the focus for NCRR-supported simulation/modeling high performance computing activities. Areas of interest include simulations of subjects as small as molecules and as large as the entire body--cells, tissues, organs, and organ systems. In addition, there are epidemiological models, especially for pressing health problems, such as AIDS and cardiovascular disease.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 5.80 |
| FY 97 Pres | 5.30 |
| FY 97 Est. | 5.30 |
| FY 98 Rqst. | 5.30 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | 4.50 | 4.50 |
| LSN | 0.10 | 0.10 |
| HCS | | |
| HuCS | 0.70 | 0.70 |
| ETHR | | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| It is estimated that simulations of large molecular systems in excess of 100,000 atoms will be visualized and interactively controlled through the integration of improved parallel algorithms, faster numerical methods for longer integration steps, and the new generations of massively parallel computers.<br>Capability to realistically model oxygen transport and metabolism for the whole body. Enhanced Monte Carlo models with the capability to provide dynamic visualization of epidemiological data. Extend initiatives in simulation and modeling through research project grants. | Continued simulation of increasingly large molecular systems. Enhanced models of cells and organs, e.g., Peskin heart model.<br>Increased interaction between NIH and NSF modeling centers via Internet. | Continued development of algorithms and software tools to simulate larger molecular systems more accurately.<br>Produce more detailed models of cells organs using high performance computing methods and through access to supercomputers via the Internet. |

**Agency Ties**

| | |
|---|---|
| DARPA | Partner |
| NSF | Partner |
| DOE | |
| NASA | Partner |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| NIH | NCRR Virtual Reality/Environments | Budget Code | |
|---|---|---|---|

In certain areas of basic research, the ability to visualize large amounts of data in a `natural environment` is often crucial. In clinical care the ability to `see` deep inside the body, especially the brain, can determine whether a surgical procedure or other therapeutic intervention can be successfully performed with minimum trauma to the patient. These fundamental requirements are increasingly being provided by an evolving technology known as virtual reality or virtual environments. Among requirements for effective virtual reality is the need to provide realistic images--visualization--in real time, that is, these images change in a realistic fashion according to where the observer is looking in real time. All but the most simple cases require high performance computer capability. The NCRR effort in virtual reality is focused on applications for scientific instruments for basic research, molecular visualization, and surgical and other therapeutic interventions such as radiation planning.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 4.20 |
| FY 97 Pres | 7.70 |
| FY 97 Est. | 7.70 |
| FY 98 Rqst. | 9.70 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | | |
| HCS | | |
| HuCS | 7.70 | 9.70 |
| ETHR | | |

| Milestone Changes | In FY 96 explore feasibility of establishing `collaboratory testbeds` focusing on important biomedical research problems was added. In FY 97 it will not be possible to establish collaboratory testbeds due to budget constraints and lack of reliable, wideband network need to demonstrate this capability. |
|---|---|

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Obtain preliminary results on the value of coupling virtual visualization capabilities to instruments, such as the atomic force microscope access over wideband networks. Molecular scientists to experiment with an improved version of the room-filling molecule technology.<br>Establish preliminary utility of force-arm technology for molecular docking and folding studies. Integrate kinetic and virtual displays to permit dissociation of visual and vestibular cues in the course of natural behavior for brain behavior research.<br>Explore feasibility of establishing `collaboratory testbeds` focused on important biomedical research problems. Internet response time may be a limiting factor. | Refine prototype systems of virtual environments for scientific instruments.<br>Demonstrate and evaluate new applications for these prototypes.<br>Measure the adhesion forces of viruses and bacteria on cells and observe life processes in action.<br>Define the requirements to establish and evaluate two or three collaboratory testbeds (possibly with NSF and DARPA as partners.)<br>Continue to develop and integrate kinetic and virtual environments to support cognitive neuroscience research. | Continue to develop and use virtual environments for scientific instruments. Enable users to use chemical probes on the tips of atomic force microscopes to investigate and modify biological processes.<br>Establish two or three collaboratory testbeds (possibly with other Federal agencies as partners.)<br>Develop parallel methods for accomplishing functional magnetic resonance imaging for research and real-time diagnosis of brain pathologies.<br>Extend cognitive neuroscience research capability to simulate human memory circuits leading to a model of human working memory with the potential to impact on all aspects of learning. |

**Agency Ties**

| | |
|---|---|
| DARPA | Partner |
| NSF | Partner |
| DOE | |
| NASA | |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| NIH | **NCRR HPCC Training** | Budget Code | |
|---|---|---|---|

NCRR provides training in high performance computing mainly through its research resource centers that focus on the use of this technology. This training, which is generally integrated with the research and development activities of the resource centers, can involve undergraduate and graduate students, postdoctoral fellows, and established scientists from within and outside of the host institution. The primary focus of this training is to introduce biomedical scientists to high performance computing, make them aware of how to use available software tools for biomedical research, and instruct them on how to access high performance computer resources from their laboratories over the Internet.

| Milestone Changes | Delayed implementation of NRSA Training to FY 1998. |
|---|---|

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Continue hands-on training programs<br>Continue science education projects.<br>Develop plan for NRSA awards for formalized training for biomedical scientists in the use of high performance computing; awards not limited to NCRR resource centers. | Continue hands-on training programs. Continue science education projects.<br>Implement a pilot training program at selected NCRR supported HPC resource centers to introduce biomedical scientists to high performance computer methods and tools. | Continue hands-on training programs. Continue science education projects.<br>Implement an NRSA awards program, not limited to NCRR resource centers, to train biomedical scientists to use HPC technology efficiently and effectively. |

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 3.50 |
| FY 97 Pres | 1.80 |
| FY 97 Est. | 1.80 |
| FY 98 Rqst. | 1.80 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | | |
| HCS | | |
| HuCS | | |
| ETHR | 1.80 | 1.80 |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | |
| DOE | |
| NASA | |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| NIH | DCRT High Performance Biomedical Computing Program | Budget Code | |
|---|---|---|---|

The goal of the Division of Computer Research and Technology (DCRT) High Performance Biomedical Computing Program is to make available to the NIH staff the benefits of high performance computing and communication systems in their scientific and clinical research efforts. To achieve this goal, DCRT determines which high performance parallel architectures are best for the classes of problems that arise in biomedical computing, develops parallel algorithms and computational techniques for advanced biomedical computing problems, and provides a high performance distributed computing environment that benefits the NIH staff in their scientific computing needs including the appropriate network and workstation technologies. DCRT is developing methods and algorithms for a number of biomedical applications that can benefit from computational speedup. These include image processing of electron micrographs, radiation treatment planning, medical imaging, protein and nucleic acid sequence analysis, human genetic linkage analysis, protein folding prediction, nuclear magnetic resonance spectroscopy, x-ray crystallography, quantum chemical methods, and molecular dynamics simulations.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 8.90 |
| FY 97 Pres | 8.90 |
| FY 97 Est. | 8.90 |
| FY 98 Rqst. | 8.92 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | 6.10 | 6.12 |
| LSN | 2.30 | 2.30 |
| HCS | | |
| HuCS | 0.50 | 0.50 |
| ETHR | | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Expanded the IBM SP2 Scalable POWER parallel system initially deployed in FY 1995 for biomedical applications.<br>Continued to apply high performance parallel computing and communication methods to biomedical applications at NIH.<br>Demonstrated a scalable parallel method for searching the conformational space of proteins to be used for predicting the three-dimensional structure of proteins from their amino acid sequence.<br>Developed parallel software tools for NMR Spectroscopy and X- ray Crystallography.<br>Developed ATM network, multimedia workstation, and parallel computing technologies for medical imaging applications. | Expand the IBM SP2 Scalable POWER parallel system for biomedical applications. Continue to apply high performance parallel computing and communication methods to biomedical applications at NIH.<br>Develop new Positron Emission Tomography (PET) reconstruction algorithms using parallel techniques that will result in higher resolution images.<br>Continue to develop ATM network, multimedia workstation, and parallel computing technologies for medical imaging and scientific visualization.<br>Deploy an ATM-based Radiology Consultation Workstation in the NIH Clinical Center.<br>Implement high-speed network connections to other high performance computer centers in the Washington, D.C. metropolitan area using ATM technology. | Evaluate new scalable parallel architectures to determine if a new system should be obtained for biomedical applications at NIH.<br>Continue to apply high performance parallel computing and communication methods to biomedical applications at NIH.<br>Continue to develop ATM network, multimedia workstation, and parallel computing technologies for medical imaging and scientific visualization. |

**Agency Ties**

| | |
|---|---|
| DARPA | Partner |
| NSF | |
| DOE | Partner |
| NASA | Partner |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| NIH | NCI Frederick Biomedical Supercomputing Center | Budget Code | |
|---|---|---|---|

The NCI Frederick Biomedical Supercomputing Center's (FBSC) purpose is to provide high performance computing dedicated and available to the entire biomedical scientific community to develop basic knowledge for the diagnosis, treatment, understanding and prevention of cancer and other diseases. It employs advanced techniques in a fully integrated environment of workstations, mid-level, supercomputer and massively parallel computers connected by networks. Activities are concentrated in those areas of biomedical research computation that are too demanding to be pursued on conventional or immature computers. Primary concerns are structure determination by x-ray and magnetic resonance, structure prediction of nucleic acids and proteins, computational biochemistry and problems that arise from modern molecular biology. Genomic sequence analysis, molecular mechanics, ab initio chemistry, linkage analysis, image analysis and mathematical modeling are primary problem areas. High production algorithms are adapted to vector-multiprocessor and massively parallel systems, entirely new algorithms are developed and leading-edge computer science discoveries from the areas of computer vision, robotics, deterministic and non-deterministic, algorithms.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 5.90 |
| FY 97 Pres | 5.90 |
| FY 97 Est. | 5.90 |
| FY 98 Rqst. | 6.21 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | 3.60 | 3.91 |
| LSN | 1.39 | 1.39 |
| HCS | 0.14 | 0.14 |
| HuCS | 0.28 | 0.28 |
| ETHR | 0.49 | 0.49 |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Continue to attract important areas of research for the application of high performance computing to health-related basic research.<br>Expand activities in the use of distributed, heterogeneous computing for problems such as molecular mechanical calculations.<br>Provide expanded scalable computing such as workstation farms, and distributed batch computing queues for rapid throughput of smaller tasks.<br>Evaluate the advanced computational hardware and software available for productive, forefront application, especially those architectures showing promise of proven balanced performance in a research production environment. | Expand activities in high performance computing applications to molecular structure prediction of nucleic acids and proteins.<br>Apply computational chemistry to understanding of drug interactions with enzymes and nucleic acids as a basis for discovery of new drugs.<br>Provide support for increasing numbers of users in extramural and intramural research in biomedical computing. | Provide state of the art capabilities in a fully integrated high performance computing center. |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | |
| DOE | |
| NASA | |
| NIH | |
| NSA | Partner |
| NIST | Partner |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| NIH | **NCI High Speed Networking and Distributed Conferencing** | Budget Code | |
|---|---|---|---|

Improve access methodologies for diverse members of the biomedical research community to the entire computational infrastructure of the NCI Frederick Biomedical Supercomputing Center (FBSC) by improving the data communications and networking infrastructure through the implementation of evolving networking technologies and high speed interfaces. Initiatives in this area cover a wide variety of data communications technologies including local area networking, wide area networking, requirements for multimedia data transmission, dedicated specialized high speed interfaces for local computer to computer connections (e.g. high speed crossbar switches, HiPPI, fiber channel, etc.), and the use of evolving data communications standards such as ATM and SONET.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 1.34 |
| FY 97 Pres | 1.31 |
| FY 97 Est. | 1.31 |
| FY 98 Rqst. | 1.31 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | 0.20 | 0.20 |
| LSN | 0.72 | 0.72 |
| HCS | | |
| HuCS | 0.34 | 0.34 |
| ETHR | 0.05 | 0.05 |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Bring demonstrated capabilities in high performance computing to health research organizations of the public and private sector in open and efficient manner.<br>Develop and expand high speed links between remote sites for access of the intramural and extramural biomedical research community for video and data conferencing, distributed collaborations and distributed database and computing. | Expand availability of visual and voice interactions between biomedical computing researchers and projects. | Improve systems of visual and voice interactions between biomedical computing researchers and projects. |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | |
| DOE | |
| NASA | |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| NIH | **NCI High Perf. Comms for PDQ, CancerNet, and Electronic Publishing** | Budget Code | |
|---|---|---|---|

CancerFax and CancerNet are free services that allow users to access data from NCI databases. CancerFax allows users to dial into one of ICIC's computers from a fax machine and retrieve a faxed image of any of the Physician Data Query (PDQ) statements on cancer screening, prevention, treatment, or supportive care in English or Spanish, current CANCERLIT searches on over 60 topics, and over 100 Fact Sheets from NCI's Office of Cancer Communications. CancerNet is a free e-mail service on the Internet, enabling users to obtain free access to the same information in CancerFax. Additional cancer information is being added to CancerFax and CancerNet, and utilization is increasing rapidly. Approximately 30% of CancerNet requests originate outside the U.S. This information is also available and highly used on Gopher and WWW servers at NIH, Tokyo, Japan, and Singapore. ICIC strategic plans call for emphasis on the creation of multimedia information servers to take advantage of technology advances and R&D in the areas of communications and personal multimedia/computing devices.-

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 0.60 |
| FY 97 Pres | 0.60 |
| FY 97 Est. | 0.60 |
| FY 98 Rqst. | 0.75 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | 0.30 | 0.38 |
| HCS | | |
| HuCS | 0.30 | 0.38 |
| ETHR | | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Continue to develop multi-media informational products for distribution via the Internet: Build a reliable network of sources for multimedia such as medical images, patient oriented videos, etc., and develop the ability to create these materials where not already available.<br>Develop an infrastructure to maintain these media and to disseminate multimedia enhanced cancer information. Explore the dissemination of this information using cable TV and telephone lines.<br>Continue working with community networks to utilize ICIC's electronic information products. | Complete client server integrated multi-media database to serve communication media of the future. | Develop additional multimedia content to enhance PDQ database. Enhance integrated multimedia database in areas of information linkages and concept based searching. |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | |
| DOE | |
| NASA | |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| NIH | NIGMS HPCC Extramural Activities | Budget Code | |
|---|---|---|---|

Through its extramural grants program, the National Institute of General Medical Sciences (NIGMS) is supporting activities that contribute significantly to understanding the theoretical basis of the structure and dynamics of biological macromolecules, including proteins and nucleic acids. This program supports the prediction of the folded structure of proteins from the amino acid sequence, solvation of proteins and nucleic acids, new computational methods for solving the phase problem in crystallography, and the binding of ligands to proteins, the latter with an emphasis on targeted drug design. These efforts are done in collaboration with investigators at and make extensive use of facilities supported by the HPCC initiatives at the National Science Foundation, the National Center for Research Resources, the Division of Computer Research and Technology, and the Department of Energy

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | |
| FY 97 Pres | 0.50 |
| FY 97 Est. | 0.50 |
| FY 98 Rqst. | 0.51 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | 0.50 | 0.51 |
| LSN | | |
| HCS | | |
| HuCS | | |
| ETHR | | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| | Through its extramural grants program, the National Institute of General Medical Sciences (NIGMS) is supporting activities that contribute significantly to understanding the theoretical basis of the structure and dynamics of biological macromolecules, including proteins and nucleic acids. This program supports the prediction of the folded structure of proteins from the amino acid sequence, solvation of proteins and nucleic acids, new computational methods for solving the phase problem in crystallography, and the binding of ligands to proteins, the latter with an emphasis on targeted drug design. These efforts are done in collaboration with investigators at and make extensive use of facilities supported by the HPCC initiatives at the National Science Foundation, the National Center for Research Resources, the Division of Computer Research and Technology, and the Department of Energy<br>Making software that results from these efforts available through the HPCC initiatives supported by NSF, NCRR, and DCRT. | The completion and distribution of algorithms and associated software to:<br>(1) predict the folded structure of proteins,<br>(2) select from the small molecule database inhibitors for therapeutically important enzymes and receptors, and<br>(3) determine the structure of biological macromolecules up to 1,600 atoms by direct methods is expected. |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | Partner |
| DOE | Partner |
| NASA | |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

# National Security Agency

The National Security Agency (NSA) has traditionally influenced and been a very early and sophisticated user of the highest performance commercial computer, storage, and networking systems. For these reasons, NSA actively participated in the original HPCC studies which led to the Federal HPCC program. Through the entire period of growth of high performance computing and networking, spanning several decades, NSA has stimulated both industry and academia with some of the most challenging problems in the nation. A number of major U.S. computer companies are now using hardware and software technology in their products which originated at NSA. This role must continue, both to assure the availability of increasingly higher performance systems to meet the nation's national security interests and to ensure that benefits of NSA's activities accrue to the overall advantage of the industry and the satisfaction of other HPCC Grand Challenges.

NSA will continue to pursue high performance computing and very high speed networks in order to perform its mission. Many of these programs will also contribute directly to the overall goals of HPCC. NSA sponsors divisions of the Institute for Defense Analyses (an FFRDC) to do most of this research.

Results of programs and external drivers have led to revised priorities and funding levels for the supercomputing, superconducting, and very high speed research programs.

| Program Activity | Budget Account Code | Partner/User Agencies | Budget (BA, $ M) | | | | HPCCPCAs by 1998 Pres. Request | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | FY 96 Actual | FY 97 Pres. | FY 97 Est. | FY 98 Rqst. | HECC | LSN | HCS | HuCS | ETHR |
| Supercomputing Research | | ARPA, NASA, NIH | 27.48 | 23.43 | 27.93 | 24.20 | 24.20 | | | | |
| Supercomputing Research (continued) | | ARPA, NASA, NIH | | | | | | | | | |
| Superconducting Research | | NASA | 2.00 | 2.50 | 2.50 | 2.22 | 2.22 | | | | |
| Very High Speed Networking | | ARPA | 3.00 | 3.50 | 3.50 | 2.18 | | 2.18 | | | |
| Very High Speed Networking (continued) | | ARPA | | | | | | | | | |
| Secure Operating System Development | | NIST | 4.70 | 4.50 | 4.50 | 4.50 | | | 4.50 | | |
| High Speed Data Protection Electronics | | ARPA, NASA | 2.70 | 2.80 | 2.80 | 2.70 | | | 2.70 | | |
| Technology Based Training | | | 0.15 | | | | | | | | |
| Totals: | | | 40.03 | 36.73 | 41.23 | 35.80 | 26.42 | 2.18 | 7.20 | | |

# National Security Agency

## FY 1998 President's Request by Program Component Area

| Program Activity | Budget Account Code | Partner/User Agencies | Budget (BA, $ M) | | | | HPCC PCAs by 1998 Pres. Request | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | FY 96 Actual | FY 97 Pres. | FY 97 Est. | FY 98 Rqst. | HECC | LSN | HCS | HuCS | ETHR |
| Supercomputing Research | | ARPA, NASA, NIH | 27.48 | 23.43 | 27.93 | 24.20 | 24.20 | | | | |
| Supercomputing Research (continued) | | ARPA, NASA, NIH | | | | | | | | | |
| Superconducting Research | | NASA | 2.00 | 2.50 | 2.50 | 2.22 | 2.22 | | | | |
| Very High Speed Networking | | ARPA | 3.00 | 3.50 | 3.50 | 2.18 | | 2.18 | | | |
| Very High Speed Networking (continued) | | ARPA | | | | | | | | | |
| Secure Operating System Development | | NIST | 4.70 | 4.50 | 4.50 | 4.50 | | | 4.50 | | |
| High Speed Data Protection Electronics | | ARPA, NASA | 2.70 | 2.80 | 2.80 | 2.70 | | | 2.70 | | |
| Technology Based Training | | | 0.15 | | | | | | | | |
| Totals: | | | 40.03 | 36.73 | 41.23 | 35.80 | 26.42 | 2.18 | 7.20 | | |

| NSA | **Supercomputing Research** | Budget Code | |
|---|---|---|---|

NSA has a perennial requirement for the highest performance computing technology in order to perform its mission, the national security "Grand Challenge." The Supercomputing Research Program is directed to the discovery and application of methods seeking order of magnitude improvements in the computer support required for deriving intelligence from mathematical and signal processing problems. Activities range from invention and prototyping of new concepts, to improvement in the ability to use leading edge commercial products. A current focus of the research is on parallelism, the ability to apply many processing elements simultaneously to a single problem. The following projects are included within the Supercomputing Research Program:

SPLASH – A field programmable gate array-based architecture;

Parallel language work – AC (for T3D); implementation of `futures` model of message-passing programming;

MARQUISE/SOLITAIRE – Repackage a High Performance Computer (HPC) using diamond-based Multi-Chip Modules (MCMs). This computer will demonstrate the performance and reliability characteristics of diamond substrate and MCMs.

TEARDROP – Area array I/O (AAIO) microelectronic technologies have the potential to improve device interconnect bandwidths by an order of magnitude. This project will evaluate the impact of AAIO integrated circuits and MCMs on the performance and scalability of uniform-memory-access (UMA) supercomputer architectures.

3-D DIAMOND MCM CUBE COMPUTER – DARPA program to build test vehicle to demonstrate a 3-D computer architecture with a nanosecond system clock

MICRO SPRAY COOLING – Heat extraction values as high as 250 Watts per square centimeter have been demonstrated using micromachined spray head cooling. Values as high as 700 Watts per square centimeter are claimed to be possible by using dynamic feedback temperature sensors. (Continued )

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 27.48 |
| FY 97 Pres | 23.43 |
| FY 97 Est. | 27.93 |
| FY 98 Rqst. | 24.20 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | 27.93 | 24.20 |
| LSN | | |
| HCS | | |
| HuCS | | |
| ETHR | | |

**Agency Ties**

| | |
|---|---|
| DARPA | Partner |
| NSF | |
| DOE | |
| NASA | Partner |
| NIH | User |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| PARALLEL LANGUAGE WORK – Continued development of C-based compilers -- expansion of AC-supported parallel processing platforms.<br>MARQUISE/SOLITAIRE – Demonstration of repackaged commercial supercomputer with all logic and network components implemented with diamond-based MCMs for reliability and size reduction. Resultant machine will use micro-machined spray cooling. Completion of coolant study and spray cooler environment testing.<br>TEARDROP – Completion of evaluation study.<br>3-D DIAMOND MCM CUBE COMPUTER – Completion and demonstration of all components and test vehicle.<br>MICRO SPRAY – Delivery of several prototype systems and establishment of a reliability data base for system operation.<br>FIBER-OPTIC LOGIC – Demonstration of cascaded multiple optical gates to support high speed logic operation.<br>(Continued) | BRIOLETTE -- A follow-on program to MARQUISE. The MARQUISE program implemented all of the technologies demonstrated in the DARPA 3-D Diamond MCM Cube except for the Z axis. Phase 1 of the BRIOLETTE program is the design and evaluation phase (including limited hardware test vehicles) of a uniform memory access (UMA) supercomputer without a backplane, thereby improving processor-to-memory latency and bandwidth by an order of magnitude.<br>New initiative in the area of materials, devices, optoelectronics for very high communication rates and computing.<br>LIGHTNING -- Support for a wavelength division multiplexing testbed. Develop an optically-addressed spatial light modulator.<br>FIBER-OPTIC LOGIC -- Techniques that can restore data signals so that high bit error rates can be maintained without compromise of signal quality. (Continued) | Demonstrate the impact of Advanced Packaging techniques to greatly decrease the size and weight (by up to a factor of 4X) of a commercial high performance computer. Create a prototype for a powerful, mobile, front-end processor that supports high capacity I/O, high performance computing, high utilization of peak processor performance (50-80%), and is programmable in a high level language (such as C, C++). In FY 98 the effort will include:<br>Flight Test of MARQUISE (the embedded High Performance Computer) on Air Force and Navy aircraft<br>Miniaturized spray cooled, embedded diamond power supply research<br>Embedded Scalable Node (follow-on architecture to MARQUISE) for actual mission scenarios<br>* Continue a joint NSA/University of Maryland EE Department program with a research emphasis on microelectronics applied to high speed computing. The program is actively engaged in research in very high speed (many Gb/s) optoelectronic devices and systems using 1.5 micron WDM interconnect technology; |

| NSA | **Supercomputing Research (continued)** | Budget Code | |
|---|---|---|---|

(Continued)

FIBER-OPTIC LOGIC – Optical techniques can theoretically support data rates of several hundred Gb/s for future communications and computing systems.

OPTOELECTRONIC CIRCUITS ─ supports research into a high performance spectrometer on a chip, and a semiconductor optical amplifier.

PROGRAMMING METHODS AND LANGUAGES ─ Provides computational methods and languages for massively parallel, distributed heterogeneous computing platforms and special-purpose processors.

ADVANCED COMPUTATIONAL TECHNIQUES ─ Develops mathematical theory and computational methods to analyze many complex problems akin to factoring discrete logarithms, digital signatures, etc.

GLOBAL NETWORK ISSUES ─ Understanding and using methods and technology concerning computing systems and the "Global Network" to support the NSA's communications missions.

TECHNOLOGY OF COMPUTING ─ Assist in the research of extremely fast communications and computations based on exotic concepts such as nanosecond devices, quantum mechanics, DNA, and non-linear optics.

NSA supports research to determine whether it is possible to build a useful quantum computer (QC), and to do so if it is. If possible, a QC could perform computations (discrete logarithms and integer factoring) not possible by any other conceivable device. The objectives over about five years are to perform initial experiments in the basic physics of several possible realizations of the quantum theory. Only a few hundred binary operations on a few bits of information will be possible within this time.

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| (Continued)<br>OPTOELECTRONIC CIRCUITS ─ Develop an infrared-sensitive photodetector which, when assembled with a liquid crystal, will form an optically-addressed spatial light modulator. In addition a circular grating infrared laser source will be developed for open beam communication of 1 Gbit/sec data.<br>CYC ─ Evaluate Cyc for use in message understanding, machine translation, and text retrieval applications. | (Continued)<br>DATA HANDLING TOOLS ─ Applications-driven knowledge-based tool research. | (Continued)<br>it is engaged in research on new electronic (Si) structures for future very high speed, high density VLSI with feature sizes well below 0.1 micron; and it has a strong program in silicon surface science; related areas of current research include synthetic diamond packaging technology, all-optical switching and optoelectronic IC packaging technology.<br>Some of the practical output for FY 98 includes: point of use power conversion (for power reduction), area array I/O design studies for low power implementations of high performance MCM, and very high level programmable accelerator plug-ins for standard architectures (study, prototyping).<br>FY 98 efforts will continue research in several avenues of quantum computing in association with NIST, DOE Labs, and other research agencies. |

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | |
| FY 97 Pres | |
| FY 97 Est. | |
| FY 98 Rqst. | |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | | |
| HCS | | |
| HuCS | | |
| ETHR | | |

**Agency Ties**

| | |
|---|---|
| DARPA | Partner |
| NSF | |
| DOE | |
| NASA | Partner |
| NIH | User |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| NSA | **Superconducting Research** | Budget Code | |
|---|---|---|---|

The program in superconducting electronics is aimed at providing high performance computing alternatives to current silicon and gallium arsenide technologies, which have speed and power limitations. Prior research suggests that superconducting supercomputers can deliver very high performance with very low power requirements. NSA would like to cooperate with industry to develop such a computer.

| Milestone Changes | Delay initiating design of a superconducting supercomputer until components are tested. FY95 cost growth slipped some FY96 milestones to FY97. |
|---|---|

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Fifteen-level multi-gigabit per second MCMs will be constructed and tested.<br>One-hundred-and-twenty five-trace stripline, 2.5 gigabit per second ribbon cables will be fabricated and tested.<br>High speed connectors will be built and tested.<br>Superconductive detector chips will be tested. | Complete development of the superconducting crossbar switch and associated electronics. | This work is directed at developing a multi-gigabit per second crossbar switch for supercomputer and data transfer applications. This work is to demonstrate a 128x128 crossbar switch with 2.5Gb/s per port data rate and a latency less than 10ns. The device technology is cryogenic superconductive digital circuits. The final system components will be selected and assembly begun during FY97 and continue through FY 98 for an FY 99 delivery of:<br>An operational 128 X 128 superconductive crossbar switch;<br>A 100 Gb/s serial to parallel device with clock recovery; and<br>Two types of 16Kb subnanosecond access-time memory chips—one room temperature, and one superconductive |

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 2.00 |
| FY 97 Pres | 2.50 |
| FY 97 Est. | 2.50 |
| FY 98 Rqst. | 2.22 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | 2.50 | 2.22 |
| LSN | | |
| HCS | | |
| HuCS | | |
| ETHR | | |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | |
| DOE | |
| NASA | Partner |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| NSA | **Very High Speed Networking** | Budget Code | |
|---|---|---|---|

The National Security Agency has a perennial requirement for the fastest networking technology in order to perform its mission, the national security `Grand Challenge.` The Very High Speed Networking Program will provide NSA a high performance network infrastructure characterized by both multi-gigabit per second trunking speeds and the ability to support sustained data flows of at least hundreds of megabits per second each now, and ultimately multi-gigabits per second each.

| Milestone Changes | Delay demonstration of electronic switching of individual data flows at 2.4 Gb/s data streams to FY97. |
|---|---|

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Demonstrate electronic switching of individual data flows at 650 Mb/s data streams.<br>Initiate resolution of discovered ATM/IP incompatibilities, and the development of IP routers at Gb/s, to achieve a truly Gb/s Internet.<br>Determine the characteristics of end-to-end protocols that are effective in a Gigabit Internet.<br>Continue the development of optical switching and wave division multiplexing devices to support up to 10 Gb/s data rates.<br>Integrate and experiment with out of band network control in optical crossbar network.<br>Test multi-wavelength signals on installed fibers for multi-wavelength overlay on DC Metro area ATM/SONET testbed. Ultimately (1999), the full multi-wavelength testbed will begin to show transition path from ATM/SONET cell switching to wave division switching and wave conversion network.<br><br>(Continued) | Demonstrate electronic switching of individual data flows at 2.4 Gb/s data streams.<br>Demonstrate a Gb/s Internet capability by connecting Gb/s ATM networks with a Gb/s IP router, with individual data flow of 2.4 Gb/s over same.<br>Continue the development of optical switching and wave division multiplexing devices to support up to 10 Gb/s data rates.<br>Transition out of band network control for ATM to multi-wavelength overlay terminal devices in anticipation of FY98-99 testing of multi-wavelength switching devices on the DC-area testbed multi-wavelength overlay.<br>Begin significant implementation and multi-network testing over DC-area ATM testbed and attached networks of interoperable network management.<br><br>(Continued) | Very high speed networking research is applying the latest technologies to inter-agency testbeds that can be migrated to deployment. Enabling technologies such as materials and photonics research are also being pursued for new capabilities that will speed processing power and enhance sensitivity.<br>In FY98, we expect to have in place all the parts necessary for a truly Gb/s Internet, capable of supporting multiple individual data streams, each at 2.4 Gb/s, over ATM and IP.<br>In FY98, installation of all-optical networks will begin. ATDnet in the District of Columbia area will act as a public network capable of interconnection with an all-optical (crossbar) premises network acting as a DoD private network, as well as use individual wavelengths for support of "legacy" ATM networks |

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 3.00 |
| FY 97 Pres | 3.50 |
| FY 97 Est. | 3.50 |
| FY 98 Rqst. | 2.18 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | 3.50 | 2.18 |
| HCS | | |
| HuCS | | |
| ETHR | | |

**Agency Ties**

| DARPA | Partner |
|---|---|
| NSF | |
| DOE | |
| NASA | |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| NSA | Very High Speed Networking (continued) | Budget Code | |
|---|---|---|---|

| Milestone Changes | |
|---|---|

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| (Continued)<br>Continue soliton research to explore application to high-speed networks by developing soliton source and logic gates.<br>Continue collaboration with industry on the development of high-speed (electronic and optical) prototype switching equipment.<br>Continue collaboration with industry on the development of operation, administration and management protocols for optically switched networks. In particular, implement and experiment with prototype signaling implementations conformant to ATM Forum Standard on the DC-areas' ATM Testbed. Further define and begin implementation of network management system on DC area testbed. | (Continued)<br>Demonstrate as a system a soliton source and transmission, driving a couple of all-optical soliton-based logic gates, including the optical synchronization of the soliton transmission with the logic gate soliton signal. | |

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | |
| FY 97 Pres | |
| FY 97 Est. | |
| FY 98 Rqst. | |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | | |
| HCS | | |
| HuCS | | |
| ETHR | | |

**Agency Ties**

| | Partner |
|---|---|
| DARPA | |
| NSF | |
| DOE | |
| NASA | |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| NSA | **Secure Operating System Development** | Budget Code | |
|---|---|---|---|

NSA is responsible for researching solutions to ensure the security of the nation's networks and distributed systems. In collaboration with NIST and DISA, NSA is identifying issues and researching security policy-flexible, cost- effective ways to ensure the security of both government and commercial enterprise systems. The Synergy research program at NSA is developing an `open architecture` along with secure distributed system prototypes based uponsecurity policy-flexible, operating system microkernels. Synergy will provide a means for commercial vendors to address a wide variety of security markets with a single architecture, thus lowering everyone's costs. Synergy can be the foundation on which security solutions for major initiatives can be built, whether addressing government-peculiar needs or commercial-enterprise needs, from the Defense Department Global Grid to the National Information Infrastructure. Synergy will integrate the INFOSEC research work in computer misuse and anomaly detection (audit/intrusion detection), real-time and multimedia, availability, network security management, high speed networking, and secure database management systems.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 4.70 |
| FY 97 Pres | 4.50 |
| FY 97 Est. | 4.50 |
| FY 98 Rqst. | 4.50 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | | |
| HCS | 4.50 | 4.50 |
| HuCS | | |
| ETHR | | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Second public release of Synergy software and initial evaluation documentation and experience, to encourage modular system design and evaluation.<br>Continue research on Synergy architecture to improve security, assurance, performance, availability, and portability in distributed and real-time operating environments.<br>Demonstrate and make available higher assured versions of security managers and Synergy components.<br>Continue university research contracts, and ensure successful technology transfer of research results into Synergy architecture development efforts.<br>Continue collaboration with commercial vendors to encourage the development of Synergy-based systems that can satisfy commercial enterprise security requirements and those of DoD and the government. | Release expanded Synergy prototype including enhancements and improvements derived from collaboration with vendors and universities, to influence the design of commercial operating system development.<br>Continue Synergy research to improve the security of distributed operating systems. Investigate high-assurance security mechanisms to support future distributed operating system architectures.<br>Demonstrate and make available higher assurance components for distributed operating systems.<br>Continue funding university research in the areas of high-assurance operating systems and distributed systems. Integrate results into Synergy security solutions.<br>Continue working relationships with commercial vendors to influence the design of future commercial architectures. | Demonstrate solutions to high assurance configurable security architectures.<br>Continue constructions of prototypes to enable the efficient replacement of security policies and security mechanisms with minimal impact on system service or assurance.<br>Research solutions will be integrated into future commercial technology via collaboration with various research labs. This effort will include:<br>- Integration of security research results into advanced operating system technologies.<br>- Creation of system framework for flexible authentication services.<br>- Securing computing related to distributed and mobile computing. |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | |
| DOE | |
| NASA | |
| NIH | |
| NSA | |
| NIST | Partner |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| NSA | **High Speed Data Protection Electronics** | Budget Code | |
|---|---|---|---|

Network data security is a requirement throughout the National community, from the financial community through the medical community to a wide range of research activities. NSA will take the lead in developing network security and information security techniques and products for high speed networks. It will establish high speed network testbeds to explore network security issues. Many of the research efforts have moved from protection of network trunks to protection of high speed individualized computer links. The focus of this effort is to develop a technology that will interface to network management systems that can be used with the high speed networks that are exemplified by the National Security Community and the NII.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 2.70 |
| FY 97 Pres | 2.80 |
| FY 97 Est. | 2.80 |
| FY 98 Rqst. | 2.70 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | | |
| HCS | 2.80 | 2.70 |
| HuCS | | |
| ETHR | | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Revise the detailed design of the 2.5 Gb/s systems based upon the actual IC performance as previously tested. Fabrication, assembly, and testing will then take place.<br>Develop larger arrays of optical smart pixels for a second generation demonstration with an order of magnitude increase. | Develop architectures for high speed key management processors or servers.<br>Continue development of second-generation optical smart pixel demonstration. | High Speed Electronics Research - Complementary Gallium Arsenide: Continue development of functional devices including core cryptographic processors, numeric processors, high speed memories, and test and characterization devices. Also explore other related silicon technologies that employ high speed, low power characteristics.<br>Optics Research - Devices: Continue multi-year study of physics of materials, and develop processes for integrating dissimilar materials on one substrate to produce optoelectronic devices. Fabricate initial devices and evaluate in smart pixel architectures. Optical Network Technology: Complete architecture, and build initial system of nonlinear optical processor and associated components (smart pixels) to develop demonstration for network encryption. Optical Key Generator: Continue with intermediate development and assembly of proof-of concept photonics key generator |

**Agency Ties**

| | |
|---|---|
| DARPA | Partner |
| NSF | |
| DOE | |
| NASA | Partner |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| NSA | **Technology Based Training** | Budget Code | |
|---|---|---|---|

NSA considers lifelong access to education and training for all employees to be highly crucial in order to maintain and enhance their skills. NSA must ensure its viability in a world of rapidly changing technology. Traditional training approaches take too long and are too expensive. Consequently, NSA is developing a skill-based assessment and training model that will use emerging communications and computer techniques to sustain each employee's abilities at the levels required in today's constantly changing workplace. The key ingredient in this approach will be on-demand access to Technology Based Training (TBT) of known quality and relevance delivered directly to the workplace. Delivery over corporate LANs and the Internet, and the possible use of ISDN technology, will be addressed. Although initial offerings would consist largely of text-based TBT courseware, digital video and other media will be accommodated as they become available.

Placing existing TBT courseware on the network is something that can be accomplished quickly, but there are various conceptual, technical and procedural issues that must be addressed before it can be made generally accessible. Foremost among these issues are:

1 -- Definition of the skills needed to perform specific jobs and a process for certifying the efficacy of training modules that address those skills;
2 -- Storage, access, and maintenance of large numbers of TBT courses;
3 -- Cataloging of available courseware in a manner that minimizes the difficulty of identifying suitable courses or training modules;
4 -- Identifying and resolving the interoperability problems in delivering TBT courses over a network to a wide variety of computer terminals;
5 -- Defining and selecting appropriate user interfaces (special effort will be focused on interfaces for home-computer configurations);
6 -- Developing an EDI-based business model bringing market forces to bear on the availability and costs of Technology Based Training.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 0.15 |
| FY 97 Pres | |
| FY 97 Est. | |
| FY 98 Rqst. | |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | | |
| HCS | | |
| HuCS | | |
| ETHR | | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Evaluate, modify, and extend Electronic Payment business model for online training modules.<br>Complete formal guidelines and procedures for creation of certified skill-based training modules.<br>Design and pilot Individual Development Plan (IDP) database and management software. | | |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | |
| DOE | |
| NASA | |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

# National Institute of Standards and Technology

The NIST HPCC program supports the NIST mission through:

* Development of advanced information technology metrology and test methods for systems, components, and human machine interfaces;
* Application of high performance computing and networking technology to promote improved U.S. product quality and manufacturing performance, to reduce production costs and time-to-market, and to increase competitiveness in international markets;
* Development of efficient algorithms and portable, scalable software for the application of high performance computing systems to industrial problems, and the development of improved methods for the public dissemination of advanced software and documentation;
* Promoting the development and deployment of advanced information technology to support the education, research and manufacturing communities and to increase the electronic availability of scientific and engineering data; and
* Supporting, promoting, and coordinating the development of voluntary standards that provide interoperability and common user interfaces within the NII, and increase industrial competitiveness.

| Program Activity | Budget Account Code | Partner/User Agencies | Budget (BA, $ M) | | | | HPCCPCAs by 1998 Pres. Request | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | FY 96 Actual | FY 97 Pres. | FY 97 Est. | FY 98 Rqst. | HECC | LSN | HCS | HuCS | ETHR |
| Information Technology Metrology, Testing, and Applications | STRS for Computer Systems | NSF, DOE, NASA | | 12.85 | 12.85 | 13.85 | 3.99 | 3.46 | 3.40 | 3.00 | |
| Information Technology Metrology, Testing and Applications (Continued) | STRS for Computer Systems | NSF, DOE, NASA | | | | | | | | | |
| Systems Integration for Manufacturing Applications | STRS for Computer Systems | ARPA, DOE | 10.66 | 10.66 | 10.66 | 12.66 | | 2.00 | | 10.66 | |
| Systems Integration for Manufacturing Applications (Continued) | STRS for Computer Systems | ARPA, DOE | 0.00 | | 0.00 | | | | | | |
| Development and Dissemination of Scientific Software for HPCS | STRS for Computer Systems | NSF, DOE, NASA | 3.37 | | | | | | | | |
| Infrastructure for Information Technology | STRS for Computer Systems | ARPA, DOE, NSA... | 9.48 | | | | | | | | |
| Infrastructure for Information Technology (continued) | STRS for Computer Systems | ARPA, DOE, NSA... | | | | | | | | | |
| | | Totals: | 23.51 | 23.51 | 23.51 | 26.51 | 3.99 | 5.46 | 3.40 | 13.66 | |

# National Institute of Standards and Technology

## Comparison of FY 1997 and FY 1998 by Program Component Area

| Program Activity | Budget (BA, $ M) | | | | HPCC PCAs by 1998 President's Request | | | | | HPCC PCAs by 1997 Estimated | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | FY 96 Actual | FY 97 Pres. | FY 97 Est. | FY 98 Rqst. | HECC | LSN | HCS | HuCS | ETHR | HECC | LSN | HCS | HuCS | ETHR |
| Information Technology Metrology, Testing, and Applications | | 12.85 | 12.85 | 13.85 | 3.99 | 3.46 | 3.40 | 3.00 | | 3.99 | 2.46 | 3.40 | 3.00 | |
| Information Technology Metrology, Testing and Applications (Continued) | | | | | | | | | | | | | | |
| Systems Integration for Manufacturing Applications | 10.66 | 10.66 | 10.66 | 12.66 | | 2.00 | | 10.66 | | | | | 10.66 | 0.00 |
| Systems Integration for Manufacturing Applications (Continued) | 0.00 | | 0.00 | | | | | | | | | | | 0.00 |
| Development and Dissemination of Scientific Software for HPCS | 3.37 | | | | | | | | | | | | | |
| Infrastructure for Information Technology | 9.48 | | | | | | | | | | | | | |
| Infrastructure for Information Technology (continued) | | | | | | | | | | | | | | |
| Totals: | 23.51 | 23.51 | 23.51 | 26.51 | 3.99 | 5.46 | 3.40 | 13.66 | | 3.99 | 2.46 | 3.40 | 13.66 | 0.00 |

| NIST | **Information Technology Metrology, Testing, and Applications** | Budget Code | STRS for Computer Systems |
|---|---|---|---|

Collaborate with industry and other agencies to support development of standards to provide interoperability, common user interfaces and enhanced security for computer and communications systems; and promotes the specification, development, testing and deployment of communications protocols and services within the National Information Infrastructure.

Collaborate with industry and academia to conduct R&D, evaluate and apply methods to specify, verify, and test for conformity and interoperability of high-integrity, distributed systems. Support and contribute to the development of test methods and test suites for assessing conformity of products to standards and interoperation with other products; develop prototype implementations; establish testbeds and support technology demonstrations.

Promote the research, development and application of measurement sciences to assess the performance of human-machine interface technologies. Conduct collaborative research and development of algorithms, recognition methods, and reference materials to assist industrial and academic researchers commercialize R&D in spoken natural language recognition, image recognition including printed or cursive handwritten text, and text search and information retrieval. Develop methods for measuring performance of scalable, high performance systems, and identification of performance bottlenecks in systems and software.

(Continued)

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | |
| FY 97 Pres | 12.85 |
| FY 97 Est. | 12.85 |
| FY 98 Rqst. | 13.85 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | 3.99 | 3.99 |
| LSN | 2.46 | 3.46 |
| HCS | 3.40 | 3.40 |
| HuCS | 3.00 | 3.00 |
| ETHR | | |

| Milestone Changes | Interoperability testing program deferred one year due to impact of continuing resolution and furlough. |
|---|---|

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Establish an interoperabililty testing program for Internet security technologies (e.g, firewalls, authentication mechanisms), Ipv6, network management and NII Services. Assess the security requirements and vulnerabilities of emerging wireless technologies.<br>Develop and test algorithms for understanding of documents and their component parts, and develop associated metrics for judging algorithm performance.<br>Improve search and browsing mechanisms and expand information on algorithms and software available from GAMS servers.<br>Expand implementation of high-performance object-oriented libraries for sparse linear algebra.<br>Utilize modern software design technologies to implement portable and reliable mathematical software to provide significant performance improvement on scalable computing architectures.<br>(Continued) | Establish an interoperability testing program including laboratory facilities for Internet security technologies, Ipv.6, network management and information infrastructure services.<br>Establish laboratory facilities to conduct R&D and assess candidate technologies which support automated testing and integrated software engineering. Collaborate with industry and standards bodies to support the specification, development, validation and testing of standards and interoperation of conforming products.<br>Provide an expanded mathematical repository service, including new classification technology that provides expert level performance.<br>Demonstrate high performance object-oriented libraries for sparse linear algebra on challenging applications. Stabilize and release a scalable parallel multigrid solver for unstructured adaptive grids.<br>(Continued) | Integrate network performance evaluation chip with the Pardyn system (joint with UMD) and install on NIST ATM heterogeneous distributed testbed.<br>Adapt software performance evaluation tools for use on MPI clusters.<br>Enhance laboratory facilities for automated testing and integrated software engineering, and broaden industry and standards bodies involvement in support of the specification, development, validation and testing of standards and interoperation of conforming products.<br>Provide remote Internet access to IPV6 interoperability testbed and Integrated Services Packet Switched Network testbed. Develop tests and test tools that promote interoperability.<br>Develop methods for evaluation of image quality effects of OCR and test sample models.<br>Evolve mathematical software repositories into problem-solving environments.<br>(Continued) |

**Agency Ties**

| | |
|---|---|
| DARPA | Partner |
| NSF | Partner |
| DOE | Partner |
| NASA | Partner |
| NIH | User |
| NSA | Partner |
| NIST | |
| NOAA | User |
| EPA | Partner |
| ED | User |
| AHCPR | User |
| VA | User |

| NIST | **Information Technology Metrology, Testing and Applications (Continued)** | Budget Code | STRS for Computer Systems |
|---|---|---|---|

(Continued)

Develop advanced algorithms, software, methodology and tools to support the efficient application of computationally intensive science to key problems arising in the industrial sector. Current application areas of emphasis include the development of improved methods for computational chemistry and related advanced materials processing industries which are important for advanced product and process design and computationally derived fundamental data for competitive, environmentally sound manufacturing processes.

Develop efficient, robust and flexible templates, class libraries and components for basic mathematical computation, such as the solution of large linear systems, which provide a foundation for applications such as these.

Develop modern, network-based reusable software classification and distribution technology for making new computational software readily available to industry and the public. The focus of this activity is the Guide to Available Mathematical Software (GAMS) virtual repository project.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | |
| FY 97 Pres | |
| FY 97 Est. | |
| FY 98 Rqst. | |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | | |
| HCS | | |
| HuCS | | |
| ETHR | | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| (Continued)<br>Develop scalable algorithms for treatment of dissipative systems and apply to optically trapped atoms and to properties of recently discovered Bose- Einstein condensates. | (Continued)<br>Develop user-friendly computational chemistry codes for calculating rate constants for molecular decomposition.<br>Develop ab initio quantum mechanical methods for improving the accuracy of kinetic and thermodynamic parameter calculation. | (Continued)<br>Complete object-oriented libraries for basic linear algebra and related capabilities.<br>Demonstrate capabilities on distributed systems. |

**Agency Ties**

| | |
|---|---|
| DARPA | Partner |
| NSF | Partner |
| DOE | Partner |
| NASA | Partner |
| NIH | User |
| NSA | Partner |
| NIST | |
| NOAA | User |
| EPA | Partner |
| ED | User |
| AHCPR | User |
| VA | User |

| NIST | **Systems Integration for Manufacturing Applications** | Budget Code | STRS for Computer Systems |
|---|---|---|---|

Emphasis is on information technology solutions providing reliable information exchange among manufacturing applications. This standards-based effort for computer integrated manufacturing focuses on integration problems existing in the activities of product/process design, manufacturing engineering, and production system control . The effort will address these problem areas both within and across enterprises. Manufacturing application integration mechanisms will be developed and structured in the context of emerging Enterprise Integration Frameworks (EIFs). Integration mechanisms supporting incorporation of remote data sources into manufacturing applications as well as distributing manufacturing software application components and processes will be a significant focus. Development of reliable mechanisms for testing of manufacturing application integration solutions is also a priority. The program of work addresses activities that fall within standards development efforts and development of technology within industry and government. Interface specifications that have been tested in prototype systems will be communicated to standards organizations. Results will be made available to U.S. industry through workshops, training materials, electronic data repositories, and pre-commercial prototype implementations that can be installed for test and evaluation. NIST will distribute standard reference data, technical information, and digital product/process specifications using NII technologies. The industry domains to be addressed include discrete mechanical product manufacturing, electronic manufacturing, chemical manufacturing, material manufacturing, and manufacturing plant construction. NIST's Advanced Manufacturing and Networking Testbed (AMSANT) facilities support application of high performance computing and networking technologies to manufacturing system and application integration problems.
(Continued)

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 10.66 |
| FY 97 Pres | 10.66 |
| FY 97 Est. | 10.66 |
| FY 98 Rqst. | 12.66 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | | 2.00 |
| HCS | | |
| HuCS | 10.66 | 10.66 |
| ETHR | 0.00 | |

| Milestone Changes | Milestone eliminated due to Program redirection: Implementation of a production testbed for custom therapeutic footwear. |
|---|---|

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Demonstrated information exchange protocols for: configuration controlled 3D design, process planning and numerically controlled programming; plant spatial configuration.<br>Demonstrated initial interface protocols for Product Data Management applications; simulation/virtual reality applications; discrete product inspection applications.<br>Published reports on manufacturing application integration: manufacturing engineering toolkit overview; architecture of integrated toolkit for manufacturing engineering; architecture for intelligent control; requirements for process specification. Specification contributions to ISO, IEC, and OMG. AMSANT facilities enhanced with ATM links and additional software applications.<br>Distributed tests conducted with NIIIP Program Testbed in Ohio and DOE Sandia facility in New Mexico.<br>(Continued) | Conduct series of workshops on Enterprise Integration Frameworks and submit resulting model for voluntary standardization.<br>Develop initial model for representation of process capabilities enabling integration of planning, simulation, and other manufacturing applications.<br>Develop initial models and specifications enabling integration of production system engineering and production system simulation.<br>Provide prototype Web access to statistical solutions for engineering product and process design problems.<br>Demonstrate initial prototype integration of computer-aided design and virtual assembly applications.<br>Develop test specifications enabling conformance testing of data exchange protocols for plant spatial configuration, associative drafting, and process planning/NC programming.<br>(Continued) | Develop interface protocols enabling integration of Web-based scientific and engineering reference data with manufacturing applications and processes.<br>Submit specifications resulting from development of integration prototypes for inspection systems for voluntary standardization.<br>Submit specifications resulting from prototype design and virtual assembly integration for voluntary standardization.<br>Demonstrate intelligent systems architecture for manufacturing system and machine control in AMSANT facilities.<br>Demonstrate remote operator interfaces for machine and production system monitoring and control.<br>Demonstrate distributed design, planning, and production application integration using object-based interfaces in AMSANT and remote partner facilities.<br>(Continued) |

**Agency Ties**

| | |
|---|---|
| DARPA | Partner |
| NSF | |
| DOE | Partner |
| NASA | |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| NIST | **Systems Integration for Manufacturing Applications (Continued)** | Budget Code | STRS for Computer Systems |
|---|---|---|---|

(Continued)

Facilities include Asynchronous Transfer Mode (ATM) network connections, high performance compute servers and workstations, as well as software applications for mechanical computer-aided design (CAD), electronic CAD, architectural/engineering/construction CAD, product data management, process planning, production system scheduling, machine tool programming, and process simulation. Hardware and software supporting application of collaborative technologies, remote operation, virtual reality interfaces/environments to the manufacturing domain is also employed. The facilities serve as development, testing, and demonstration sites for use by NIST, government partners, and industrial technology suppliers and users. The program of work strongly supports cooperative research and development agreements with industry and academic researchers.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 0.00 |
| FY 97 Pres | |
| FY 97 Est. | 0.00 |
| FY 98 Rqst. | |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | | |
| HCS | | |
| HuCS | | |
| ETHR | 0.00 | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| (Continued)<br>Deployed additional Application Protocol Development Environment capabilities with availability of Web gateway to the Application Protocol Information Database.<br>Expanded scope of standard reference data available via Web interface with additional Physics and Chemistry database access. | (Continued).<br>Develop initial collaboratory environment supporting development and validation of manufacturing integration specifications.<br>Demonstrate virtual reality interfaces to production system simulations.<br>Expand scope of technical reference data available via Web with provision of additional physical, chemical, and material data. | (Continued)<br>Demonstrate integration of planning and simulation applications using process data models.<br>Demonstrate collaboratory environment use by government and industry partners in development and validation of manufacturing integration specifications. |

**Agency Ties**

| | |
|---|---|
| DARPA | Partner |
| NSF | |
| DOE | Partner |
| NASA | |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| NIST | **Development and Dissemination of Scientific Software for HPCS** | Budget Code | STRS for Computer Systems |
|---|---|---|---|

This program activity focuses on the development of advanced mathematical, computational and visualization algorithms, software, methodology and tools which support the efficient application of computationally intensive science to key problems arising in the industrial sector. Current application areas of emphasis include the development of improved methods for computational chemistry and related advanced materials processing industries which are important for advanced product and process design and computationally derived fundamental data for competitive, environmentally sound manufacturing processes. Technology areas of emphasis include the interactive visualization of complex structures and data, large-scale ab initio computational chemistry, Monte Carlo and molecular dynamics modeling and scientific database utilization. Includes the development of efficient, robust and flexible templates, class libraries and components for basic mathematical computation, such as the solution of large linear systems, which provide a foundation for applications such as these.

This program activity also supports the development of modern, network-based reusable software classification and distribution technology for making new computational software readily available to industry and the public. The focus of this activity is the Guide to Available Mathematical Software (GAMS) project. GAMS is a working cross index and virtual repository which provides users transparent access to thousands of reusable software modules accessible from a variety of network-accessible repositories.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 3.37 |
| FY 97 Pres | |
| FY 97 Est. | |
| FY 98 Rqst. | |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | | |
| HCS | | |
| HuCS | | |
| ETHR | | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Develop and apply algorithms for molecular dynamic simulations of cluster growth and deposition of use in modeling sintering processes for applications in ceramic manufacturing.<br>Develop scalable algorithms for treatment of dissipative systems and apply to optically-trapped atoms and to properties of newly-discovered Bose-Einstein condensates.<br>Improve search and browsing mechanisms and expand information on algorithms and software available from GAMS servers.<br>Expand implementation of high-performance object-oriented libraries for sparse linear algebra.<br>Utilize modern software design technologies to implement portable and reliable mathematical software to provide significant performance improvement on scalable computing architectures. | | |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | Partner |
| DOE | Partner |
| NASA | Partner |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | User |
| ED | |
| AHCPR | |
| VA | |

| NIST | **Infrastructure for Information Technology** | Budget Code | STRS for Computer Systems |
|---|---|---|---|

Collaborate with industry and other agencies to support development of standards to provide interoperability, common user interfaces and enhanced security for computer and communications systems; and promotes the specification, development, testing and deployment of communications protocols and services within the National Information Infrastructure. Collaborate with industry and academia to conduct R&D, evaluate and apply methods to specify, verify, and test for conformity and interoperability of high-integrity, distributed systems. Support and contribute to the development of test methods and test suites for assessing conformity of products to standards and interoperation with other products; develop prototype implementations; establish testbeds and support technology demonstrations; host workshops and open fora to promote open standards and to aid in the commercialization and deployment of information technology by U.S. Industry.

Promote the research, development and application of measurement sciences to assess the performance of human-machine interface technologies, and to assess the performance of high-performance computing and communications systems. Conduct collaborative research and development of algorithms, recognition methods, and reference materials to assist industrial and academic researchers commercialize R&D in spoken natural language recognition, image recognition including printed or cursive handwritten text, and text search and information retrieval. Collaborate by developing corpora of reference materials for speech and image recognition, and for text search and retrieval; and by developing related scoring protocols which use the reference materials in assessing performance of systems implementing these human-machine interface technologies. Develop methods for measuring performance of scalable, high performance systems, and identification of performance bottlenecks in systems and software.

(continued)

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 9.48 |
| FY 97 Pres | |
| FY 97 Est. | |
| FY 98 Rqst. | |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | | |
| HCS | | |
| HuCS | | |
| ETHR | | |

Milestone Changes: Note: this element reflects the integration of three elements from the FY 96 plan: Networking and Information Infrastructure Services, Metrology for Human-Machine Interfaces & Scalable HPCS, and Electronic commerce and Digital Libraries. Milestones deferred for one or more years due to budget (continued)

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Establish an interoperability testing program including laboratory facilities for Internet security technologies (e.g., firewalls, authentication mechanisms), IPv.6, network management and NII Services. Assess the security requirements and vulnerabilities of emerging wireless technologies.<br>Develop and test methods for human-machine spoken dialogue management and clarification, dialogue error recovery, and evaluation of speech corpora portability. Design and implement new architecture for Z39.50/PRISE that will handle complex objects in both search and display modes.<br>Develop initial algorithms for understanding of documents and their component parts, and associated metrics for judging algorithm performance.<br>Improve and extend the software and hardware based tools for performance measurement of scalable parallel systems.<br>Initiate development of conversion tools for electronic data interchange standards. | | |

**Agency Ties**

| | |
|---|---|
| DARPA | Partner |
| NSF | Partner |
| DOE | Partner |
| NASA | User |
| NIH | User |
| NSA | Partner |
| NIST | |
| NOAA | User |
| EPA | User |
| ED | User |
| AHCPR | User |
| VA | Partner |

| NIST | **Infrastructure for Information Technology (continued)** | Budget Code | STRS for Computer Systems |
|---|---|---|---|

(continued)

Collaborate with industry and other agencies to develop, integrate and apply technologies which enable electronic commerce and integration of product specifications into computer aided design and manufacturing tools. Establish laboratory facilities to support demonstrations, evaluation, and inter-operation testing.

Conduct R&D to support development of tools which generate software for electronic commerce applications.

Conduct R&D in application programming interfaces for digital signature, authentication, and other security services required to support electronic commerce.

Establish an electronic library pilot project which includes the creation, editorial review, production and dissemination of scientific and engineering papers, documents, data and other published information in a working, production environment via the library and scientific and engineering operating units at NIST.

| Milestone Changes | (continued) constraints include: interoperability testing program, assessment of wireless security vulnerabilities, algorithms for improved understanding of compound documents, and implementation of information infrastructure testbeds. |
|---|---|

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| | | |

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | |
| FY 97 Pres | |
| FY 97 Est. | |
| FY 98 Rqst. | |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | | |
| HCS | | |
| HuCS | | |
| ETHR | | |

**Agency Ties**

| | |
|---|---|
| DARPA | Partner |
| NSF | Partner |
| DOE | Partner |
| NASA | User |
| NIH | User |
| NSA | Partner |
| NIST | |
| NOAA | User |
| EPA | User |
| ED | User |
| AHCPR | User |
| VA | Partner |

# Department of Veterans Affairs

The Department of Veteran Affairs (VA) operates the largest centrally directed health care system in the United States through 173 VA medical centers (VAMC), 391 outpatient community and outreach clinics, 131 nursing homes, and 39 domiciliaries. The VHA Medical Care Network has converted to 22 Veterans Integrated Service Networks (VISNs) with a large number of access points that focus on pooling and aligning resources to best meet local needs in a cost effective manner and provide greater access to care. VHA automation systems are being adapted to support this business restructuring. The goal is to allow easy access to appropriate information independent of the location of the staff or the location of the data.

The VA has a coordinated, integrated automation program focused on improving patient care and administrative operations by introducing advanced automation to deliver the right information to the right person at the right time in an economical manner. More effective administrative operations emphasize automated administrative simplification, procurement, and electronic commerce. Improved patient care emphasizes making the correct information and services available electronically to the clinician on the wards where they make decisions. This information is currently drawn from the facility based integrated patient based information system, local area network CD-ROM data bases, and other VA facilities on the VA's Wide Area Network (WAN). Plans include increased accessibility to other WAN resources such as Medline and Internet based digital libraries. Various aspects of the program focus on integrating technologies to enhance the existing computer based patient record, as well as to improve methods of data capture, data presentation, and inter- facility data exchange. The projects concentrate on the technical areas of information system architectures, workstations, local and wide area networks, and appropriate security and privacy alternatives. Standards based solutions will be necessary to insure continued interoperability and meaningful data exchange. These systems are being developed using a blend of in-house resources, federal sharing initiatives, and private industry support.

# Department of Veterans Affairs

## FY 1998 President's Request by Program Component Area

| Program Activity | Budget Account Code | Partner/User Agencies | Budget (BA, $ M) | | | | HPCC PCAs by 1998 Pres. Request | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | FY 96 Actual | FY 97 Pres. | FY 97 Est. | FY 98 Rqst. | HECC | LSN | HCS | HuCS | ETHR |
| Computerized Patient Record and Telemedicine | | NIH, NIST, AHCPR | 1.40 | 1.80 | 1.80 | 7.00 | | 2.50 | 1.50 | 3.00 | |
| Clinical Workstations and Medical Imaging | | NIST, AHCPR... | 5.20 | 3.00 | 3.00 | 2.25 | | 0.75 | 0.85 | 0.65 | |
| Improve Telecommunications Infrastructure and Internet Connectivity | | ARPA, NIST | 0.18 | 0.75 | 0.75 | 3.75 | | 1.70 | 0.75 | 1.30 | |
| VA Hybrid Open Systems Technology (VA HOST) | | AHCPR, NIST | 14.50 | 7.75 | 7.75 | 6.50 | | 1.50 | 1.75 | 3.25 | |
| VA/DoD Sharing | | NIST, AHCPR | 0.65 | 1.25 | 1.25 | 2.50 | | 1.00 | 0.50 | 1.00 | |
| Totals: | | | 21.93 | 14.55 | 14.55 | 22.00 | | 7.45 | 5.35 | 9.20 | |

# Department of Veterans Affairs

## Comparison of FY 1997 and FY 1998 by Program Component Area

| Program Activity | Budget (BA, $ M) | | | | HPCC PCAs by 1998 President's Request | | | | | HPCC PCAs by 1997 Estimated | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | FY 96 Actual | FY 97 Pres. | FY 97 Est. | FY 98 Rqst. | HECC | LSN | HCS | HuCS | ETHR | HECC | LSN | HCS | HuCS | ETHR |
| Computerized Patient Record and Telemedicine | 1.40 | 1.80 | 1.80 | 7.00 | | 2.50 | 1.50 | 3.00 | | | 1.20 | 0.20 | 0.40 | |
| Clinical Workstations and Medical Imaging | 5.20 | 3.00 | 3.00 | 2.25 | | 0.75 | 0.85 | 0.65 | | | 2.00 | 0.60 | 0.40 | |
| Improve Telecommunications Infrastructure and Internet Connectivity | 0.18 | 0.75 | 0.75 | 3.75 | | 1.70 | 0.75 | 1.30 | | | 0.50 | 0.25 | | |
| VA Hybrid Open Systems Technology (VA HOST) | 14.50 | 7.75 | 7.75 | 6.50 | | 1.50 | 1.75 | 3.25 | | 1.00 | 4.75 | 1.00 | 1.00 | |
| VA/DoD Sharing | 0.65 | 1.25 | 1.25 | 2.50 | | 1.00 | 0.50 | 1.00 | | | 1.00 | 0.25 | | |
| Totals: | 21.93 | 14.55 | 14.55 | 22.00 | | 7.45 | 5.35 | 9.20 | | 1.00 | 9.45 | 2.30 | 1.80 | |

| VA | **Computerized Patient Record and Telemedicine** | Budget Code | |
|---|---|---|---|

The continued development of the VA computerized patient record will expand availability of patient data and images to health care providers. Computerized records ensure that data will be available at the point of care and accessible throughout the distributed network of VA and Federal health care facilities where patients are treated. Components of the record will include: PDX patient demographics and health summary data between treating VA facilities; Clinical Lexicon - Integration and application of national and international standard nomenclatures, e.g., NLM's UMLS, to bring precision to the communication of clinical data across different health care organizations; Patient Care Encounter - A framework into which order information can be associated with a given visit. Orders can be linked to a given diagnosis or complaint and eventual outcome, so that the effectiveness of specific orders or order sets can be established; Standards based inter application communications messaging system, HL7, SQL, and controlled vocabularies. Implementing these national and international standards will permit the exchange of data among the public and private sectors; CIRN - Clinical Information Resources Network project including establishing a 'home' for data from each patient, synchronized demographic data feeding a VHA master patient index, clinical data repository, cross facility integration of patient records and additional data feeds as needed by subscription.

Telemedicine - increased Agency focus on clinical telemedicine modalities as well as establishment of Agency Telemedicine Office.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 1.40 |
| FY 97 Pres | 1.80 |
| FY 97 Est. | 1.80 |
| FY 98 Rqst. | 7.00 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | 1.20 | 2.50 |
| HCS | 0.20 | 1.50 |
| HuCS | 0.40 | 3.00 |
| ETHR | | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Develop and test Enhanced PDX- the Enhanced Patient Data Exchange package that will enable direct merging of patient data from multiple treating facilities.<br>Develop and test VISTA Request Broker which processes messages between the Workstation front end and the Clinical Data Base.<br>Conversion of customized medical device interfaces to standards based HL7 messages. | Enhance and test Computerized Patient Record (CPR) System.<br>Begin testing the integration of Telemedicine Systems with the CPR.<br>Begin testing and expand development of the Clinical Repository and the controlled vocabulary.<br>Expand evaluation of options to use SQL as a mechanism of accessing medical data contained in disparate systems. | Enhance and test CPR System.<br>Enhance and test the integration of Telemedicine Systems with the CPR.<br>Expand development of the Clinical Repository and the controlled vocabulary. |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | |
| DOE | |
| NASA | |
| NIH | Partner |
| NSA | |
| NIST | Partner |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | Partner |
| VA | |

| VA | **Clinical Workstations and Medical Imaging** | Budget Code | |
|---|---|---|---|

This program activity focuses on testing Clinical Workstations at pilot facilities. If these tests are successful, a non HPCC initiative could lead to installation of Clinical Workstations at all 173 VA facilities over a 4 year period beginning in 1997. There have been three pilot sites implemented in FY 96, with additional sites being added in the subsequent years. Clinical workstations will improve and expand presentation of information from VA's Veterans Health Information System and Technology Architecture (VISTA) computerized patient record and from other sources. These multimedia workstations will be capable of accessing information from the hospitals LAN and the VA's WAN, as well as networks such as the Internet that link the VA with outside resources. Portable workstations will ensure access to information at the point of care. The VISTA Integrated Medical Imaging Project currently is a model of a clinical workstation. This program has been operational at the Washington and Baltimore VAMCs for several years. Multiple types of true color and black and-white medical images are captured and retrieved as an integrated part of the computerized patient record. Additional functionality is constantly being added to the system, and additional sites are installing the system.

| Milestone Changes | Funding for access to Clinical Guidelines was made available at the end of FY 95. This initiative was therefore moved to FY 96 for completion. |
|---|---|

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| AHCPR Clinical Guidelines will be accessible electronically from the medical center wards at the Washington VAMC. Impact on clinicians activities will be evaluated. Initial phase of national workstation installation.<br>Design and pilot test additional functionality for the clinical workstation. Develop and test GUI interface for selected VISTA applications.<br>Develop and test GUI interface for existing Medical Imaging System. | Expand development and testing of GUI interface for existing Medical Imaging System. Expand development and testing of GUI interface for selected VISTA applications converting applications from existing dumb terminal user interface to an open systems client serve architecture.<br>Develop and test an interactive voice response system to enable access to information from existing VA computer systems 24 hours a day, 7 days a week | Explore alternative input devices.<br>Expand standards based gateway to incorporate additional commercial technologies into the integrated patient data base. |

## Budget ($ M)

| | |
|---|---|
| FY 96 Act | 5.20 |
| FY 97 Pres | 3.00 |
| FY 97 Est. | 3.00 |
| FY 98 Rqst. | 2.25 |

## Program Component Areas

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | 2.00 | 0.75 |
| HCS | 0.60 | 0.85 |
| HuCS | 0.40 | 0.65 |
| ETHR | | |

## Agency Ties

| | |
|---|---|
| DARPA | |
| NSF | |
| DOE | |
| NASA | |
| NIH | |
| NSA | |
| NIST | Partner |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | Partner |
| VA | |

| VA | **Improve Telecommunications Infrastructure and Internet Connectivity** | Budget Code | |
|---|---|---|---|

This program activity is to test expanded telecommunications configurations that will connect the clinicians desktop to Internet resources. Components to be tested include workstations at desktop, Local Area Network (LAN) connections, high speed facility communications backbones, routers connecting to the VA's Wide Area Network and interconnections with the Internet.

All VA facilities are currently connected to each other by an electronic packet switched wide area network (WAN). The network is used to exchange medical (text and image), administrative, central reporting, and electronic commerce data across the VA and through gateways to facilities outside the VA. Traffic has grown five fold between 1990 and 1996. This network currently transports 120 billion characters per month.

Basic nationwide Internet connectivity infrastructure is installed. An Intranet initiative is planned to begin in 1997. An Internet gateway has linked the VA electronic mail systems to Internet and provided basic connectivity to VAMCs nationwide. All Medical Center computer users have been able to send and receive Internet mail. Testing determined that it was feasible to furnish nationwide network connectivity to Internet. In 1996, the mail access was expanded to include other functionality including Telnet, FTP, gopher and World Wide Web access. The goal is to provide expanded functionality, improved access and upgraded performance with appropriate security.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 0.18 |
| FY 97 Pres | 0.75 |
| FY 97 Est. | 0.75 |
| FY 98 Rqst. | 3.75 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | 0.50 | 1.70 |
| HCS | 0.25 | 0.75 |
| HuCS | | 1.30 |
| ETHR | | |

**Agency Ties**

| | |
|---|---|
| DARPA | Partner |
| NSF | |
| DOE | |
| NASA | |
| NIH | |
| NSA | |
| NIST | Partner |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Evaluate demand, performance, configuration and the impact of tools like Mosaic on the needs of the gateway(s). Test expanded Internet accessibility to support access from additional clinical workstations being installed throughout the VA.<br>Evaluate capacity impact of multimedia data.<br>Expanded universal access to Internet including functionality of Telnet, FTP, gopher and World Wide Web access. . Pilot test ATM for use within and between facilities. | Explore use WWW (World Wide Web) technology to access patient clinical information in a secure manner.<br>Pilot test and evaluate for integration of voice, data and video using ATM within and between facilities.<br>Evaluate advanced security mechanisms for clinical and administrative information systems. Begin testing of VA Nationwide Authentication, Authorization and Encryption Services to allow secure transmission of medical data across unsecured telecommunication links such as public networks, phone systems and Internet. Begin development of Intranet initiative for VHA administrative and clinical use.<br>Complete installation and evaluate impact of 3 Internet gateways.<br>Complete installation and evaluation of impact of adding T1 frame relay links to VA WAN.<br>Evaluate impact of various high speed backbone technologies for facility LANs and recommend best solutions for implementation across all medical centers. | Expand testing of VA Nationwide Authentication, Authorization and Encryption services to allow secure transmission of medical data across unsecured telecommunication links such as public networks, phone system and Internet.<br>Expand development of Intranet initiative.<br>Join one or more gigabit speed testbeds in order to further investigate advanced telecommunications capabilities and their applications to clinical care.<br>Evaluate needs for increased bandwidth for 3 gateways between VA WAN and Internet |

| VA | VA Hybrid Open Systems Technology (VA HOST) | Budget Code | |
|---|---|---|---|

The purpose of the VA Hybrid Open Systems Technology (VA HOST) program is to investigate the feasibility of interfacing commercial technologies with the VA's Integrated Hospital Information System called the Veterans Health Information Systems and Technology Architecture (VISTA). This interfacing of commercial technologies is based on the development of standards based interfaces in both the commercial technologies and in the VISTA.

The VA HOST program activity has enjoyed positive Congressional attention as a mechanism to support the VA in its efforts to continue to enhance the high level hospital of information systems support currently installed at all VA Medical Centers. Traditionally, in-house developed, integrated software has provided the basis for automation within the VA's medical automation initiatives. As more commercial systems become available, and as Open Systems standards and technologies evolve, investigation of commercial and Open System technologies for enhancement of the VA VISTA became the focus of this program activity.

The VA HOST emphasizes a combination of the best of the in-house integrated system with the best of commercial technologies. Standards- based interfacing technologies are required in the VA HOST program. Currently, the VA HOST Program is undergoing a major business restructuring with new leadership in order to assure the accomplishment of the goals of integrating commercial products with VISTA. Because of this restructuring, particular milestones may change.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 14.50 |
| FY 97 Pres | 7.75 |
| FY 97 Est. | 7.75 |
| FY 98 Rqst. | 6.50 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | 1.00 | |
| LSN | 4.75 | 1.50 |
| HCS | 1.00 | 1.75 |
| HuCS | 1.00 | 3.25 |
| ETHR | | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Complete technical assessments of five pilot projects.<br>Enhance standards based integration paths to VA HIS for three additional commercial technologies.<br>Initiate three project demonstrations in the Open Systems Integration Laboratory. | Enhance standards based integration paths to VA HIS for three additional commercial technologies.<br>Test and select clinical and administrative projects for migration to multiple facilities. | Continue to enhance standards based integration paths to VA HIS.<br>Test and select clinical and administrative projects for migration to multiple facilities |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | |
| DOE | |
| NASA | |
| NIH | |
| NSA | |
| NIST | Partner |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | Partner |
| VA | |

| VA | **VA/DoD Sharing** | Budget Code | |
|---|---|---|---|

As a joint VA and DoD initiative under the Vice President's Reinventing Government Phase II (REGOII), both agencies are pursuing mutually beneficial strategies for jointly improving VA and DoD Health Systems.

This program increases the sharing of Medical Information Resources between VA and DoD. Initiatives include: Electronic standards based data exchange; Investigate the feasibility of movement towards standard (common) data dictionary definitions; Creation of a laboratory for VA, DoD, and Indian Health Service to partner the assessment of methodologies and technologies for data sharing; Investigate the feasibility of shared software modules; Examination of the feasibility of a standard Federal health care system software architecture; Investigation of prototypes for interoperability and interconnectivity using common standards such as the medical HL-7 specification methodology; Development of automated DoD Contingency Data Reporting systems for sharing bed availability, peacetime transportation of VA patients on DoD transportation, and the integration of VA VISTA to the DoD US TRANSCOM Regulating and Command & Control Evacuation System (TRACES); Development of a generic VA/DoD medical imaging interface to allow both text and medical images to be exchanged between commercial radiology imaging systems and the Federal medical information systems (VA VISTA and DoD CHCS).

Goals include: (a) Establish an integrated imaging system at VA/DoD Joint Venture sites that will provide high quality image and textural data exchange from cardiology, pulmonary and gastrointestinal endoscopy, pathology, radiology, hematology, and nuclear medicine to facilitate the clinician's task of correlating such data, as well as making patient care decisions in a timely and accurate way; (b) Maximize use of Federal health care resources through systems integration as charged by Congress; (c) Reduce redundant equipment and software requirements for VISTA and CHCS at VA/DoD Joint Venture sites; (d) Facilitate implementation of the One Patient-One Record system at VA/DoD Joint Venture sites.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 0.65 |
| FY 97 Pres | 1.25 |
| FY 97 Est. | 1.25 |
| FY 98 Rqst. | 2.50 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | 1.00 | 1.00 |
| HCS | 0.25 | 0.50 |
| HuCS | | 1.00 |
| ETHR | | |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | |
| DOE | |
| NASA | |
| NIH | |
| NSA | |
| NIST | Partner |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | Partner |
| VA | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Imaging: develop, test, and install enhanced gateway at two test facilities for exchange of both text and digitized images between VA and DoD Radiology systems at Joint Venture sites.<br>Computerized patient record: continue development, testing, and collaboration with particular focus on the graphical user interface and a common approach to characterizing the clinician's view of the patient record<br>Support standardization of nomenclature for health care records<br>Integration Laboratory: support a standards-based, Open Systems integration laboratory for testing interoperability of CHCS, VISTA, Indian Health Service HIS, and commercial computerized patient record software. | Imaging: develop and test an imaging and text system to allow remote facilities to exchange multi media clinical information initially focused on the radiology application.<br>Computerized patient record: continue development, testing, and collaboration with particular focus on the graphical user interface and a common approach to characterizing the clinician's view of the patient record.<br>Support standardization of nomenclature for health care records.<br>Integration Laboratory: support a standards-based, Open Systems integration laboratory for testing interoperability of CHCS, VISTA, Indian Health Service HIS, and commercial computerized patient record software.<br>Initiate a focused joint VA DoD initiative to select mutually acceptable methods to electronically exchange patient data.<br>Identify REGO II VA/DoD health care projects using standards-based approaches that facilitate interagency collaboration. | Based on REGO II decisions, VA and DoD will implement VA/DoD health care projects in teleradiology, telepathology, and video conferencing that asses the feasibility and value of interagency collaboration using standards-based approaches.<br>Expand Imaging: continue development and testing of an imaging and text system to allow remote facilities to exchange multimedia clinical information initially focused on the radiology application.<br>Computerized patient record: continue development, testing, and collaboration with particular focus on the graphical user interface and a common approach to characterizing the clinician's view of the patient record.<br>Support standardization of nomenclature for health care records.<br>Integration Laboratory: expand support of a standards-based, Open Systems integration laboratory for testing interoperability of CHCS, VISTA, Indian Health Service HIS, and commercial computerized patient record software to focus on the electronic exchange of patient data. |

# Department of Education

The U.S. Department of Education (ED) conducts research and development in a number of areas relating to developing resources for and skills within the Education community. These activities are conducted through regional technical assistance and research entities. The Department also conducts activities relating to implementing effective uses of educational technology through the Technology Literacy Challenge Fund, the Technology Innovation Challenge Grants program, special education and rehabilitation services programs, and others. These activities are not included here.

| Program Activity | Budget Account Code | Partner/User Agencies | Budget (BA, $ M) | | | | HPCCPCAs by 1998 Pres. Request | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | FY 96 Actual | FY 97 Pres. | FY 97 Est. | FY 98 Rqst. | HECC | LSN | HCS | HuCS | ETHR |
| AskERIC Service | | | 0.34 | 1.00 | 1.00 | | | | | | |
| OERI Institutional Communications Network (INET) | | NSF | 0.93 | 1.90 | 1.90 | | | | | | |
| Regional Education Laboratory Program | | | 1.50 | 1.50 | 1.50 | 2.00 | | | | 2.00 | |
| Teacher Networking Project | | | 13.21 | | | | | | | | |
| National Institute on Disability and Rehabilitation Research | | VA, NSF | 11.40 | 11.40 | 11.40 | | | | | | |
| National Parents Information Network | | | 0.20 | 0.23 | 0.23 | | | | | | |
| ERIC Clearinghouses | | | 1.35 | 1.98 | 1.98 | | | | | | |
| Regional Technology in Education Consortia | | | | | | 10.00 | | | | 10.00 | |
| | | Totals: | 28.93 | 18.01 | 18.01 | 12.00 | | | | 12.00 | |

# Department of Education

## Comparison of FY 1997 and FY 1998 by Program Component Area

| Program Activity | Budget (BA, $ M) | | | | HPCC PCAs by 1998 President's Request | | | | | HPCC PCAs by 1997 Estimated | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | FY 96 Actual | FY 97 Pres. | FY 97 Est. | FY 98 Rqst. | HECC | LSN | HCS | HuCS | ETHR | HECC | LSN | HCS | HuCS | ETHR |
| AskERIC Service | 0.34 | 1.00 | 1.00 | | | | | | | | | | | 1.00 |
| OERI Institutional Communications Network (INET) | 0.93 | 1.90 | 1.90 | | | | | | | | | | | 1.90 |
| Regional Education Laboratory Program | 1.50 | 1.50 | 1.50 | 2.00 | | | | 2.00 | | | | | | 1.50 |
| Teacher Networking Project | 13.21 | | | | | | | | | | | | | |
| National Institute on Disability and Rehabilitation Research | 11.40 | 11.40 | 11.40 | | | | | | | | | | 11.40 | |
| National Parents Information Network | 0.20 | 0.23 | 0.23 | | | | | | | | | | | 0.23 |
| ERIC Clearinghouses | 1.35 | 1.98 | 1.98 | | | | | | | | | | | 1.98 |
| Regional Technology in Education Consortia | | | | 10.00 | | | | 10.00 | | | | | | |
| Totals: | 28.93 | 18.01 | 18.01 | 12.00 | | | | 12.00 | | | | | 11.40 | 6.61 |

| ED | **AskERIC Service** | Budget Code | |
|---|---|---|---|

AskERIC is an online information service available free of charge to teachers, parents, and students. AskERIC provides its users with customized information on a vast array of educational topics, delivered via the Internet and commercial services such as America Online. Using state-of-the-art technology, AskERIC also provides a personal touch through trained specialists available to assist educators and parents in their search for information.

AskERIC has four components: a question answering (Q&A) service, the AskERIC Virtual Library, the National Parent Information Network, and a research and development (R&D) program.

For the Q&A service, information specialists draw on the resources of the Internet and the ERIC system to provide answers --within 48 hours-- to any question about education. Users can try the Q&A service by sending a question via e-mail to AskERIC@ericir.syr.edu.

The AskERIC Virtual Library is a collection of education resources that teachers have requested. These materials include lesson plans, print, and video materials (from organizations such as CNN, PBS and the Discovery Channel), research summaries, digests, Infoguides on key educational topics, frequently-asked questions, and discussion groups for practicing educators and librarians. This is immediately available electronically. The National Parent Information Network (NPIN) _ developed in conjunction with the National Urban League, local housing authorities, and PrairieNet _ is an online collection of materials to help parents better support their children's educational, physical, and societal development.

AskERIC R&D applies emerging tools and technologies to deliver services and provide on-demand access to a full range of electronic media. Currently, the AskERIC R&D team is working on: expanding the AskERIC Virtual Library to provide image, sound, and video resources; providing free Internet access to the ERIC bibliographic database using friendly, high performance retrieval software; creating a full-text electronic collection of the documents in the ERIC database; and, experimenting with new Internet products to ascertain their value for serving educators.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 0.34 |
| FY 97 Pres | 1.00 |
| FY 97 Est. | 1.00 |
| FY 98 Rqst. | |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | | |
| HCS | | |
| HuCS | | |
| ETHR | 1.00 | |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | |
| DOE | |
| NASA | |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Will dramatically expand access to multimedia and hypermedia materials.<br>AskERIC will harness a nationwide network of information specialists, using two-way interactive telecommunications, to serve the needs of teachers, administrators, parents and students. | ERIC will continue to fulfill its mission of maintaining, and providing access to, the world's largest electronic bibliographic database of education-related publications and documents through a national system of specialist clearing houses. The ERIC system synthesizes education information and disseminates it in print and electronic formats. The ERIC system provides access to its network of bibliographic information to educators, policy makers, parents and the general public. It provides access to the database clearinghouses via mail, telephone, and electronic routes. It maintains a question and answer service via the Internet. | |

| ED | **OERI Institutional Communications Network (INET)** | Budget Code | |
|---|---|---|---|

The Institutional Communications Network (INet) was established in FY 93 by the Department of Education's Office of Educational Research and Improvement (OERI) to use the emerging National Information Infrastructure to accomplish the interrelated goals of: (1) improving collaboration and information sharing among the education R&D institutions funded by OERI, including the Regional Educational Laboratories, National Educational Research & Development Centers, Educational Resources Information Center (ERIC), and National Diffusion Network; and (2) disseminating relevant and useful research, statistics, information, products, and publications developed through or supported by the Department to schools, educators, parents, and policy makers throughout the United States.

In FY 94, INet initiated public access Gopher, FTP, and World Wide Web servers, which have rapidly become important resources to the education community. Although INet initially concentrated on disseminating OERI's research and statistical information, its coverage has expanded to include extensive information from other Department offices--press releases, grant announcements, and libraries of information about major initiatives such as GOALS 2000, Technology, School-to-Work, and Elementary and Secondary Education Schoolwide Programs. Dissemination activities are closely coordinated with other Department-funded entities that sponsor Internet services, including AskERIC, the Eisenhower National Clearinghouse for Mathematics and Science Education, and the Regional Educational Laboratories. The GOALS 2000 legislation calls for increased emphasis on electronic networking and dissemination to support education reform. INet will continue to play a key role in the Department's efforts to make a significant, high quality collection of education information available online for the rapidly growing number of educators who are connecting to the NII.-

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 0.93 |
| FY 97 Pres | 1.90 |
| FY 97 Est. | 1.90 |
| FY 98 Rqst. | |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | | |
| HCS | | |
| HuCS | | |
| ETHR | 1.90 | |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | Partner |
| DOE | |
| NASA | |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Continue implementation of core set of searchable databases.<br>Enhance services to exploit emerging data, retrieval, and interface technology; expand content to incorporate enhanced document and data formats. Support Department's integration of clearinghouses, categorical and comprehensive technical assistance centers into a coordinated, unified customer service/technical assistance system.<br>Expand participation of other Department programs; coordinate linkages and organization of on-line libraries with other sites and systems. | The primary focus of the INet program will continue to be linking the National Library of Education, OERI-funded institutions, and other Department of Education services with schools, educators, parents, and policy makers.<br>INet manages the Internet and World Wide Web presence of the National Library of Education and the Department of Education. Improvements are planned in two areas: Providing increased access through the Internet node (gopher and WWW) to the National Library's repository of information about Department programs, projects, publications, and statistics by beginning the development of a digital library; and actively disseminating syntheses of research and development findings and other materials through electronic networking. | |

| ED | **Regional Education Laboratory Program** | Budget Code | |
|---|---|---|---|

The Regional Educational Laboratories conduct applied research and development, disseminate information, and provide technical assistance that supports educational improvement. Their principal clients are educators and policy makers. The ten Regional Educational Laboratories also work together as a network on problems that affect several regions. Under the direction of a representative governing board, each laboratory serves clients in a defined region consisting of four to seven states. Using the best available knowledge, the Laboratories identify solutions to educational problems, try new approaches, furnish research results and publications, and provide training to teachers and administrators. The laboratories support school restructuring with major efforts in curriculum, instruction, and assessment.

There is a growing effort by the Labs to use technology to link educators in schools and other educational agencies with educational R&D results. The Labs have created a Technology Task Force, which is developing an Internet-based communication and information system called the National Educational R&D Network. The Network will support the Labs' collaboration, dissemination, and constituent support activities. The goals of this network are: 1) To provide the staff of regional laboratories with the capabilities of electronic communication and data and information sharing for intra-Lab communication and collaboration purposes; 2) To provide clients of the Regional Educational Laboratories with easy access to a wide range of information and data services; 3) To provide for electronic communication, dissemination, and collaboration between individual Regional Educational Laboratories and their clients and constituents.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 1.50 |
| FY 97 Pres | 1.50 |
| FY 97 Est. | 1.50 |
| FY 98 Rqst. | 2.00 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | | |
| HCS | | |
| HuCS | | 2.00 |
| ETHR | 1.50 | |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | |
| DOE | |
| NASA | |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Complete work on the Phase III plan and evaluation.<br>Continue support for projects funded under the laboratory contract and increased connectivity with constituents and OERI. | The laboratories assist educators and policy makers in their efforts to implement effective school reforms and solve State and local education problems. Each laboratory will promote widespread access to information regarding research and best practice as well as connectivity to establish communities of learners; and use advanced technologies as an integral method of their operations.<br>Develop models of comprehensive, effective reform that are used to show States and local school districts how to implement successful programs in which all students achieve at high levels, and in which technology is an integral part of the instructional environment. | The regional laboratories assist educators and policy makers in implementing effective school reform strategies. A major focus of the laboratories is to improve access to the research and resources of the labs.<br>The labs will work with ERIC and the RTECs to develop a strategy for providing access to full-text, decentralized materials online, using a search engine which would include resources from all labs and other Department funded institutions.<br>Specific labs will continue to provide a variety of services in educational technology. For example: labs are providing telecommunications services for outlying areas without modern technology; a vast network for teachers to share ideas, lessons, and increase technological literacy; and tools to train teachers in effective uses of technology and model exemplary teaching and learning through video and CD-ROM. |

| ED | **Teacher Networking Project** | Budget Code | |
|---|---|---|---|

This activity provides support for model projects that demonstrate compelling applications of electronic networks in support of teacher professional development. It is intended to increase teacher participation in electronic networking to enhance teachers' access to resources for self- improvement, and provide information about how teachers can use electronic networks as an effective means of professional development. Priority is given to networks for teachers in schools serving high concentrations of students from poor families.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 13.21 |
| FY 97 Pres | |
| FY 97 Est. | |
| FY 98 Rqst. | |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | | |
| HCS | | |
| HuCS | | |
| ETHR | | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Continue support for projects funded under previous years and disseminate information about teacher outcomes and results.<br>Conduct evaluation of projects funded under previous years and disseminate results of the evaluation study. | | |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | |
| DOE | |
| NASA | |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| ED | **National Institute on Disability and Rehabilitation Research** | Budget Code | |
|---|---|---|---|

The Education Department's National Institute on Disability and Rehabilitation Research, within the office of Special Education and Rehabilitative Services, funds several programs with projects related to High Performance Computing and Communication. These include the Rehabilitation Engineering Research Centers (RERC) program, the Technology-Related Assistance program (TRA), the Research and Demonstration program, the Field Initiated Research program, and interagency programs

RERCs conduct coordinated programs of advanced engineering or technological research: to develop and test new engineering solutions to problems confronting individuals with disabilities; to develop systems for the exchange of technical and engineering information; and to improve the distribution of technological devices and equipment to individuals with disabilities. These Centers have been established in the following areas supporting universal access to HPCC technology: Adaptive Computers and Information Systems; Augmentative and Alternative Communication; Hearing Enhancement and Assistive Devices; Technology for Blind, Visually Impaired, and Multihandicapped Individuals; and for planning purposes only, Universal Access and Telecommunications. Funding for these activities is about $3 million per year.

The combined Research and Demonstration and Field Initiated Research programs yield about $1.7 million per year in HPCC relevant research activities. The TRA program involves 52 entities (primarily states) with programs of systems change that include personnel, equipment, and a system to generate database information that could be network accessible. Approximately 14% of the funding for the TRA program or $4.9 million per year is allocated to this activity. Dissemination and Utilization activities account for about $2.5 million per year allocated to production of information available for network access primarily through contract support of the National Rehabilitation Information Center (NARIC). NARIC collects the results of federally funded research projects related to disability and rehabilitation research.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 11.40 |
| FY 97 Pres | 11.40 |
| FY 97 Est. | 11.40 |
| FY 98 Rqst. | |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | | |
| HCS | | |
| HuCS | 11.40 | |
| ETHR | | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Demonstrate an enhanced capability to deliver useful government information to persons with disabilities. | NIDR will continue funding of 15 continuing and 1 new Rehabilitation Engineering Research Centers (RERCs). These centers support programs designed to conduct research, demonstration, and training activities. RERCs focus on issues dealing with rehabilitation technology, including rehabilitation engineering and assistive technology devices and services. | |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | Partner |
| DOE | |
| NASA | |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | Partner |

| ED | National Parents Information Network | Budget Code | |
|---|---|---|---|

National Parent Information Network (NPIN) The ERIC Clearinghouse of Elementary and Early Childhood Education (ERIC/EECE) at the University of Urbana-Champaign has created a World Wide Web (WWW) server on the Internet specifically devoted to child development, care and education, and the parenting of children from birth through early adolescence. `Parents have fewer family members close by these days to ask for advice on find a preschool, working with their child's teachers, or helping their shy child make friends,` says Professor Lilian Katz, director of ERIC/EECE and a long-time contributor to Parents magazine. `They need high-quality information from reliable sources, and sometimes they need subject experts to talk to. Many parents would like to use the 'information superhighway' to find such information, and NPIN will help them do that.

NPIN will also add a significant piece to the information infrastructure for those who work with parents and families in schools and libraries, parent centers, after-school programs, social service agencies, health clinics, parenting programs, and professional groups.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 0.20 |
| FY 97 Pres | 0.23 |
| FY 97 Est. | 0.23 |
| FY 98 Rqst. | |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | | |
| HCS | | |
| HuCS | | |
| ETHR | 0.23 | |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | |
| DOE | |
| NASA | |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| | NPIN resources include:Short articles from groups such as the National Urban League, the National PTA, and the Center for Early Adolescence Discussion groups and forums on early childhood topics Parents AskERIC, a question-answering service that taps the resources of the federally funded ERIC system to respond to parents' questions. This national resource for parents and those who support them may be reached at the following addresses: Gopher ericps.ed.uiuc.edu WWW: http://ericps.e.d.uiuc.edu/npin/npinhome.html | |

| ED | **ERIC Clearinghouses** | Budget Code | |
|---|---|---|---|

The National Library of Education with the Office of Educational Research and Improvement administers the Education Resources Information Center (ERIC), which includes 16 clearinghouses that synthesize and disseminate education information, and is responsible for various other dissemination efforts, including dissemination through electronic networking and other technologies.

ERIC will continue to fulfill its mission of maintaining, and providing access to, the world's largest electronic bibliographic database of education-related publications and documents through a national system of specialist clearinghouses. Although OERI has begun exploring the inclusion of published books in the ERIC system, it remains primarily a resource for documents and publications not readily available elsewhere, providing significant services to classroom teachers and other users who do not have ready access to large reference libraries. The ERIC system synthesizes education information and disseminates it in print and electronic formats. It also provides information services to individuals and organizations in cooperation with the National Library and OERI-funded institutions.

The ERIC system provides syntheses of research and development findings and access to its network of bibliographic information to educators, policy makers, parents, and the general public. It provides access to the database clearinghouses via mail, telephone, and electronic routes. It maintains and operates a question and answer service via the Internet. In addition to its 16 major clearinghouses, the system includes a network of adjunct, volunteer clearinghouses that provide services in narrow topical areas.-

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 1.35 |
| FY 97 Pres | 1.98 |
| FY 97 Est. | 1.98 |
| FY 98 Rqst. | |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | | |
| HCS | | |
| HuCS | | |
| ETHR | 1.98 | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| | OERI plans to improve the ERIC system in significant ways. First is an effort to integrate and standardize the information services, particularly electronic, of the clearinghouses so as to provide better customer service. The bibliographic databases will be enhanced and full text dissemination capabilities will be added. | |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | |
| DOE | |
| NASA | |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| ED | **Regional Technology in Education Consortia** | Budget Code | |
|---|---|---|---|

Regional Technology in Education Consortia (RTEC): The RTECs provide state and local education agencies with technical assistance in developing comprehensive educational technology plans, drawing upon existing resources and anticipating future technological needs and innovations.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | |
| FY 97 Pres | |
| FY 97 Est. | |
| FY 98 Rqst. | 10.00 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | | |
| HCS | | |
| HuCS | | 10.00 |
| ETHR | | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| | | The RTECs will continue to provide assistance in all aspects of integrating technology with teaching and learning, including the acquisition, maintenance, and effective use of new technologies.<br>The RTECs will also focus on making the most valuable resources on technology more accessible to educators, through a variety of sources including the Internet and telecommunications technologies.<br>A new focus will be assisting schools in taking full advantage of the Universal Service Fund (the "e-rate"). |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | |
| DOE | |
| NASA | |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

# National Oceanic and Atmospheric Administration

NOAA's Grand Challenge research in weather forecasting and climate prediction depends on advances in high-end computing and on the collection and dissemination of environmental information. Increased computing power will enable more accurate representation of the atmosphere-ocean system, resulting in improved weather forecasts and making possible better decision making by Government and industry on issues that affect both the environment and the economy. NOAA's environmental data and information on the NII will be enabled through NOAA's ability to disseminate its vast holdings of real- time and historical information to all users more completely, in a more usable form, and in a much more timely manner.

| Program Activity | Budget Account Code | Partner/User Agencies | Budget (BA, $ M) | | | | HPCCPCAs by 1998 Pres. Request | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | FY 96 Actual | FY 97 Pres. | FY 97 Est. | FY 98 Rqst. | HECC | LSN | HCS | HuCS | ETHR |
| Advanced Computation | ORF EI | ARPA, NSF, DOE | 3.30 | 6.30 | 4.30 | 4.30 | 4.30 | | | | |
| Networking Connectivity | ORF EI | NASA | 2.70 | 2.70 | 2.70 | 2.70 | | 2.70 | | | |
| Information Dissemination Pilots | ORF EI | | 0.50 | 0.50 | 0.50 | 0.50 | | | | 0.50 | |
| | | Totals: | 6.50 | 9.50 | 7.50 | 7.50 | 4.30 | 2.70 | | 0.50 | |

# National Oceanic and Atmospheric Administration

## Comparison of FY 1997 and FY 1998 by Program Component Area

| Program Activity | Budget (BA, $ M) | | | | HPCC PCAs by 1998 President's Request | | | | | HPCC PCAs by 1997 Estimated | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | FY 96 Actual | FY 97 Pres. | FY 97 Est. | FY 98 Rqst. | HECC | LSN | HCS | HuCS | ETHR | HECC | LSN | HCS | HuCS | ETHR |
| Advanced Computation | 3.30 | 6.30 | 4.30 | 4.30 | 4.30 | | | | | 4.30 | | | | |
| Networking Connectivity | 2.70 | 2.70 | 2.70 | 2.70 | | 2.70 | | | | | 2.70 | | | |
| Information Dissemination Pilots | 0.50 | 0.50 | 0.50 | 0.50 | | | | 0.50 | | | | | 0.50 | |
| Totals: | 6.50 | 9.50 | 7.50 | 7.50 | 4.30 | 2.70 | | 0.50 | | 4.30 | 2.70 | | 0.50 | |

| NOAA | **Advanced Computation** | Budget Code | ORF EI |
|---|---|---|---|

Advanced Scalable Computation is NOAA's program to make possible major improvement in the Nation's ability to forecast the weather and predict climate change by taking full advantage of highly parallel, high performance computing systems that, over the long term, are expected to provide substantially greater computing power at lower cost.

NOAA/GFDL's collaborative efforts with DOE/LANL have resulted in the scientific implementation of a parallel version of a very high-resolution global atmospheric grid-point model in a study of stratospheric dynamics on a scalable system.
NOAA/NMC's collaborative efforts with DOD/NRL have resulted in execution of a parallel, adiabatic version of the NMC global spectral model with excellent performance at high resolution.

The Intel Paragon, installed at NOAA/FSL, is being used by NOAA scientists in conjunction with the DARPA-sponsored National Consortium for High-Performance Computing and as a part of the Boulder Front Range Consortium involving NCAR, the University of Colorado, and FSL. NOAA Northwest Center's collaboration efforts through the Cooperative Institute for Arctic Research (CIFAR) is a cooperative government university-industry effort in environmental research utilizing the Alaska Regional Supercomputer Center.-

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 3.30 |
| FY 97 Pres | 6.30 |
| FY 97 Est. | 4.30 |
| FY 98 Rqst. | 4.30 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | 4.30 | 4.30 |
| LSN | | |
| HCS | | |
| HuCS | | |
| ETHR | | |

**Agency Ties**

| | |
|---|---|
| DARPA | Partner |
| NSF | Partner |
| DOE | Partner |
| NASA | |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

Milestone Changes: Scalable HPCS for NOAA/NMC changed from FY 96 to FY 97 Implementation of an advanced visualization laboratory to support high end climate and weather research postponed from FY 96 to a later date.

**FY 1996 Actual Milestones**

Implement scientific experiments utilizing redesigned scalable weather and climate models on HPCS at NOAA/GFDL.

Complete development of scalable versions of NMC global spectral and ETA models for scalable architectures and compare performance on different scalable HPCSs.

Perform ensemble forecast experiments on scalable HPCS.

Complete, test and run in real time the restructured ETA model (8-16 km resolution) on a scalable hardware machine as a prototype forecast experiment in support of the 1996 Olympic Games.

Develop and test restructured parallel version of regional data assimilation code. Implement ETA model on FSL's Intel Paragon; evaluate performance at various grid resolutions and assess potential for operational forecast purposes.

Update real-time experimental forecast models (RUC and RAMS) to support nesting.

**FY 1997 Estimated Milestones**

Initiate algorithm development on scalable system toward achieving 5-10 km resolution in mesoscale atmospheric models.

Explore design of next-generation environmental observing systems utilizing HPCS to test data assimilation needs for optimizing future forecast systems. Develop software tools to facilitate software conversion from traditional shared-memory machine to scalable systems.

Continue and enhance scientific experiments running on HPCS at NOAA/GFDL.

Implement ETA model on FSL's Intel Paragon; evaluate performance at various grid resolutions and assess potential for operational forecast purposes.

Update real-time experimental forecast models (RUC and RAMS) to support nesting. Implement advanced visualization laboratory to support high end climate and weather research.-

**FY 1998 Agency Request / Expected Milestones**

Continue algorithm development on scalable system toward achieving 5-10 km resolution in mesoscale atmospheric models.

Develop software tools to facilitate software conversion from traditional shared-memory machine to scalable systems.

Continue and enhance scientific experiments running on HPCS at NOAA/GFDL.

Update real-time experimental forecast models to support nesting.

| NOAA | **Networking Connectivity** | Budget Code | ORF EI |
|---|---|---|---|

Networking Connectivity is NOAA's program activity to greatly increase its ability to disseminate NOAA real-time and historical environmental data and information through the Internet to a broad range of users in the U.S. business community, government at all levels, research, education, and the general public. NOAA is also developing collaborative tools to facilitate researchers and managers in working together regardless of physical location. The most severe test of collaboration occurs during an emergency, and since a large percentage of all declared emergencies in the U.S. are weather-related, crisis response tools are also an important aspect of NOAA's work.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 2.70 |
| FY 97 Pres | 2.70 |
| FY 97 Est. | 2.70 |
| FY 98 Rqst. | 2.70 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | 2.70 | 2.70 |
| HCS | | |
| HuCS | | |
| ETHR | | |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | |
| DOE | |
| NASA | Partner |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Expand the number of major environmental databases accessible through Internet to greater than 30.<br>Increase bandwidth to accommodate rapidly increasing user access.<br>Expand the implementation of Internet tools such as MOSAIC, WAIS, and Gopher toward development of NOAA's portion of the NII.<br>Develop integrated view of NOAA's nationally distributed online environmental information systems utilizing WWW technologies. | Expand number of NOAA nationally distributed archive facilities connected to Internet at high speed.<br>Exploit WWW software technologies to implement advanced visualization of NOAA environmental information on the Web. Implement integrated view of environmental data across NOAA WWW servers.<br>Explore use of advanced communications technologies, e.g., ATM, for environmental data dissemination and collaboration. | Exploit WWW software technologies to implement advanced dissemination and visualization of NOAA environmental information on the Web.<br>Implement integrated view of environmental data across NOAA WWW servers.<br>Explore use of advanced communications technologies, e.g., ATM, for environmental data dissemination and collaboration.<br>Explore strategies to make use of the Internet more robust. Test and evaluate collaborative desktop technologies. Evaluate these technologies for use in emergency situations. |

| NOAA | **Information Dissemination Pilots** | Budget Code | ORF EI |
|---|---|---|---|

Information Dissemination Pilots is NOAA's program activity to begin pilot dissemination through the Internet of some of the vast amount of environmental data and information for which NOAA is responsible. This information is distributed geographically at NOAA data centers across the country as part of the emerging National Information Infrastructure, for use by the private sector, academic researchers, educators, and the general public. Since most national emergencies are related to the weather, NOAA also has a strong need to provide data, model results, and information in crisis situations. Hence future NOAA work will include technologies that are viable under emergency conditions.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 0.50 |
| FY 97 Pres | 0.50 |
| FY 97 Est. | 0.50 |
| FY 98 Rqst. | 0.50 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | | |
| HCS | | |
| HuCS | 0.50 | 0.50 |
| ETHR | | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Explore emerging tools such as Java applications to facilitate information dissemination. Develop a data dissemination pilot that uses advanced data access tools on the Internet, and that makes selected heterogeneous NOAA environmental data distributed geographically at NOAA data centers accessible to users in a more timely and complete way. | Research and develop advanced visualization techniques for remote viewing of environmental phenomena represented in NOAA's nationally distributed databases. | Investigate emerging programming paradigms for presenting NOAA data and information through more useful, understandable methods. Merge these with advanced visualization techniques to expand the universe of information available to the public |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | |
| DOE | |
| NASA | |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

# Environmental Protection Agency

The goal of the EPA's HPCC program is to accelerate the evolution of high-end computing technologies and their use to meet environmental protection mission objectives. HPCC technology enables more effective, scientifically defensible, and timely environmental decision making resulting in economic benefits for states and industry by reducing the cost of achieving legislated environmental standards and by increasing the market for HPCC technologies. Research focuses on high end computing technologies required to facilitate multi-pollutant, multi-scale, cross media environmental modeling, risk assessments, and community decision making. The research targets technologies for advanced problem solving environments, reusable software needed for rapid intelligent data access and synthesis, integrated visualization and geographical information systems capabilities closely tied to environmental modeling, and scalable parallel computing and communications to support multi-disciplinary ecosystem risk assessments. Research in distributed computing provides for better access and management of large collections of environmental data and sharing of powerful computational resources needed to support advanced environmental problem solving. To facilitate technology transfer of high end environmental assessment tools to real world users, the EPA HPCC program is involved in a series of pilot projects. These projects provide for open communication of the needs of environmental scientists, analysts and decision makers.

| Program Activity | Budget Account Code | Partner/User Agencies | Budget (BA, $ M) | | | | HPCCPCAs by 1998 Pres. Request | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | FY 96 Actual | FY 97 Pres. | FY 97 Est. | FY 98 Rqst. | HECC | LSN | HCS | HuCS | ETHR |
| Environmental Modeling | CC9,CC1 | NSF | 5.53 | 3.45 | 3.45 | 3.25 | 3.25 | | | | |
| Computational Techniques | CC9, CC1, CA2 | DOE | 3.17 | 3.13 | 2.13 | 2.13 | 2.13 | | | | |
| Education/Training | CC9 | | 0.08 | | | | | | | | |
| Public Data Access | CC9 | NASA, NOAA | 0.60 | 0.60 | 0.60 | 0.80 | | | | 0.80 | |
| Totals: | | | 9.38 | 7.18 | 6.18 | 6.18 | 5.38 | | | 0.80 | |

# Environmental Protection Agency

## Comparison of FY 1997 and FY 1998 by Program Component Area

| Program Activity | Budget (BA, $ M) | | | | HPCC PCAs by 1998 President's Request | | | | | HPCC PCAs by 1997 Estimated | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | FY 96 Actual | FY 97 Pres. | FY 97 Est. | FY 98 Rqst. | HECC | LSN | HCS | HuCS | ETHR | HECC | LSN | HCS | HuCS | ETHR |
| Environmental Modeling | 5.53 | 3.45 | 3.45 | 3.25 | 3.25 | | | | | 3.45 | | | | |
| Computational Techniques | 3.17 | 3.13 | 2.13 | 2.13 | 2.13 | | | | | 2.13 | | | | |
| Education/Training | 0.08 | | | | | | | | | | | | | |
| Public Data Access | 0.60 | 0.60 | 0.60 | 0.80 | | | | 0.80 | | | | | 0.60 | |
| Totals: | 9.38 | 7.18 | 6.18 | 6.18 | 5.38 | | | 0.80 | | 5.58 | | | 0.60 | |

| EPA | **Environmental Modeling** | Budget Code | CC9,CC1 |
|---|---|---|---|

This program activity supports fundamental research on the systematic integration of advanced multi-pollutant, multi-scale, and multi-media environmental modeling components into a high performance distributed computing framework, addressing such issues as human-computer interface, distributed data management, software reuse and scalability, and system performance.

EPA is integrating research results to develop a technology foundation to support community-based environmental decision-making and risk assessment. The objective is a community multi discipline problem solving framework for environmental modeling and decision support built upon emerging HPCC technology and capable of adapting to continuous advances in science and technology.

The initial focus of the program was on oxidant, acid deposition, and particulate models, but has been expanding to encompass integration of more complex processes such as aerosols and visibility, and cross-media ecosystem assessments. Both research and prototyping of system framework capabilities such as graphical user interface, intelligent system builders and data management, collaborative tools, interactive analysis and visualization, multimedia electronic `tutor and help`, and decision support are being performed to better define technology/user requirements and design alternatives for environmental modeling and decision support systems. The resultant modeling and decision support framework will have general applicability for use in air quality, surface and ground water quality modeling and ecosystem management. Advanced collaborative methods of analyzing and visualizing the multi-dimensional measurements and model predictions from environmental assessment studies are being developed to provide a means of gaining greater insight into interactions of the science in the models and for better interpretation of results.

| Milestone Changes | The reduction in the EPA FY-96 HPCC budget delayed linkage of air and water models. |
|---|---|

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Developed an air quality modeling and decision support system for regional and urban oxidant, regional acid deposition, and particulate issues.<br>Implemented a 1st order method for analyzing the propagation of uncertainty in input data to model predictions.<br>Implemented video conferencing to key agency and research sites.<br>Awarded grants for research to advance environmental decision support tools through 1) coupling of Geographical Information Systems and environmental models, 2) parallel and distributed optimization techniques, and advanced multi-variate visualization techniques. | Demonstrate linked air and water quality models in a distributed computing environment to facilitate cross-media assessment of water quality.<br>Award grants for development of scalable techniques for assimilation of remote-sensing data into environmental models. | Award grants for research on object oriented numerical methods for environmental models |

## Budget ($ M)

| | |
|---|---|
| FY 96 Act | 5.53 |
| FY 97 Pres | 3.45 |
| FY 97 Est. | 3.45 |
| FY 98 Rqst. | 3.25 |

## Program Component Areas

| | FY 97 | FY 98 |
|---|---|---|
| HECC | 3.45 | 3.25 |
| LSN | | |
| HCS | | |
| HuCS | | |
| ETHR | | |

## Agency Ties

| | |
|---|---|
| DARPA | |
| NSF | Partner |
| DOE | |
| NASA | |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| EPA | **Computational Techniques** | Budget Code | CC9, CC1, CA2 |
|---|---|---|---|

The primary objective of the computational techniques research is to improve the performance of key numerical algorithms that form the computational foundation of environmental models. The research develops and evaluates practical parallel computing techniques encompassing interconnected workstations, vector and parallel supercomputers, parallel software and algorithms, and communication capabilities to determine the most effective approach to support complex multi-pollutant and cross-media environmental modeling activities. Fundamental research is also conducted on computational techniques for quantifying uncertainty as an integral part of the numerical computation. Several universities, a state technology center, the DOE's Oak Ridge National Laboratory, and several EPA research laboratories are engaged in this research which directly impacts the performance of environmental Grand Challenge applications and contributes to the shared software libraries and parallel testbed codes.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 3.17 |
| FY 97 Pres | 3.13 |
| FY 97 Est. | 2.13 |
| FY 98 Rqst. | 2.13 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | 2.13 | 2.13 |
| LSN | | |
| HCS | | |
| HuCS | | |
| ETHR | | |

| Milestone Changes | Agency budget reductions eliminate planned upgrades for scalable computing. |
|---|---|

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Developed a parallel analytic element method for regional ground water modeling.<br>Implemented parallel, distributed, gas-phase chemistry code for use in operational advanced air quality models.<br>Awarded grants for development of parallel methods for optimization problems, coupled air and water exchange, adaptive grid approaches, and parallelization of legacy codes. | Incorporate 4-D data assimilation into parallel meteorology models.<br>Develop parallel algorithms for aerosol dynamics.<br>Award grants for development of parallel algorithms and domain decomposition approaches for multi-media modeling. | Award grants for research on parallel algorithms for linear & non-linear optimization processes to support pollution control strategy optimization and risk assessment. |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | |
| DOE | Partner |
| NASA | |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| EPA | **Education/Training** | Budget Code | CC9 |
|---|---|---|---|

This program activity targets the dissemination of high performance computing and advanced environmental modeling capabilities to select groups from industry, State and federal sectors. The target groups of State users are selected from States with professionals involved in front-line environmental decision making and using models of regional and urban air quality. Pilot users gain first-hand experience on how high performance computing can alleviate many of their decision making constraints while at the same time they work with developers to ensure that system capabilities and interfaces address their needs. A high performance computing learning environment is created through workshops, involvement of professional trainers and curriculum developers, and establishment of a `virtual center` which functions remotely through Internet to support a distributed base of users of environmental models for decision making across the country.

| Milestone Changes | Budget reductions eliminated planned environmental education grants |
|---|---|

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Evaluated a distributed modeling support`center` approach.<br>Defined infrastructure requirements for extending advanced modeling and training to a broad user community. | Internet-based training for environmental modeling. | |

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 0.08 |
| FY 97 Pres | |
| FY 97 Est. | |
| FY 98 Rqst. | |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | | |
| HCS | | |
| HuCS | | |
| ETHR | | |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | |
| DOE | |
| NASA | |
| NIH | |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

| EPA | **Public Data Access** | Budget Code | CC9 |
|---|---|---|---|

A wealth of environmental data from diverse sources at multiple scales exists and continues to accumulate each day. Scientists, policy makers, industry and the general public have diverse needs for data access, manipulation, summarization, and interpretation. This research addresses fundamental technology issues associated with a multi discipline approach to finding, assimilating, and analyzing useful information from large, distributed multi-media environmental databases. Technology areas include intelligent agents for searches among data collections, natural language data navigation techniques, machine learning, rule-based systems, data visualization, object data bases, interoperability over heterogeneous hardware/software platforms, and synthesis of information for scientific and public use.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 0.60 |
| FY 97 Pres | 0.60 |
| FY 97 Est. | 0.60 |
| FY 98 Rqst. | 0.80 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | | |
| HCS | | |
| HuCS | 0.60 | 0.80 |
| ETHR | | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Awarded grants for development of data assimilation and analysis techniques for multi-scale environmental data including satellite imagery. | Continue grants for development of data assimilation and analysis techniques for multi-scale environmental data including satellite imagery. | Award grants for research on data access techniques in a distributed heterogeneous environment. |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | |
| DOE | |
| NASA | Partner |
| NIH | |
| NSA | |
| NIST | |
| NOAA | Partner |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

# Agency for Health Care Policy and Research

The Agency for Health Care Policy and Research (AHCPR) contribution to the High Performance Computing and Communication initiative focuses on health care technology applications of computer-based patient records, computerized clinical decision support systems, and patient care data standards. These HPCC activities are predominantly technology applications support for promoting the development and evaluation of systems to foster their economic and medical feasibility. The HPCC program at AHCPR advances information technology that can provide significant benefits to all Americans by improving the quality, appropriateness, and effectiveness of health care, and improving their access to health care.

AHCPR supported the change from a temporary standards planning panel to a permanent ANSI board in FY 1996. Produced a report of an AHCPR-sponsored meeting of international (American, European, Australian, Japanese, Canadian and other) experts on `Computer-based Patient Records and Modeling.

AHCPR fostered collaboration of the U.S. patient care data standards developers through support of the American National Standards Institute's (ANSI) Healthcare Informatics Standards Board.

| Program Activity | Budget Account Code | Partner/User Agencies | Budget (BA, $ M) | | | | HPCCPCAs by 1998 Pres. Request | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | FY 96 Actual | FY 97 Pres. | FY 97 Est. | FY 98 Rqst. | HECC | LSN | HCS | HuCS | ETHR |
| Computer-Based Patient Records | | NIH | 3.20 | 4.20 | 4.20 | 5.50 | | | | 5.50 | |
| | | Totals: | 3.20 | 4.20 | 4.20 | 5.50 | | | | 5.50 | |

# Agency for Health Care Policy and Research

## Comparison of FY 1997 and FY 1998 by Program Component Area

| Program Activity | Budget (BA, $ M) | | | | HPCC PCAs by 1998 President's Request | | | | | HPCC PCAs by 1997 Estimated | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | FY 96 Actual | FY 97 Pres. | FY 97 Est. | FY 98 Rqst. | HECC | LSN | HCS | HuCS | ETHR | HECC | LSN | HCS | HuCS | ETHR |
| Computer-Based Patient Records | 3.20 | 4.20 | 4.20 | 5.50 | | | | 5.50 | | | | | 4.20 | |
| Totals: | 3.20 | 4.20 | 4.20 | 5.50 | | | | 5.50 | | | | | 4.20 | |

| AHCPR | **Computer-Based Patient Records** | Budget Code | |
|---|---|---|---|

The objective of the computer-based patient record program activity is to improve the uniformity, accuracy, and retrievability of data about patient care in the community and to promote its use for improved clinical decisions. It requires the development of clinical data standards and the integration of information systems in diverse locations within institutions and across institutions and health care providers. Testing the application of computer-based patient record systems, decision support algorithms, and knowledge servers in physicians' offices, hospitals, patients' homes and other locations is of national importance to bring rapidly the benefits of HPCC to the provider and consumer of health care throughout the U.S.

**Budget ($ M)**

| | |
|---|---|
| FY 96 Act | 3.20 |
| FY 97 Pres | 4.20 |
| FY 97 Est. | 4.20 |
| FY 98 Rqst. | 5.50 |

**Program Component Areas**

| | FY 97 | FY 98 |
|---|---|---|
| HECC | | |
| LSN | | |
| HCS | | |
| HuCS | 4.20 | 5.50 |
| ETHR | | |

Milestone Changes

| FY 1996 Actual Milestones | FY 1997 Estimated Milestones | FY 1998 Agency Request / Expected Milestones |
|---|---|---|
| Supported private sector development and testing of clinical patient care data standards for:<br>(1) the definition and coding of medical terms,<br>(2) the content of specific data sets for decision making, and<br>(3) the electronic exchange of patient care data.<br>Initiated the evaluation of electronic medical record applications, including those in telemedicine, to determine the extent to which they improve: clinical decision making; the delivery of health services; and patient outcomes.<br>These evaluations should include:<br>(1) how such systems are received by health care providers and patients;<br>(2) how physician and patient behavior changes; and<br>(3) how patient outcomes, productivity, and costs of care are affected. | Support research into the barriers to successful acquisition and use of clinical health information systems, emphasizing the speed, cost, and human factors that affect success--to accelerate the transfer of computer-based information technology.<br>Evaluate the medical effectiveness and economic impact (cost benefits) of automated clinical decision support systems for a variety of clinical conditions in diverse health care settings. | Accelerate the development of information standards essential for integrating clinical information systems with knowledge based servers.<br>Test the use of such standards in pilot projects across medical settings to determine their contribution to the medical effectiveness and cost effectiveness of clinical decision support systems.<br>Test the confidentiality and privacy protection of computer-based patient record security measures. |

**Agency Ties**

| | |
|---|---|
| DARPA | |
| NSF | |
| DOE | |
| NASA | |
| NIH | Partner |
| NSA | |
| NIST | |
| NOAA | |
| EPA | |
| ED | |
| AHCPR | |
| VA | |

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