HIGH PERFORMANCE COMPUTING and COMMUNICATIONS

FY 1999 - FY 2000

Implementation Plan

April 2000

National Coordination Office for Computing, Information, and Communications

Interagency Working Group on
Information Technology Research and Development

Office of Science and Technology Policy
Executive Office of the President

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April 5, 2000

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

Dear Dr. Lane,

I am pleased to forward you the FY 1999 - FY 2000 Implementation Plan (IP) for the High Performance Computing and Communications (HPCC) Program. This Plan provides a detailed description of FY 1999 HPCC plans and accomplishments and FY 2000 HPCC plans as reflected in the President's FY 1999 and FY 2000 budget proposals. The plans, accomplishments, and budget material in this document were prepared by the National Coordination Office for Computing, Information and Communications (NCO/CIC) and the ten Agencies that participate in the Federal Information Technology Research and Development (IT R&D) programs. In FY 2000, the HPCC and the Computing, Information, and Communications (CIC) programs are coordinated by the Interagency Working Group (IWG) on Information Technology (IT) Research and Development (R&D). Previously these efforts were coordinated by the Subcommittee on CIC R&D.

In addition to the HPCC activities described in this document, in FY 2000 the President proposed the Information Technology for the Twenty-first Century (IT^2) initiative in response to recommendations by the President's Information Technology Advisory Committee (PITAC). The Implementation Plan for IT^2 which builds on the HPCC/CIC programs was published in June 1999 and is a companion to this document.

The format and contents of this two year IP are similar to previous year's plans and were determined through substantial interactions with the Office of Management and Budget, and the Agencies that participate in the HPCC/CIC programs. This Plan will be made available to the public in printed form and can also be accessed via the NCO Web site http://www.ccic.gov/.

Working cooperatively with the academia and industry, the multi-agency IT programs described in this plan support important national missions and nurture innovation and discovery. The IWG for IT R&D and the NCO staff look forward to working with you in further strengthening the investments in fundamental information technology research that will in turn assure America's scientific and economic leadership.

Respectfully yours,

Kay Howell
Director

HPCC FY 1999 - FY 2000 Implementation Plan

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High Performance Computing and Communications Program

FY 1999 - FY 2000 Implementation Plan

1. Executive Summary

This document presents the FY 1999 - FY 2000 Implementation Plan (IP) for the Federal High Performance Computing and Communications (HPCC)/Computing, Information, and Communications (CIC) Research and Development (R&D) programs. 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 select NII applications

During FY 1999 – FY 2000 the following ten Federal agencies participated in these programs:

(1) National Science Foundation (NSF)

(2) National Aeronautics and Space Administration (NASA)

(3) Defense Advanced Research Projects Agency (DARPA)

(4) Department of Energy (DOE) Office of Science

(5) National Institutes of Health (NIH)

(6) National Security Agency (NSA)

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

(8) National Oceanic and Atmospheric Administration (NOAA)

(9) Agency for Healthcare Research and Quality (AHRQ), formerly Agency for Health Care Policy and Research (AHCPR)

(10) Environmental Protection Agency (EPA)

The original goals of HPCC are consistent with the goals of the CIC R&D programs, and will be realized by focusing the HPCC and expanded CIC activities within each of the participating Federal agencies and the coordination process that has been instituted for overall success. The highly successful HPCC/CIC programs build upon decades of Federal computing and communications R&D and receive bipartisan Congressional support (see Table 1).

This IP is based on the President's FY 1999 and FY 2000 HPCC/CIC budget requests of $827 and $919 million (Table 4 - 5) respectively. The content of this IP is consistent with two earlier publications, usually called the Blue Books (BB):

- Supplement to the President's FY 1999 Budget entitled "Computing, Information, and Communications: Networked Computing for the 21st Century"
- Supplement to the President's FY 2000 Budget entitled "High Performance Computing and Communications: Information Technology Frontiers for a New Millennium"

This IP is prepared from the Agency IP input provided in the section 5 of this document. Please refer to this section for details about Agency activities. This IP provides a summary of FY 1999 HPCC accomplishments and FY 1999 - FY 2000 HPCC plans carried out by the participating agencies as reflected in the President's FY 1999 - FY 2000 HPCC budget proposals to the U. S. Congress. The FY 1999 - FY 2000 budget figures derive from a base of $489 million (Table 1) in place at the beginning of the HPCC program in FY 1992.

Beginning in FY 1997, to address the growing information technology challenges, the HPCC/CIC programs redefined themselves and reorganized their coordinated activities into five enhanced Program Component Areas (PCAs):

(1) High End Computing and Computation (HECC)

(2) Large Scale Networking (LSN)

(3) High Confidence Systems (HCS)

(4) Human Centered Systems (HuCS)

(5) Education, Training, and Human Resources (ETHR)

The expanded programs also include coordination efforts such as the Federal Information Services and Application Council (FISAC) which has no separate budget. Beginning in FY 2000, with the new Information Technology for the Twenty-first Century (IT^2) initiative, additional PCAs are being included in these programs.

Prior to FY 1999, all five PCAs were part of the President's HPCC/CIC budget crosscut. Not all PCAs were part of the FY 1999 and FY 2000 budget crosscuts. The formal HECC and LSN PCAs had well-defined HPCC/CIC programs and were included in the President's FY 1999 and FY 2000 HPCC/CIC formal budget crosscuts. By FY 2000 the HCS PCA had developed an expanded research agenda and was added to the FY 2000 formal crosscut. However, the remaining two PCAs, HuCS and ETHR, have not been included in the FY 1999 or FY 2000 HPCC/CIC crosscuts. These informal PCAs are reorganizing their R&D to include work being conducted both by CIC organizations – but outside their historical HPCC budget crosscuts – and by other Federal organizations.

For FY 1999, the President's HECC R&D Budget Request was $518 million (section 4, Tables 4-5) and the Congressional appropriation (Estimate) was $504 million (Tables 4-5). In FY 2000, the President's HECC Request was $519 million (Table 4-5) and the appropriated funding will be reported in the FY 2001 IP. HECC research explores algorithms for physical, chemical, and biological modeling and simulation in complex systems; information intensive science and engineering applications; and the advanced concepts in quantum, biological, and optical computing. The thrust of HECC R&D includes short-term efforts such as infrastructure and software for teraflops (10^{12} floating point operations per second) systems and enabling tools and environment for complex scientific and engineering applications. One of the long-term R&D goals of HECC includes technologies for a reliable petaflops (10^{15} flops) computing system with exabyte (10^{18} bytes) storage capability.

For FY 1999, the President's LSN R&D Budget Request, including Next Generation Internet (NGI) funding, was $316 million (section 4, Tables 4-5) and the Congressional appropriation (Estimate) was $291 million (Table 4-5). In FY 2000, the President's LSN Request was $290 million (Table 4-5) and the appropriated funding will be reported in the FY 2001 IP. The LSN R&D areas include high performance network communications with advances in leading edge technologies, services, and performance. Advanced network components and technologies for engineering and management of large-scale networks of the future are current thrust areas. The NGI initiative adds functionality and improves performance of the base LSN activities. Development of testbeds and demonstration of revolutionary applications are some of the current NGI thrust areas.

Both HECC and LSN provide important infrastructure for HCS, HuCS, and ETHR advances. For example, the networking infrastructure being provided by the LSN PCA is vital to almost every R&D activity of the Federal HPCC/CIC programs.

In FY 2000, the President's HCS Request was $103 million (section 4, Tables 4-5) and the appropriated funding will be reported in the FY 2001 IP. The focus of HCS R&D includes the high performance aspects of system availability, reliability, safety, security, and survivability. These technologies are needed as we increasingly rely on our information infrastructure to support our financial, healthcare, manufacturing, power, and transportation infrastructure.

2. Introduction

As we proudly welcome the dawn of a new millennium, advances made possible by computing, information, and communication R&D are rapidly transforming every aspect of our lives in ways that are exciting but very difficult to predict. 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 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.

With broad bipartisan support, Congress authorized the HPCC Program in the High Performance Computing Act of 1991 (Public Law 102-194), signed on December 9, 1991. The original program and Agency participation have been steadily growing since its inception. To meet many of the new and continued challenges, under the direction of the National Science and Technology Council's (NSTC), the Federal Computing, Information, and Communications (CIC) programs are investing in long-term information technology R&D. The original HPCC Program was the foundation for the CIC programs. In FY 1999, HPCC and CIC activities were coordinated by the Subcommittee on Computing, Information, and Communications R&D of the Committee on Technology (CT), one of the five committees of the NSTC in the Office of Science and Technology Policy (OSTP), Executive Office of the President. Beginning FY 2000 the activities are coordinated by an Interagency Working Group (IWG) on Information technology (IT) R&D, chaired by NSF's Directorate for Computer and Information Science and Engineering (CISE) Director. This Plan provides a detailed description of FY 1999 - FY 2000 HPCC/CIC Agency plans, accomplishments, and projected accomplishments.

2.1 Grand and National Challenges

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 that 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 computation 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 GCs are computational structural biology and global climate modeling. National Challenges on the other hand focus on efforts that are information intensive, have broad and direct impact on the nation's competitiveness and well-being of its citizens, and that can benefit from the application of HPCC technologies and resources. Some examples of NCs are digital libraries, electronic commerce, education and life-long learning, and healthcare.

2.2 Program Overview

Through the goals of its PCAs, described below, the HPCC Program provides the focus for the member agencies' planning, implementation, and management of their coordinated HPCC activities. Through collaborative coordination, the participating agencies seek to leverage each other's activities wherever possible and minimize redundancy. However, funding for each Agency's HPCC 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 updated World Wide Web (WWW) sites are used to distribute the results of HPCC research and to evaluate overall program progress. Many of these activities are summarized below.

2.3 Formal HPCC Program Component Areas (PCAs)

The PCAs are areas of high priority investments by the Federal agencies that participate in the coordinated HPCC/CIC R&D programs. The PCAs, the formal ones, that are included in the FY 1999 and FY 2000 HPCC/CIC budget crosscuts are defined briefly below, and more extensive definitions, characteristics, and budget details are given in section 4. Detailed Agency PCA participation and budget tables are presented in section 5.

2.3.1 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 the research infrastructure required to carry out this R&D. The HECC R&D is organized into four thrust areas:

- System Software Technologies
- Leading-edge Research for Future Generations of Computing
- Incorporation of Technology into Real Applications
- Infrastructure for Research in HECC

One key HECC R&D focus has been on creating environments for the effective use of Teraflops (10^{12} floating point operations per second) systems by means of investing in operating systems, languages and compilers, programming, environments and libraries, debugging and performance tools, and scientific visualization. Modeling and simulation for computation-and information-intensive science and engineering applications including the Grand Challenges and the infrastructure that supports computational science research is another focus area. Additional attention has been on 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. One long-term HECC focus is R&D toward implementing petaflops (10^{15} flops) level performance and exabyte (10^{18} bytes) storage.

2.3.2 Large Scale Networking (LSN)

The goal of LSN R&D is to provide 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. The Next Generation Internet initiative that was authorized by Congress in FY 1998, is coordinated under the LSN PCA.

LSN activities are coordinated by a Working Group and four Teams, each of which includes non-Federal participants:

- The Joint Engineering Team (JET) that coordinates connectivity among Federal agency networks
- The Network Research Team (NRT) that coordinates Agency networking research programs, shares networking research information among Federal agencies, and supports the NGI networking R&D activities
- The High Performance Network Applications Team (HPNAT) that coordinates Federal R&D in high performance networking applications in science and engineering, weather and the environment, biomedicine, and health care
- The Internet Security Team (IST) that facilitates testing and experimentation with emerging advanced security technologies and serves as a focal point and clearing house for application and engineering requirements for security systems

The Next Generation Internet has the following focus areas:

- Conduct R&D and experimentation in networking technologies to add functionality and performance improvements
- Develop testbeds for system-scale testing and for developing and demonstrating advanced applications
- Develop and demonstrate revolutionary applications in (1) enabling technologies such as digital libraries, collaboration technologies, distributed computing, privacy and security, remote operation and simulation, and in (2) discipline applications such as basic sciences, crisis management, education, the environment, Federal information systems, healthcare, and manufacturing.

2.3.3 High Confidence Systems (HCS)

Security-critical, safety-critical, and life-critical systems are needed in chemical production, electric power generation, financial services, health care, manufacturing, oil and gas production, and transportation, as well as in emergency services, law enforcement, and national defense. Systems for power generation and distribution, banking, medical implants, automated surgical assistants, and transportation also need reliable computing and telecommunication technologies.

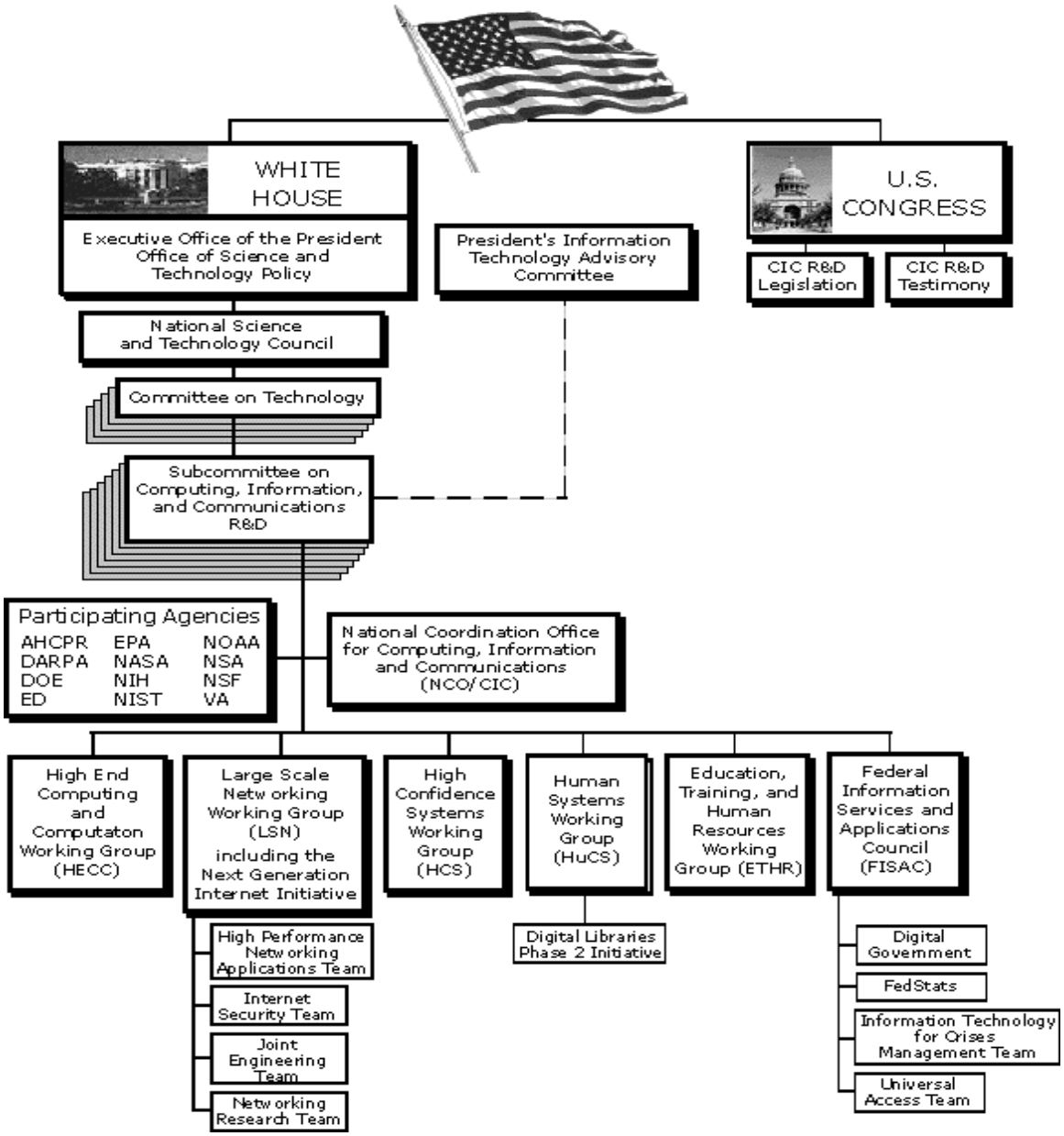
HCS R&D focuses on the critical information technologies necessary to achieve predictably high levels of system availability, reliability, safety, security, and survivability. A high confidence system is one in which the consequences of its behavior are well understood and predictable. It must withstand internal and external threats and must deal with naturally occurring hazards as well as malicious attacks from a sophisticated and well-funded adversary. Systems that employ HCS technologies will be resistant to component failure and malicious manipulation and will respond to damage or perceived threat by adaptation or reconfiguration.

The goal of HCS R&D is to develop technologies that provide high levels of system safety, security, protection of privacy and data, reliability, and restorability of information services. The HCS Working Group is developing an expanded R&D agenda that is being implemented beginning in FY 2000.

3. HPCC R&D Planning, Management, 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. In FY 1999 and FY 2000, program oversight and budgetary review were provided by the Committee on Technology (CT) through its Subcommittee on CIC R&D. The National Coordination Office for Computing, Information, and Communications (NCO/CIC) provides a central focus for interagency R&D activities. These include the preparation of planning, budget, and assessment documents; the development of inter-agency CIC programs; and coordination of the various HPCC and CIC activities of the participating agencies. The NCO also provides an interface to Congress, academia, industry, and the public. In FY 1999, the NCO Director, who reports to the Director of the Office of Science and Technology Policy (OSTP), Executive Office of the President, served as the Chair of the Subcommittee on CIC R&D.

Organizational Chart (FY 1999)



In FY 1999, the Subcommittee on CIC R&D and in FY 2000, its successor the IWG on IT R&D, met quarterly to coordinate Agency HPCC and CIC programs through information exchanges, development of interagency programs, and the review of Agency plans and budgets. These organizations chartered a Working Group for each PCA to coordinate activities in specific areas.

The Federal Information Services and Applications Council (FISAC) 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.

3.1 Selecting Projects for Funding

In FY 1999 the Subcommittee on CIC R&D and in FY 2000, the IWG on IT R&D, worked with the agencies to coordinate interagency programs, encourage adequate funding, and minimize redundancy. The mechanisms used to evaluate proposals and fund activities differ among the ten agencies that support R&D conducted by Agency staff and researchers in universities, industry, and national laboratories. Agencies in general have programs 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 the selection of the highest quality proposals and to ensure active participation by the entire research community.

3.2 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 section 4. This document reports on milestones for two Fiscal Years. The FY 1999 milestones are those that were accomplished by the end of that year. The FY 2000 milestones reported herein are the expected accomplishments, based on Congressional appropriations. FY 2000 anticipated accomplishments are based on 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.

3.3 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.

3.4 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. Renamed in 1998 as the President's Information Technology Advisory Committee (PITAC), this Committee advises the Administration on the HPCC and CIC R&D efforts and progress. The Committee members are specially qualified to provide independent assessment, advice, and information on high performance computing and communications. The PITAC reviewed the NGI program in April 1999 and reviewed the proposed IT^2 initiative in August 1999.

In addition, representatives from academia, industry, and professional associations have conferred with and advised the Subcommittee on CIC R&D on several public sessions.

3.5 Agency Program Oversight

Individual agencies review programs in detail via their management review structures, including official advisory committees. This section highlights Agency oversight and review activities and describes review mechanisms in most of the HPCC/CIC agencies.

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 programs use several means to help it define specific objectives, implementation mechanisms, and evaluation measures, and 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
- Bodies of opinion held by the community of researchers themselves as captured in publications and their review

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/CIC programs. As new research is funded under the HPCC/CIC 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 **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 with program managers on details 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 **Department of Energy (DOE)** HPCC and CIC programs focus 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 progress in reaching specific numerical targets.

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:

- 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
- National Cancer Advisory Board
- National Cancer Institute (NCI) Division of Cancer Biology and Diagnosis Board of Scientific Counselors
- 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. Each Institute has mechanisms 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.

3.6 HPCC and CIC Planning Beyond FY 1999 - FY 2000

The Subcommittee on CIC R&D and its successor IWG on IT R&D 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. As an additional part of this process, the IWG 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 IWG 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. Other significant developments that were conceived during FY 2000 will be reported in the FY 2001 IP.

3.7 Conferences, Workshops, and Publications

During FY 1998 and FY 1999, the CIC R&D Subcommittee and its Working Groups and the participating agencies, sponsored or participated in numerous outreach conferences and workshops. Some representative examples are:

- “Netamorphosis Demonstrations” (Washington DC, March 1998)
- “High End Computing Systems Briefings” (Bethesda, MD, August 1998)
- “HCS Planning Workshop” (Washington DC, March 1998)
- “SC98” (Orlando FL, November 1998)
- “IT Expo” (Washington DC, May 1999)
- “SC99” (Portland, OR, November 1999)

HPCC and CIC publications for FY 1998 and FY 1999 include:

- “Networked Computing for the 21st Century” Supplement to the President’s FY 1999 Budget (known as a Blue Book)
- “Information Technology Frontiers for a New Millennium” Supplement to the President’s FY 2000 Budget (known as a Blue Book)
- “HPCC FY 1998 Implementation Plan,” which details FY 1998 HPCC plans and budget crosscut
- “The Role of High-Performance Computing in Industry: Customer Perspective and Market Analysis. HECC Working Group, October 1998
- “Information Technology for the Twenty-First Century: A Bold Investment in America’s Future” (known as IT^2) (Arlington VA, June 1999)

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

4. HPCC and CIC FY 1999 - FY 2000 Budget Overview

This section provides overview budget data for the HPCC/CIC programs and for each PCA. It begins with definitions of the terms found in the budget tables and descriptions of which PCAs were included in FY 1999 and FY 2000.

4.1 Terminology and Scope

The “FY 1999 Req” and “FY 2000 Req” refer to the funds requested by the President in his budget request to Congress for those two years. The “FY 1998 Est” and "FY 1999 Est" estimates the funds that each Agency has been authorized to spend on HPCC and CIC as a result of Congressional appropriations. The term "Actual" funding, in Table 1, in a fiscal year refers to the actual funds spent for the program in that year.

For FY 1999, only the HECC and LSN PCAs were included in the budget crosscut; HCS was also included in FY 2000. The other two PCAs, HuCS and ETHR, continued to perform their on-going work and to reassess and redefine their scope during this period, but were not part of the formal budget crosscut and are not included in this IP.

All budget numbers reported in this IP may not agree completely with the corresponding numbers reported in the Blue Book. Major disagreements in budget numbers are always footnoted in the IP tables as well as in the text. The FY 1998 disagreements are somewhat significant while the FY 1999 and FY 2000 are minor.

A highlight of the President’s FY 2000 R&D budget is the proposed Information Technology for the Twenty-first Century (IT^2) initiative. This initiative proposed $366 million in increased investments to help advance the knowledge base in fundamental information science and to train the next generation of researchers who will sustain the Information Revolution well into the 21st century. The FY 2000 implementation plan of this new initiative has already been published.

A new initiative at NIH, the Biomedical Information Sciences and Technology Initiative started in FY 2000, is not reported in this IP as the details are still being worked.

In FY 2000, the President's Budget also included the Department of Energy's Defense Program (DOE-DP), Accelerated Strategic Computing Initiative (ASCI) funding of $484 million for FY 1999 (Estimate or Appropriated) and $543 million for FY 2000 (Request). Although the President's FY 2000 HPCC/CIC budget includes this funding, it is not covered in this IP.

4.2 History of HPCC/CIC Funding Profiles

The overall funding profile for the HPCC/CIC programs since their inception in FY 1991 is given in Tables 1, 2, and 3. Tables 2 and 3 track and compare FY 1998 to FY 2000 funding for appropriate collections of PCAs. The five columns in Table 1, from left to right refer to:

- The fiscal year
- Total budget for the original eight HPCC agencies in FY 1991: DARPA, NSF, DOE, NASA, NIH, Department of Commerce (DOC)/NIST, DOC/NOAA, and EPA
- Change of funding (in percentage) for the original eight agencies from the previous fiscal year
- Total funding for all participating agencies in a given fiscal year (for several years there were 12 agencies — the originals plus NSA, AHRQ (formerly AHCPR), Veteran’s Administration (VA), and Department of Education (ED) — then there were only 10 — the originals plus NSA and AHRQ)
- Change in total funding (in percentage) from the previous fiscal year

Table 1: Funding Profile for HPCC/CIC Programs

Fiscal Year (Number of Agencies)	Budget for Original Eight Agencies (Dollars in Millions)	Change from Previous Year for Original Eight Agencies	Budget for Current Participating Agencies (Dollars in Millions)	Change from Previous Year for Participating Agencies
FY 1991 Base (Eight agencies[1])	$ 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[2])	$ 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 Estimate (Twelve agencies)	$ 998	+7.1%	$ 1,074	+6.4%
FY 1999 Estimate[3] (Ten agencies)	$764	See Tables 2 and 3	$ 795	See Tables 2 and 3
FY 2000 President's Request[4] (Ten agencies excluding DOE's ASCI program)	$ 830	See Tables 2 and 3	$ 911	See Tables 2 and 3

[1] Original eight agencies: DARPA, NSF, DOE, NASA, NIH, DOC/NIST, DOC/NOAA, and EPA.
[2] Twelve agencies: DARPA, NSF, DOE, NASA, NIH, NSA, NIST, NOAA, EPA, AHCPR, ED, and VA
[3] Department of Education (ED) and Veteran's Administration (VA) did not participate, formal crosscut includes only HECC and LSN.
[4] Department of Education (ED) and Veteran's Administration (VA) did not participate, formal crosscut includes only HECC, LSN, and HCS.

Table 2: Funding Profile for HECC and LSN PCAs in HPCC/CIC Budget Crosscut

Fiscal Year (Number of Agencies)	**Budget for Original Eight Agencies (Dollars in Millions)**	**Change from FY 1998 for Original Eight Agencies**	**Budget for Current Participating Agencies (Dollars in Millions)**	**Change from FY 1998 for Participating Agencies**
FY 1998 Estimate (Ten agencies)	$ 711	--	$739	--
FY 1999 Estimate (Ten agencies)	$765	+8%	$ 795	+8%
FY 2000 President's Request (Ten agencies excluding DOE's ASCI program)	$ 774	+1%	$ 808	+2%

Table 3: Funding Profile for HECC, LSN, and HCS PCAs in HPCC/CIC Budget Crosscut

Fiscal Year (Number of Agencies)	**Budget for Original Eight Agencies (Dollars in Millions)**	**Change from FY 1998 for Original Eight Agencies**	**Budget for Current Participating Agencies (Dollars in Millions)**	**Change from FY 1998 for Participating Agencies**
FY 1998 Estimate (Ten agencies)	$ 730	--	$ 766	--
FY 2000 President's Request (Ten agencies excluding DOE's ASCI program)	$ 830	+14%	$ 913	+19%

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 (Table 1). The program has remained a healthy and vital mechanism for R&D in the enabling technologies required for computing, information, and communications.

From FY 1991 to FY 1995, the number of participating agencies and the budget grew steadily (Table 1). In FY 1995 twelve agencies participated in this program and doubled the budget from its base level ($489 million) funding to $1,019 million. From FY 1996 to FY 1997 the funding decreased for both the original eight agencies and all participating agencies. In FY 1998 the funding improved with the passage of the NGI initiative and other plus ups.

FY 1999 and FY 2000 have been transition years for the HPCC/CIC programs with several changes leading to new R&D efforts. This was also the period in which HPCC/CIC programs were divided into formal and informal crosscuts. Due to these changes, for meaningful comparison, the funding profiles for FY 1999 and 2000 are provided separately in Tables 2 and 3. These tables show that there has been a positive trend in HPCC/CIC funding since FY 1998, similar to the one observed until FY 1995.

4.3 Budget Crosscut by PCA

Tables 4 and 5 present HPCC and CIC budget summaries for FY 1998 through FY 2000. The "FY 1999 Req" and "FY 2000 Req" columns refer to the funds requested by the President in his budget request to Congress for those two years. The "FY 1998 Est" and "FY 1999 Est" columns estimate the funds each Agency spent on HPCC and CIC as a result of Congressional appropriations. The last five columns in Table 4 break down the FY 1999 and FY 2000 Presidential Requests into PCAs. Table 5 provides a comparison by PCA of funding in FY 1998 Est, FY 1999 Req and Est, and FY 2000 Req. Tables 6-8 include comparisons for each PCA of activities in FY 1998 (Est), 1999 (Req and Est), and 2000 (Req). Breakdowns may be subjective when activities span multiple PCAs.

Table 4: HPCC/CIC FY 1999-2000 Budget Crosscut (Dollars in Millions)

Agency	Budget (BA)				President's Budget Request by HPCC				
					FY 1999		FY 2000		
	FY98 Est	FY99 Req	FY99 Est	FY00 Req	HECC	LSN	HECC	LSN	HCS
NSF	296.63	308.75	296.62	314.33	234.63	74.12	216.84	76.38	21.11
NASA	128.40	92.00	92.00	136.40	71.40	20.60	108.20	20.40	7.80
DARPA	321.20	158.90	130.60	128.40	57.00	101.90	38.00	74.70	15.70
DOE	124.02	126.32	125.81	116.55	85.82	40.50	82.66	33.89	-
NIH	91.28	91.49	94.92	101.98	27.07	64.42	27.66	69.02	5.30
NSA	35.80	26.97	26.97	76.50	23.97	3.00	27.50	1.72	47.28
NIST	25.10	8.70	8.70	14.20	3.50	5.20	3.50	5.20	5.50
NOAA	7.50	12.00	11.50	13.00	9.30	2.70	10.30	2.70	-
AHRQ	5.50	3.10	3.10	5.50	-	3.10	-	5.50	-
EPA	4.18	4.18	4.17	4.23	4.18	-	4.23	-	-
Sub totals	1,039.61	832.41	794.39	911.09	516.87	315.54	518.89	289.51	102.69
Adjustments a:FY98 Est b:FY99 Req c:FY99 Est d:FY00 Req	34.00	13.13	32.50	7.50					
Totals[e]	**1,073.61**	**845.54**	**826.89**	**918.59**	**516.87**	**315.54**	**518.89**	**289.51**	**102.69**

The following adjustments reconcile these numbers with the President's Budget:

a: Includes VA and ED contributions (nonparticipants in FY 1999-2000)

b: HHS included budgets for five PCAs, instead of two

c: Several agencies included budget for more than two PCAs

d: HHS included budget for more than three PCAs

e: Differs slightly from President's Budget due to roundoff

HPCC FY 1999 - FY 2000 Implementation Plan
Table 5: HPCC/CIC Budget Comparison for FY 1998, FY 1999, and FY 2000 (Dollars in Millions)

Agency	High End Computing and Communications (HECC)				Large Scale Networking (LSN)				High Confidence Systems (HCS)	
	FY98 Est	FY99 Req	FY99 Est	FY00 Req	FY98 Est	FY99 Req	FY99 Est	FY00 Req	FY98 Est	FY00 Req
NSF	132.90	234.63	224.65	216.84	81.70	74.12	71.97	76.38	0.90	21.11
NASA	90.10	71.40	71.40	108.20	25.00	20.60	20.60	20.40	2.80	7.80
DARPA	84.80	57.00	48.30	38.00	89.20	101.90	82.30	74.70	9.40	15.70
DOE	93.70	85.82	91.92	82.66	20.77	40.50	33.89	33.89		
NIH	25.93	27.07	27.07	27.66	46.72	64.42	67.85	69.02	3.51	5.30
NSA	26.42	23.97	23.97	27.50	2.18	3.00	3.00	1.72	7.20	47.28
NIST	3.50	3.50	3.50	3.50	5.20	5.20	5.20	5.20	2.50	5.50
NOAA	4.30	9.30	8.80	10.30	2.70	2.70	2.70	2.70		
AHRQ	-	-	-	-	-	3.10	3.10	5.50		
EPA	4.18	4.18	4.17	4.23	-	-	-	-		
Totals[a]	**465.83**	**516.87**	**503.78**	**518.89**	**273.47**	**315.54**	**290.61**	**289.51**	**26.31**	**102.69**

a: Differs slightly from President's Budget due to reasons identified in Table 1 and Sections 4.4.2, 4.5.2, and 4.6.2.

4.4 High End Computing and Computation (HECC)

4.4.1 HECC Definition

HECC research and development investments provide the foundation for U.S. leadership in high end computing and promote the use of high end computing and computation in government, academia, industry, and in broad societal applications. HECC research explores algorithms for modeling and simulation of complex physical, chemical, and biological systems; information-intensive science and engineering applications; and advanced concepts in quantum, biological, and optical computing that will keep the U.S. in the forefront of computing breakthroughs for years to come.

HECC R&D supports critical Federal government mission needs, including:

- National security
- Environment/climate/weather
- Aeronautics and space exploration
- Energy research (solar, combustion, fusion)

HECC efforts also promote broad societal applications, including:

- Healthcare
- Crisis management/natural disaster warnings
- Long-term environment and energy management
- Education and lifelong learning

Federal investments in four HECC areas, or thrusts, will enable the development of distributed computation-intensive applications to support future U.S. science and engineering research, national security priorities, and economic competitiveness.

Thrust 1 (System Software Technology)

The aim of this thrust is to improve the usability and effectiveness of Teraflops-scale systems across a wide range of government, industry, and academic applications, concentrating on medium term (three to five year) technology development. Thrust 1 activities address high end architectures, including symmetric multiprocessor systems (SMPs), clusters of SMPs, and a computational grid of distributed homogeneous and heterogeneous clustered systems. Longer-term activities will focus on the system software technology requirements of future generations of high end system architectures.

Thrust 1 efforts recognize that Government investments are required, since the market size for high end computing is not large enough for system vendors and independent software vendors (ISVs) to make significant investments in the Federal mission-critical system software technology required for computationally intensive applications. It is appropriate that as Government-developed system software and tools mature they become the property of non-government entities and shared resources throughout appropriate segments of the research community and industry.

Thrust 1 investment focus areas are:

- Operating systems and input/output (I/O) systems
- Languages and compilers
- Programming interfaces and libraries
- Debugging and performance tools
- Scientific visualization
- Data management
- Common framework and infrastructure

Thrust 2 (Leading-edge Research for Future Generations of Computing)

Driven by Federal, academic, and commercial applications, Thrust 2 focuses on long range research and technology development to achieve a sustained petaflops (10^{15} floating-point operations per second) computational rate and exabyte (10^{18} byte) storage.

Thrust 2 activities will support U.S. global leadership in high end computing (HEC), ensuring that scientists and engineers, especially those working on Federal missions, will continue to have access to the most powerful computers, and assuring that the research and technology necessary for HEC systems will be available to U.S. industry. Activities requiring petaflops speed and exabyte storage include:

Biology:

- Simulations of complex biological systems (membranes, synthesis machinery, and Deoxyribonucleic Acid (DNA)) and "post genome" connection of genome information to biological function

Business:

- Modeling of complex transportation, communication, and economic systems

The Earth and the environment:

- Modeling of integrated Earth systems (ocean, atmosphere, bio-geosphere)
- Comprehensive modeling of ground water and oil reservoirs for contamination and management
- Design of new chemical compounds and synthesis pathways for environmental safety and cost improvements
- Data assimilation and data fusion capabilities applied to remote sensing and environmental models for 4-D/6-D integration of information

Materials science and manufacturing:

- Materials simulations that bridge the gap between microscale and macroscale (bulk materials)
- Coupled electro-mechanical simulations of nano-scale structures (dynamics and mechanics of micro-machines)
- Full plant optimization for complex processes (chemical, manufacturing, and assembly problems)
- Complete engine simulation combining high-resolution reacting flow problems (combustion, chemical mixing, and multiphase flow) with mechanical and material properties

Physics:

- Multidisciplinary optimization problems in combining structures, fluids, and geometry
- Simulation of plasma fusion devices and basic physics for controlled fusion (to optimize the design of future reactors) combining all length and time scales from electrons to macroscopic turbulence
- Total design of new experimental facilities in high-energy physics — from beams to magnets to detectors to tunnels
- Modeling and simulation of complex physical processes related to DOE's ASCI program, to include areas such as the simulation of gas turbine engines, shock waves, astrophysical thermonuclear flashes, accidental fires and explosions, and solid propellant rockets

Thrust 3 (Incorporation of HECC Technologies into Applications)

Many HECC agencies support mission-driven scientific applications requiring large-scale computation-intensive and/or data-intensive operations spanning the full space-time spectrum of scientific problems. Thrust 3 R&D will incorporate the first use of HECC methods into Agency applications and encourage the use of computational science algorithms to solve problems requiring high performance computational facilities, ensuring that key applications execute at full potential.

Advances are needed in fast, efficient algorithms for computational science techniques that address problems in very large, sparse matrices, searching, sorting, and pattern matching. Research on algorithms with large amounts of concurrency, fault tolerance, and latency-hiding is crucial for high end computational systems of the future.

Thrust 4 (Infrastructure for HECC Research)

The Thrust 4 objective is to ensure a balanced R&D infrastructure with maximum computational strength and bandwidth. Interdependent with LSN activities, this thrust supports the research facilities built on large-scale test systems and on large scale, high performance computational grids and networks.

Prudent Agency investments in coordinated R&D areas will enable development of the distributed, computation-intensive, and data-intensive applications needed to assure future scientific, engineering, and economic competitiveness, and fulfill national security requirements.

4.4.2 HECC Status

HECC was part of the formal HPCC/CIC budget crosscut during both FY 1999 and FY 2000. All HPCC/CIC agencies except AHRQ (formerly AHCPR) participate in HECC. HECC is the largest HPCC/CIC program component. Tables 6 provides a summary of FY 1998 (Estimate), FY 1999 (Request and Estimate), and FY 2000 (Request) HECC budgets for these agencies divided into various program activities.

HECC funding reported in these tables and in the Blue Book has the following similarities and differences:

- The HECC FY 1998 Budget Estimate of $465.8 million documented in this IP updates the $462.2 million estimated in the FY 1999 Blue Book.
- The FY 1999 Budget Request of $541.4 million reported in the FY 1999 Blue Book differs from the $517.6 million reported in this IP. This is due to a $15.3 million difference for NIH, $3.5 million for AHCPR (that is included only in the Blue Book), and other differences that are no more than $2 million for any Agency.
- The FY 1999 Estimate of $504.3 million and FY 2000 Request of $518.9 million are the same as the HECC total funding, $503.6 and $519.2 millions respectively, published in the FY 2000 Blue Book up to round-off.

The proposed FY 2000 HECC funding of $519.2 million documented here is a slight increase above the FY 1999 Request of $517.6 million.

A brief analysis of individual Agency HECC funding in the past three years reveals the following:

- For the FY 1998 Estimate, NSF had the largest HECC funding of $132.9 million. NSF is also the largest HECC Agency in its FY 1999 Request ($234.6 million), Estimate ($224.7 million) and FY 2000 Request ($217 million). NSF's FY 2000 is approximately 7.5 percent less than its FY 1999 Request.
- NASA's FY 1998 Estimate ($90.1 million), FY 1999 Request ($71.4 million), and FY 1999 Estimate ($71.4 million) maintained third position in HECC funding. Its FY 2000 Request of $108.2 million is 52 percent more than its FY 1999 Request and Estimate and is the second largest HECC funding Agency.
- DOE is the second largest HECC Agency in the FY 1998 Estimate ($93.7 million), FY 1999 HECC Request ($85.8 million), HECC Estimate ($91.9 million), and is the third largest in FY 2000 HECC Request ($82.7 million).
- For DARPA, the FY 2000 Request of $38.0 million is 33.3 percent less than the $57.0 million FY 1999 HECC Request and 21.3 percent smaller than the $48.3 million FY 1999 Estimate. DARPA's funding in HECC activities has been declining since FY 1998.
- NIH and EPA HECC funding have been steady during the past three years; NIH has the largest number of HECC activities to its credit.
- NSA and NOAA have increased their HECC investments and budgets.

Table 6: HECC Progran Activity Summary for FY 1999 - FY 2000, Dollars in Millions

Agency	Program Activity	HECC			
		FY98 Est	FY99 Req	FY99 Est	FY00 Req
NSF	Advanced Computational Infrastructure and Research	-	81.09	77.64	84.29
	Applications	28.71	50.94	49.14	51.86
	Computing Systems	51.02	-	-	-
	Computing-Communications Research	-	62.30	60.53	46.25
	Experimental and Integrative Activities	-	40.30	37.34	34.44
	Supercomputer Centers	53.17	-	-	-
	NSF TOTAL	**132.90**	**234.63**	**224.65**	**216.84**
NASA	Grand Challenge Support	48.60	37.80	37.80	42.20
	Systems Software	17.00	17.10	17.10	22.80
	Testbeds	24.50	16.50	16.50	43.20
	NASA TOTAL	**90.10**	**71.40**	**71.40**	**108.20**
DARPA	Data Intensive and Adaptive Computing	49.80	37.20	29.50	21.30
	Information Sciences	8.60	11.00	6.70	-
	Information Survivability	-	-	-	0.50
	Networking	0.70	-	-	-
	System Environments	15.80	8.80	12.10	6.20
	Technology Integration	9.90	-	-	10.00
	DARPA TOTAL	**84.80**	**57.00**	**48.30**	**38.00**
DOE	Advanced Computing Research Facilities (ACRFs)	22.90	12.02	17.41	11.88
	Advanced Computing Software Tools	5.00	5.00	5.00	5.00
	Applied Mathematics	20.02	21.68	21.68	20.49
	Computer Science	14.00	14.00	14.00	14.00
	NERSC	26.50	26.50	26.50	27.50
	Scientific Applications Pilot Projects	5.28	6.62	7.33	3.79
	DOE TOTAL	**93.70**	**85.82**	**91.92**	**82.66**

Table 6: HECC Progran Activity Summary for FY 1999 - FY 2000, Dollars in Millions (continued)

Agency	Program Activity	HECC			
		FY98 Est	FY99 Req	FY99 Est	FY00 Req
NIH	CIT - High Performance Biomedical Computing and Communications Program	6.61	6.61	6.61	6.61
	NCI - Biomedical Computing Center	3.04	3.12	3.12	3.19
	NCRR - Biomolecular Computing	6.30	6.70	6.70	6.70
	NCRR - Modeling/Simulation	5.75	5.60	5.60	5.60
	NCRR - Software Tools for Structure-Based Drug Design	3.20	3.70	3.70	4.15
	NCRR - Virtual Reality /Environments	0.50	0.75	0.75	0.75
	NIGMS - HPCC Extramural Activities	0.53	0.59	0.59	0.66
	NIH TOTAL	**25.93**	**27.07**	**27.07**	**27.66**
NSA	Supercomputing Research	24.20	21.67	21.67	24.90
	Superconducting Research	2.22	2.30	2.30	2.60
	NSA TOTAL	**26.42**	**23.97**	**23.97**	**27.50**
NIST	Information Technology Metrology, Testing and Applications	3.50	3.50	3.50	3.50
	NIST TOTAL	**3.50**	**3.50**	**3.50**	**3.50**
NOAA	Advanced Scalable Computation	4.30	9.30	8.80	10.30
	NOAA TOTAL	**4.30**	**9.30**	**8.80**	**10.30**
EPA	Environmental Modeling	2.18	2.20	2.20	2.26
	Numerical and Data Manipulation Techniques	2.00	1.98	1.97	1.97
	EPA TOTAL	**4.18**	**4.18**	**4.17**	**4.23**
	GRAND TOTAL	**465.83**	**516.87**	**503.78**	**518.89**

The Agency Section (section 5) of this document provides details about Agency-specific HECC program activities for FY 1999 and FY 2000. Some highlights of these activities are included here.

NSF

NSF's HECC program objectives for FY 1999 - FY 2000 include:

- 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

Since FY 1998, NSF has restructured its program, consolidating related activities to reflect both the HPCC/CIC PCAs and the structure of NSF. NSF's HECC activities span four areas:

- Advanced Computational Infrastructure and Research (ACIR)
- Applications
- Computing-Communications Research (CCR)
- Experimental and Integrative Activities (EIA)

The restructuring is exemplified by the fact that the Supercomputer Centers and Computing Systems program activities shown in Tables 6 under FY 1998 Estimate is succeeded in FY 1999 and FY 2000 by ACIR and EIA.

In the ACIR program, the Partnerships for Advanced Computational Infrastructure (PACI) Program consolidates, integrates, and refocuses the Supercomputer Centers Program and associated research. It provides the science and engineering community with access to high-performance computational resources, advanced visualization facilities, and state-of-the-art data handling capabilities. PACI has two partnerships: (1) NPACI (the National Partnership for Advanced Computational Infrastructure) and, (2) NCSA (the National Computational Science Alliance). Each partnership consists of a leading edge site together with cooperating partners.

Each leading-edge site maintains a high-end hardware system that is one to two orders of magnitude more capable than those typically available at a major research university. The partners will complete the overall infrastructure by:

- Facilitating research and experimentation with new hardware and software, including appropriate support technologies such as visualization and mass storage
- Providing scalable resources for applications and applications development that can be best done on mid-level systems
- Providing access to unique experimental systems and facilities
- Promoting education and training

Activities within each Partnership is structured to provide:

- Access - providing access to a diverse set of advanced and mid-range compute and visualization engines, data storage systems, and experimental machine architectures
- Application Technologies - computational science groups engaged in high-end applications that develop and optimize their discipline-specific codes and software infrastructure and make these available to researchers in other areas

- Enabling Technologies - computer science groups developing both software tools for parallel computation and software that will enable the effective use of widely distributed and architecturally diverse machines and data sources

The Advanced Computational Research program complements the PACI infrastructure program by supporting smaller, single-investigator, or small-group research grants. This program has three principal technical thrusts:

- Visualization and Data Handling - develops new methods of summarizing, manipulating, and presenting large data sets to enable better human understanding
- Scalable Software - develops parallel software at all levels, including runtime systems, libraries, compilers, and problem-solving environments that enable effective and efficient use of high-performance computers
- Numerical Algorithms - develops and implements parallel numerical methods, typically for simulation of complex physical phenomena

This program supports approximately 50 awards at any given time, including one of NSF's Science and Technology Centers.

NSF's Applications program pursues fundamental knowledge in science and engineering and general societal goals. It consists of the following categories:

- High Performance Applications for Science and Engineering - intended to push the envelope of computational capabilities in order to enable new discoveries in science and engineering
- High Confidence Applications for Dynamic Enterprises - intended to push the envelope of information processing in order to demonstrate and advance new technologies in the Information Age. Benefits will include improvements in integration, privacy, security, and reliability of information flows within and across organizations
- High Capability Applications for the Individual - 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 spaces" for personal use. Examples include digital libraries and medical information servers

These applications have one or both of the following attributes:

- Will drive and stress the enabling research of computing systems, human centered systems, and networking and communications, and the convergence of computing and communication.
- May 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, geo-sciences, social and behavioral sciences, and engineering.

CCR is another major component of NSF's HECC program. It supports research that underlies:

- Design of advanced computing systems, both hardware and software
- Design of algorithms for advanced scientific and engineering applications of computing
- Computer communications
- Software engineering
- Theory of computing

CCR's unifying systems focus is the development and demonstration of balanced parallel systems that can gracefully scale across a wide range of underlying numbers of processor nodes and interconnection structures.

NSF's EIA program promotes the development of experimental computer and communications research, the evolution of multidisciplinary research, exploratory and prototype projects, and special studies and analyses on issues affecting HPCC. Specialized research is supported at four NSF Science and Technology Centers that share several important characteristics such as undertaking a unifying and cross-disciplinary intellectual focus and emphasizing knowledge-transfer and linkages with private sector organizations. It also supports computer and communications systems, involving both hardware and software systems, for parallel and distributed computing.

The activity also supports national infrastructure development to provide distributed resources that enable broad participation in HPCC research.

NASA

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 space-borne research communities. The program is structured to contribute to broad Federal efforts while addressing Agency-specific Grand Challenge computational problems. The three HECC-related NASA HPCC projects are Grand Challenge Support, System Software, and Testbeds.

The Grand Challenge Support area develops and enhances techniques for the multidisciplinary modeling and simulation of Grand Challenge problems such as:

- Computational AeroSciences (CAS) research focuses on understanding and using the high performance computing environment to solve a range of problems in aerospace engineering at a cost that represents the value, flexibility, and short cycle time required by the aerospace community.
- Earth and Space Sciences (ESS) research covers the coupling of advanced discipline models into scalable global simulations providing realistic global change understanding with 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.

Under this program, NASA also develops algorithms for common techniques such as multidimensional Fast Fourier Transforms (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.

Research in Systems Software includes developing program debugging tools and instrumenting facilities for use in developing 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 tools. Research is also conducted in designing data management software for Grand Challenge applications on highly parallel systems. Techniques to control efficient high performance I/O in parallel computer systems are explored, dynamic resource management methods are prototyped and evaluated, and the portability of these methods to various high performance systems is studied.

NASA also ensures that new systems software technologies and algorithms are available to potential users through its leadership of the 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.

The objective of the Testbed activity is to encourage and accelerate U.S. commercial development of high performance computing systems that support Grand Challenges through:

- Acquiring advanced prototype and early production high performance computing systems for use and evaluation
- Providing a testbed control environment for use in collecting data about testbed operations
- Developing parallel benchmark software based on the Grand Challenge applications for use in evaluating different architectures
- R&D in ground- and flight-based testbeds for use in demonstrating, evaluating, and validating performance and scalability of both high performance and ultra low power prototypes

To compare different Teraflops systems, NASA is developing scalable parallel benchmarks to reflect the computational demands of the various Grand Challenge areas. These benchmarks are used on NASA testbeds.

NASA helps accelerate transition to new generations of high performance computing technologies by providing access to its NASA Research and Education Network (NREN) and to early systems or prototype storage subsystems and state-of-the-art visualization applications at its high performance computing research facilities.

DARPA

DARPA's HECC component focuses on developing high performance technologies (both hardware and software) for computing. Elements of the program are aimed at producing high performance building blocks, scalable software, and architectures to meet defense-oriented computing requirements. DARPA's HECC activities include Data Intensive and Adaptive Computing, Information Sciences, Information Survivability, System Environments, and Technology Integration.

Under the Data Intensive and Adaptive Computing activity, the data intensive systems and software project develops software and hardware technologies for applications with highly demanding (for example, irregular) data access patterns, such as those exhibited by sparse matrix analysis and object garbage collection. This project will develop a new approach to computer memory organization to eliminate severe bottlenecks in present designs.

The adaptive computing project develops new approaches to the design of computer hardware that incorporates dynamic configuration. The resultant devices will enable a wide variety of specialized systems by reusing a relatively small set of hardware designs, each of which can be affordably produced in high volumes.

DARPA's Information Sciences activity supports scientific study and experimentation in information sciences technology to help meet long-term national security requirements. An example is developing new mechanisms and computational models for using biological and optical processes in computation and communication. This activity also explores innovative approaches to the composition of software and novel human computer interface technologies.

Within Information Sciences, DARPA's biological computing project supports R&D at the interface between information technology and biological technology, with emphasis on computation based on biological materials, physical interfaces between electronics and biology, and interactive biology. Its optical communication and computing project will explore new approaches to transmission based on solitons and identify novel buffering technologies that can be substituted for optical delay lines. DARPA's software composition project will investigate formal techniques for constructing safety critical systems.

DARPA's Information Survivability activity is developing technologies to protect critical systems against attack upon or through the supporting information infrastructure.

DARPA's Systems Environments activity develops scalable software and operating systems that are tailored toward easing the programming of real-time, high performance, and globally distributed systems. This includes run-time services, resource allocation, and experimental applications.

DARPA's Technology Integration activity is demonstrating new system capabilities that emerge through the integration of select CIC technologies.

DOE

The DOE HPCC is focused on two major strategic thrusts: National Collaboratories and Advanced Computational Testing and Simulation (ACTS). The NC thrust is developing tools and capabilities that 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 ACTS thrust 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 infeasible. These two thrusts support the mathematical and information technology needs of all DOE mission areas (for example, Defense, Energy Efficiency, Environmental, and Fossil programs) and these efforts are closely coordinated with related activities supported by DOE's Defense Programs.

DOE's FY 1999 - FY 2000 HECC activities include Advanced Computing Research Facilities (ACRFs), ACTS, Applied Mathematics, Computer Science, National Energy Research Scientific Computing Center (NERSC), and Scientific Applications Pilot Projects.

ACRFs support large scale advanced computational hardware testbeds for scientific application pilot projects and fundamental research in applied mathematics and computer science. The ACRFs have a full range of computer architectures to enable comparison and reduce risk. Research issues include operating system stability and performance, system manageability and scheduling, fault tolerance and recovery, and details of the interprocessor communications network. ACRFs are located at Los Alamos, Argonne, and Lawrence Berkeley National Laboratories. Related capital equipment such as high-speed disk-storage systems, archival data storage systems, and high performance visualization hardware are also supported.

ACTS takes the results of fundamental research in applied mathematics and computer science into an integrated set of tools that can be used by scientists in various disciplines. These tools can represent complex geometries, solve diverse numerical equations, simplify multi-language parallel execution, evaluate and enhance code performance, and dynamically steer calculations during program execution.

DOE's Applied Mathematics program activity conducts research on the mathematical understanding and numerical algorithms for describing and predicting physical systems. The program supports research in areas including:

- Mathematical physics
- Ordinary and partial differential equations
- Control theory
- Shock wave theory
- Fluid dynamics
- Dynamical systems
- Programming and optimization
- Geometric and symbolic computing

DOE's Computer Science activity supports research in (1) software to enable applications to make effective use of computers with up to thousands of processors and computers located at different sites, and (2) large scale data management and visualization. The first area includes research in protocols for message passing and parallel I/O as well as tools to monitor the performance of scientific applications. The second area includes research in effective techniques for retrieving data with complex internal structure from massive data archives that may be geographically distributed as well as advanced techniques for visualizing very large scale scientific data.

NERSC, DOE's National Energy Research Supercomputer Center located at Lawrence Berkley National Laboratory (LBNL), provides high performance computing for investigators supported by DOE's Office of Science. The Center serves about 4,000 users working on about 700 projects, 35 percent of users are university based, 60 percent are in National Laboratories, and 5 percent are in industry. NERSC provides a range of high performance computing resources and associated software, which are integrated by the common high-performance file storage system (HPSS) that facilitates interdisciplinary collaborations.

DOE's Scientific Applications Pilot Projects apply computational techniques and tools developed in the ACTS effort to basic research problems. Examples include:

- Simulations of the Earth's climate
- Research in the fundamental structure and properties of magnetic materials
- Creation of advanced tools to understand the chemistry of actinides
- Partnerships with experimental disciplines such as high energy and nuclear physics, human genomics, and crystallography to improve the ability of these disciplines to manage and analyze the petabytes of data produced by their experiments and simulations

These efforts are the successors to the HPCC Program's Grand Challenge activities.

NIH

NIH's HECC-related activities for FY 1999 - FY 2000 include:

- Center for Information Technology's (CIT) High Performance Biomedical Computing and Communications Program
- National Cancer Institute's (NCI) Biomedical Computing Center
- National Center for Research Resources' (NCRR) Biomolecular Computing, Modeling/Simulation, Software Tools for Structure-Based Drug Design, and Virtual Reality /Environments
- National Institute of General Medical Sciences' (NIGMS) HPCC Extramural Activities

The status of NIH's major HECC activities are summarized in the following paragraphs.

The goal of the CIT's High Performance Biomedical Computing and Communications Program is to make available to the NIH staff the benefits of high performance computing and communication systems in their scientific and clinical research. CIT is also developing computational methods and tools needed by biomedical scientists in conducting research in structural biology, biomedical imaging, and bioinformatics.

The purpose of NCI's Advanced Biomedical Computing Center, formerly the NCI Frederick Biomedical Supercomputing Center, is to provide high performance computing to the biomedical community to develop basic knowledge for the understanding, diagnosis, treatment, and prevention of cancer and related diseases. Problem areas include *ab initio* chemistry, computational biochemistry, genetic linkage analysis, genomic sequence analysis, image analysis, molecular biology, molecular mechanics, structure determination by x-ray and magnetic resonance, and structure prediction of nucleic acids and proteins.

NCRR's Biomolecular Computing program involves R&D in algorithms and software for high performance computing systems to determine or predict:

- The structure of biological macromolecules such as proteins
- The structural and functional changes in proteins due to their interaction with other molecules or drugs
- How proteins are made in the cell and how they fold
- How proteins interact with water and biological membranes
- The energetics of molecules, especially drugs, as they dissolve to form solutions

NCRR research resource centers focus on modeling and simulation using high performance computing in its Modeling/Simulation activity. Areas of interest include simulations of subjects as small as molecules and as large as the entire body — cells, tissues, organs and organ systems, and epidemiological modeling for pressing health problems such as AIDS and cardiovascular disease.

The goal of NCRR's Software Tools for Structure-Based Drug Design activity is to develop computational methods for designing drugs. This endeavor includes establishing high performance computer-based environments that:

- Accurately and efficiently estimate electrostatic forces among molecular and atomic interactions
- Effectively use computer technologies to calculate drug-protein binding energies with quantum mechanics, statistical mechanics, and simulation techniques
- Improve the performance of molecular dynamics software so that theoretical and experimental studies are executed in similar time steps

Through its extramural grants program, NIGMS helps in theoretical understanding of the structure and dynamics of biological macromolecules such as proteins and nucleic acids. This includes predicting 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 (with an emphasis on targeted drug design).

NSA

NSA will continue to pursue high performance computing and very high-speed networks in order to perform its national security mission. NSA's HECC program activities include Supercomputing Research and Superconducting Research.

NSA's Supercomputing Research program is directed to the discovery and application of methods seeking order of magnitude improvements 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 is on parallelism. The following projects are included within the program:

- Marquise/Solitaire - Repackage a High Performance Computer (HPC) using diamond-based Multi-Chip Modules (MCMs) and thin film spray cooling. It will demonstrate binary software code compatibility with the commercial product on which it is based
- 3-D Diamond MCM Cube Computer –Build a test vehicle to demonstrate a 3-D computer architecture with a nanosecond system clock
- Micro Spray Cooling - Develop a high density, high efficiency power converter using spray cooling and planar laminated transformers. Investigations will include a novel approach of applying isothermal spray cooling to overcome the fundamental co-efficient of thermal expansion mismatch encountered during hybrid integration of silicon or gallium arsenide (GaAs) devices with diamond substrates
- Fiber-Optic Logic - Optical techniques can theoretically support data rates of several hundred Gigabits per second (Gbps) for future communications and computing systems. This is accomplished by providing logical functions that expedite the data routing process. Transmission at high data rates demands techniques that can restore data signals so that low bit error rates can be maintained without compromise of signal quality.
- Optoelectronic Circuits - Research into a high performance spectrometer on a chip and a semiconductor optical amplifier.
- Programming Methods and Languages - Research in computational methods and languages for massively parallel, distributed heterogeneous computing platforms, and special-purpose processors. Includes the ongoing development of the compiler AC (which targets the Cray T3D and T3E architectures) and the implementation of the "futures" model of message-passing programming.
- Quantum Computing - Demonstrate 1-qubit operations, experiment to achieve 2-qubit operations using the optical-lattice method of trapping atoms, and simulate the dynamics of a set of qubits in finer detail than previously achieved. Experimental research on quantum dots and Josephson junctions as possible qubits will be started. Another project will investigate individual nuclear spins implanted in a silicon crystal as qubits.

NSA's Superconducting program is aimed at providing high performance computing alternatives to current silicon and GaAs technologies, which have speed and power limitations.

- Hybrid Technology Multithreaded Architecture (HTMT) – Evaluate the feasibility of constructing a computer capable of performing at a sustained rate of a Petaflops (10^{15} floating point operations per second). A multithreaded architecture has been postulated which is enabled by a blend of modified semiconductor technology with the necessary addition of components demonstrated at the research level. These hybrid technologies — superconductive, optical, semiconductor, and magnetic — are configured to produce the necessary memory and processor elements to satisfy the architecture requirements.
- Superconductive Crossbar Switch - Demonstrate the construction of a 128 x 128 crossbar switch that operates at 2.5 Gigabits (billions of bits) per second per port for use in supercomputing and network applications. Although the crossbar electronics operate at 4 degrees Kelvin, its input and output ports are at room temperature, and the cryogenic elements are cooled by a refrigerator, thus providing the user with standard room temperature support. Extended to higher speed and size, this switch is a candidate element for use in HTMT.
- Optical Tape Development.

- Smart Memories - Produce a flexible computing architecture that is more power efficient than the current evolutionary path of Reduced Instruction Set Chip (RISC) architectures and still programmable in a high level language. This architecture will be able to reconfigure itself to be optimal for the computation currently executing.

NIST

The NIST's HECC program develops efficient algorithms and portable scalable software for applying high performance computing systems to industrial problems, and develops improved methods for public dissemination of advanced software and documentation.

Under its Information Technology Metrology, Testing, and Applications program, NIST will:

- Collaborate with industry and other agencies to develop measurement methods and standards to promote interoperability, common user interfaces, and enhanced security for computing and communications systems
- Develop prototype implementations
- Establish testbeds and support advanced technology demonstrations
- Develop, enhance, and demonstrate methods for measuring performance of scalable, high performance systems and identify performance bottlenecks in systems and software
- Conduct collaborative research and development of algorithms, recognition methods, and reference materials to promote commercial viability of the results of R&D in image recognition, information search and retrieval, and advanced collaboration technologies
- Develop advanced algorithms, software, methods, and tools to support the efficient application of computationally intensive science to key problems arising in the industrial sector
- Develop efficient, robust, and flexible templates, class libraries, and components for basic mathematical computation, such as the solution of large linear systems that provide a foundation for industrial applications
- Develop modern, network-based, reusable software classification and distribution technology for making new computational software readily available to industry and the public

NOAA

Advanced Scalable Computation is NOAA's HECC activity that is making major improvements in the Nation's ability to forecast the weather and predict climate change by taking full advantage of scalable highly parallel computing systems that, over the long term, are expected to provide substantially greater computing power at lower cost. NOAA activities include:

- Geophysical Fluid Dynamic Laboratory's (GFDL) collaboration with DOE on a scalable parallel version of a high-resolution global atmospheric grid-point model for a study of stratospheric dynamics
- GFDL redesign of the Modular Ocean Model using advanced software technologies for more efficient use of massively parallel computing systems
- National Meteorological Center's (NMC) collaboration with NASA and DoD's Naval Research Laboratory to develop a parallel adiabatic version of the NMC global spectral model with excellent scalability at high resolution
- NOAA's Forecast Systems Laboratory has developed and published the first modules in the Scalable Modeling System that use advanced software technologies to rapidly develop atmospheric models

EPA

EPA's Environmental Modeling 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 distributed data management, software reuse and scalability, and system performance.

The main objective of EPA's Numerical and Data Manipulation Techniques program is to improve the performance of key numerical algorithms that form the computational foundation of environmental models. This research develops and evaluates parallel computing techniques encompassing interconnected workstations, vector and parallel supercomputers, parallel software and algorithms, and communication to determine the most effective approach to complex, multi-pollutant, and cross-media environmental modeling. Fundamental research is also conducted on computational techniques for quantifying uncertainty as an integral part of the numerical computation.

4.4.3 HECC FY 1999 - FY 2000 Milestones and Plans

The following describes some of the individual Agency FY 1999 HECC milestones and FY 2000 plans.

NSF

In FY 1999, for the ACIR program, NSF will:

- Deploy a balanced Teraflops computing capability
- Deploy a large (>512 processor) commodity workstation supercluster using a high-performance interconnect
- Develop tools for visualizing terabyte-sized data sets
- Develop a prototype Storage Area Network (SAN) architecture that eliminates disk caches in favor of direct access to data on disks
- Port advanced immersive visualization software to a new generation of powerful personal computer (PC) based systems to make virtual reality for computational science widely available on the desktop
- Integrate Quality of Service mechanisms with queuing and resource accounting to enable practical use of the Grid on a national scale
- Extend Grid testbed to Experimental Program to Simulate Competitive Research (EPSCoR)
- Integrate scientific applications and data with the Web, e.g., use Grid software architecture to develop a Chemical Engineer's Workbench and a Computational Cosmology Observatory
- Build interactive, shared virtual spaces, a remote virtual collaboration with the ability to manage, navigate, record, and document large, multi-dimensional datasets using advanced Virtual Reality (VR) technologies -- for example, use the Grid to support tele-immersive analysis of the Chesapeake Bay
- Instrument the Grid to create a national-scale computer science laboratory
- Experiment with applications using National Transparent Optical Network's (NTON) OC-192 capabilities
- Sponsor Visualization of Large Data Sets workshop, helping to set a research agenda and possibly leading to collaboration with DOE's Data Visualization Corridors project
- Co-sponsor Petaflops Workshop to drive future architecture and software development concepts

In FY 2000, for the ACIR program, NSF will:

- Deploy a balanced multi-Teraflops system
- More widely deploy the Grid over enhanced high-performance networking
- Increase integration of collaborative and immersive technologies
- Produce prototype implementations of new concepts in parallel file systems, visualization and virtual reality libraries, numerical and communication libraries, and highly optimizing compilers
- Refine parallel numerical methods and support; test on realistic problems in materials science and computational fluid dynamics
- Investigate Web-enabled parallel processing via Java extensions

In its Applications program, during FY 1999 - 2000 NSF will:

- Continue the development of Earth system models and high spatial resolution meso-scale forecast models in a collaborative effort with the university community, National Center for Atmospheric Research (NCAR), and other Federal laboratories
- By the end of FY 1999 provide to the research community a set of simulations that exemplify the changes to the Earth's climate under various anthropogenic influences
- Begin to create an efficient computer model of space weather environment
- NCAR will obtain a new supercomputer system and will develop computational techniques to make large codes run efficiently on that system

For FY 1999 - FY 2000, NSF's CCR will issue awards for high-performance computing and communications research in topics that include:

- Parallel computation models
- Parallel algorithms and software for scientific computing
- Dynamic compilation and optimizing parallel compilation
- Distributed operating systems
- Superscalar architectures
- High-performance memory systems

In FY 2000, CCR will fund hardware/software co-design and high-performance scientific and commercial applications.

During FY 1999 - FY 2000, NSF's EIA will:

- Establish HPCC infrastructure at several university departments
- Initiate research projects in next generation software
- Expand research and infrastructure support for HPCC goals

NASA

For Grand Challenge Support, during FY 1999 - FY 2000, NASA will:

- Demonstrate a 200-fold improvement over the FY 1992 baseline in time-to-solution for Grand Challenge applications on Teraflops testbeds
- Show this performance improvement for one application in each of the CAS and ESS projects
- Show the portability of one application for each project across all current testbeds
- Demonstrate a 50 percent or better improvement in computation speed for one application in each project
- Demonstrate scalable spaceborne applications on a first generation embedded computing testbed
- Perform this demonstration using three applications from the Remote Exploration and Experimentation Project
- Show a performance level of 50 percent of peak for the architecture
- Work to increase the above performance improvements from 200-fold to 1000-fold

In the Systems Software area, NASA will:

- Demonstrate portable, scalable, distributed visualization of multi-terabyte 4D datasets on scalable Teraflops systems
- Show portability of these applications across all current testbeds
- Demonstrate software-implemented fault tolerance on a first generation embedded computing testbed
- Show portability for all Remote Exploration and Experimentation applications
- Demonstrate a reliability of 0.99 over five years

- Show a computing speedup of 50 percent or better
- Begin work to demonstrate a portable scalable debugging and test environment for GC applications on a full Teraflops system

In Testbeds, NASA will:

- Complete installation of a 1,000 Gigaflops sustained testbed with 95 percent availability
- Install a first generation scalable embedded computing testbed operating at 30 - 200 MOPS/watt
- This testbed should scale to a maximum configuration of 50 nodes and should operate at 30 MOPS/watt in a flight configuration

DARPA

In Data Intensive and Adaptive Computing, for FY 1999 DARPA will:

- Demonstrate multiprocessor RISC chip
- Demonstrate enabling technologies for embedded systems including Discrete Fourier Transform chips based on clockless logic, Single Instruction Multiple Datastream and multi-Digital Signal Processing board designs, and 2.5 Gbps high speed configurable interconnect
- Publish benchmarks for embedded signal processing
- Investigate instruction set extensions and storage components to allow applications to specify whether operations are to be executed in the central processor or in logic circuits embedded in the memory hierarchy
- Debug and validate novel configurable component technologies
- Release new algorithm design software environment optimized to leverage adaptive technology
- Demonstrate user-level software performance improvement over commodity microprocessors on challenge problems
- Conduct a system-level design and simulation study of a computation model based on large amorphous arrays

And for FY 2000, it will:

- Design “processor in memory” (PIM) components that support in situ processing of application data
- Implement a compiler that generates code compatible with a PIM architecture
- Simulate data-intensive systems, demonstrating 10-fold performance improvement on critical applications
- Develop architectural framework for use of data intensive technologies in embedded applications; investigate alternative approaches to package level integration of data intensive technologies with high bandwidth sensor interfaces
- Prototype implementation and runtime libraries supporting adaptive performance monitoring and analysis
- Demonstrate synthesis of digital signal processing, application specific integrated circuit/field programmable gate array, and general purpose systems
- Investigate novel approaches to in-situ logic placement and routing based on techniques such as amphorous computing
- Establish challenge problem testbed for experimental development of one cubic foot Synthetic Aperture Radar

For FY 1999 - FY 2000, DARPA’s Information Sciences program will:

- Investigate novel control mechanisms for self-organizing and autonomous systems
- Demonstrate human-computer interaction for crisis planning
- Investigate feedback-driven approaches to information management

Biological Computing:

- Evaluate alternative approaches to DNA-based computing and identify the most promising research opportunities for enhancement and acceleration
- Explore mechanisms for sequencing DNA-based computations
- Investigate novel approaches to real-time biological instrumentation to support interactive biology

Optical Computing and Communication:

- Demonstrate optical logic gate operating at 100 GHz
- Identify alternative optical buffering technologies

Software Engineering and Human Computer Interface:

- Investigate design of domain specific languages for use in safety critical systems
- Investigate machine translation and relevance of new results in cognitive science research to spoken language and haptic interfaces
- Investigate the potential roles of stochastic models and game theory in large scale distributed systems

DARPA's FY 1999 - FY 2000 Information Survivability milestones and plans will include:

- Demonstrate techniques for general pair-wise tradeoffs among real-time operations
- Evaluate prototype compiler for certifying proof-carrying code
- Release operating system prototype supporting efficient, secure nested virtual machines
- Complete initial wrapper-generator toolkits
- Develop techniques for diagnosing multi-agent, multi-staged attack, through common Intrusion Detection Framework
- Advanced prototype demonstration of secure agent network nodes
- Develop tools for inserting integrity checks into mobile code
- Complete enhanced wrapper-generator toolkits
- Implement prototype of artificial diversity toolkit
- Investigate new approaches to large-scale software composition based on software tolerances and redundancy instead of absolute correctness; identify relevant challenge problems
- Common framework for linking intrusion assessment and response components

In System Environments, during FY 1999 DARPA will:

- Demonstrate experimental scalable structural dynamics application using DARPA's sparse matrix library
- Demonstrate micro-feedback technologies for adaptive resource allocation
- Release prototype subsystem supporting adaptive resource allocation and consumption in response to changing workload and resource availability

In System Environments, during FY 2000 DARPA will:

- Release reference implementation of mission-critical Quality of Service (QoS) architecture
- Release prototype operating system with partitioned resource management for strict QoS guarantees
- Specify common services for scalable active software; develop technologies to support the migration of continuously operating processes
- Develop latency management framework that incorporates techniques such as optimistic processing, caching and approximation to decrease the apparent access time to remotely hosted datasets

DARPA's FY 1999 Technology Integration projected accomplishments include:

- Develop a framework for federating text, image, and relational databases
- Validate the design of a secure repository architecture for digital objects
- Develop session management middleware, leveraging multicasting technology that adjusts to variations in bandwidth and connectivity
- Develop tools that enable teams and individuals to retrieve situation and task relevant information from static and dynamic archives containing a record of experiences from multi-sensory sources, and adjust team dynamics in real-time in response to changes in task and situation

DARPA's FY 2000 Technology Integration plans and milestones will include:

- Demonstrate QoS management software in a U.S. Navy application
- Alpha level prototype demonstrating integration of information management tools with high capacity storage subsystems to mask impact of limited and/or sporadic network connectivity
- Field experiment to characterize protocols developed for use in Mobile Information Systems
- Demonstrate Multiple Beyond Line-of-Sight Communications including voice and data

DOE

Advanced Computing Research Facility FY 1999 accomplishments and FY 2000 plans include:

- Technology-refresh system for the Nirvana Blue system at Los Alamos delivered
- Argonne National laboratory (ANL) begins Message Passing Interface (MPI) experiments between IBM SP and SGI Origin 2000 computers
- ORNL begins evaluation of SRC 6 computer
- DOE completes funding of TERA joint evaluation project at San Diego Supercomputing Center (SDSC)
- IBM SP at ANL to be shut down in mid FY 2000

Advanced Computing Software Tools program plans and milestones will include:

- Rapid application development -- tools that will enable scientists to create computer software to solve scientific problems
- The Parallel Object-Oriented Methods and Applications (POOMA) Framework effort at Los Alamos National Laboratory (LANL) to develop effective tools for discipline scientists to develop software
- POOMA is used in the computational accelerator physics and numerical tokamak turbulence projects
- Possible collaborations also include compiler researchers and fault tolerant software component designers.

Applied Mathematics milestones include:

- Simulation of instabilities in fluid layers
- Research in optimization
- R&D 100 Award to Sandia researchers

Computer Science milestones and plans include**:**

- Publication of open interfaces for dynamic parallel instrumentation tools
- Research on data file indexing enables real time contouring of terabyte data sets
- Successful demonstration of grid technologies to enable access to experimental devices
- Large-scale data management including developing multi-resolution data structures
- Techniques for generating optimal meshes for scientific computing and computational grid technologies

NERSC milestones include:

- Participation in Gordon Bell Prize competition
- Procurement and installation of the next generation NERSC computer
- Archival system transition to HPSS completed

DOE's Scientific Applications Pilot Projects plans and milestones include:

- The High Energy and Nuclear Physics data Grand Challenge participated in the first mock data challenge for the Relativistic Heavy Ion Collider (RHIC) experiment, a petabyte per year facility
- The accelerator design GC ran the largest ever simulation of beam halo and electromagnetic simulations with resolution sufficient to describe the as-built cavities.
- The materials science project, a partnership between ORNL, Ames Laboratory, and NERSC won the 1998 Gordon Bell Prize for its simulation of 1024 atoms in a metallic magnet that achieved one terflop of sustained performance.

- Advances in numerics coupled with work to enable software to run in parallel on many processors have enabled researchers in the "Supercomputer Solution of Massive Crystallographic and Microtomographic Structural Problems" scientific application pilot project to dramatically reduce the time required to analyze the data from Laue diffraction experiments. These results are expected to be important for the 30 percent of DOE light source users involved in discovering protein structures.

NIH

During FY 1999 - FY 2000 in HECC R&D**,** CIT will:

- Continue to apply HPCC methods to biomedical applications at NIH, including expanding existing systems and evaluating new architectures
- Develop new reconstruction algorithms, visualization techniques in biomedical imaging
- Provide software tools for x-ray crystallography, Nuclear Magnetic Resonance (NMR) spectroscopy, bioinformatics, and genetic linkage analysis
- Develop tools for 3-D structure determination and refinement of biomolecules using crystallographic or NMR data and innovative methods for modeling molecular complexes
- Develop new methods for generating, displaying, and analyzing images in electron and light microscopy and medical imaging modalities such as positron emission tomography and electron paramagnetic resonance imaging
- Implement new approaches to the analysis and storage of genetic data, and develop new tools for genetic linkage analysis
- Apply the results of these projects to areas such as the NIH Cancer Genome Anatomy Project (CGAP) and the NIH Small Animal Phenotype Imaging Project

During FY 1999 - FY 2000, NCI's Biomedical Computing Center will:

- Extend its research on the atomic level mechanisms of enzymes relevant to malignant change and to viral diseases to provide explanations of drug sensitivity and resistance
- Predict nucleic acid structures for its functional elements that are involved in critical processes
- Develop plans for the continued support of high end computing in cancer research such as the evolution to new architectures and adaptation of new algorithms from genomic projects including CGAP and mouse genome

During FY 1999 NCRR's Biomolecular Computing program will develop more accurate and efficient approaches for predicting protein structure from sequence data, including refining new methods for *ab initio* structure prediction and more accurate methods for determining molecular potential functions for quantitative protein modeling. In FY2000 these emerging methods and tools will be adapted to run efficiently on the most powerful computing systems available, in order to take advantage of emerging Teraflops computing capabilities.

For FY 1999 - FY 2000 NCRR will use networked high performance computing facilities for the modeling and simulation of**:**

- Larger molecular systems and assemblies
- Detailed models of cells and organs

In FY 2000 NCRR will use parallel computing systems to study biopolymer aggregates by modeling systems of hundreds of thousands of atoms. More accurate models of cells and organs will be developed by integrating spatial anatomical data with biochemical data.

NCRR's Software Tools for Structure-Based Drug Design activity will develop software tools to study protein-small molecule interaction and extend this technology for developing new gene therapies.

Under the NIGMS HPCC Extramural Activities, a major FY 1999 accomplishment was "marrying" the new "Shake and Bake" method for phase determination with Multiple-wavelength Anomalous Diffraction (MAD) phasing to locate selenium molecules in seleno-methionine doped proteins. NIGMS's new structural genomics efforts that will begin in FY 2000 will require hard core molecular dynamics and bioinformatics.

NSA

For Supercomputing Research, in FY 1999, NSA achieved the following milestones:

- The Marquise/Solitaire project was completed in FY 1999. The miniaturized high performance computer architecture was condensed onto a 500 Watt, 8-inch by 8-inch double-sided printed wiring board.
- The Operating System was successfully booted on this prototype board, and several NSA HPC benchmarks gave identical results to the commercial system without software modification to source code.
- A Solitaire rack system was assembled and successfully tested with a 500 Watt load board.
- For Micro Spray Cooling, a compliant diamond substrate was designed and analyzed.
- GaAs and silicon were directly attached to diamond substrates. Power switches were studied and measured.
- For Fiber-Optic Logic, the data rate for the wavelength converter was increased to 80 Gbps.
- A solid state optical amplifier was used as a switched converter to reshape the pulse in an interferometric configuration.
- Wavelength conversion in a distributed feed back (DFB) laser was demonstrated through the cross grain modulation in the solid state optical amplifier.

More than nine universities and companies conducted research in Quantum Computing (QC). Projected accomplishments include:

- Development of the quantum analogues of classical information and communication theory to help in future QC design and evaluation
- Application of the "hidden subgroup" problem to the design of new quantum algorithms
- Studies of the computational power achievable in models between classical and quantum computing
- Experiments to verify a new pulsed-laser technique for implementing quantum logic gates between photons
- Attempts to create entanglements of three photons
- Coherent quantum state manipulations of a few ions
- Clear evidence of quantum superposition, entanglement, multi-qubit operations, and characterization of the resulting quantum coherence

For Programming Methods and Languages, accomplishments include:

- More efficient compilers for AC and UPC (extensions to American National Standards Institute (ANSI) C in which a shared memory parallel computation model is both easily programmable and scalable to very large systems) for the widely used SGI T3D and T3E multiprocessors, through code optimization and efficient memory system interface.
- Efforts to obtain UPC support on a wide variety of vendor platforms.

Optoelectronic Circuits milestones include:

- Fabrication and testing of a fully integrated 4 x 4 semiconductor optical amplifier cross-connected switch
- Fabrication and testing of 10 GHz transimpedance amplifiers on Wavelength Division Multiplexing (WDM) receivers
- Fabrication of 1.55 micron VCSELs and modulators using Sb-based mirror stacks

For Supercomputing Research, NSA plans for FY 2000 include**:**

- Micro Spray Cooling
- Definition of a structural and process design methodology
- Refinement of power circuit requirements and the selection of a power converter topology
- A single-level assembly will be built and tested
- Quantum Computing
- Demonstrating 1-qubit operations and performing experiments to achieve 2-qubit operations using the optical-lattice method of trapping atoms
- Simulation of the dynamics of a set of qubits in finer detail than previously achieved
- Programming Methods and Languages

- Enhance the AC and UPC compilers for the T3D and T3E and develop capabilities for a large clustered platform
- Continue efforts to support UPC in native compilers on systems from multiple vendors

For Superconducting Research NSA's FY 1999 accomplishments and FY 2000 plans include:

- HTMT
  - Report on all sub-elements including preliminary tests, data, simulations, sizing, produceability, and performance estimates for a full system, plus cost estimates and recommendations for any follow-on work
  - If recommended, begin to construct a machine to allow testing and verification of all elements
- Superconductive Crossbar Switch
  - Specify room temperature electronics and support connections. Work to complete the layout of the 24-chip multi-chip module. Modify circuits to increase operating margins. Characterize the cooling system. Complete the preliminary design of the physical housing for the crossbar.
  - Begin to construct and assemble the 128 x 128 crossbar switch — build the chips, complete the electronics, complete the housing of the MCM and cables
- Optical Tape Development
- Design, build, and test a 25 MBps (megabits or millions of bits per second) alpha level prototype of an optical tape drive
- Design a prototype tape transport, integrate optical path modules, and package modulator drivers, detection array, and pre-amps in final form factors
- Smart Memories
- Define a streaming applications benchmark set, conduct a Very Large Scale Integration (VLSI) wire design study, and study smart memory (incorporating fabrication and OS constraints)
- Design and fabricate a reconfigurable wiring test chip, develop programming models for smart memories, and complete a proposed smart memory architecture

NIST

For FY 1999 - 2000, NIST will:

- Develop evaluation methodologies and test corpora for measuring scalability and usability of visual interfaces that support access to large collections of complex documents
- Develop new metrics and software tools for evaluating the quality of linear algebra software
- Develop and release a portable high-performance parallel software package for core sparse matrix computations
- Develop new designs and prototypes for a software library of mathematical functions based on network client-server transactions for medium-scale computational problems such as the solution of linear systems and eigenvalue problems
- Develop a unified system that supports testing and evaluation of mathematical software, and dissemination of related reference data sets for linear algebra, special functions, and statistics on the Web
- Continue research in computational tools for modeling the micro-magnetic properties of materials
- Provide conformity assessment methods to ensure consistency and accurate use of the Java specification, develop formal description of the Java Virtual Machine specification, and release a Java SmartCard simulator
- Provide a forum for organizations interested in comparing text retrieval results and develop metrics for assessing search results for multimedia information

NOAA

In FY 1999 NOAA will:

- Develop parallel versions of GFDL models, such as the Limited-Area Nonhydrostatic model and the atmospheric spectral core model, to run on scalable high-performance computing systems
- Modernize the Forecast Systems Laboratory's (FSL) High Performance Computing System to support further enhancements to the Scalable Modeling System

- Complete the distributed memory version of National Centers for Environmental Prediction (NCEP) global analysis and evaluate the NCEP Regional 4-D data assimilation systems

In FY 2000 NOAA will:

- Use advanced technologies, including the new computing system at FSL, to develop software to ease the conversion of numerical software to run on scalable parallel machines
- Conduct data sensitivity analyses to test and evaluate weather observing systems design in order to identify the most cost-effective mix of sensors and measurements in next generation systems
- Implement highly parallel state-of-the-art numerical models for weather prediction, especially a national domain meso-scale high-resolution model
- Develop the next-generation NOAA coupled research model using more realistic physics, higher resolution, and full ocean-atmosphere-soil coupling. Evaluate its seasonal-interannual climate prediction and ability to elucidate the processes controlling El-Niño-Southern-Oscillation events.

EPA

For FY 1999 - FY 2000 in Environmental Modeling, EPA will:

- Demonstrate the potential of same-time different-place immersive visualization of environmental data
- Demonstrate a space-time tool kit allowing the "on-the-fly" transformation of multi-source (disparate in space and time) environmental data into an interactive integrated visual display
- Award grants for research on scalable parallel I/O supporting data assimilation, fast queries over distributed data bases and archives, and multi-scale data integration to enhance multi-discipline ecosystem models
- Begin to explore the use of problem-solving environments and component architectures for ecosystem modeling

For Numerical and Data Manipulation Techniques, EPA will:

- Demonstrate the diagnostic phase of automatic parallelization for legacy finite difference codes
- Demonstration implementation of genetic algorithms on a heterogeneous distributed network of computing systems as a computational basis for decision support
- Award grants for scalable parallel algorithms for subsurface geohydraulic modeling and visualization of geologic substructure

4.5 Large Scale Networking (LSN)

4.5.1 LSN Definition

The LSN R&D provides the technological leadership in high performance network communications that will develop the networking technologies, services, and performance needed for the future growth of the Internet and network requirements of Federal government agencies. Early Federal networking R&D investments were instrumental in building the technological foundation of today's global Internet. Federal research laboratories, academia, and industry helped deploy prototype networking capabilities on a national scale and produced popular applications – such as email and World Wide Web (WWW) browsers – that changed the way people use computers and networks. This paved the way for our Nation's current leadership in the multi-billion dollar information technology industry.

LSN R&D in conjunction with academia, industry, and government is transitioning leading-edge networking technologies and capabilities to the private sector where their use is transforming the way we live and work. Key LSN research areas include advanced network components and technologies for engineering and managing large-scale networks of the future. The LSN programs will:

- Increase the effectiveness of Federally-funded network technology research
- Increase the effectiveness of Federal research networks

- Enable network-intensive applications that advance Federal goals
- Facilitate interagency collaborations in LSN R&D
- Provide mechanisms for cooperation in LSN R&D among Federal agencies, Government laboratories, academia, and industry

Since FY 1998, the NGI initiative has been a major LSN focus. NGI builds on the LSN programs to provide the R&D and advanced networking testbeds in new technologies and applications to rapidly expand the capabilities of the Internet. The NGI initiative fosters 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.

4.5.2. LSN Status

The LSN budget is a formal crosscut of the HPCC/CIC programs during both FY 1999 and FY 2000. The LSN budget includes the NGI activities and associated budget. Tables 7 provides a summary of FY 1998 (Estimate), FY 1999 (Request and Estimate), and FY 2000 (Request) LSN budgets for agencies divided into various program activities. All FY 1999/FY 2000 HPCC/CIC agencies except EPA actively participate in LSN; VA and ED are not a part of the President's FY 1999 and FY 2000 HPCC/CIC budget.

The FY 1998 LSN Estimate (Est.) of $273 million differs from the $255 million published in the FY 1999 Blue Book mainly due to increased LSN estimates for NSF, for which appropriated funds became available late in the fiscal year, and NIH.

The FY 1999 Budget Request (Req.) for LSN is close to the number published in the FY 1999 Blue Book ($315.5 vs. $319.4 million). The $3.9 million difference is due to the exclusion of VA ($ 1.9 million), the correct AHRQ amount of $3.1 million compared to the $2.1 million reported in the Blue Book, and round off. For the FY 1999 Budget Estimate (Est.), the LSN total of $290.6 million is the same as is published in the FY 2000 Blue Book. In FY 1999, DARPA received the most LSN funding ($101.9 million), followed by NSF ($74.1 million), and NIH ($64.4 million). The NIH FY 1999 LSN funding of $64.4 million requested and $67.9 million estimate was about 40 percent more than the $47 million FY 1998 estimate.

The FY 2000 LSN Budget Request (Req.) of $289.5 million is almost identical to the $289.9 million request published in the FY 2000 Blue Book. From FY 1999 to FY 2000 there was an overall 8 percent reduction in the President's Request for LSN. In FY 2000, the Agency with the largest LSN budget request was NSF with $76 million, while DARPA dropped to the second position with a funding request of $74.7 million (approximately 27 percent lower than the previous year). NIH continued active participation in LSN with its $69 million FY 2000 request versus its FY 1999 $64.4 million request, and remains the third largest LSN-funded agencies. NIH also has the largest number of program activities in networking and communications research. In FY 1999, DOE requested $22 million for its NGI activities and was appropriated $14.6 million. This almost doubled DOE's LSN funding from the previous year.

Section 5 of this document provides details about Agency-specific LSN program activities.

NSF’s LSN activities for FY 1999 - FY 2000 include:

- Advanced Networking Infrastructure and Research, Applications, Experimental and Integrative Activities, and Information and Intelligent Systems
- NSF's LSN R&D objectives include the development of a 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
- The Advanced Networking Infrastructure and Research (ANIR) Program, consolidating and integrating the NSFNET program and critical associated research, has the responsibility for advanced networking infrastructure for the science and engineering community and fundamental research in networking
- Under the ANIR program, the very high speed network backbone service (vBNS) links NSF-supported high performance computing centers and almost 100 research institutions

Table 7: LSN Program Activity Summary for FY1999 - FY 2000, Dollars in Millions

Agency	Program Activity	LSN			
		FY98 Est	FY99 Req	FY99 Est	FY00 Req
NSF	Advanced Networking Infrastructure and Research	-	62.12	59.97	60.78
	Applications	8.65	4.00	4.00	7.60
	Education and Training	2.50	-	-	-
	Experimental and Integrative Activities	-	6.00	6.00	6.00
	Information and Intelligent Systems	-	2.00	2.00	2.00
	Networking, Communications and the Convergence of Computing & Communications	26.05	-	-	-
	NSFNET	44.50	-	-	-
	NSF TOTAL	**81.70**	**74.12**	**71.97**	**76.38**
NASA	NREN	15.00	10.60	10.60	10.40
	NREN-NGI	10.00	10.00	10.00	10.00
	NASA TOTAL	**25.00**	**20.60**	**20.60**	**20.40**
DARPA	Global Grid Communications	16.20	4.70	5.60	-
	Information Survivability	-	-	-	0.50
	Networking	33.70	57.20	29.80	34.20
	Next Generation Internet	39.30	40.00	46.90	40.00
	DARPA TOTAL	**89.20**	**101.90**	**82.30**	**74.70**
DOE	ESnet	14.78	14.00	14.79	14.79
	Networks & Communications	5.99	4.50	4.50	4.50
	Next Generation Internet	-	22.00	14.60	14.60
	DOE TOTAL	**20.77**	**40.50**	**33.89**	**33.89**
NIH	CIT - High Performance Biomedical Computing and Communications Program	2.30	2.30	2.30	2.30
	NCI - Biomedical Computing Center	1.20	1.50	1.50	1.50
	NCRR - Biomolecular Computing	0.20	0.50	0.50	0.50
	NCRR - Modeling/Simulation	0.10	0.50	0.50	0.50
	NCRR - Virtual Reality /Environments	5.95	7.45	7.45	8.00
	NLM - Biotechnology Informatics	7.69	8.44	8.44	8.44
	NLM - Electronic Imaging	0.50	2.45	2.39	2.39
	NLM - HPCC Health Care Applications	13.47	20.91	16.08	17.06
	NLM - HPCC Training Grants	-	4.04	4.54	4.54

Table 7: LSN Program Activity Summary for FY1999 - FY 2000, Dollars in Millions (continued)

Agency	Program Activity	LSN			
		FY98 Est	FY99 Req	FY99 Est	FY00 Req
NIH	NLM - IAIMS grants	1.99	2.89	2.89	2.99
	NLM - Intelligent Agent DB searching	11.95	11.97	19.89	19.55
	NLM - Medical Connections Program	1.37	1.47	1.37	1.25
	NIH TOTAL	**46.72**	**64.42**	**67.85**	**69.02**
NSA	Very High Speed Networking	2.18	3.00	3.00	1.72
	NSA TOTAL	**2.18**	**3.00**	**3.00**	**1.72**
NIST	Information Technology Metrology, Testing and Applications	3.20	3.20	3.20	3.20
	Systems Integration for Manufacturing Applications	2.00	2.00	2.00	2.00
	NIST TOTAL	**5.20**	**5.20**	**5.20**	**5.20**
NOAA	Networking Connectivity	2.70	2.70	2.70	2.70
	NOAA TOTAL	**2.70**	**2.70**	**2.70**	**2.70**
AHRQ	Computer-based Patient Records	-	3.10	3.10	2.75
	Information Technology	-	-	-	2.75
	AHCPR TOTAL	**-**	**3.10**	**3.10**	**5.50**
	GRAND TOTAL	**273.47**	**315.54**	**290.61**	**289.51**

- This activity also supports collaborative development of national and international networks with other agencies and countries, and is actively involved in the interagency NGI Initiative and the university-based Internet2 program
- The ANIR activities span foundations, technology, experimentation, and infrastructure
- NSF's Experimental and Integrative Activities and Information and Intelligent Systems programs promote access to high performance networks and promote communications research specific to their special needs

NASA's LSN R&D includes the NASA Research and Education Network (NREN) and its NGI components:

- NREN will deploy advanced communications required by NASA Grand Challenge investigators.
- 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
  - Emerging high-performance user services

- NASA has deployed 622 MBps (millions of bits per second) network testbeds among five NASA centers, significantly improving communications between investigators using its CAS and ESS testbeds
- NASA's research collaboration with the DoD's Application Technology Demonstration Network (ATDnet) supports interoperability among independently managed networks that are based on ATM technology supplied by multiple vendors
- As a participant in the NGI, NASA tests high performance applications (Grand Challenges) that require high performance networks

DARPA's LSN R&D activities for FY 1999 and FY 2000 include Global Grid Communications, Information Survivability, Intelligent Systems and Software, and Networking.

- The Networking component develops mobile and active networking technologies. Its research is coordinated with DoD, NASA, DOE, NSF, and other agencies
- The Active Networks thrust is pioneering a new approach to networks that leverages mobile code (e.g., Java) to dynamically change the software running within the network, i.e., the software running on switches and routers
- The Global Mobile Information Systems effort will enable mobile users to access and use the full range of services available in the information infrastructure
- DARPA's NGI program will develop and demonstrate end-to-end network connectivity at 1+ gigabits-per-second for 10 or more NGI sites. Topics of DARPA's NGI research in network technologies include multi-gigabit broadband networks, guaranteed quality of service mechanisms, and integrated network management. These technologies will be demonstrated in an NGI-developed testbed environment
- DARPA's Global Grid Communication project, which concluded in FY 1999, has demonstrated that information technologies can be integrated with advanced optical, high performance networks. This will provide multimedia information flows, efficient use of bandwidth for warfighting, disaster relief, and emergency medical support
- Within the Global Grid project, the Broadband Information Technology (BIT) effort has developed all-optical multiple wavelength transmission technologies and has created a multi-billion dollar industry based on DARPA's WDM technology

DOE - Office of Science's LSN R&D activities for FY 1999 and 2000 include ESnet, Networks & Communications, and Next Generation Internet.

- DOE's ESnet provides worldwide access to energy research facilities such as advanced light sources, neutron sources, particle accelerators, fusion reactors, spectrometers, ACRFs, and other leading-edge science instruments and facilities. ESnet management is responsible for the interfaces between its network

and the worldwide Internet including NSF's vBNS. It also supports high-speed network routers, Asynchronous Transfer Mode (ATM) switches, and network management and testing equipment.

- DOE's Networks and Communications research is in high performance computer networks and information surety for high performance computer applications. This includes protocols for high performance networks, methods for measuring the performance of high performance networks, and software to enable high speed connections among high performance computers (both local area and wide area) networks. In addition, this activity supports research in network protocols to enable applications to request and be guaranteed certain levels of network capability.
- DOE's NGI research program is focused on discovering, understanding, developing, testing, and validating the networking technologies needed to enable wide area, data intensive, and collaborative computing that are not currently possible. This research is needed to enable effective use of petabyte/year High Enenrgy Nuclear Physics (HENP) facilities such as the Relativistic Heavy Ion Collider; to provide remote visualization of terabyte to petabye data sets from computational simulations; to develop advanced collaboratories; and to enable effective remote access to tomorrow's advanced scientific computers. These applications involve extremely large data sets and require that scientists be able to interact with the data in (nearly) real time.

NIH's LSN R&D activities include:

- CIT's High Performance Biomedical Computing and Communications Program
- NCI's Biomedical Computing Center
- NCRR's Biomolecular Computing, Modeling/Simulation, Software Tools for Structure-Based Drug Design, Training, and Virtual Reality/Environments
- NIGMS's HPCC Extramural Activities
- NLM's Biotechnology Informatics, IAIMS grants, Intelligent Agent Database (DB) searching, and Medical Connections Program
- NIH's CIT High Performance Biomedical Computing and Communications Program provides high performance distributed computing environments including the appropriate network and workstation technologies that benefits the NIH staff in their biomedical computing needs
- The NCI Advanced Biomedical Computing Center's (ABCC) purpose is to provide networked and fully integrated high performance computing to the biomedical scientific community to develop basic knowledge for the diagnosis, treatment, understanding, and prevention of cancer and other diseases
- NIH's NCRR program in Modeling/Simulation strives to understand increasingly complex biomedical processes, which requires high-speed and high-bandwidth network connectivity to high performance computing facilities at research resource centers
- NCRR's Virtual Reality/Environments program requires the establishment, demonstration, and evaluation of collaboratories (laboratories without walls). Virtual reality collaboratories are to access scientific instruments for basic research, molecular visualization, and surgical and other therapeutic interventions such as radiation treatment planning. All but the simplest cases require high performance computing and high-speed intra- and Internet capabilities to enable remote users to access these resources and to visualize in real time images that change in realistic fashion according to where the observer is looking
- NLM's National Center for Biotechnology Information (NCBI) program 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. Within a distributed database architecture, the NCBI collects sequence data from researchers worldwide and incorporates them into GenBank, the NIH DNA sequence data bank which is a key data resource of the Human Genome Project. These databases are accessed daily over the Internet from more than 90,000 different sites and account for over four million hits per day
- NLM's Electronic Imaging activity supports building and evaluating digital image libraries of anatomical structures of the human body through its Visible Human Project. The large sizes of the Visible Human image set and other medical images offer storage and transmission challenges such as advanced compression and communication techniques
- NLM's HPCC Health Care Applications program promotes the application of HPCC technologies to health care. The program supports R&D projects in areas such as:
    - Testbed networks for linking hospitals, clinics, doctors offices, medical schools, medical libraries, and universities to enable health care providers and researchers to share medical data and imagery

  - Telemedicine or collaborative technology to allow several health care providers in remote locations to provide real time treatment to patients
  - Database technology to provide health care providers with access to relevant medical information and literature
  - Database technology for storing, accessing, and transmitting patient's medical records while protecting the accuracy and privacy of those records
- NLM's HPCC Training Grants program addresses the computer and telecommunications workforce issues in biomedical fields and is expanding its pre-doctoral and post-doctoral grants program for career training in Medical Informatics and an HPCC-in-medicine fellowship training support
- The goal of NLM's IAIMS grants program is the development, testing, and implementation of generalizable systems of information flow management within academic medical centers and major teaching hospitals. Expected outcomes include greater research productivity, improved access to patient data for technology assessment and health outcomes research, and more efficient patient care
- NLM's Intelligent Agent DB searching program addresses user difficulties associated with finding and processing medical information on the Internet. NLM is developing intelligent gateways among data base services, using its Unified Medical Language System (UMLS) to compensate for the dissimilarity in the ways related information is classified in different automated systems

NSA requires the fastest networking technology 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.

NIST's LSN R&D activities include (1) Information Technology Metrology, Testing, and Applications and (2) Systems Integration for Manufacturing Applications (SIMA), to improve U.S. product quality and manufacturing performance, reduce production costs and time-to-market, and increase competitiveness in international markets.

- Under the Information Technology Metrology, Testing, and Applications program, NIST collaborates with industry and other agencies to support the development of measurement methods and standards to promote interoperability, common user interfaces, and enhanced security for computer and communications systems; develop prototype implementations; and establish testbeds and support advanced technology demonstrations.

- SIMA efforts include work on interfaces for information interchange among manufacturing applications and virtual reality environments, and on collaboratories for manufacturing-related R&D (for example, validating NGI infrastructure).

NOAA's Networking Connectivity program increases its ability to disseminate high volumes of 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 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 important aspects of NOAA's work.

AHCPR's (now AHRQ) LSN R&D activities include Computer-based Patient Records and Information Technology.

- The objective of AHCPR's Computer-based Patient Records 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.
- The Information Technology program supports research into the uses of information technology to improve the medical effectiveness and cost effectiveness of health care.

4.5.3 LSN FY 1999 - FY 2000 Milestones and Plans

This section describes the FY 1999 accomplishments and FY 2000 plans in LSN R&D and the NGI initiative.

NSF

- NSF will award 150 high performance connections to the vBNS and other high performance network testbeds, will increase by approximately 50 percent the funding for basic research in networking, and will plan for the "post-vBNS cooperative agreement era" (the Cooperative Agreement with MCI for vBNS concludes in March, 2000)
- In FY 2000, NSF will initiate the post-vBNS Cooperative Agreement era for the advanced networking infrastructure programs
- The NSF-funded NCAR will obtain a major new supercomputer system and will be developing new computational techniques to make large codes run efficiently on the new system. New scenarios and ensembles will be run with the community climate model that will explore natural and anthropogenic effects on the climate system. These simulations will help to reduce the uncertainty of the model results and explore the sensitivity of the model to natural variations, such as the variations of the amount of solar radiance
- NSF will achieve network-related milestones such as second-year Knowledge and Distributed Intelligence (KDI) awards, Digital Library (DL) awards (including international digital library research), Universal Access research, and Personal Robotics research.

NASA

- Under the NREN program NASA will demonstrate a 100X increased capability to access NASA high-end resources by NASA Grand Challenge researchers. This will be accomplished by establishing an NGI-X for NASA to connect GC university principal investigators to NASA high-end resources.
- During FY 2000 NASA will demonstrate a 500X end-to-end performance improvement over the FY 1996 performance baseline for NASA's GC and/or mission applications. This will be achieved over a 622 MBps wide-area network.
- Under the NGI program, NASA will demonstrate an end-to-end performance improvement in at least three NASA mission applications or GCs across a 500-times more capable network (as compared to the FY 1996 baseline).

DARPA

- In Global Grid Communications, DARPA demonstrated 20 Gb/s reconfigurable WDM metropolitan network and multi-vendor network element interoperability. This program terminates in FY1999.
- In Networking, during FY 1999 and FY 2000 DARPA will:
  - Demonstrate an active node execution environment supporting resource security and survivability functions
  - Extend operation of the Active Network testbed to traverse approximately 10 sites with approximately 10 switches, each using SmartPackets and composite protocols
  - Demonstrate application support for distributed computing in mobile environments and continuous multi-tier networking across wireless domains
  - Prototype implementation of integrated high data-rate untethered nodes
  - Demonstrate use of the active network approach to achieve live protocol updates within two roundtrips
  - Release prototype active network toolkits for end-user stations and network elements
  - Conduct engineering analysis of active network performance
  - Do beta-level implementation of high data-rate untethered nodes incorporating miniature codec
  - Prototype an implementation of a mobile wireless ATM network
  - Integrate Global Mobile (GloMo) simulation models and conduct scenario simulations for an 100+ node ad hoc network

In its NGI activities in FY 1999 and FY 2000, DARPA will:

- Implement 10 gigabit-per-second, multi-wave optically switched WDM technology in NGI testbed
- Implement an alpha-level prototype high-speed optical multiplexor and develop a specification of an Internet Protocol (IP)/WDM protocol structure
- Expand its NGI testbed to DoD supported laboratories
- Implement prototype components of a network monitoring and management system
- Demonstrate 1.5 Gbps uncompressed High Definition Television (HDTV) image multicast
- Implement prototype of a distributed optical switching capability compatible with a 100 Gbps optical network
- Implement a streamlined Internet over WDM protocol structure, eliminating two layers of existing telecommunications infrastructure
- Develop network planning and simulation technology to meet requirements for NGI scale networks
- Demonstrate real-time (500-msec response) monitoring and control of network resources at all levels
- Complete interconnection of Supernet testbed components and software with 2.5 Gbps access architecture, up to 10 Gbps backbone, and 100 Gbps distributed switching capacity
- Demonstrate information management and collaborative applications operating over the NGI testbed

DOE

- In FY 1999 DOE was a partner in the first demonstration of Priority Service for Internet traffic in which scientists at two national laboratories selected marked Internet traffic for priority services over unmarked traffic in a cross-country demonstration. This is a key milestone in the development of a broad set of capabilities called "differentiated services," which are required for the Internet to be able to give different levels of service on demand to network customers. The demonstration involved complex interactions between software on computers, network hardware such as routers, and telecommunications equipment operated by commercial carriers.
- In FY 1999 numerous sites were added to ESnet and production services were increased to 622 MBps (OC12).
- Other DOE accomplishments include acceptance of the High Performance Parallel Interface (HiPPI) 6400 standard, significant evaluation of issues related to Virtual Interface Architecture (VIA), cooperation with National Laboratory for Applied Network Research (NLANR) on network monitoring tools, and the initiation of the China Clipper project among Stanford Linear Accelerator Center (SLAC), LBNL, and ANL to explore issues in wide area data intensive computing and WDM ATM peering.
- DOE plans to accomplish the following under its NGI program:
- First, research in basic underlying technologies such as:
  - Protocols and techniques for coordinating multiple, heterogeneous network-attached devices
  - Congestion and flow control techniques
  - Multi-gigabit end system interfaces, analyzers, and switches along with mechanisms to reduce operating system overhead for data transfers
  - Mechanisms to provide application controlled Class of Service and Quality of Service
  - Middleware to provide IP, ATM, and WDM resource and admission control, scheduling, management, prioritization, accounting, and debugging
- Second, Application-Network Technology-Network Testbed Partnerships to:
  - Integrate and test advanced network R&D and testbeds with DOE mission applications such as High Energy and Nuclear Physics (HENP) data, remote visualization of simulation results, and advanced collaboratories
  - Define what network and middleware services are required to permit these applications to effectively run over wide area networks
  - Define the features and the Application Programming Interface's (API) necessary to allow the application and middleware to communicate
  - Integrate local and wide-area network technologies to create distributed collaboratories
  - Integrate Differentiated Services, or other QoS functions, into wide area networks and production network testbeds without compromising the existing production network services
- Third, DOE-University Technology Testbeds will focus on:
  - R&D to implement advanced network services across multiple interconnected networks
  - Deployment of advanced differentiated services technologies across autonomous networks when priority flow represents a significant fraction of the available capability

- Development and testing of advanced tools to manage “peering” of networks with advanced services
- Cross-domain implementations of security and authentication technologies
- Development and testing of network performance monitoring and characterization software that applications can use in this environment to optimize their performance
- Development of policy frameworks and specification languages to facilitate the negotiation of capabilities across autonomous system boundaries

NIH

- During FY 1999 - FY 2000 CIT will continue developing ATM network and multimedia workstation technologies for medical imaging and scientific visualization.
- Additional CIT work in LSN R&D will include:
  - Improving methods for the biomedical research community to access high performance computing resources
  - Providing tools for accessing molecular biology, biochemistry, and genetics data
  - Creating virtual environments for molecular and biomedical image visualization
  - Developing telemedicine and collaborative haptic technologies that allow multi-modal human-system interactions for biomedical research and clinical remote-sensing applications
  - Developing database technologies so that health care providers can access medical information and literature
- During FY 1999 - FY 2000 NCRR will continue using virtual reality for interfacing with high resolution instruments (e.g., atomic force microscopes) and in augmented reality (a form of virtual reality) to support image-guided neurosurgery. Eight collaborative demonstrations that cover a wide range of technology R&D will be initiated at resource center sites.
- In FY 1999 NLM will continue the segmentation and labeling of the male and female anatomical structures in the Visible Man and the Visible Woman, and convert the thorax sections from Visible Human image file format into national 3D image file format. The program will also expand access software for text/x-ray image databases with tools to organize and statistically analyze retrieved data.
- During FY 2000 NLM will begin evaluating the retrieval engine and 3D file format for the Visible Human Anatomical database, which will be accessed over the Internet as well as via NGI networks using current Web browsers for data queries and image retrieval.
- In FY 1999 - FY 2000 NLM will fund individual and program grants for HPCC training for health professionals
- For FY 1999 – FY 2000, under the Intelligent Agent DB searching program NLM will:
  - Continue to develop and deploy new capabilities for automatic source selection and for retrieving and sorting information from multiple databases available via NLM's Web site and from the Internet Grateful Med (IGM), PubMed, and TOXNET retrieval services
  - Test the use of metadata for enhancing retrieval from disparate electronic information sources
  - Continue in-house R&D and extramural R&D funding in the use of UMLS Knowledge Sources and programs to integrate access to multimedia information sources into computer-based patient record systems used by patients and health professionals
- During FY 1999 - FY 2000, as part of its Medical Connections Program, NLM will make 100 awards to connect U.S. health care institutions to the Internet.
- During FY 1999 - FY 2000, under the HPCC Health Care Applications program, NLM will fund 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 projects concerned with digital libraries.
- In FY 1999, NLM's NCBI has achieved the following milestones:
  - Coordinated the activities of GenBank that has now reached three million sequences and over two billion base pairs of DNA
  - Handled over 90,000 visitors and over four million hits to the NCBI Web site each day
  - Supported 70,000 DNA searches conducted daily using BLAST, one of the fastest and most sensitive comparison algorithms known, which was developed by NCBI scientists
  - BLAST can compare an unknown sequence of 10,000 bases against two billion bases in less than 30 seconds.
  - BLAST has become an essential tool for gene discovery and is used by over 7,000 researchers from universities and industry daily.

- NCBI has also begun assembling a variety of human genome resources including genetic and physical mapping data, the UniGene gene map, genetic disease descriptions (Online Mendelian Inheritance in Man (OMIM)), and data on human gene variability
- Another major NCBI resource is a collection of protein 3D structure data that has allowed integrated searching on sequence, structure, and homology information

- In FY 2000, NCBI has the following target milestones:

    - The Human Genome Project has accelerated its pace and the predicted date of a draft complete human sequence has moved forward to the year 2003.
    - In preparation for the more than three billion base pairs of human DNA, NCBI is building the databases and analysis tools for model organisms (bacteria, yeast, worm, fruit fly) that will serve as primary data resources and will also provide a foundation for creating the next generation of human genomic tools.
    - Continue the RefSeq project, which is now assembling reference sequences for each known gene that will eliminate the redundancy, incompleteness, and errors that result from having multiple versions of sequences in the public archival databases. RefSeq will become an encyclopedia of genomes, capturing the key information on genes from a range of organisms from bacteria to human, along with links to variation data, mutation databases, and cross-species homologs.
    - The biggest challenge for NCBI in the next few years is to maintain the speed and accuracy in sequence searching in the face of rapidly expanding data and increased demands by users.
    - Over the next 24 months, NCBI will be developing a uniform classification scheme based on a library of protein motifs/profiles that will help identify subtle similarities with speed and accuracy.
    - In functional genomics research, which is determining the activity and expression of specific genes in the developing as well as the mature organism, NCBI will collaborate with several NIH institutes to study the expression of genes in various phases of cancer and neurological development. It will also continue to build the infrastructure that can rapidly respond to new scientific directions, which is acknowledged by NIH leadership as the focal point of all NIH-wide bioinformatics efforts.
    - In FY 1999 - FY 2000 under the IAIMS grants program, NLM will fund projects to help American medical centers integrate academic information management.

NSA

- In FY 1999 NSA demonstrated ATM over a wavelength, without any intervening SONET infrastructure (e.g., intervening SONET terminals), as part of an effort to reduce the layers, make the network less complex, and move control back to the endpoints of the network. In FY 1999, NSA will field an all-optical transparent Internet on the ATDnet in the Washington, DC, area. During this period NSA will also demonstrate optical multicasting, employing the "drop and continue" feature of the wavelength routers acting as a public network, and the natural multicasting capability of an optical crossbar switch, acting as a private all-optical network.
- NSA's plans for FY 2000 include working to advance the definition of a signaling, routing, addressing, and multicasting architecture.
- In this period NSA will also address multi-domain network management and will look at a peer relationship between network management centers, which exchange information in a controlled way, that will enable end to end monitoring and fault isolation of connections.

NIST

During FY 1999 - FY 2000, in Information Technology Metrology, Testing, and Applications, NIST will:

- Develop and demonstrate remotely-accessible, network-based conformance and interoperability test engines built on a standard network interface
- Integrate emerging search, retrieval and network computing technologies into Web services for the computational science community
- Develop characterization and instrumentation methods for heterogeneous networked computing

- For the SIMA program, during FY 1999 - FY 2000, NIST will support:
  - Experimental collaboratory supporting robotic arc welding research
  - Experimental multi-user robotic arc welding virtual reality environment
  - Prototype manufacturing visualization language specification for control of virtual reality environments
  - Internet-accessible chemical property repository with search capabilities based on species substructure
  - Initial version of Internet-accessible macromolecular protein structure repository
  - Revised version of Internet-accessible high-temperature superconducting material data repository
  - Internet-accessible engineering statistics handbook
  - Demonstrate remote operation, data collection, and simulation of a new class of parallel-actuated machine tools
  - Conference on virtual reality for manufacturing
  - Virtual reality environment for visualization of milling machine error data
  - Initial evaluation of manufacturing collaboratory environment in industrial use
  - Initial specification enabling integration of human ergonomic simulations with manufacturing simulations
  - Initial Internet-accessible repository of full structural crystallographic data for inorganic materials
  - Initial version of Internet-accessible molecular recognition knowledge repository

NOAA

- During FY 1999**,** NOAA is leveraging the high performance wide area networks developed under the NGI initiative to enhance the productivity of its researchers.
- NOAA installed an OC-12 network in its Boulder laboratories to provide a virtual Local Area Network (LAN) for ATM-based video that is interoperable with nationwide Integrative Services Digital Networks (ISDN)-based conferencing systems.
- In this period NOAA will evaluate an HPCC-based mobile/wireless emergency response/crisis management system that includes mobile on-scene data, voice, and video for the evaluation of hazardous materials spills.
- In FY 2000 NOAA will continue to enhance its information dissemination capabilities by expanding access to high-speed networks, developing advanced techniques to efficiently and effectively use the existing bandwidth, and develop tools to support advanced network monitoring features.
- NOAA's experimentation with and evaluation of advanced wireless technologies will continue as they work toward the ability to provide managers and decision makers with tele-immersion capabilities for evaluating hazardous materials spills.

AHRQ (formerly AHCPR)

- In FY 1999 in Computer-based Patient Records (CPR), AHRQ will initiate computerized decision support projects to use Web technology to link clinical practice guidelines developed in the private sector with computer-based patient record systems
  - AHRQ will support the U.S. Technical Advisory Group to International Standards Organization (ISO) Technical Committee 215, Health Informatics, formed in 1998 to coordinate the development of ISO standards in health informatics, and the ANSI Health Informatics Standards Board to coordinate health informatics standards developing organizations in the U.S.
  - For FY 2000 AHRQ will publish results from the CPR program and initiate additional grant projects in decision support systems.
  - In FY 1999 in Information Technology, AHRQ will produce an improved set of clinical performance measures for health care, investigate their validity, develop a relational database of population characteristics and disease prevalence, and make this information available in automated format.
  - AHRQ will partner with the American Medical Association and the American Association of Health Plans to produce a clinical practice guideline clearinghouse that uses Web technology
  - In FY 2000 AHRQ will enhance the quality of health care decision-making tools with the latest Internet access technologies.
  - It will also investigate the uses and resulting changes in health care processes and patient outcomes, and conduct pilot studies in specific sites of patient care.

4.6 High Confidence Systems (HCS)

4.6.1 HCS Definition

HCS R&D, the third program component of the FY 1999 – FY 2000 HPCC/CIC Implementation Plan, 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 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 (NIT). 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.

4.6.2 HCS Status

In FY 1999 the HCS budget was an informal crosscut under the HPCC/CIC programs and therefore it was not a part of the President's FY 1999 Budget and will not be covered in this report. HCS has been added as a formal crosscut in the President's FY 2000 Budget.

Table 8 provides a summary of FY 1998 (Estimate) and FY 2000 (President's Request) HCS budgets by program activity. In 1998, seven Federal agencies (DARPA, NSA, NIH, NASA, NIST, VA and NSF) participated in this program. VA is not part of the FY 2000 HCS budget. DOE, NOAA, EPA, and AHCPR do not participate in HCS.

The HCS FY 1998 Budget Estimate that was reported in the FY 1999 Blue Book differs from the numbers reported in this IP ($33 million vs. $26.3 million) due to the exclusion of the VA funds ($5.4 million) in the IP. The FY 2000 HCS Request ($102.69 million) differs from the number in the FY 2000 Blue Book ($103.5 million) due to rounding. This increase of approximately 300 percent over the estimated FY 1998 budget of $26.3 million reflects expanding the program beyond high performance computing and communications. All the participating agencies have substantially revamped their program activities and associated budget investments. Among the six participating agencies, NSA has requested almost 46 percent ($47.3 millions) of the HCS funds, followed by NSF (21 percent) and DARPA (15 percent). NSA, also with maximum number of activities, leads this program with a variety of national security activities.

Table 8: HCS Program Activity Summary for FY1999 - FY 2000, Dollars in Millions

Agency	Program Activity	HCS	
		FY98 Est	FY00 Req
NSF	Advanced Networking Infrastructure and Research	-	-
	Applications	-	1.96
	Computing Systems	0.90	-
	Computing-Communications Research	-	17.15
	Information and Intelligent Systems	-	2.00
	NSF TOTAL	**0.90**	**21.11**
NASA	Grand Challenge Support	2.80	-
	Systems Software	-	4.50
	Testbeds	-	3.30
	NASA TOTAL	**2.80**	**7.80**
DARPA	Information Survivability	9.40	15.70
	DARPA TOTAL	**9.40**	**15.70**
NIH	NCI - Biomedical Computing Center	0.12	0.12
	NCRR - Biomolecular Computing	-	0.80
	NCRR - Modeling/Simulation	-	0.80
	NCRR - Virtual Reality /Environments	-	1.00
	NLM - Biotechnology Informatics	1.20	0.70
	NLM - HPCC Health Care Applications	1.69	1.48
	NLM - IAIMS grants	0.50	0.40
	NIH TOTAL	**3.51**	**5.30**
NSA	Active Network Defense	-	5.08
	Centers of Excellence	-	2.50
	Cryptography	-	0.79
	High Speed Data Protection Electronics	2.70	-
	Network Security Engineering	-	12.50
	Overhead	-	16.90
	Secure Communications	-	4.12
	Secure Network Management	-	5.39
	Secure Operating System Development	4.50	-
	NSA TOTAL	**7.20**	**47.28**
NIST	Information Technology Metrology, Testing and Applications	2.50	5.50
	NIST TOTAL	**2.50**	**5.50**
	GRAND TOTAL	**26.31**	**102.69**

Section 5 of this document provides details about Agency-specific HCS program activities. Some highlights are:

- FY 2000 NSF HCS efforts are in the Applications, Computing-Communications Research (CCR), and Information and Intelligent Systems program activities. For example, Applications for Dynamic Enterprises include improvements in integration, privacy, security, and reliability of information flows within and across organizations; and CCR supports research on high-confidence software systems and the empirical science of software construction.
- NASA's HCS activities are in the System Software and Testbeds program activities. The latter includes demonstration, evaluation, and validation of performance of ground and flight-based prototypes.
- DARPA's Information Survivability program activity focuses on developing technology required to protect critical systems against attack upon or through the supporting information infrastructure. These technologies will enable our critical systems to provide continuous correct operation even when they are subject to attack, and will lead to generations of stronger protection, higher performance, and more cost-effective security and survivability solutions scalable to several thousand sites. In FY 2000, the program activity will enter a new phase, emphasizing characteristics that improve tolerance (that is, the ability of the system to tolerate attacks and sustain continuous operation).
- NIH's HCS efforts are included in NCI, NCRR, and NIGMS program activities. For example, there is a small HCS component in NCRR research to 'see' deep inside the body, especially the brain, to determine whether a surgical procedure or other therapeutic intervention can be successfully performed with minimum trauma to the patient.
- The goal of NSA's HCS research is to ensure that solutions keep pace with leading-edge information technologies, and provide NSA customers with essential security services. NSA HCS program activities include Active Network Defense, Centers of Excellence, Cryptography, High Speed Data Protection Electronics, Network Security Engineering, Overhead (INFOSEC Research and Technology programs), Secure Communications, Secure Network Management, and Secure Operating System Development.

- NSA supports and participates in the INFOSEC Research Council (IRC) that coordinates research with DARPA, DOE, NIST, and the Service Laboratories. NSA also funds university-level educational programs in security.
- NSA's Network Security Engineering (NSE) research is concerned with providing information security in a networked environment characterized by globally distributed systems and services coupled with dynamic and pervasive information sharing and collaboration
- In Secure Network Management, NSA supports the operation of a security management infrastructure (SMI) through the development of secure protocols for information sharing, network control, and monitoring of events within information systems. This includes NSA's development of the Internet Security Association and Key Management Protocol (ISAKMP) standards through the Internet Engineering Task Force (IETF)
- In Active Network Defense, NSA provides research and advanced technology development for DoD's needs in Defense Information Operations

NIST is collaborating with industry and other Federal agencies to support development of measurement methods and standards to promote interoperability, common user interfaces, and enhanced security for computer and communications systems; develop prototype implementations; establish testbeds; and support advanced technology demonstrations.

4.6.3 HCS 1999-2000 Milestones and Plans

The following is a list of select HCS milestones from the Agency section that appears under the headings Projected FY 1999 Accomplishments and FY 2000 Plans.

NSF

- Research on methods and tools to construct and deliver software-based systems with guaranteed behavior
- Predictable development of software products with predictable behavior

NASA

- Complete the installation of a 1,000 Gigaflops (sustained) testbed with 95 percent availability
- Install a first generation, scalable, embedded computing testbed operating at 30 to 200 MOPS/watt and scalable up to 50 nodes

DARPA

- Evaluate prototype compiler for certifying proof-carrying code
- Release operating system prototype supporting efficient, secure nested virtual machines
- Develop techniques for diagnosing multi-agent, multi-staged attack, through common Intrusion Detection Framework
- Advanced prototype demonstration of secure agent network nodes
- Develop tools for inserting integrity checks into mobile code
- Investigate new approaches to large-scale software composition based on software tolerances and redundancy instead of absolute correctness; identify relevant challenge problems
- Common framework for linking intrusion assessment and response components

NIH

- In FY 1999 there will be continued effort in using virtual reality for interfacing with high resolution instruments (for example, atomic force microscopes)
- Progress is expected in augmented reality (a form of virtual reality) to support image guided neurosurgery
- Eight collaborative demonstrations at resource center sites will cover a wide range of technology R&D

NSA

- For the National INFOSEC Technical Baseline, NSA will complete studies of the state-of-the-art in specific Information Assurance (IA) areas
- NSA will complete a coordinated program roll-up to reflect the combined IA research investments of IRC members
- NSA will extend INFOSEC curriculum development to a broader set of universities
- The IRC will develop and publish a coordinated list of hard research problems to help derive a national IA research agenda
- NSA is undertaking a program to assess the security implications of advanced ATM network switching technology, such as IP Switching, in order to develop appropriate network architectures and IA solutions
- In the area of assurance, NSA's research will investigate how to define, represent, and use logical and verifiable specifications for components used to construct high confidence systems
- In the area of identification and authentication, NSA will continue work in biometric and smartcard technologies and begin work that will investigate maintenance of identities across and throughout a distributed environment
- NSA work is proceeding on the development of a reference implementation of the IPSec protocol
- NSA is developing proofs-of-concept for multicast security key management, fractional keying for multicast security, secure but non-cryptographic techniques for multicast, multicast routing security mechanisms, and group key management services
- NSA's FY 2000 research will produce security-enhanced Internet protocol specifications, reference implementations, and support in worldwide standards bodies
- NSA will complete a study of the concept of a DoD Minimum Essential Information Infrastructure (MEII) in response to recommendations of the Defense Science Board
- NSA's research in mobile agents will investigate the applicability of that technology to the problem of network attack detection and response
- Visual analysis of network attacks at NSA will permit the development of prototypes and display of multi-variable data in forms that can cope with massive datasets associated with very large-scale systems

NIST

- NIST will adopt an Advanced Encryption Standard that satisfies the need for a successor to the Data Encryption Standard, Data Encryption Standard (DES) Federal Information Processing Standard (FIPS) 46-2
- NIST will provide conformity assessment methods to ensure consistency and accurate use of the Java specification and release a Java SmartCard simulator
- NIST will develop standard reference data and guidelines for a more reliable means of identifying and matching persons based on facial data and reliable means of identifying, exchanging, and storing fingerprint information.

5. Agency Input Section

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
* Multidisciplinary teams working on complex problems
* Building capability to perform experimental computer research
* 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 educational

For FY 1998, NSF has restructured its program, consolidating related activities to reflect 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 six activity sheets; the original activities are included to capture past accomplishments and to help elucidate the transition.

NSF

FY 1999-2000 Budget (Dollars in Millions) Comparison by PCAs

Program Activity	Budget				President's Budget by HPCC PCAs						
					FY 1999 Request		FY 1999 Estimate		FY 2000 Request		
	FY98 Estimate	FY99 Request	FY99 Estimate	FY 00 Request	HECC	LSN	HECC	LSN	HECC	LSN	HCS
Advanced Computational Infrastructure and Research	-	81.09	77.64	84.29	81.09	-	77.64	-	84.29	-	-
Advanced Networking Infrastructure and Research	-	62.12	59.97	60.78	-	62.12	-	59.97	-	60.78	-
Applications	59.85	54.94	53.14	61.42	50.94	4.00	49.14	4.00	51.86	7.60	1.96
Computing Systems	51.92	-	-	-	-	-	-	-	-	-	-
Computing-Communications Research	-	62.30	60.53	63.40	62.30	-	60.53	-	46.25	-	17.15
Education and Training	11.07	-	-	-	-	-	-	-	-	-	-
Experimental and Integrative Activities	-	46.30	43.34	40.44	40.30	6.00	37.34	6.00	34.44	6.00	-
Human Centered Systems	50.07	-	-	-	-	-	-	-	-	-	-
Information and Intelligent Systems	-	2.00	2.00	4.00	-	2.00	-	2.00	-	2.00	2.00
Networking, Communications and the Convergence of Computing & Communications	26.05	-	-	-	-	-	-	-	-	-	-
NSFNET	44.50	-	-	-	-	-	-	-	-	-	-
Supercomputer Centers	53.17	-	-	-	-	-	-	-	-	-	-
Totals	**296.63**	**308.75**	**296.62**	**314.33**	**234.63**	**74.12**	**224.65**	**71.97**	**216.84**	**76.38**	**21.11**

NSF

Advanced Computational Infrastructure and Research

Budget

PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
HECC	0.00	81.09	77.64	84.29
LSN	0.00	0.00	0.00	0.00
HCS	0.00			0.00
HuCS	0.00			
ETHR	0.00			
TOTALS	**0.00**	**81.09**	**77.64**	**84.29**

Description

The Partnerships for Advanced Computational Infrastructure (PACI) Program consolidates, integrates and refocuses the former Supercomputer Centers Program and critical associated research. It continues to provide the science and engineering community with access to high-performance computational resources advanced visualization facilities, and state-of-the-art data handling capabilities. While taking advantage of emerging opportunities in high-speed communications networks to build a new national information infrastructure Grid, the program will continue its support of computational science and engineering. There are two partnerships: (1) NPACI (the National Partnership for Advanced Computational Infrastructure) and, (2) NCSA (the National Computational Science Alliance). Each partnership consists of a leading edge site together with cooperating partners.

The leading-edge site maintains a high-end hardware system that is one to two orders of magnitude more capable than those typically available at a major research university. The partners will complete the overall infrastructure by (a) facilitating research and experimentation with new hardware and software, including appropriate support technologies such as visualization and mass storage, (b) providing scalable resources for applications and applications development that can be best done on mid-level systems, (c) providing access to unique experimental systems and facilities, and (d) promoting education and training.

Activities within each Partnership will be structured to provide:

* Access - providing access to a diverse set of advanced and mid-range compute and visualization engines, data storage systems, and experimental machine architectures.

* Application Technologies - computational science groups engaged in high-end applications that develop and optimize their discipline specific codes and software infrastructure and make these available to researchers in other areas.

* Enabling Technologies - computer science groups developing both software tools for parallel computation and software that will enable the effective use of

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Advanced Computational Infrastructure and Research

widely distributed and architecturally diverse machines and data sources.

* Education Outreach and Training - ensuring that all citizens may make productive use of emerging computing technologies to advance their ability to understand and solve problems in education, science, business, government, and society.

The Advanced Computational Research (ACR) program complements the PACI infrastructure program by supporting smaller, single-investigator or small-group research grants. The program has three principal technical thrusts:

* Visualization and Data Handling - develops new methods of summarizing, manipulating, and presenting large data sets to enable better human understanding.

* Scalable Software - develops parallel software at all levels, including runtime systems, libraries, compilers, and problem-solving environments that enable effective and efficient use of high-performance computers.

* Numerical Algorithms - develops and implements parallel numerical methods, typically for simulation of complex physical phenomena.

The program supports approximately 50 awards at any given time, including one of NSF's Science and Technology Centers.

HECC Thrusts:

Technology: $7M;
Foundations $7M
Experimental: $12M;
Infrastructure: $51M

Projected FY99 Accomplishments and Plans

* Deploy a balanced Teraflop computing capability.

* Deploy a large (>512 processor) commodity workstation supercluster using a high-performance interconnect.

* Develop tools for visualizing terabyte-sized data sets.

* Develop a prototype Storage Area Network (SAN) architecture that eliminates disk caches in favor of direct access to data on disks.

* Port advanced immersive visualization software to a new generation of powerful PC based systems to make virtual reality for computational science widely available on the desktop.

NSF

Advanced Computational Infrastructure and Research

* Integrate Quality of Service mechanisms with queuing and resource accounting to enable practical use of the Grid on a national scale.

* Extend Grid testbed to EPSCoR.

* Integrate scientific applications and data with the web, e.g., use Grid software architecture to develop a Chemical Engineer's Workbench and a Computational Cosmology Observatory.

* Build interactive, shared virtual spaces, e.g., use the Grid to support tele-immersive analysis of the Chesapeake Bay; a remote virtual collaboration with the ability to manage, navigate, record, and document large, multi-dimensional datasets using advanced VR technologies.

* Instrument the Grid to create a national scale computer science laboratory.

* Expand the outreach efforts to communities new to high performance computing such as the humanities and the social sciences.

* Experiment with applications using OC-192 capabilities of NTON.

* Sponsor workshop on Visualization of Large Data Sets, helping set community research agenda. We expect this to lead to collaboration with the DOE Data Visualization Corridors project.

* Co-sponsor PetaFLOPS workshop to drive future architecture and software development concepts. Long-term goal is the design of computers with a usable performance capacity 1000 times higher than today.

FY 2000 Plans

* Deploy a balanced multi-Teraflops system.

* Wider deployment of Grid over enhanced high-performance network.

* Increase integration of collaborative and immersive technologies.

* Produce prototype implementations of new concepts in parallel file systems, visualization and virtual reality libraries, numerical and communication libraries, and highly optimizing compilers.

* Refine parallel numerical methods and support; test on realistic problems in materials science and CFD.

* Investigate web-enabled parallel processing via Java extensions.

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Advanced Computational Infrastructure and Research

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Related Web Links
http://www.npaci.edu/
http://www.ncsa.uiuc.edu/
http://www.eot.org/
http://www.cise.nsf.gov/acir/paci/
http://www.cise.nsf.gov/acir/acr/

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Advanced Networking Infrastructure and Research

Budget	PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
	HECC	0.00	0.00	0.00	0.00
	LSN	0.00	62.12	59.97	60.78
	HCS	0.00			0.00
	HuCS	0.00			
	ETHR	0.00			
	TOTALS	**0.00**	**62.12**	**59.97**	**60.78**

Description

The Advanced Networking Infrastructure and Research Program, consolidating and integrating the NSFNET program and critical associated research, has the responsibility for advanced networking infrastructure for the science and engineering community and fundamental research in networking. It emphasizes the development and deployment of the high performance networking required for cutting-edge research in all disciplines, the testing and development of prototype networks, and fundamental research underpinning the realization of practical future high capability networks. Under this program, the very high speed network backbone service (vBNS) links NSF-supported high performance computing centers and almost 100 research institutions engaged in cutting-edge research that demand next generation network capabilities. That is, links are being established competitively to research institutions with scientific applications that demand the highest performance available for their solution. 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. The activity supports collaborative development of national and international networks with other agencies and countries, and is actively involved in the interagency Next Generation Internet Initiative and the University-based Internet2 program.

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; to wireless systems to widely

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Advanced Networking Infrastructure and Research

	distributed databases and network storage devices. The vBNS is an example of infrastructure development that will support several classes of research activity.
Projected FY99 Accomplishments and Plans	150 awards will have been made for high performance connections to the vBNS and other high performance network testbeds; a significant increase (~50%) will be made in the funding of basic research in networking; plan for the "post-vBNS cooperative agreement era" (the Cooperative Agreement with MCI regarding the vBNS concludes in March of 2000).
FY 2000 Plans	Initiate the "post-vBNS Cooperative Agreement era" of NSF advanced networking infrastructure programs
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Related Web Links	www.nsf.gov/cise; www.vbns.net

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Applications

Budget

PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
HECC	28.71	50.94	49.14	51.86
LSN	8.65	4.00	4.00	7.60
HCS	0.00			1.96
HuCS	10.10			
ETHR	12.39			
TOTALS	**59.85**	**54.94**	**53.14**	**61.42**

Description

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

High Performance Applications for Science and Engineering (HPASE): 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.

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.

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. Examples include digital libraries and medical information servers.

These applications have one or both of the following attributes. They will drive and stress the enabling research of computing systems, human centered systems, and networking, communications, and the convergence of computing & communication, and; they may 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.

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Applications

Projected FY99 Accomplishments and Plans

HPASE: Continued development of Earth System models and high spatial resolution meso-scale forecast models in a collaborative effort among the university community, NCAR, and other Federal Laboratories. By the end of FY 1999 a set of simulations will be available to the research community that example the changes to the Earth's climate under various anthropogentic influences. The simulation period will be from 1860 through about 2300. A continuous process of model improvements will be guided, in part, by ther results from these major simulations. The next version of the community meso-scale model will be available by the end of this fiscal year and will provide users with increased capability to incorporate additional observation set (e.g. the NOAA NERAD radars) into the initial conditions and through the process of data assimilation. Work will begin to create a high efficiency computer model of the Space Weather Environment. Improvements in the model physics and computational techniques will accelerate discovery within the Space Science community.

FY 2000 Plans

NSF's National Center for Atmospheric Research (NCAR) will obtain a major new supercomputer system and will be developing new computational techniques to make large codes run efficiently on the new supercomputer. This effort will be closely coupled to the on going activities in model development and improvement. New scenarios and ensembles will be run with the community climate model that will explore natural and anthoprogentic effects on the climate system. These simulations will help to reduce the uncertainty of the model results and explore the sensitivity of the model to natural variations, such as the variations of the amount of solar radiance.

Contacts

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Division of Atmospheric Sciences
Directorate for Geosciences
National Science Foundation

Related Web Links

http://www.ucar.edu/rs.html
http://www.geo.nsf.gov

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Computing Systems

Budget

PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
HECC	51.02	0.00	0.00	0.00
LSN	0.00	0.00	0.00	0.00
HCS	0.90			0.00
HuCS	0.00			
ETHR	0.00			
TOTALS	**51.92**	**0.00**	**0.00**	**0.00**

Description

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.

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Computing Systems

Projected FY99 Accomplishments and Plans	This program activity has been absorbed into new activities defined in FY99 and onward.
FY 2000 Plans	Not Applicable
Contacts	Not Applicable
Related Web Links	Not Applicable

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Computing-Communications Research

Budget

PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
HECC	0.00	62.30	60.53	46.25
LSN	0.00	0.00	0.00	0.00
HCS	0.00			17.15
HuCS	0.00			
ETHR	0.00			
TOTALS	**0.00**	**62.30**	**60.53**	**63.40**

Description

The Computing-Commmunications Research Program supports research that underlies the design of advanced computing systems, both hardware and software; the design of algorithms for advanced scientific and engineering applications of computing; computer communications; software engineering; and the theory of computing. This program incorporates research focused on: communications, including that required for distributed high performance computation and networking; design methodology and automation; computer system architecture; numeric, symbolic and geometric computation; signal processing systems; software engineering; software systems; and the theory of computing. 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) graphic display and visualization systems; (9) parallel algorithms; (10) fault tolerant and redundant hardware structures; (11) high-performance input/output systems; and (12) high-confidence systems. (57%)

FOUNDATIONS: Development of a fundamental understanding of architectural design, interconnection structures, computational complexity, programming language semantics, simulation of physical processes, and models of computation, with current emphasis on parallel and distributed algorithms and systems. (25%)

EXPERIMENTAL: Design, construction, and evaluation of high performance computing systems. (10%)

INFRASTRUCTURE: Access to high performance networks and computing systems for teams of university researchers. (5%)

EDUCATION AND TRAINING: Training of workforce capable of using and

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Computing-Communications Research

advancing high performance computing and communications. (3%)

Projected FY99 Accomplishments and Plans

Awards for high-performance computing and communications research that includes topics such as

* Parallel computation models
* Parallel algorithms and software for scientific computing
* Dynamic compilation and optimizing parallel compilation
* Distributed operating systems
* Superscalar architectures
* High-performance memory systems
* Signal processing and communications systems research, especially that resulting from the Wireless Information Technology and Networks Program Announcement

FY 2000 Plans

Implementation of PITAC program with additional funding for many of the topics above, plus:

* A wireless center
* Hardware/software co-design
* High-performance scientific and commercial applications

Contacts

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National Science Foundation

Related Web Links

http://www.cise.nsf.gov/ccr
http://www.crpc.rice.edu

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Education and Training

Budget	PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
	HECC	0.00	0.00	0.00	0.00
	LSN	2.50	0.00	0.00	0.00
	HCS	0.00			0.00
	HuCS	0.00			
	ETHR	8.57			
	TOTALS	**11.07**	**0.00**	**0.00**	**0.00**

Description

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.

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Education and Training

Projected FY99 Accomplishments and Plans	This program activity has been absorbed into new activities defined in FY99 and onward.
FY 2000 Plans	Not Applicable
Contacts	Not Applicable
Related Web Links	Not Applicable

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Experimental and Integrative Activities

Budget	PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
	HECC	0.00	40.30	37.34	34.44
	LSN	0.00	6.00	6.00	6.00
	HCS	0.00			0.00
	HuCS	0.00			
	ETHR	0.00			
	TOTALS	**0.00**	**46.30**	**43.34**	**40.44**

Description

Experimental and Integrative Activities promotes the development of experimental computer and communications research; furthers the evolution of multidisciplinary research; carries out exploratory and prototype projects; supports special studies and analyses on issues affecting HPCC; and contributes to the creation of a diverse personnel pool.

The establishment, enhancement, and operation of major experimental facilities and the acquisition of equipment such as workstations supports research activities in the areas of computer and information science, computer engineering, and computational science.

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. Example activities include: activity which provides for new course and curriculum development in high performance computing and communication and information processing in undergraduate education; research experiences for undergraduates which are opportunities for undergraduates to perform research in high performance computing and communication and information processing; and collaborative research on learning technologies which use high performance computing and communications in education.

Specialized research is supported at four Science and Technology Centers which 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.

Experimental and integrative research is supported on computer and communications systems involving both hardware and software systems for parallel and distributed computing. The activity also supports national infrastructure development to provide distributed resources to enable broad participation in HPCC research.

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Experimental and Integrative Activities

	HECC Thrusts breadkdown: Technology: 15%; Foundations: 30%; Experimental: 25%; Infrastructure: 30%
Projected FY99 Accomplishments and Plans	Infrastructure supporting HPCC will have been established at several university departments, for both departmental use and distributed use by other researchers. Research projects in next generation software will have been initiated. Educational projects in support of HPCC will contribute to curricula and will involve undergraduates in HPCC research.
FY 2000 Plans	Expand research, infrastructure,and educational support for HPCC goals. Encourage introduction of high-performance computing into K-12 environments as appropriate.
Contacts	W. Richards Adrion, wadrion@nsf.gov Division of Experimental and Integrative Activities National Science Foundation
Related Web Links	http://www.cise.nsf.gov/eia/

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Human Centered Systems

Budget

PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
HECC	0.00	0.00	0.00	0.00
LSN	0.00	0.00	0.00	0.00
HCS	0.00			0.00
HuCS	50.07			
ETHR	0.00			
TOTALS	**50.07**	**0.00**	**0.00**	**0.00**

Description

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.

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Human Centered Systems

Projected FY99 Accomplishments and Plans	This program activity has been absorbed into new activities defined in FY99 and onward.
FY 2000 Plans	Not Applicable
Contacts	Not Applicable
Related Web Links	Not Applicable

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Information and Intelligent Systems

Budget

PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
HECC	0.00	0.00	0.00	0.00
LSN	0.00	2.00	2.00	2.00
HCS	0.00			2.00
HuCS	0.00			
ETHR	0.00			
TOTALS	**0.00**	**2.00**	**2.00**	**4.00**

Description

The Information and Intelligent Systems Program supports research to enable the rapidly emerging information-based society made possible by high performance computing and communications technologies. Its goals are to improve the basic understanding and design of information and knowledge processing systems, including issues such as data capture and storage, information management and access, knowledge representation, intelligent human/computer interfaces; group and organizational interactions; and determination of usability and adaptability. The program focuses on the overlapping areas of human centered systems; knowledge networking; knowledge and cognitive systems; database and expert systems; robotics and machine intelligence; interactive systems; information and technology and organizations. It includes new efforts in the areas of personal robotics, universal access to technology, and the ethical, legal and social implications of information technology.

The key challenge in this research is how to harness new information technologies for the benefits of diverse end users. For example, our new effort in universal access funds research in new technology to help those with limitations of sight, hearing, or arm/finger motion.

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 including digital libraries; (5) Machine learning technology, enabling the system to adapt its operations and interactions to human preferences; (6) Collaboration technology, including research in the KDI program on distributed collaboration systems; (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.

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Information and Intelligent 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.

Projected FY99 Accomplishments and Plans

Second-year KDI awards
Digital Library awards
Universal Access research
Personal robotics
Ethical, legal and social implications of information technology Visualization research

FY 2000 Plans

Implementation of PITAC program with additional funding for many of the topics above plus multilingual technology, international digital library research, and related areas.

Contacts

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Related Web Links

http://www.cise.nsf.gov/iis/index.html
http://www.dli2.nsf.gov

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Networking, Communications and the Convergence of Computing & Communications

Budget

PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
HECC	0.00	0.00	0.00	0.00
LSN	26.05	0.00	0.00	0.00
HCS	0.00			0.00
HuCS	0.00			
ETHR	0.00			
TOTALS	**26.05**	**0.00**	**0.00**	**0.00**

Description

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

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Networking, Communications and the Convergence of Computing & Communications

	computing. The vBNS is another example of infrastructure that will support several classes of research activity.
Projected FY99 Accomplishments and Plans	This program activity has been absorbed into new activities defined in FY99 and onward.
FY 2000 Plans	Not Applicable
Contacts	Not Applicable
Related Web Links	Not Applicable

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NSFNET

Budget	PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
	HECC	0.00	0.00	0.00	0.00
	LSN	44.50	0.00	0.00	0.00
	HCS	0.00			0.00
	HuCS	0.00			
	ETHR	0.00			
	TOTALS	**44.50**	**0.00**	**0.00**	**0.00**

Description

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.

Projected FY99 Accomplishments and Plans

This program activity has been absorbed into new activities defined in FY99 and onward.

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NSFNET

FY 2000 Plans	Not Applicable
Contacts	Not Applicable
Related Web Links	Not Applicable

NSF

Supercomputer Centers

Budget	PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
	HECC	53.17	0.00	0.00	0.00
	LSN	0.00	0.00	0.00	0.00
	HCS	0.00			0.00
	HuCS	0.00			
	ETHR	0.00			
	TOTALS	**53.17**	**0.00**	**0.00**	**0.00**

Description

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

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Supercomputer Centers

	leadership in computational science and engineering; and Broaden the base for the nation's advanced computational and communications infrastructure.
Projected FY99 Accomplishments and Plans	This program activity has been absorbed into new activities defined in FY99 and onward.
FY 2000 Plans	Not Applicable
Contacts	Not Applicable
Related Web Links	National Center for Supercomputer Applications http://www.ncsa.edu/ San Diego Supercomputer Center http://www.sdsc.edu/ Cornell Theory Center http://www.tc.cornell.edu/ Pittsburgh Supercomputing Center http://www.psc.edu/

National Aeronautics and Space Administration

As a key participant of the Federal Program, the primary NASA's purpose of the 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 five HPCC projects: Computational Aerosciences (CAS), Earth and Space Sciences (ESS), Remote Exploration and Experimentation (REE), Learning Technologies (LT), and the NASA Research and Education Network (NREN). 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 leads CAS, LT and NREN; Goddard Space Flight Center, which leads ESS; and Jet Propulsion Lab, which leads 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; and (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 all 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.

NASA

FY 1999-2000 Budget (Dollars in Millions) Comparison by PCAs

Program Activity	Budget				President's Budget by HPCC PCAs						
					FY 1999 Request		FY 1999 Estimate		FY 2000 Request		
	FY98 Estimate	FY99 Request	FY99 Estimate	FY 00 Request	HECC	LSN	HECC	LSN	HECC	LSN	HCS
BRHR	8.60	-	-	-	-	-	-	-	-	-	-
Grand Challenge Support	51.40	37.80	37.80	42.20	37.80	-	37.80	-	42.20	-	-
NREN	15.00	10.60	10.60	10.40	-	10.60	-	10.60	-	10.40	-
NREN-NGI	10.00	10.00	10.00	10.00	-	10.00	-	10.00	-	10.00	-
Systems Software	18.90	17.10	17.10	27.30	17.10	-	17.10	-	22.80	-	4.50
Testbeds	24.50	16.50	16.50	46.50	16.50	-	16.50	-	43.20	-	3.30
Totals	**128.40**	**92.00**	**92.00**	**136.40**	**71.40**	**20.60**	**71.40**	**20.60**	**108.20**	**20.40**	**7.80**

NASA

BRHR

Budget

PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
HECC	0.00	0.00	0.00	0.00
LSN	0.00	0.00	0.00	0.00
HCS	0.00			0.00
HuCS	0.30			
ETHR	8.30			
TOTALS	**8.60**	**0.00**	**0.00**	**0.00**

Description

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

Projected FY99 Accomplishments and Plans

This program activity has been absorbed into other actvities in FY 1999.

NASA

BRHR

FY 2000 Plans	Not Applicable
Contacts	Not Applicable
Related Web Links	Not Applicable

NASA

Grand Challenge Support

Budget

PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
HECC	48.60	37.80	37.80	42.20
LSN	0.00	0.00	0.00	0.00
HCS	2.80			0.00
HuCS	0.00			
ETHR	0.00			
TOTALS	**51.40**	**37.80**	**37.80**	**42.20**

Description

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 solve a range of problems in aerospace engineering at a cost that represents the value, flexibility, and short cycle time required by the aerospace community.

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.

This work component's HECC funding is devoted to HECC Thrust # 3.

NASA

Grand Challenge Support

Projected FY99 Accomplishments and Plans

Demonstrated a 200-fold improvement over the FY 92 baseline in time-to-solution for Grand Challenge applications on Teraflops testbeds:
(*) Showed this performance improvement for one application in each of the CAS and ESS projects
(*) Demonstrated a 50% or better improvement in computation speed for one application in each project

FY 2000 Plans

Integrate hardware and software to provide a computing and communications testbed for HPCC applications capable of 250 GFLOPS (benchmarks) and 3 locations with Gigabit WAN capability.

Contacts

Catherine Schulbach
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NASA Ames Research Center
Mail Stop T27A-2
Moffett Field, CA 94035-1000
(650) 604-3180

Related Web Links

http://outside.gsfc.nasa.gov/ESS

http://cas.arc.nasa.gov

Additional Agency Contact:

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NASA Goddard Space Flight Center
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Greenbelt, MD 20771
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NASA

NREN

Budget

PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
HECC	0.00	0.00	0.00	0.00
LSN	15.00	10.60	10.60	10.40
HCS	0.00			0.00
HuCS	0.00			
ETHR	0.00			
TOTALS	**15.00**	**10.60**	**10.60**	**10.40**

Description

The National Research and Education Network (NREN) is a network testbed. The NREN effort will establish standards and provide working models for commercial communications infrastructure deployment. NREN'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 has deployed 622 Mb/s network testbeds among five NASA centers significantly improving communications between investigators using the 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.

Projected FY99 Accomplishments and Plans

Demonstrated a 100X increased capability to access NASA high-end resources by the Grand Challenge researchers. Established an NGI-X for NASA to connect Grand Challenge universities' principal investigators to NASA high-end resources.

NASA

NREN

FY 2000 Plans

Demonstrate a 500X end-to-end performance improvement over the FY 96 performance baseline for NASA's Grand Challenge and/or mission applications. Do this over a 622 MBPS wide area network.

Contacts

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(650) 604-1263

Related Web Links

http://www.nren.nasa.gov

NASA

NREN-NGI

Budget	PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
	HECC	0.00	0.00	0.00	0.00
	LSN	10.00	10.00	10.00	10.00
	HCS	0.00			0.00
	HuCS	0.00			
	ETHR	0.00			
	TOTALS	**10.00**	**10.00**	**10.00**	**10.00**

Description

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

The NREN Project exists to facilitate the high-end networking needs of NASA Grand Challenges and other NASA Enterprise functions. It is tightly aligned with NASA's programs. As a participant in the NGI initiative, NREN brings to the table not only the technical networking expertise (and existing high-end networking capabilities) but also provides access to NASA's high performance applications that require high performance networks. Providing these civil-sector applications is complementary to the support provided to the NGI initiatives by other agencies.

Projected FY99 Accomplishments and Plans

Demonstrated a 100X increased capability to access NASA high-end resources by the Grand Challenge researchers. Established an NGI-X for NASA to connect Grand Challenge universities' principal investigators to NASA high-end resources.

FY 2000 Plans

Integrate hardware and software to provide a computing and communications testbed for HPCC applications capable of 250 GFLOPS (benchmarks) and 3 locations with Gigabit WAN capability.

Contacts

Ken Freeman
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NASA Ames Research Center
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NASA

NREN-NGI

Related Web Links http://www.nren.nasa.gov

NASA

Systems Software

Budget	PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
	HECC	17.00	17.10	17.10	22.80
	LSN	0.00	0.00	0.00	0.00
	HCS	0.00			4.50
	HuCS	1.90			
	ETHR	0.00			
	TOTALS	**18.90**	**17.10**	**17.10**	**27.30**

Description

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.

NASA

Systems Software

This work component's HECC funding is devoted to HECC Thrust # 1.

Projected FY99 Accomplishments and Plans

(*) Demonstrated portable, scaleable, distributed visualization of multi-terabyte 4D datasets on Teraflops scaleable systems.
(*) Showed portability of these applications across all current testbeds.

FY 2000 Plans

* Integrate hardware and software to provide a computing and communications testbed for HPCC applications capable of 250 GFLOPS (benchmarks) and 3 locations with Gigabit WAN capability.

* Demonstrate applications with 10X improvement (per processor) in throughput over the 1999 RAD600, sqrt(n) processor scalability and 50% of ideal speedup.

Contacts

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Related Web Links

http://cas.arc.nasa.gov

http://outside.gsfc.nasa.gov/ESS

http://www-ree.jpl.nasa.gov

Additional Agency Contacts:

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NASA

Systems Software

(818) 354-1340

NASA

Testbeds

Budget

PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
HECC	24.50	16.50	16.50	43.20
LSN	0.00	0.00	0.00	0.00
HCS	0.00			3.30
HuCS	0.00			
ETHR	0.00			
TOTALS	**24.50**	**16.50**	**16.50**	**46.50**

Description

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.

This work component's HECC funding is devoted to HECC Thrust # 4.

Projected FY99 Accomplishments and Plans

(*) Demonstrated portable, scaleable, distributed visualization of multi-terabyte 4D datasets on Teraflops scaleable systems.
(*) Showed portability of these applications across all current testbeds.

NASA

Testbeds

FY 2000 Plans

* Integrate hardware and software to provide a computing and communications testbed for HPCC applications capable of 250 GFLOPS (benchmarks) and 3 locations with Gigabit WAN capability.

* Demonstrate applications with 10X improvement (per processor) in throughput over the 1999 RAD600, sqrt(n) processor scalability and 50% of ideal speedup.

Contacts

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Related Web Links

http://outside.gsfc.nasa.gov/ESS

http://www-ree.nasa.jpl.gov

Additional Agency Contact:

Robert Ferraro
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NASA Jet Propulsion Laboratory
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(818) 354-1340

Defense Advanced Research Projects Agency

DARPA is the lead DoD agency for advanced technology research, and has the leadership responsibility for the CIC program within DoD. This is based on DARPA's history of technical innovations in computer architecture, integrated circuits, networking, system software, and human-centered systems. DARPA's strategy is to focus on developing the underlying technology base for computing and communications.

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

The Large Scale Networking (LSN) component focuses on distributed services over broadly based, large scale interconnections of networks. Efforts are aimed at ultra high-bandwidth networks, network engineering, fault tolerant networking, and integrated testbeds including special defense applications. These network elements are aimed at interoperability, mobility, and performance.

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

DARPA

FY 1999-2000 Budget (Dollars in Millions) Comparison by PCAs

Program Activity	Budget				President's Budget by HPCC PCAs						
	FY98 Estimate	FY99 Request	FY99 Estimate	FY 00 Request	FY 1999 Request		FY 1999 Estimate		FY 2000 Request		
					HECC	LSN	HECC	LSN	HECC	LSN	HCS
Technology Integration	34.90	-	-	10.00	-	-	-	-	10.00	-	-
Networking	45.90	57.20	29.80	34.20	-	57.20	-	29.80	-	34.20	-
System Environments	23.70	8.80	12.10	6.20	8.80	-	12.10	-	6.20	-	-
Next Generation Internet	39.30	40.00	46.90	40.00	-	40.00	-	46.90	-	40.00	-
Intelligent Systems and Software	64.00	-	-	-	-	-	-	-	-	-	-
Information Sciences	16.50	11.00	6.70	-	11.00	-	6.70	-	-	-	-
Global Grid Communications	16.20	4.70	5.60	-	-	4.70	-	5.60	-	-	-
Data Intensive and Adaptive Computing	55.80	37.20	29.50	21.30	37.20	-	29.50	-	21.30	-	-
Information Survivability	24.90	-	-	16.70	-	-	-	-	0.50	0.50	15.70
Totals	**321.20**	**158.90**	**130.60**	**128.40**	**57.00**	**101.90**	**48.30**	**82.30**	**38.00**	**74.70**	**15.70**

DARPA

Technology Integration

Budget	PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
	HECC	9.90	0.00	0.00	10.00
	LSN	0.00	0.00	0.00	0.00
	HCS	0.00			0.00
	HuCS	25.00			
	ETHR	0.00			
	TOTALS	**34.90**	**0.00**	**0.00**	**10.00**

Description

The Technology Integration component is demonstrating new system capabilities that emerge through the integration of selected technologies developed within the CIC program.

Projected FY99 Accomplishments and Plans

* Develop framework for federation of text, image and relational databases.
* Validate design of secure repository architecture for digital objects.
* Develop Session Management middleware, leveraging multicasting technology that adjusts to variations in bandwidth and connectivity.
* Develop tools that enable teams and individuals to retrieve situation and task relevant information from static and dynamic archives containing a record of experiences from multi-sensory sources; and adjust team dynamics in real-time in response to changes in task and situation.

FY 2000 Plans

* Demonstration of Quality of Service (QoS) management software in U.S. Navy application.
* Alpha level prototype demonstrating integration of information management tools with high capacity storage subsystems to mask impact of limited and/or sporadic network connectivity.
* Field experiment to characterize protocols developed for use in Mobile Information Systems.
* Demonstrate Multiple Beyond Line-of-Sight Communications (MUBLCOM) including voice and data.

Contacts

Gary Koob, Rob Ruth, Jean Scholtz

Related Web Links

http://www.darpa.mil/ito/research/icv/index.html

DARPA

Networking

Budget

PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
HECC	0.70	0.00	0.00	0.00
LSN	33.70	57.20	29.80	34.20
HCS	0.00			0.00
HuCS	11.50			
ETHR	0.00			
TOTALS	**45.90**	**57.20**	**29.80**	**34.20**

Description

The Networking component develops mobile and active networking technologies. Research is coordinated with DoD, NASA, DOE, NSF, and other federal agencies.

The Active Networks thrust is pioneering a new approach to networks that leverages mobile code (e.g., Java) to dynamically change the software running within the network, i.e., the software running on the switches and routers. In one variant of this approach every packet includes a small program that is executed at each node as it traverses the network. This approach allows applications to tailor the network to provide customized services such as network-based information fusion, application-specific web caching, security, etc.

The Global Mobile Information Systems effort will enable mobile users to access and utilize the full range of services available in the Information Infrastructure. To achieve this goal, it will develop nomadic technologies and techniques at the applications, networking, and wireless link/node levels.

Projected FY99 Accomplishments and Plans

* Demonstrate active node execution environment supporting resource security, and survivability functions.
* Extend operation of Active Network testbed to traverse ~10 sites of ~10 switches; each using SmartPackets and composite protocols.
* Demonstrate application support for distributed computing in mobile environments and continuous multi-tier networking across wireless domains.
* Prototype implementation of integrated high data-rate untethered node.

FY 2000 Plans

* Demonstrate use of active network approach to achieve live protocol updates within two roundtrip times.
* Release prototype active network toolkits for end-user stations and network elements.
* Engineering analysis of active network performance.
* Beta-level implementation of high data-rate untethered node incorporating miniature codec.

DARPA

Networking

	* Prototype implementation of mobile wireless Asynchronous Transfer Mode (ATM) network. * Integrate GloMo simulation models and conduct scenario simulations for 100+ node ad hoc network.
Contacts	Doug Maughan, Mari Maeda, Rob Ruth
Related Web Links	http://www.darpa.mil/ito/research/anets/index.html http://www.darpa.mil/ito/research/glomo/index.html

DARPA

System Environments

Budget	PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
	HECC	15.80	8.80	12.10	6.20
	LSN	0.00	0.00	0.00	0.00
	HCS	0.00			0.00
	HuCS	7.90			
	ETHR	0.00			
	TOTALS	**23.70**	**8.80**	**12.10**	**6.20**

Description

The Systems Environments component develops scalable software and operating systems that are tailored toward easing the programming of real-time, high performance, and globally distributed systems. This includes run-time services, resource allocation, and experimental applications.

Projected FY99 Accomplishments and Plans

* Demonstrate experimental scalable structural dynamics application using DARPA sparse matrix library.
* Demonstrate microfeedback technologies for adaptive resource allocation.
* Release prototype subsystem supporting adaptive resource allocation and consumption in response to changing workload and resource availability.

FY 2000 Plans

* Release reference implementation of mission-critical Quality of Service (QoS) architecture.
* Release prototype operating system with partitioned resource management for strict QoS guarantees.
* Specify common services for scalable active software; develop technologies to support the migration of continuously operating processes.
* Develop latency management framework that incorporates techniques such as optimistic processing, caching and approximation to decrease the apparent access time to remotely hosted datasets.

Contacts

Gary Koob

Related Web Links

http://www.darpa.mil/ito/research/sysenv/index.html
http://www.darpa.mil/ito/research/quorum/index.html

DARPA

Next Generation Internet

Budget	PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
	HECC	0.00	0.00	0.00	0.00
	LSN	39.30	40.00	46.90	40.00
	HCS	0.00			0.00
	HuCS	0.00			
	ETHR	0.00			
	TOTALS	**39.30**	**40.00**	**46.90**	**40.00**

Description

The Next Generation Internet (NGI) initiative has three goals: (1) promote experimentation with the next generation of networking technologies; (2) connect universities and national laboratories with high speed networks that are 100 - 1000 times faster than today's Internet; and (3) demonstrate revolutionary applications that meet important national goals and missions. The principal agencies involved in this initiative are DARPA, NSF, NIST, NIH and NASA.

The DARPA activity is focused on the first two goals. DARPA will demonstrate end-to-end network connectivity at 1+ gigabits-per-second for 10 or more NGI sites. The network technologies to be addressed include multi-gigabit broadband networks, guaranteed quality of service mechanisms, and integrated network management. These technologies will be demonstrated in an NGI developed testbed environment.

Projected FY99 Accomplishments and Plans

* Implement 10 gigabit-per-second, multi-wave optically switched Wavelength Division Multiplexed (WDM) technology in NGI testbed.
* Implement an alpha-level prototype high-speed optical multiplexor and develop specification of Internet Protocol (IP)/WDM protocol structure.
* Expand testbed to DoD supported laboratories.
* Implement prototype components of network monitoring and management system.
* Demonstrate 1.5 Gb/s uncompressed HDTV image multicast.

FY 2000 Plans

* Implement prototype of distributed optical switching capability compatible with 100 Gb/s optical network.
* Implement streamlined Internet over WDM protocol structure, eliminating two layers of existing telecommunications infrastructure.
* Develop network planning and simulation technology to meet requirements for NGI scale networks.
* Demonstrate real-time (500-msec response) monitoring and control of network resources at all levels.
* Complete interconnection of Supernet testbed components and software with

DARPA

Next Generation Internet

	2.5 gigabit-per-second access architecture, up to 10 gigabit-per-second backbone, and 100 Gb/s distributed switching capacity. * Demonstrate information management and collaborative applications operating over NGI testbed.
Contacts	Mari Maeda
Related Web Links	http://www.darpa.mil/ito/research/ngi/index.html

DARPA

Intelligent Systems and Software

Budget	PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
	HECC	0.00	0.00	0.00	0.00
	LSN	0.00	0.00	0.00	0.00
	HCS	0.00			0.00
	HuCS	64.00			
	ETHR	0.00			
	TOTALS	**64.00**	**0.00**	**0.00**	**0.00**

Description

This project develops new concepts that will 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-intensive systems.

Major areas of technical emphasis are: (a) software composition; (b) situation analysis technologies that provide for the intelligent integration of information from heterogeneous sources, including interactive problem solving, planning, scheduling and decision analysis; (c) presentation technologies that provide intelligent interfaces to the resultant information streams, including the integration and application of emerging language understanding and translation capabilities.

Beginning in FY 2000, there will be an increased emphasis on the development of presentation technologies and of intelligent applications that leverage software composition tools developed in the earlier phase of the project.

Projected FY99 Accomplishments and Plans

Software Composition:
* Conduct Instrumented Feasibility Demonstration (IFDs) of evolutionary design technologies.
* Investigate active approaches to software composition, with emphasis on aspect-oriented programming; on-the-fly component generation and interconnection; and module self-evaluation and configuration.
* Demonstrate web-based toolkit of representation, analysis and generation tools.

Situation Analysis:
* Develop language comprehension technology to provide extraction of web-based content and production of summary information.
* Develop and demonstrate fully automatic algorithms to determine the structure of radio and TV news broadcasts.
* Demonstrate tools and techniques to enable the rapid construction of large-scale information associates to filter, access, and integrate information from 100s of disparate, data sources.

DARPA

Intelligent Systems and Software

FY 2000 Plans

Situation Analysis:
* Demonstrate statistically based semantic analysis capabilities across four repositories, at least one of which supports access controls.
* Demonstrate translingual document clustering for representative European and Asian languages.
* Identify opportunities to apply DARPA-developed analysis technologies to crisis management environments.
* Demonstrate persistent query of audio and video streams to detect user-defined significant events and to generate alerts.

Presentation and Interaction:
* Specify network-based Application Program Interface s (API s) for key components of dialogue architecture.
* Alpha release of reference implementation of dialog architecture.
* Initiate Translingual Information Detection, Extraction and Summarization (TIDES) activity.
* Create rapid prototype of geo-based analysis and presentation capability.
* Experimental evaluation of crisis management tools in conjunction with U.S. Pacific Command (PACOM).

Contacts

Gary Strong, Jean Scholtz

Related Web Links

http://www.darpa.mil/ito/research/hls/index.html
http://www.darpa.mil/ito/research/im/index.html
http://www.darpa.mil/ito/research/tides/index.html
http://www.darpa.mil/ito/research/com/index.html

DARPA

Information Sciences

Budget	PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
	HECC	8.60	11.00	6.70	0.00
	LSN	0.00	0.00	0.00	0.00
	HCS	0.00			0.00
	HuCS	7.90			
	ETHR	0.00			
	TOTALS	**16.50**	**11.00**	**6.70**	**0.00**

Description

This project supports scientific study and experimentation that is the basis for more advanced knowledge and understanding in information sciences technology areas related to long-term national security requirements such as computational models and new mechanisms for performing computation and communication involving biological and optical processes. This project is also exploring innovative approaches to the composition of software and novel human computer interface technologies.

In the area of biological computing, the project will support the scientific study and experimentation that is at the interface of information technology and biological technology, with emphasis on computation based on biological materials, physical interfaces between electronics and biology, and interactive biology.

In the area of optical communication and computing, the project will explore new approaches to transmission based on solitons and identify novel buffering technologies that can be substituted for optical delay lines.

In the areas of software composition, the project will investigate formal techniques for the construction of safety critical systems.

In the area of human computer interfaces the project will study novel, interface technologies and their relationship to cognitive processes.

Projected FY99 Accomplishments and Plans

* Investigate novel control mechanisms for self-organizing and autonomous systems.
* Demonstrate human-computer interaction for crisis planning.
* Investigate feedback-driven approaches to information management.

DARPA

Information Sciences

FY 2000 Plans

Biological Computing:
* Evaluate alternative approaches to DNA-based computing and identify the most promising research opportunities for enhancement and acceleration.
* Explore mechanisms for sequencing of DNA-based computations.
* Investigate novel approaches to real-time biological instrumentation in support of interactive biology.

Optical Computing and Communication:
* Demonstrate optical logic gate operating at 100 GHz
* Identify alternative optical buffering technologies.

Software Engineering and Human Computer Interface:
* Investigate design of domain specific languages for use in safety critical systems.
* Investigate machine translation and relevance of new results in cognitive science research to spoken language and haptic interfaces.
* Investigate the potential roles of stochastic models and game theory in large scale distributed systems.

Contacts

Sri Kumar (Biological Computing)
Mari Maeda (Optical Computing & Communication)
Helen Gill (Software Engineering)

Related Web Links

http://www.darpa.mil/ito/research/ultra/index.html

DARPA

Global Grid Communications

Budget	PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
	HECC	0.00	0.00	0.00	0.00
	LSN	16.20	4.70	5.60	0.00
	HCS	0.00			0.00
	HuCS	0.00			
	ETHR	0.00			
	TOTALS	**16.20**	**4.70**	**5.60**	**0.00**

Description

This project, which is concluding in FY99 has developed advanced networking technologies needed for global defense operations in the 21st century. The program has demonstrated that information technologies can be integrated with advanced optical, high performance networks. This will provide multimedia information flows, efficient use of bandwidth for warfighting, disaster relief, and emergency medical support.

This Broadband Information Technology (BIT) effort developed all-optical multiple wavelength transmission technologies. Specifically, this program has attained three goals: (1) billion bit per second bandwidth on demand, independent of the analog and digital nature of the applications, (2) multiplexing of continuous transmission rates (bit rates from thousands of bit per second to billion of bits per second), and (3) transmission of analog and digital signals in a single fiber.

These transmission technologies have created a multi-billion dollar industry based on DARPA's Wavelength Division Multiplexing (WDM) technology and have provided the optical componentry underlying the very high performance networking research being conducted within the Next Generation Internet program.

Projected FY99 Accomplishments and Plans

* Demonstrated 20 Gb/s reconfigurable WDM metropolitan network
* Demonstrated multi-vendor network element interoperability

FY 2000 Plans

This program will terminate in FY1999.

Contacts

Bert Hui

DARPA

Global Grid Communications

Related Web Links http://www.darpa.mil/ito/research/bit/index.html

DARPA

Data Intensive and Adaptive Computing

Budget

PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
HECC	49.80	37.20	29.50	21.30
LSN	0.00	0.00	0.00	0.00
HCS	0.00			0.00
HuCS	6.00			
ETHR	0.00			
TOTALS	**55.80**	**37.20**	**29.50**	**21.30**

Description

The Data Intensive Systems and Software component develops software and hardware technologies for applications with highly demanding (e.g., irregular) data access patterns, such as those exhibited by sparse matrix analysis and object garbage collection. This component will develop a new approach to computer memory organization that will eliminate severe bottlenecks in present designs.

The Adaptive Computing component develops new approaches to the design of computer hardware that incorporates dynamic configuration capabilities. The resultant devices will enable a wide variety of specialized systems by reusing a relatively small set of hardware designs, each of which can be affordably produced in high volumes.

DARPA's highly successful Scalable and Embeddable Systems programs are ending in FY99 and some of their most recent accomplishments are also reported within this activity.

Projected FY99 Accomplishments and Plans

* Demonstrate multiprocessor reduced instruction set computer (RISC) chip (16 issue, 1.6 gigaoperations (GOP), 5-cycle message latency).

* Demonstrate enabling technologies including: Discrete Fourier Transform (DFT) chips based on clockless logic, Single Instruction Multiple Datastream (SIMD) and multi-Digital Signal Processing (DSP) board designs, 2.5 Gbps high speed configurable interconnect.
* Publish benchmarks for embedded signal processing.
* Investigate instruction set extensions and storage components to allow applications to specify whether operations are executed in the central processor or in logic circuits embedded in the memory hierarchy.
* Debug and validate novel, configurable component technologies.
* Release new algorithm design software environment optimized to leverage adaptive technology.
* Demonstrate user-level software performance improvement over commodity microprocessors on challenge problems.
* Conduct system-level design and simulation study of a computation model

DARPA

Data Intensive and Adaptive Computing

based on large amorphous arrays.

FY 2000 Plans

* Design "processor in memory" components that support in situ processing of application data.
* Implement compiler that generates code compatible with processor in memory architecture.
* Simulate data-intensive systems, demonstrating 10-fold performance improvement on critical applications.
* Develop architectural framework for use of data intensive technologies in embedded applications; investigate alternative approaches to package level integration of data intensive technologies with high bandwidth sensor interfaces.
* Prototype implementation and runtime libraries supporting adaptive performance monitoring and analysis.
* Demonstrate synthesis of Digital Signal Processing (DSP), Application Specific Integrated Circuit/Field Programmable Gate Array (ASIC/FPGA), and General Purpose (GP) systems.
* Investigate novel approaches to in-situ logic placement and routing based on techniques such as amphorous computing.
* Establish challenge problem testbed for experimental development of 1 cubic foot Synthetic Aperture Radar (SAR).

Contacts

Robert Graybill

Related Web Links

http://www.darpa.mil/ito/research/dis/index.html
http://www.darpa.mil/ito/research/acs/index.html
http://www.darpa.mil/ito/research/embedsys/index.html

DARPA

Information Survivability

Budget

PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
HECC	0.00	0.00	0.00	0.50
LSN	0.00	0.00	0.00	0.50
HCS	9.40			15.70
HuCS	15.50			
ETHR	0.00			
TOTALS	**24.90**	**0.00**	**0.00**	**16.70**

Description

This project is developing the technology required to protect critical systems against attack upon or through the supporting information infrastructure. These technologies will enable our critical systems to provide continuous correct operation even when they are subject to attack, and will lead to generations of stronger protection, higher performance, and more cost-effective security and survivability solutions scalable to several thousand sites

Information Survivability focuses on early prototypes of software technologies leading to protection for large-scale, heterogeneous systems usable over a wide range of performance in diverse threat environments. High confidence computing systems will be developed that provide modular security services and mechanisms, provide high reliability for distributed computations, and allow geographically separated parts of an organization to interact as if they shared a common security perimeter. This also includes integrity mechanisms to allow damage to be detected rapidly.

In FY00, the program will enter a new phase, emphasizing characteristics that improve tolerance, i.e., the ability of the system(s) to tolerate attacks and sustain continuous operation.

Projected FY99 Accomplishments and Plans

* Demonstrate techniques for general pairwise tradeoffs among realtime operations.
* Evaluate prototype compiler for certifying proof-carrying code.
* Release operating system prototype supporting efficient, secure nested virtual machines.
* Complete initial wrapper-generator toolkits.
* Develop techniques for diagnosing multi-agent, multi-staged attack, through common Intrusion Detection Framework.

DARPA

Information Survivability

FY 2000 Plans	* Advanced prototype demonstration of secure agent network nodes. * Develop tools for inserting integrity checks into mobile code. * Complete enhanced wrapper-generator toolkits. * Implement prototype of artificial diversity toolkit. * Investigate new approaches to large-scale software composition based on software tolerances and redundancy instead of absolute correctness; identify relevant challenge problems. * Common framework for linking intrusion assessment and response components.
Contacts	Doug Maughan
Related Web Links	http://www.darpa.mil/ito/research/is/index.html http://www.darpa.mil/ito/research/tnt/index.html

Department of Energy

DOE faces unprecedented 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 provides supercomputer access and advanced communication capabilities (through the ESnet computer network) to scientific researchers.

DOE

FY 1999-2000 Budget (Dollars in Millions) Comparison by PCAs

Program Activity	Budget				President's Budget by HPCC PCAs						
	FY98 Estimate	FY99 Request	FY99 Estimate	FY 00 Request	FY 1999 Request		FY 1999 Estimate		FY 2000 Request		
					HECC	LSN	HECC	LSN	HECC	LSN	HCS
Advanced Computing Research Facilities (ACRFs)	22.90	12.02	17.41	11.88	12.02	-	17.41	-	11.88	-	-
Advanced Computing Software Tools	5.00	5.00	5.00	5.00	5.00	-	5.00	-	5.00	-	-
Applied Mathematics	20.02	21.68	21.68	20.49	21.68	-	21.68	-	20.49	-	-
Collaboratory Tools	3.00	-	-	-	-	-	-	-	-	-	-
Computational Science Education	3.55	-	-	-	-	-	-	-	-	-	-
Computer Science	14.00	14.00	14.00	14.00	14.00	-	14.00	-	14.00	-	-
ESnet	14.78	14.00	14.79	14.79	-	14.00	-	14.79	-	14.79	-
National Collaboratory Pilot Projects	3.00	-	-	-	-	-	-	-	-	-	-
NERSC	26.50	26.50	26.50	27.50	26.50	-	26.50	-	27.50	-	-
Networks & Communications	5.99	4.50	4.50	4.50	-	4.50	-	4.50	-	4.50	-
Next Generation Internet	-	22.00	14.60	14.60	-	22.00	-	14.60	-	14.60	-
Scientific Applications Pilot Projects	5.28	6.62	7.33	3.79	6.62	-	7.33	-	3.79	-	-
Totals	**124.02**	**126.32**	**125.81**	**116.55**	**85.82**	**40.50**	**91.92**	**33.89**	**82.66**	**33.89**	**-**

DOE

Advanced Computing Research Facilities (ACRFs)

Budget	PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
	HECC	22.90	12.02	17.41	11.88
	LSN	0.00	0.00	0.00	0.00
	HCS	0.00			0.00
	HuCS	0.00			
	ETHR	0.00			
	TOTALS	**22.90**	**12.02**	**17.41**	**11.88**

Description

ACRFs support advanced computational hardware testbeds for scientific application pilot projects and fundamental research in applied mathematics and computer science. Because many of the issues to be investigated only appear in the computer systems at significantly larger scale than the computer manufacturers' commercial design point, these facilities must procure and develop software to manage and make useful the largest scale systems that can be afforded. In addition, the ACRFs, taken together, must have a full range of different computer architectures to enable comparison and reduce overall program risk. These all involve significant research efforts, often in partnership with the vendors to resolve issues including operating system stability and performance, system manageability and scheduling, fault tolerance and recovery, and details of the interproccessor communications network. Therefore, all of these systems are managed as research programs and not as information technology investments. ACRFs are located at Los Alamos National Laboratory (Nirvana Blue partnership with OBER and DOE DP, based on SGI/Cray Technology); Argonne National Laboratory (IBM-SP); and Lawrence Berkeley National Laboratory (SGI/Cray T3E and Next Generation procurement). Related capital equipment needs such as high speed disk storage systems, archival data storage systems and high performance visualization hardware are also supported. The ACRFs represent the evolution of the High Performance Computing Research Centers that DOE initiated as a part of the Federal High Performance Computing and Communications initiative.

Projected FY99 Accomplishments and Plans

Technology refresh system for Nirvana Blue delivered. ANL begins MPI experiments between IBM SP and SGI Origin 2000 computers. ORNL begins evaluation of SRC 6 computer. DOE completes funding of joint evaluation project for TERA at SDSC.

FY 2000 Plans

Funding restrictions will force closure of IBM SP at ANL in mid FY 00.

DOE

Advanced Computing Research Facilities (ACRFs)

Contacts

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Related Web Links

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www.acl.lanl.gov
www.mcs.anl.gov

DOE

Advanced Computing Software Tools

Budget

PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
HECC	5.00	5.00	5.00	5.00
LSN	0.00	0.00	0.00	0.00
HCS	0.00			0.00
HuCS	0.00			
ETHR	0.00			
TOTALS	**5.00**	**5.00**	**5.00**	**5.00**

Description

R&D to develop the results of fundamental research in applied mathematics and computer science into an integrated set of tools that can be used by scientists in various disciplines to develop high performance scientific applications (e.g., to simulate the behavior of materials) that will have a useful life spanning many generations of computer hardware. These tools will include capabilities for representing complex geometries, solving diverse numerical equations, simplifying multi-language parallel execution, evaluating and enhancing code performance, and dynamically steering calculations during execution. This effort began as a part of the DOE2000 initiative.

Projected FY99 Accomplishments and Plans

Advanced Computing Software Tools Enable Rapid Application Development: One of the major challenges in modern high performance computing is to develop tools that enable scientists to quickly create computer software to solve scientific problems. Otherwise, chemists, materials scientists, and others would spend their entire effort creating software for computers that would be obsolete just as the applications were ready. The speed of change in the underlying computer architectures and the complexity of these computers and their operating systems makes this a major area of research. The Parallel Object-Oriented Methods and Applications (POOMA) Framework effort at LANL is one promising research approach to developing effective tools to help scientists in the disciplines develop software. In an early test with POOMA, a post-doc with no parallel programming experience developed computer software to solve a three dimensional fluid turbulence problem (including the tools to visualize the results while the program was running) in only six weeks rather than the 6-9 months required in similar efforts. POOMA is used extensively by two of the scientific applications pilots -- the computational accelerator physics and numerical tokamak turbulence projects. New Scientific Application Enabled By Interfacing Two Software Packages: One research challenge facing advanced computing is to enable software developed by different teams to work together on massively parallel computers. Recently researchers at Argonne National Laboratory (ANL) and Lawrence Livermore National Laboratory (LLNL) have demonstrated that it is possible for well-designed components developed at different laboratories to be easily used together by providing each with a common interface. The latest generation of

DOE

Advanced Computing Software Tools

ordinary differential equation solvers for systems, whose behavior combines fine scale and large scale features, developed at LLNL has been interfaced with a large family of parallel algebraic solvers developed at ANL. This coupled software system has enabled several new applications. One of these is a collaboration of researchers at Louisiana Tech University and Oak Ridge National Laboratory (ORNL) to develop a code for fully three-dimensional simulations of the dynamics of micro-structural interactions in materials. This code would not have been possible before the researchers had access to the coupled ANL-LLNL system.

FY 2000 Plans

This work will be extended to a common component architecture in FY00. Possible collaborations include compiler researchers and fault tolerand software component designers.

Contacts

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Related Web Links

www.mcs.anl.gov/DOE2000

DOE

Applied Mathematics

Budget

PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
HECC	20.02	21.68	21.68	20.49
LSN	0.00	0.00	0.00	0.00
HCS	0.00			0.00
HuCS	0.00			
ETHR	0.00			
TOTALS	**20.02**	**21.68**	**21.68**	**20.49**

Description

Research on the underlying mathematical understanding and numerical algorithms to enable effective description and prediction of physical systems. This activity supports research at DOE laboratories, universities, and private companies to provide the DOE laboratory community and the wider national scientific and engineering communities with the most powerful and effective mathematical and computational tools for modeling, analyzing, and simulating complex phenomena in the core disciplinary and technology areas of DOE. Laboratory, academic, and industry researchers supported by the program are expected to work as closely together as possible and to collaborate with potential users of the techniques they are developing. In addition, graduate students and postdoctoral associates are expected to spend as much time as possible working at laboratory sites with DOE mentors.

To accomplish its goals, the program supports research in a number of areas including: Mathematical Physics including string theory, superstring theory, geometry of space-time, and quantum effects; Ordinary and Partial Differential Equations including numerical methods, high performance algorithms, massively parallel algorithms, distributed computing, novel gridding schemes, numerical linear algebra, iterative methods, sparse solvers, and dense solvers; Control Theory including differential-algebraic systems, order reduction, queuing theory; Shock Wave Theory including hyperbolic systems, multipole expansions, mixed elliptic-hyperbolic problems, and wavelet transforms; Fluid Dynamics including; compressible, incompressible, and reacting flows, turbulence modeling, and multiphase flows; Dynamical Systems including chaos-theory and control, and bifurcation theory; Programming and Optimization including linear and nonlinear programming, interior-point methods, and discrete and integer programming; and Geometric and Symbolic Computing including minimal surfaces and automated theorem proving.

The FY 2000 budget includes the continuation of work initiated in FY 1999 to develop the mathematical basis for modeling and simulating complex stochastic phenomena of the type that arise in vital DOE areas such as global climate modeling.

DOE

Applied Mathematics

Projected FY99 Accomplishments and Plans

Simulation of Instabilities in Fluid Layers

Research in Optimization Impacts U.S. Industry

Law for Turbulent Stress Proved to be Invalid

R&D 100 Award to Sandia Researchers

FY 2000 Plans

Continue research program. In addition, FY2000 will be the second full year of work in the initiative to understand the limits of predictability in computer simulations.

Contacts

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Related Web Links

www.er.doe.gov/production/octr/mics/index.html

DOE

Collaboratory Tools

Budget

PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
HECC	0.00	0.00	0.00	0.00
LSN	0.00	0.00	0.00	0.00
HCS	0.00			0.00
HuCS	3.00			
ETHR	0.00			
TOTALS	**3.00**	**0.00**	**0.00**	**0.00**

Description

R&D to develop the results of fundamental research in computer science and networking into an integrated set of tools to enable scientists to remotely access and control facilities and share data in real time. In order to accomplish this goal a number of issues are under investigation including: definition and demonstration of a general and modular security architecture that can protect open network applications such as control of experimental devices; development a modular electronic notebook prototype that can be used in a number of desktop computer environments to enable the sharing of scientific results, data from scientific instruments, and design of scientific procedures; development of tools to manage distributed collaborations such as tools for managing multipoint videoconferences ranging from the current "whoever is speaking has the floor" to more formal meetings where a meeting leader controls who has the "floor"; development of advanced techniques for managing and returning to the electronic record of the collaboration; and exploration of techniques such as virtual reality to enable large groups to work together effectively at a distance. This effort began as a part of the DOE2000 initiative.

Projected FY99 Accomplishments and Plans

Collaboratory Tool Attracts Users. The electronic notebook collaboratory tool project has been so well received that over eighty groups across the country have adopted the prototype electronic notebook. Some are DOE projects, but many are from outside the Department including pharmaceuticals, chemical processing and medicine. The electronic notebook is valuable to researchers because: it can be shared by a group of researchers; it can be accessed remotely; it cannot be misplaced, lost, or accidentally destroyed (if backed up); it is easy to incorporate computer files, plots, etc.; notarization and authentication are possible; it can easily be searched for information; it can include multimedia; and it can include hyperlinks to other information. In order to enable these capabilities, the electronic notebook project has had to overcome a number of challenges including the development of new technologies for describing types of data such as experimental protocols and experimental devices, which are not well treated by traditional techniques.

DOE

Collaboratory Tools

FY 2000 Plans	Plans for FY 2000 include adding authentication to the tools as well as use of virtual spaces for multipoint collaboration meetings.
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Related Web Links	www.mcs.anl.gov/DOE2000

DOE

Computational Science Education

Budget	PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
	HECC	0.00	0.00	0.00	0.00
	LSN	0.00	0.00	0.00	0.00
	HCS	0.00			0.00
	HuCS	0.00			
	ETHR	3.54			
	TOTALS	**3.54**	**0.00**	**0.00**	**0.00**

Description

The main component of this program is the Computational Science Graduate Fellowship (CSGF) program. The basic objective of the Computational Science Graduate Fellowship Program is to encourage talented students to enter a period of study and research in computational science accompanied by practical work experience at recognized DOE research facilities. The fellowship program is designed to provide incentive and encouragement to students with outstanding academic records to continue their graduate studies in preparation for careers in computational science. In addition, in past years this activity has supported the Adventures in Supercomputing high school program and the Undergraduate Computational Engineering and Sciences curriculum development project.

Projected FY99 Accomplishments and Plans

Successful transition of AiS from pilot project to incorporation in local school planning. 50 fellows in CGSF program.

FY 2000 Plans

Continue CGSF. Possible initiative in workforce retraining for advanced computation.

Contacts

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Related Web Links

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DOE

Computer Science

Budget	PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
	HECC	14.00	14.00	14.00	14.00
	LSN	0.00	0.00	0.00	0.00
	HCS	0.00			0.00
	HuCS	0.00			
	ETHR	0.00			
	TOTALS	**14.00**	**14.00**	**14.00**	**14.00**

Description

Research in computer science to enable large scientific applications. This activity supports research in two general areas: the underlying software to enable applications to make effective use of computers with hundreds or thousands of processors as well as computers that are located at different sites; and large scale data management and visualization. The first area includes research in protocols for message passing and parallel input/output (IO) as well as tools to monitor the performance of scientific applications. The second area includes research in effective techniques for retrieving data with complex internal structure from massive data archives that may be geographically distributed as well as advanced techniques for visualizing very large scale scientific data.

Projected FY99 Accomplishments and Plans

Publication of open interfaces for dynamic parallel instrumentation tools. Research on data file indexing enables real time contouring of terabyte data sets. Successful demonstration of grid technologies to enable access to experimental devices.

FY 2000 Plans

Future focus will include issues for large scale data management including development of appropriate multi resolution data structures. In addition, techniques for generating optimal meshes for scientific computing and the underlying technologies for computational grids will be researched.

Contacts

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Related Web Links

www.er.doe.gov/production/octr/mics/index.html

DOE

ESnet

Budget	PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
	HECC	0.00	0.00	0.00	0.00
	LSN	14.78	14.00	14.79	14.79
	HCS	0.00			0.00
	HuCS	0.00			
	ETHR	0.00			
	TOTALS	**14.78**	**14.00**	**14.79**	**14.79**

Description

ESnet provides worldwide access to Energy Research facilities, including: advanced light sources; neutron sources; particle accelerators; fusion reactors; spectrometers; ACRFs; and other leading-edge science instruments and facilities. ESnet provides the communications fabric that links DOE researchers to one another and forms the basis for fundamental research in networking, enabling R&D in collaboratory tools, and applications testbeds such as the national collaboratory pilot projects. To provide these facilities, ESnet management at LBNL contracts with commercial vendors for advanced communications services including Asynchronous Transfer Mode and Wave Division Multiplexing. ESnet management provides system integration to provide a uniform interface to these services for DOE laboratories. In addition, ESnet management is responsible for the interfaces between the network fabric it provides and the worldwide Internet including NSF's vBNS network that provides high performance connections to many research universities. Related capital equipment needs are also supported such as high speed network routers, Asynchronous Transfer Mode switches, and network management and testing equipment.

Projected FY99 Accomplishments and Plans

ESnet continues to provide very high quality service to its users. In addition, ESnet was a partner in the first demonstration of Priority Service For Internet Traffic. Scientists at two national laboratories successfully selected marked Internet traffic for priority service over unmarked traffic in a cross-country demonstration. This demonstration is a key milestone in the development of a broad set of capabilities called "differentiated services," which are required for the Internet to be able to give different levels of service on demand to network customers. The demonstration of such capabilities for production-mode scientific research between LBNL and ANL across the ESnet paves the way for more reliable and constant connectivity via priority bandwidth on the Internet. Achieving this improved level of service is essential to the work of the Department, which is pioneering the use of various technologies to allow scientists at more than 30 DOE national labs to share access to some of the Nation's most advanced research facilities. The complex interactions between software on computers, network hardware such as routers, and telecommunications equipment operated by commercial carriers make this a

DOE

ESnet

difficult research problem. In addition, all of these components must be capable of efficiently scaling up to operate across the worldwide Internet which processes tens of billions of packets a month.

ESnet continues to provide leading edge production level network services to the DOE research community. In FY 1999 numerous sites were added to the network as well as increasing high speed production service to 622Mbs (OC12). International connectivity peering was also changed to the New York area to enhance connectivity to European sites. ESnet is also participating and providing support for the DOE NGI program during FY 1999. During the later half of FY1999, the ESnet services contract, presently with Sprint, is being recompeted.

FY 2000 Plans

Award of the new contract is expected in early FY2000. The new contract will provide additonal leading edge services and allow ESnet to provide support to other DOE programs such as the Strategic Simulation Initiative (SSI) and Accelerated Strategic Computing Initiative (ASCI) which require procution level services at the OC192 level within two years.

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Related Web Links

www.es.net

DOE

National Collaboratory Pilot Projects

Budget	PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
	HECC	0.00	0.00	0.00	0.00
	LSN	0.00	0.00	0.00	0.00
	HCS	0.00			0.00
	HuCS	3.00			
	ETHR	0.00			
	TOTALS	**3.00**	**0.00**	**0.00**	**0.00**

Description

R&D to test, validate, and apply collaboratory tools in partnership with other ER and DOE programs. The two pilot projects are: (1) the Materials MicroCharacterization Collaboratory, a partnership with Basic Energy Sciences and Energy Efficiency and Renewable Energy to provide remote access to facilities located at ORNL, LBNL, ANL, NIST, and the University of Illinois for electron beam microcharacterization of materials, and (2) the Diesel Combustion Collaboratory, a partnership with Basic Energy Sciences, Energy Efficiency and Renewable Energy, and three U.S. manufacturers of diesel engines, to link the research and researchers at SNL, LBNL, LLNL, and the University of Wisconsin with efforts and researchers at industrial laboratories in Indiana and Michigan to develop the next generation of clean diesel engines. This effort began as a part of the DOE2000 initiative.

Projected FY99 Accomplishments and Plans

First remote use of an electron microscope across the Atlantic and Pacific oceans. Significant improvement in remote control of devices.

FY 2000 Plans

Current pilot projects will continue.

Contacts

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Related Web Links

www.mcs.anl.gov/DOE2000

DOE

NERSC

Budget	PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
	HECC	26.50	26.50	26.50	27.50
	LSN	0.00	0.00	0.00	0.00
	HCS	0.00			0.00
	HuCS	0.00			
	ETHR	0.00			
	TOTALS	**26.50**	**26.50**	**26.50**	**27.50**

Description

NERSC, located at LBNL, provides high performance computing for investigators supported by the Office of Energy Research. The Center serves about 4,000 users working on about 700 projects; 35% of users are university based, 60% are in National Laboratories, and 5% are in industry. NERSC provides a spectrum of supercomputers offering a range of high performance computing resources and associated software support. These computational resources are integrated by a common high performance file storage system that facilitates interdisciplinary collaborations.

Projected FY99 Accomplishments and Plans

NERSC participation in Gordon Bell Prize computation. Successful partnerships of facility with scientific users. Conclusion of procurement for next generation NERSC computer. Archivalsystem transition to HPSS completed.

FY 2000 Plans

Installation of next generation computer at NERSC.

Contacts

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Related Web Links

www.nersc.gov

DOE

Networks & Communications

Budget	PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
	HECC	0.00	0.00	0.00	0.00
	LSN	5.99	4.50	4.50	4.50
	HCS	0.00			0.00
	HuCS	0.00			
	ETHR	0.00			
	TOTALS	**5.99**	**4.50**	**4.50**	**4.50**

Description

Research in high performance computer networks and information surety required to support high performance computer applications -- protocols for high performance networks, methods for measuring the performance of high performance networks, and software to enable high speed connections between high performance computers and both local area and wide area networks. In addition, this activity supports research in network protocols to enable applications to request, and be guaranteed, certain levels of network capability.

Projected FY99 Accomplishments and Plans

In cooperation with ESnet first wide area demonstration of differentiated services. HiPPI 6400 standard accepted. Significant evaluation of issues related to VIA.Cooperation with NLANR on network monitoring tools. Initiation of China Clipper project between SLAC, LBNL, and ANL to explore issues in wide area data intensive computing and WDM ATM peering.

FY 2000 Plans

Continue China Clipper. Work on local interconnections of network-attached devices.

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Related Web Links

www.er.doe.gov/production/octr/mics/index.html

DOE

Next Generation Internet

Budget	PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
	HECC	0.00	0.00	0.00	0.00
	LSN	0.00	22.00	14.60	14.60
	HCS	0.00			0.00
	HuCS	0.00			
	ETHR	0.00			
	TOTALS	**0.00**	**22.00**	**14.60**	**14.60**

Description

DOE's NGI research program is focused on discovering, understanding, developing, testing and validating the networking technologies needed to enable wide area, data intensive and collaborative computing that is not currently possible. This program will integrate scientists working on fundamental research in applied mathematics, computer science, and networking with scientists working on DOE applications to develop new ways to link scientists with DOE's major scientific user facilities and computational centers. Such research is needed to enable effective use of petabyte/ year HENP facilities such as the Relativistic Heavy Ion Collider(RHIC); to provide remote visualization of terabyte to petabye data sets from computational simulation; to develop advanced collaboratories; and to enable effective remote access to tomorrow's advanced scientific computers. These applications share two important characteristics. They all involve extremely large data sets, and they all require that scientists be able to interact with the data in (nearly) real time. Current network technology limitations significantly limit our ability to address either of these characteristics.

Projected FY99 Accomplishments and Plans

FY 1999 is first year of DOE participation in this effort.

FY 2000 Plans

DOE's program will be announced in three Federal Register Announcements. First, research in basic underlying technologies such as: protocols and techniques for coordinating multiple, heterogeneous network-attached devices; congestion and flow control techniques; multi-gigabit end system interfaces, analyzers, and switches along with mechanisms to reduce operating system overhead for data transfers; mechanisms to provide application controlled Class of Service and Quality of Service; and middleware to provide IP, ATM, and WDM resource and admission control, scheduling, management, prioritization, accounting, and debugging. Second, Application-Network Technology-Network Testbed Partnerships to: integrate and test advanced network R&D and testbeds with DOE mission applications such as HENP Data, remote visualization of simulation

DOE

Next Generation Internet

results, advanced collaboratories; define what network & middleware services are required to permit these applications to effectively run over wide area networks; define the features and the API's necessary to allow the application and middleware to communicate; integrate local and wide-area network technologies to create distributed collaboratories; and integrate Differentiated Services, or other Quality of Service functions, into wide area networks and production network testbeds without compromising the existing production network services. Third, DOE-University Technology Testbeds focused on: R&D to implement advanced network services across multiple, interconnected networks; deployment of advanced differentiated services technology across autonomous networks when priority flow represents a significant fraction of the available capability; development and testing of advanced tools to manage "peering" of networks with advanced services; cross-domain implementations of security and authentication technologies; development and testing of network performance monitoring and characterization software which applications can use in this environment to optimize their performance; and development of policy frameworks and specification languages to facilitate the negotiation of capabilities across autonomous system boundaries.

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www.er.doe.gov/production/octr/mics/index.html

DOE

Scientific Applications Pilot Projects

Budget	PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
	HECC	5.28	6.62	7.33	3.79
	LSN	0.00	0.00	0.00	0.00
	HCS	0.00			0.00
	HuCS	0.00			
	ETHR	0.00			
	TOTALS	**5.28**	**6.62**	**7.33**	**3.79**

Description

R&D to apply computational techniques and tools developed in the Advanced Computing Software Tools effort to basic research problems in order to test the usefulness of current advanced computing research, transfer the results of this research to the scientific disciplines, and help define promising areas for future research. Examples of pilot projects include: research in simulations of the earth's climate; research in the fundamental structure and properties of magnetic materials; creation of advanced tools to understand the chemistry of actinides; and partnerships with experimental disciplines such as high energy and nuclear physics, human genomics, and crystallography to improve the ability of these disciplines to manage and analyze the petabytes of data (that would fill the hard disks of millions of today's PCs) produced by their experiments and simulations. These efforts represent the evolution of the Grand Challenge projects that were initiated as part of DOE's component of the Federal High Performance Computing and Communications program, which started in FY 1991.

Projected FY99 Accomplishments and Plans

Many of these projects have made significant progress this year. The High Energy and Nuclear Physics data grand challenge played a critical role in the success of the first mock data challenge for the RHIC experiment, a petabyte per year facility. In addition, the accelerator design grand challenge has run the largest ever simulation of beam halo and electromagnetic simulations with resolution sufficient to describe the as built cavities. The materials science project, a partnership between ORNL, Ames Laboratory, and NERSC won the 1998 Gordon Bell Prize for its simulation of 1024 atoms in a metallic magnet that achieved one terflop of sustained performance. Finally, Advances in numerics coupled with work to enable software to run in parallel on many processors has enabled researchers in the "Supercomputer Solution of Massive Crystallographic and Microtomographic Structural Problems" scientific application pilot project to dramatically reduce the time required to analyze the data from Laue diffraction experiments. A typical illustration comes from progress made on a scientific applications project--diffraction patterns and intensities produced by x-rays passing through a crystal lattice are used to deduce information about molecular structures. The Laue diffraction technique is the most important tool in time-resolved crystallography, where structure data are captured rapidly to image the

DOE

Scientific Applications Pilot Projects

structure of a molecule at various stages of a reaction. Improved optimization and numerical techniques have been applied to the code that performs the complicated task of analyzing Laue diffraction data to obtain the structure of the molecules. The dramatic improvements in time-to-solution that have been made will significantly enhance experimental capabilities because runtimes are reduced from hours to minutes. These results are expected to be especially important for the 30% of users of DOE light sources who are involved in discovering protein structures.

FY 2000 Plans

These projects will be completed in mid FY00. A competition for follow on scientific applications partnerships is anticipated.

Contacts

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Related Web Links

www.er.doe.gov/production/octr/mics/index.html

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 Center for Information Technology (CIT), the National Cancer Institute (NCI), and the National Institute of General Medical Sciences (NIGMS).

NIH

FY 1999-2000 Budget (Dollars in Millions) Comparison by PCAs

Program Activity	Budget				President's Budget by HPCC PCAs						
	FY98 Estimate	FY99 Request	FY99 Estimate	FY 00 Request	FY 1999 Request		FY 1999 Estimate		FY 2000 Request		
					HECC	LSN	HECC	LSN	HECC	LSN	HCS
CIT - High Performance Biomedical Computing and Communications Program	8.91	8.91	8.91	8.91	6.61	2.30	6.61	2.30	6.61	2.30	-
NCI - Biomedical Computing Center	5.00	4.62	4.62	4.81	3.12	1.50	3.12	1.50	3.19	1.50	0.12
NCRR - Biomolecular Computing	7.30	7.20	7.20	8.00	6.70	0.50	6.70	0.50	6.70	0.50	0.80
NCRR - Modeling/Simulation	6.55	6.10	6.10	6.90	5.60	0.50	5.60	0.50	5.60	0.50	0.80
NCRR - Software Tools for Structure-Based Drug Design	3.20	3.70	3.70	4.15	3.70	-	3.70	-	4.15	-	-
NCRR - Training	1.80	-	-	-	-	-	-	-	-	-	-
NCRR - Virtual Reality /Environments	7.45	8.20	8.20	9.75	0.75	7.45	0.75	7.45	0.75	8.00	1.00
NIGMS - HPCC Extramural Activities	0.53	0.59	0.59	0.66	0.59	-	0.59	-	0.66	-	-
NLM - Biotechnology Informatics	9.61	8.44	8.44	9.14	-	8.44	-	8.44	-	8.44	0.70
NLM - Electronic Imaging	1.96	2.45	2.39	2.39	-	2.45	-	2.39	-	2.39	-
NLM - HPCC Health Care Applications	16.85	20.91	16.08	18.54	-	20.91	-	16.08	-	17.06	1.48
NLM - HPCC Training Grants	4.04	4.04	4.54	4.54	-	4.04	-	4.54	-	4.54	-
NLM - IAIMS grants	3.39	2.89	2.89	3.39	-	2.89	-	2.89	-	2.99	0.40
NLM - Intelligent Agent DB searching	13.28	11.97	19.89	19.55	-	11.97	-	19.89	-	19.55	-
NLM - Medical Connections Program	1.37	1.47	1.37	1.25	-	1.47	-	1.37	-	1.25	-
Totals	**91.24**	**91.49**	**94.92**	**101.98**	**27.07**	**64.42**	**27.07**	**67.85**	**27.66**	**69.02**	**5.30**

NIH

CIT - High Performance Biomedical Computing and Communications Program

Budget

PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
HECC	6.61	6.61	6.61	6.61
LSN	2.30	2.30	2.30	2.30
HCS	0.00			0.00
HuCS	0.00			
ETHR	0.00			
TOTALS	**8.91**	**8.91**	**8.91**	**8.91**

Description

The goal of the NIH Center for Information Technology (CIT) High Performance Biomedical Computing and Communications 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, CIT determines which high performance architectures are best for the classes of problems that arise in biomedical computing, develops 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. CIT is developing computational methods and tools needed by biomedical scientists in conducting their research in the areas of structural biology, biomedical imaging, and bioinformatics.

Projected FY99 Accomplishments and Plans

CIT will continue to apply high performance computing and communication methods to biomedical applications at NIH. This work includes the evaluation of new architectures and the expansion of existing systems. We will develop new reconstruction algorithms and visualization techniques in biomedical imaging as well as provide software tools for x-ray crystallography, NMR spectroscopy, bioinformatics and genetic linkage analysis. We will also continue to develop ATM network and multimedia workstation technologies for medical imaging and scientific visualization.

FY 2000 Plans

Work in structural biology will involve the development of tools for the three-dimensional structure determination and refinement of biomolecules using crystallographic data or NMR data as well as innovative methods for modeling molecular complexes. We will develop new methods for generating, displaying, and analyzing images in electron and light microscopy and a number of medical imaging modalities including positron emission tomography and electron paramagnetic resonance imaging. In the area of bioinformatics, we will implement new approaches to the analysis and storage of genetic data. We will develop new tools for genetic linkage analysis. We will also train staff who can work closely with NIH scientists in applying these tools in their research programs. The results

NIH

CIT - High Performance Biomedical Computing and Communications Program

of this work will be applied to projects that require tools from all three areas such as the NIH Cancer Genome Anatomy Project (CGAP) and the NIH Small Animal Phenotype Imaging Project.

Additional work will include improving access methodologies for diverse members of the biomedical research community to high performance computing resources; providing tools for accessing data related to molecular biology, biochemistry and genetics; creating virtual environments for molecular and biomedical image visualization; developing telemedicine and collaborative haptic technologies that allow multi-modal human-system interactions for biomedical research and clinical remote-sensing applications; and developing database technology to provide health care providers with access to relevant medical information and literature.

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Related Web Links

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NIH

NCI - Biomedical Computing Center

Budget	PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
	HECC	3.04	3.12	3.12	3.19
	LSN	1.20	1.50	1.50	1.50
	HCS	0.12			0.12
	HuCS	0.23			
	ETHR	0.41			
	TOTALS	**5.00**	**4.62**	**4.62**	**4.81**

Description

(Formerly called the NCI Frederick Biomedical Supercomputing Center) The NCI Advanced Biomedical Computing Center's (ABCC), Formerly called the NCI Frederick Biomedical Supercomputing Center, 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 in the areas of computer vision, robotics, deterministic and non-deterministic, algorithms.

Projected FY99 Accomplishments and Plans

Ongoing research on the atomic level mechanisms of enzymes relevant to malignant change and to viral diseases will be extended to provide explanations of drug sensitivity and resistance. Nucleic acid structures will be predicted for functional elements that are involved in a number of critical processes.

FY 2000 Plans

Develop plans for the continued support of high end computing in Cancer research. This includes evolution to new architectures and adaptation of new algorithms as this dynamic field expands with the growing sources of data resulting from genomic projects such as the Cancer Genome Anatomy Project(CGAP), mouse genome, and others.

NIH

NCI - Biomedical Computing Center

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NIH

NCRR - Biomolecular Computing

Budget	PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
	HECC	6.30	6.70	6.70	6.70
	LSN	0.20	0.50	0.50	0.50
	HCS	0.00			0.80
	HuCS	0.80			
	ETHR	0.00			
	TOTALS	**7.30**	**7.20**	**7.20**	**8.00**

Description

Biomolecular computing involves research and development of algorithms and software for use with high performance computers in addressing the 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 interaction 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.

Projected FY99 Accomplishments and Plans

In FY 1999 significant progress is expected in the development of more accurate, more efficient approaches for predicting protein structure from sequence data. Included in this work are refining new methods developed for ab initio structure prediction and more accurate methods for determining molecular potential functions for use in quantitative protein modeling.

FY 2000 Plans

In FY2000 these emerging methods and tools will be adapted to run efficiently on the most powerful computers available. The goal of this activity to provide the biomedical research community with the necessary algorithms and software to take full advantage of emerging Teraflops computer capability.

Contacts

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Related Web Links

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NIH

NCRR - Modeling/Simulation

Budget	PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
	HECC	5.75	5.60	5.60	5.60
	LSN	0.10	0.50	0.50	0.50
	HCS	0.00			0.80
	HuCS	0.70			
	ETHR	0.00			
	TOTALS	**6.55**	**6.10**	**6.10**	**6.90**

Description

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.

Projected FY99 Accomplishments and Plans

In FY 1999 approaches to develop larger molecular systems and assemblies will be developed. Increased effort will be directed to develop detailed models of cells and organs using high performance computer facilities via the Internet.

FY 2000 Plans

In FY 2000 the use of parallel computing will be extended to study biopolymer aggregates through investigations and modeling of extremely large system in involving hundreds of thousands of atoms. New modeling approaches will be developed to integrate spatial (anatomical) data with biochemical data to create more accurate models of cells and organs.

Contacts

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NIH

NCRR - Software Tools for Structure-Based Drug Design

Budget

PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
HECC	3.20	3.70	3.70	4.15
LSN	0.00	0.00	0.00	0.00
HCS	0.00			0.00
HuCS	0.00			
ETHR	0.00			
TOTALS	**3.20**	**3.70**	**3.70**	**4.15**

Description

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.

Projected FY99 Accomplishments and Plans

In FY 1999 develop software tools to study protein-small molecule interaction.

FY 2000 Plans

Continue this research in FY 2000 to extend this technology for developing novel vectors for gene therapy.

Contacts

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Related Web Links

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NIH

NCRR - Training

Budget	PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
	HECC	0.00	0.00	0.00	0.00
	LSN	0.00	0.00	0.00	0.00
	HCS	0.00			0.00
	HuCS	0.00			
	ETHR	1.80			
	TOTALS	**1.80**	**0.00**	**0.00**	**0.00**

Description

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.

Projected FY99 Accomplishments and Plans

In FY 1999 and FY 2000 the anticipated level of train will be comparable to previous years.

FY 2000 Plans

In FY 1999 and FY 2000 the anticipated level of train will be comparable to previous years.

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Related Web Links

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NIH

NCRR - Virtual Reality /Environments

Budget	PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
	HECC	0.50	0.75	0.75	0.75
	LSN	5.95	7.45	7.45	8.00
	HCS	0.00			1.00
	HuCS	1.00			
	ETHR	0.00			
	TOTALS	**7.45**	**8.20**	**8.20**	**9.75**

Description

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 simplest cases require high performance computer capability and high-speed intra- and internet capabilities. Remote users focus the NCRR effort in these areas on applications for scientific instruments for basic research, molecular visualization, surgical and other therapeutic interventions such as radiation planning and high-speed access to these tools. Included in this program are the establishment, demonstration, and evaluation of collaboratories (laboratories without walls).

Projected FY99 Accomplishments and Plans

In FY 1999 there will be continued effort in utilizing virtual reality for interfacing with high resolution instruments (e.g. atomic force microscopes). Progress is expected in the area of augmented reality (a form of virtual reality) to support image guided neurosurgery. Eight collaborative demonstrations will be initiated at resource center sites that cover a wide range of technology research and development.

FY 2000 Plans

In FY 2000 it is expected that preliminary results of the FY 1999 initiatives will become available and will point the way to new developments and uses for the emerging virtual reality/environment field.

NIH

NCRR - Virtual Reality /Environments

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NIH

NIGMS - HPCC Extramural Activities

Budget

PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
HECC	0.53	0.59	0.59	0.66
LSN	0.00	0.00	0.00	0.00
HCS	0.00			0.00
HuCS	0.00			
ETHR	0.00			
TOTALS	**0.53**	**0.59**	**0.59**	**0.66**

Description

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.

Projected FY99 Accomplishments and Plans

A major accomplishment this last fiscal year was to marry a method for phase determination, Shake and Bake", with MAD phasing to locate selenium molecules in seleno-methionine doped proteins. Work in this area is expected to contiune. A new initiative that will eventually require the use of computer methods is the iniation this year of the NIGMS structural genomics effort. The idea is that by providing a complete library of folds, new structures can be deduced from sequence through homology modeling. The need for higher resolution deduced structures will put heavy demands on algorithm development and advanced computational methods.

FY 2000 Plans

FY 2000 will see the beginning of the marriage between hard core molecular dymanics and bioinformatics. That is as the number of structures in the Protein Data Bank increases it will become increasingly possible to take a sequence and, using sthreasding algorithms, thread the sequence through a known structure and deduce a low resolution structure from this process. Two laboratories, Barry Honig's and Michael Levitt's are pioneering this effort. Other efforts will focus on deducing function from proteins of known structure but unknown function. All of these efforts are key to the NIGMS structural genomics effort. NIGMS initiatives in computational cell biology are also expected to bear fruit.

NIH

NIGMS - HPCC Extramural Activities

Contacts

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Related Web Links

http://www.nih.gov/nigms

NIH

NLM - Biotechnology Informatics

Budget

PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
HECC	0.00	0.00	0.00	0.00
LSN	7.69	8.44	8.44	8.44
HCS	1.20			0.70
HuCS	0.72			
ETHR	0.00			
TOTALS	**9.61**	**8.44**	**8.44**	**9.14**

Description

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 bio informatics, 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 data bank which is a key data resource of the Human Genome Project. NCBI produces an integrated database system consisting of GenBank, the genetic scientific literature in Medline, taxonomy, and 3-D molecular structures. These databases are accessed daily through the Internet by over 90,000 different sites and account for over 4 million hits per day. 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.

Projected FY99 Accomplishments and Plans

GenBank has now reached 3 million sequences and over 2 billion base pairs of DNA. It took 17 years to accumulate the first billion bases and just 18 months for the second billion. NCBI is recognized as the primary data source internationally for integrated DNA information. Each day there are over 90,000 visitors to the NCBI Web site and over 4 million hits. 70,000 DNA searches are conducted daily using one of the fastest and most sensitive comparison algorithms known, BLAST, which was developed by NCBI scientists. BLAST can compare an unknown sequence of 10,000 bases against 2 billion bases in less than 30 seconds. BLAST has become an essential tool for gene discovery and is used by over 7,000 researchers from universities and industry daily. More specifically, all the major genome sequencing centers are sending their finished sequences to NCBI, which is helping coordinate the selection of sequencing targets. NCBI has also begun assembling a variety of human genome resources including genetic and physical mapping data, the UniGene gene map, genetic disease

NIH

NLM - Biotechnology Informatics

descriptions(OMIM), and data on human gene variability. Another major resource has been a collection of protein 3D structure data which has allowed integrated searching on sequence, structure, and homology information.

FY 2000 Plans

The Human Genome Project has accelerated its pace and the predicted date of a draft complete human sequence has moved forward to the year, 2003. In preparation for the more than 3 billion base pairs of human DNA, NCBI is building the databases and analysis tools for model organisms (bacteria, yeast, worm, fruit fly) that will serve as primary data resources in their own right, but will also provide a foundation for creating the next generation of human genomic tools. An example of the type of resource that will be necessary for analyzing human data is the RefSeq project, which is now assembling reference sequences for each known gene that will eliminate the redundancy, incompleteness, and errors that result from having multiple versions of sequences in the public archival databases. RefSeq will become an encyclopedia of genomes, capturing the key information on genes from a range of organisms from bacteria to human, along with links to variation data, mutation databases, and cross-species homologs. The biggest challenge for NCBI in the next few years is to maintain the speed and accuracy in sequence searching in the face of rapidly expanding data and increased demands by users. Over the next 24 months, NCBI will be developing a uniform classification scheme based on a library of protein motifs/profiles which will help identify extremely subtle similarities with speed and accuracy.

Another frontier for genome research will be functional genomics, i.e., determining the activity and expression of specific genes in the developing as well as the mature organism. NCBI is collaborating with several NIH institutes to study the expression of genes in various phases of cancer and in neurological development. Most importantly, NCBI continues to build the infrastructure that can rapidly respond to new scientific directions and has been acknowledged by leadership at NIH as the focal point of all NIH-wide bio informatics efforts.

Contacts

Dr. David J. Lipman, M.D., Director, NCBI

Related Web Links

www.ncbi.nlm.nih.gov

NIH

NLM - Electronic Imaging

Budget	PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
	HECC	0.00	0.00	0.00	0.00
	LSN	0.50	2.45	2.39	2.39
	HCS	0.00			0.00
	HuCS	1.46			
	ETHR	0.00			
	TOTALS	**1.96**	**2.45**	**2.39**	**2.39**

Description

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. The National Library of Medicine has undertaken steps to build and evaluate digital image libraries of anatomical structures of the human body, the Visible Human Project. 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. 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 CD-ROMs, 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. 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). 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) and an additional 10,000 x-rays of the hands, wrists and knees from the NHANES III survey.

Projected FY99 Accomplishments and Plans

Continue the segmentation and labeling of the male and female anatomical structures. Convert the thorax sections from Visible Human image file format into an national 3D image file format. Experiment with Interfacing the Visualization subsystem with industrial image rendering software. Begin development of platform-independent radiological atlas for epidemiological and

NIH

NLM - Electronic Imaging

	general biomedical research; expand access software for text/x-ray image databases with tools to organize and statistically analyze retrieved data.
FY 2000 Plans	Testing will begin for the Visible Human Anatomical database. A cross section of academic and industrial users will be selected to participate in the evaluation of the retrieval engine, and the 3D file format. The database will be accessed over the Internet as well as via NGI networks using current web browsers for data queries and image retrieval. Complete the development of and beta testing of the online Java-based platform-independent radiological atlas for biomedical research. The beta testing will evaluate its effectiveness as a reference tool for standardized interpretation of spine images for osteoarthritis.
Contacts	Michael J. Ackerman, Ph.D., Assistant Director for High Performance Computing and Communications, NLM
Related Web Links	www.nlm.nih.gov/research/visible/visible_ human.html archive.nlm.nih.gov/proj/dxpnet/dxpnet.html

NIH

NLM - HPCC Health Care Applications

Budget	PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
	HECC	0.00	0.00	0.00	0.00
	LSN	13.47	20.91	16.08	17.06
	HCS	1.69			1.48
	HuCS	1.69			
	ETHR	0.00			
	TOTALS	**16.85**	**20.91**	**16.08**	**18.54**

Description

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 areas: 1. Test bed networks for linking hospitals, clinics, doctors 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 realtime 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.

Projected FY99 Accomplishments and Plans

Fund 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. Fund projects concerned with digital libraries.

FY 2000 Plans

Continue funding projects promoting the application of HPCC technologies to health care, the evaluation of telemedicine, digital libraries, and the testing of methods for protecting the privacy of electronic health data.

Contacts

Dr. Milton Corn,
Associate Director for the Extramural Program, NLM

Related Web Links

http://dli2.nlm.nih.gov/
http://www.nlm.nih.gov/ep/extramural.html
http://www.nlm.nih.gov/research/telfront.html

NIH

NLM - HPCC Training Grants

Budget	PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
	HECC	0.00	0.00	0.00	0.00
	LSN	0.00	4.04	4.54	4.54
	HCS	0.00			0.00
	HuCS	0.00			
	ETHR	4.04			
	TOTALS	**4.04**	**4.04**	**4.54**	**4.54**

Description

Currently, there are too few professionals in biomedical fields trained in the use of modern computer and telecommunications systems. The need includes both biomedical professionals cross-trained in Informatics, and professionals 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 also 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.

Projected FY99 Accomplishments and Plans

Fund individual and program grants for HPCC training for health professionals

FY 2000 Plans

Continuing individual and program grants for HPCC training for health professionals.

Contacts

Dr. Milton Corn,
Associate Director for the Extramural Program, NLM

Related Web Links

http://www.nlm.nih.gov/ep/appfellow.html

NIH

NLM - IAIMS grants

Budget	PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
	HECC	0.00	0.00	0.00	0.00
	LSN	1.99	2.89	2.89	2.99
	HCS	0.50			0.40
	HuCS	0.90			
	ETHR	0.00			
	TOTALS	**3.39**	**2.89**	**2.89**	**3.39**

Description

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.

Projected FY99 Accomplishments and Plans

Fund projects aimed at making progress toward integration of academic information management by American medical centers.

FY 2000 Plans

Continuing progress toward integration of academic information management by American medical centers.

NIH

NLM - IAIMS grants

Contacts	Dr. Mlton Corn, Associate Director for the Extramural Program, NLM
Related Web Links	http://www.nlm.nih.gov/pubs/factsheets/iaims.html

NIH

NLM - Intelligent Agent DB searching

Budget

PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
HECC	0.00	0.00	0.00	0.00
LSN	11.95	11.97	19.89	19.55
HCS	0.00			0.00
HuCS	1.33			
ETHR	0.00			
TOTALS	**13.28**	**11.97**	**19.89**	**19.55**

Description

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.

Projected FY99 Accomplishments and Plans

Continue to develop and deploy new capabilities for automatic source selection and for retrieving and sorting information from multiple databases available via NLM's Web site and from the Internet Grateful Med (IGM), PubMed, and TOXNET retrieval services -- with a focus on facilitating access for the general public as well as health professionals and researchers. Test the use of Meta-data for electronic information sources as a means for enhancing retrieval from disparate information sources.

NIH

NLM - Intelligent Agent DB searching

FY 2000 Plans	In addition to continuing in-house research and development, fund extramural research and development involving the use of UMLS Knowledge Sources and programs to integrate access to multiple multimedia information sources into computer-based patient record systems used by patients and health professionals.
Contacts	Betsy Humphrys, Assistant Director, NLM
Related Web Links	www.nlm.nih.gov/research/umls/umlsmain.html

NIH

NLM - Medical Connections Program

Budget

PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
HECC	0.00	0.00	0.00	0.00
LSN	1.37	1.47	1.37	1.25
HCS	0.00			0.00
HuCS	0.00			
ETHR	0.00			
TOTALS	**1.37**	**1.47**	**1.37**	**1.25**

Description

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 Internet. 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 Internet. 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.

Projected FY99 Accomplishments and Plans

Fifty grants will be awarded. The overall program goal is to contribute to the task of connecting health care institutions in the U.S. onto the Internet.

FY 2000 Plans

Approximately 50 grants will be awarded. The overall program goal is to contribute to the task of connecting health care institutions in the U.S. onto the Internet.

Contacts

Dr. Milton Corn,
Associate Director for the Extramural Program, NLM

Related Web Links

http://www.nlm.nih.gov/ep/connect.html

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.

The goal of NSA's High Confidence Systems research program is to ensure that information assurance (IA) solutions keep pace with leading edge information technology, and provide NSA's customers with essential security services. The IA program is driven by an annually updated NSA Technology Forecast and includes five technology areas that address the pressing research needs associated with the development of high confidence systems. These technology areas include active network defense, secure network management, and network security engineering - all supported by enabling research in cryptography and secure communications.

NSA

FY 1999-2000 Budget (Dollars in Millions) Comparison by PCAs

Program Activity	Budget				President's Budget by HPCC PCAs						
	FY98 Estimate	FY99 Request	FY99 Estimate	FY 00 Request	FY 1999 Request		FY 1999 Estimate		FY 2000 Request		
					HECC	LSN	HECC	LSN	HECC	LSN	HCS
Active Network Defense	-	-	-	5.08	-	-	-	-	-	-	5.08
Centers of Excellence	-	-	-	2.50	-	-	-	-	-	-	2.50
Cryptography	-	-	-	0.79	-	-	-	-	-	-	0.79
High Speed Data Protection Electronics	2.70	-	-	-	-	-	-	-	-	-	-
Network Security Engineering	-	-	-	12.50	-	-	-	-	-	-	12.50
Overhead	-	-	-	16.90	-	-	-	-	-	-	16.90
Secure Communications	-	-	-	4.12	-	-	-	-	-	-	4.12
Secure Network Management	-	-	-	5.39	-	-	-	-	-	-	5.39
Secure Operating System Development	4.50	-	-	-	-	-	-	-	-	-	-
Supercomputing Research	24.20	21.67	21.67	24.90	21.67	-	21.67	-	24.90	-	-
Superconducting Research	2.22	2.30	2.30	2.60	2.30	-	2.30	-	2.60	-	-
Very High Speed Networking	2.18	3.00	3.00	1.72	-	3.00	-	3.00	-	1.72	-
Totals	**35.80**	**26.97**	**26.97**	**76.50**	**23.97**	**3.00**	**23.97**	**3.00**	**27.50**	**1.72**	**47.28**

NSA

Active Network Defense

Budget	PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
	HECC	0.00	0.00	0.00	0.00
	LSN	0.00	0.00	0.00	0.00
	HCS	0.00			5.08
	HuCS	0.00			
	ETHR	0.00			
	TOTALS	**0.00**	**0.00**	**0.00**	**5.08**

Description

Active Network Defense provides a source of research and advanced technology development for the DoD's needs in Defensive Information Operations. Significant effort has been devoted to community-wide coordination of a research agenda for work in this area.

Projected FY99 Accomplishments and Plans

A study of the concept of a DoD Minimum Essential Information Infrastructure (MEII) was completed in response to recommendations of the Defense Science Board. NSA established the Pacific Institute of Computer Security at the University of California at Davis and the San Diego Supercomputer Center to conduct research and develop tools to support intrusion analysis and computer forensics. NSA has successfully applied the PARENTAGE visualization tool to problems associated with network attack analysis. Additional technologies will be investigated for their application in network defense.

FY 2000 Plans

Future research efforts will develop new tools and techniques for analyzing types of attacks, their source and objectives, and technology to support manual and automatic response. New work has been initiated which will determine appropriate automated network responses under different intrusion scenarios. Research in mobile agents will investigate the applicability of that technology to the problem of network attack detection and response.

Future work in visual analysis of network attacks will develop prototypes that display multi-variable data in forms that can cope with massive datasets associated with very large-scale systems.

Contacts

Robert Meushaw, rvmeush@home.com, (301) 688-0840

Related Web Links

Not Applicable

NSA

Centers of Excellence

Budget	PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
	HECC	0.00	0.00	0.00	0.00
	LSN	0.00	0.00	0.00	0.00
	HCS	0.00			2.50
	HuCS	0.00			
	ETHR	0.00			
	TOTALS	**0.00**	**0.00**	**0.00**	**2.50**

Description

The Institute for Defense Analyses (IDA) provides NSA's research for high-level cryptologic support on current mathematical problems essential for the design and analysis of high-grade U.S. cryptography.

Projected FY99 Accomplishments and Plans

Significant advances were made in the state-of-the-art of cryptology. This work is important to establish and maintain the security of NSA-developed cryptography.

FY 2000 Plans

IDA will continue to perform research in areas of mathematics that show promise for cryptographic applications.

Contacts

Robert Meushaw, rvmeush@home.com, (301) 688-0840

Related Web Links

Not Applicable

NSA

Cryptography

Budget

PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
HECC	0.00	0.00	0.00	0.00
LSN	0.00	0.00	0.00	0.00
HCS	0.00			0.79
HuCS	0.00			
ETHR	0.00			
TOTALS	**0.00**	**0.00**	**0.00**	**0.79**

Description

Cryptography is an overall enabler for information assurance; and NSA, as the nation's primary resource for cryptography, continues to provide the Federal Government's cryptographic algorithms, backed by the highest level of cryptomathematics expertise. Recent mathematical research has provided a theoretical basis for the design of popular codebook algorithms. NSA will continue to design new algorithms for the unique requirements of the military, the DoD, and the intelligence community. A multi-year research effort in public key cryptography will produce designs for efficient public key algorithms and protocols, faster and more efficient arithmetic techniques, elliptic curve software, proactive authentication techniques, related technical support, and public key cryptography standards support.

Quantum computing is a new and powerful threat to traditional cryptography. Research has begun to counter this threat using key exchange techniques that use quantum physics as a basic protection mode. Recent work has demonstrated feasibility for key exchanges over forty-seven kilometers of fiber optic cable. A second area of research will be to devise new classes of cryptoalgorithms that are not susceptible to attacks by quantum computing techniques.

Projected FY99 Accomplishments and Plans

Recent mathematical research has provided a theoretical basis for the design of popular codebook algorithms. NSA will continue to design new algorithms for the unique requirements of the military, the DoD, and the intelligence community. A multi-year research effort in public key cryptography will produce designs for efficient public key algorithms and protocols, faster and more efficient arithmetic techniques, elliptic curve software, proactive authentication techniques, related technical support, and public key cryptography standards support. Quantum computing is a new and potentially powerful threat to traditional cryptography. Research has begun to counter this threat using key exchange techniques that use the laws of quantum physics as the basis for the fundamental protection. Another new area of research will investigate new classes of cryptoalgorithms that are not susceptible to attacks by quantum computing techniques. Specific challenges for FY99 include the design of new high-speed algorithms, algorithms practical for all-optical computation, more efficient yet wider span hashing algorithms, new

NSA

Cryptography

	authentication techniques, and more efficient elliptic curve techniques. The process of integrating cryptography into the customer's environment will include direct interaction with customers to address their needs, indirect influence through participation on standards committees, and development of standard Cryptographic Application Program Interfaces (CAPIs).
FY 2000 Plans	Mathematical research and cryptography design will continue to be performed. Areas of emphasis include: strengthening and expanding the mathematical foundations of cryptography, designing more efficient key exchange techniques, addressing key management issues (including revocation techniques and coalition mechanisms), and developing cryptologics which are resistant to quantum computing attacks. One particular area of research will continue to be Quantum Cryptography. A prototype system which requires only engineering development for actual deployment will be provided. In addition, incorporation of traditional security features such as authentication techniques will be incorporated into the Quantum Key Distribution technique to provide for an overall secure key distribution design.
Contacts	Robert Meushaw, rvmeush@home.com, (301) 688-0840
Related Web Links	Not Applicable

NSA

High Speed Data Protection Electronics

Budget	PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
	HECC	0.00	0.00	0.00	0.00
	LSN	0.00	0.00	0.00	0.00
	HCS	2.70			0.00
	HuCS	0.00			
	ETHR	0.00			
	TOTALS	**2.70**	**0.00**	**0.00**	**0.00**

Description

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 has taken the lead in developing network security and information security techniques and products for high speed networks. It has established 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 was to develop a technology that would interface to network management systems that could be used with the high speed networks that are exemplified by the National Security Community and the NII.

Projected FY99 Accomplishments and Plans

This program activity has been absorbed into new activities defined in FY99 and onward.

FY 2000 Plans

Not Applicable

Contacts

Not Applicable

Related Web Links

Not Applicable

NSA

Network Security Engineering

Budget	PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
	HECC	0.00	0.00	0.00	0.00
	LSN	0.00	0.00	0.00	0.00
	HCS	0.00			12.50
	HuCS	0.00			
	ETHR	0.00			
	TOTALS	**0.00**	**0.00**	**0.00**	**12.50**

Description

Network Security Engineering (NSE) is concerned with providing information security in a networked environment characterized by globally distributed systems and services coupled with dynamic and pervasive information sharing and collaboration. To focus its resources, NSE approaches its research by imposing an information- and services-centric systems view over the network, wherein the distributed location(s) of information and services define the information system rather than the physical network connections, end systems, servers, and mainframes.

Providing the foundation for NSE are the functional areas of policy invocation and enforcement, assurance, identification and authentication, and information domains. Policy invocation and enforcement focuses on the correct and consistent representation and enforcement of policy. One research thrust in this area is to improve the ability of operating systems to invoke and enforce policy. Current research in this area is directed at the Fluke operating system being developed at the University of Utah. A second research area area is to ensure that the design and standardization of CORBA includes security mechanisms that support policy invocation and enforcement in a distributed, object-based environment. Assurance is concerned with establishing a high degree of confidence that systems (components, software, end systems, systems of systems, etc.) are designed and implemented correctly and behave properly. To this end, this area focuses on formal methods and the development and application of techniques and technologies that can be applied throughout the system lifecycle to improve confidence in the system. Identification and authentication is concerned with establishing identities (for purposes of access control) at the entry points to the system and maintaining identity throughout the distributed system. Finally, information domains addresses architectural and systems issues associated with defining, establishing, and supporting globally distributed, services- and information-centric systems. Current emphasis is on identifying and establishing domain boundaries as points for monitoring and for access control.

NSA

Network Security Engineering

Projected FY99 Accomplishments and Plans

In the area of policy invocation and enforcement, NSA research is addressing security issues associated with the use of distributed object technology. Continuing research will identify those security problems of greatest concern to distributed object-based computing and then develop solutions for adoption by the OMG's Common Object Request Broker Architecture (CORBA). Operating System security is another component of NSA's policy invocation and enforcement research program. The focal point of current research is the Fluke operating system developed by the University of Utah. NSA has developed security-related components of the operating system which have been incorporated within Fluke.

In the area of assurance, NSA's research covers several specific topics including: verification of key generation and nuclear command and control designs, reduction of risks in executing untrusted Java code downloaded from remote Internet sites, and "belief" or higher assurance modeling in security and trust policies. Also covered in this area is protection from hands-on physical tampering. The main objectives of this research are to use industry partnerships to leverage the commercial market to develop a protective coating for semiconductor chip wafers and to develop a unique and secure government coating that can be easily produced.

In the area of identification and authentication, NSA continues to be highly successful in transferring robust and reliable biometric and smartcard identification and authentication technologies to industry.

In the area of information domains, NSA research will develop high assurance, high performance boundary protection devices that will add a capability to filter on the data itself or on specific protocols. The goal is higher efficiency and effectiveness, with much higher data rates than currently possible. NSA is also undertaking a program to assess the security implications of advanced ATM network switching technology, such as IP Switching, in order to develop appropriate network architectures and IA solutions. Finally, NSA is developing boundary devices for SONET that will provide effective management of the SONET management channel.

FY 2000 Plans

In the area of policy invocation and enforcement, NSA research will continue its focus on issues related to securing distributed systems and developing solutions for heterogeneous computing environments -- with flexibility as a key motivator and enabler for developing solutions that can accommodate a wide range of environments and needs. Special emphasis will be placed on developing mechanism-independent subsystems to enable a plug-n-play approach to constructing systems and architectural solutions to allow specific security mechanisms to function properly under the control of any of a variety of potential security policies. Additional focus will continue to address the need for strong separation of information of different sensitivities and enforcement of least

NSA

Network Security Engineering

privilege. Work with Fluke and CORBA will continue, and preliminary work with mobile agents will begin.

In the area of assurance, NSA's research will investigate how to define, represent, and use logical and verifiable specifications for components used to construct high confidence systems. Additionally, assurance research will establish basic principles that provide the foundations of measurement as scientific discipline (metrology) for IT. Particularly needed is research which focuses on establishing common frameworks and tools that enable the interchange and (semi)automated translation of specifications, domain specific languages and programs into software tools, test suites, test methods, and monitors which apply statistics and reasoning in rigorous ways, which contribute to the assessment and reasoning about complex properties, and the composition of systems with desired attributes and properties. Research is needed in both sound composition of "peer" components and in design that weighs multiple aspects of a system and composes property-based measures to achieve overall system assurance. Finally research is needed to automate the creation of models from software, including their derivation from widely used software distribution formats such as Java.

In the area of identification and authentication, NSA will continue work in biometric and smartcard technologies and begin work that will investigate maintenance of identities across and throughout a distributed environment.

In the area of information domains, assessment of the security implications of advanced ATM switching technology will continue. Additionally, research focused on identifying and defining critical research problems associated with establishing information domains will continue. Research to identify and understand architectural issues and address "system" issues associated with establishing information domains will begin. Additionally research designed to establish a framework for creating an underlying "system" infrastructure upon which information domains will depend (boundary establishment, global policy resolution, membership definition, and management) will begin.

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Related Web Links

Not Applicable

NSA

Overhead

Budget	PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
	HECC	0.00	0.00	0.00	0.00
	LSN	0.00	0.00	0.00	0.00
	HCS	0.00			16.90
	HuCS	0.00			
	ETHR	0.00			
	TOTALS	**0.00**	**0.00**	**0.00**	**16.90**

Description

This funding area includes a number of activities which support the NSA INFOSEC Research & Technology program. The technology forecasting activity identifies new information technology developments and market trends in order to help focus the research program. NSA supports and participates in the INFOSEC Research Council (IRC) as a forum for coordinating its research program with other government organizations including DARPA, DOE, NIST, and the Service Laboratories. The development of university-level educational programs in information security is another important component of the NSA research program covered by this funding area. Finally, funding is provided for personnel salaries and for the network and computing infrastructure that supports internal research activities and technology demonstrations.

Projected FY99 Accomplishments and Plans

FY99 accomplishments include publication and dissemination of a number of focused technology forecasts on the topics of middleware, optical networking, knowledge management and intelligent agents, public key infrastructure, Internet telephony, software engineering tools, VPNs, mass storage, and reconfigurable hardware. The IRC will develop and publish a coordinated list of hard research problems which will be used to guide community research agendas. Studies will be completed for the National INFOSEC Technical Baseline to capture and communicate the state-of-the-art in specific Information Assurance areas. A coordinated program roll-up will be completed to reflect the combined IA research investments of the IRC members. IA material will continue to be infused into courses and degree programs at the Naval Postgraduate School and other key universities.

FY 2000 Plans

FY00 plans include additional technology forecasts covering web caching, content protection, unified messaging, local multipoint distribution service, and mobile satellite systems. INFOSEC curriculum development will be extended to a broader set of universities. The IRC hard research problem list will be used to help derive a national IA research agenda.

NSA

Overhead

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Related Web Links	Not Applicable

NSA

Secure Communications

Budget	PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
	HECC	0.00	0.00	0.00	0.00
	LSN	0.00	0.00	0.00	0.00
	HCS	0.00			4.12
	HuCS	0.00			
	ETHR	0.00			
	TOTALS	**0.00**	**0.00**	**0.00**	**4.12**

Description

Information transport and its associated infrastructure must provide high assurance capabilities in times of crisis and attack. Secure Communications research focuses on the provision of INFOSEC services to data that is moving over a public infrastructure or over the public airways. The NSA research program encompasses the following enabling technologies: speech coding, wireless communications, high-speed cryptography, and optical networks. Coding research will develop low bit rate algorithms often required for digitizing, encrypting, and transmitting tactical voice communications. Coding research also includes noise preprocessing and forward error correction research to enhance the quality and intelligibility of the transmitted voice signal. Wireless research will investigate and counteract the vulnerabilities of the wireless services, use the results to influence the standards, provide select demonstrations for critical wireless technologies, and perform the testing, evaluation and verification needed to ensure the solutions work effectively.

Research in the area of high-speed secure communications techniques includes: high-speed microelectronics and advanced packaging, techniques to incorporate cryptographic algorithms to get higher speed performance, and consultation with customers to solve their security problems. Research in optical communications will focus on developing proof-of-concept optical logic technology and switching devices tailored for cryptographic applications.

Projected FY99 Accomplishments and Plans

During FY99 the first functional noise preprocessing algorithms will be demonstrated and tested. Significant improvements in voice quality are expected for tactical environments which have high amounts of background noise. Improvements generated by using forward error correction codes will also be demonstrated. The completion of a family of voice processing algorithms based on Mixed Excitation Linear Prediction (MELP) technology should be completed and tested. A comprehensive study of vulnerabilities of existing cellular technologies will be completed. Extensive field testing and data collection of commercial CDMA cellular systems will be completed, and recommendations will be developed to direct modifications and architectural changes to commercial systems to permit use in military applications. Vulnerability simulation tools will

NSA

Secure Communications

be developed using radio propagation models, to explore the various vulnerabilities in wireless systems. Electronics modeling techniques for multigigabit systems will continue.

Applications of advanced packaging techniques will be evaluated and tested for various core cryptographic functions. Development and demonstration of individual photonic logic cells will be completed to validate the potential for future photonics logic circuits. Initial development of small photonics subsystems made up of multiple logic devices will begin.

FY 2000 Plans

Technology transfer of the technologies developed in FY00 should be achieved. The family of MELP algorithms will be submitted as candidates for standardized NATO communications as well as US applications in new tactical radio systems. Research for improvements in voice processing technologies will continue in order to take advantage of newer, low powered processors. Prototype units of the modified commercial CDMA cellular systems will be completed and ready for extensive field testing and validation. Cellular vulnerability work will expand to include extensive analysis of satellite systems.

Modeling and simulation capability will be refined into a user friendly and useful suite of analysis tools. Assembly will be started of a proof-of-concept device which includes electronic building blocks for cryptographic functions to support 10 Gb/sec throughput. Multigigabit/sec flexible encryptors will be developed to support the secure movement of highly sensitive Intelligence Community data over public switched networks. New photonic cryptographic algorithms that employ parallel architectures will be examined for the purpose of improving system performance. Investigation of security issues particular to developing optical networks will continue in concert with DARPA, National Labs, and other Intelligence Community programs.

Contacts

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Related Web Links

Not Applicable

NSA

Secure Network Management

Budget	PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
	HECC	0.00	0.00	0.00	0.00
	LSN	0.00	0.00	0.00	0.00
	HCS	0.00			5.39
	HuCS	0.00			
	ETHR	0.00			
	TOTALS	**0.00**	**0.00**	**0.00**	**5.39**

Description

Secure Network Management is the technology area which supports the operation of a security management infrastructure (SMI) through the development of secure protocols for information sharing, network control, and monitoring of events within information systems. NSA's development of the Internet Security Association and Key Management Protocol (ISAKMP) standard through the IETF provided a valuable contribution to secure network connection establishment and network security management.

Projected FY99 Accomplishments and Plans

NSA work is proceeding on the development of a reference implementation of the IPSec protocol. Other ongoing research will develop proofs-of-concept for multicast security key management, fractional keying for multicast security, secure but non-cryptographic techniques for multicast, multicast routing security mechanisms, and group key management services. The Secure Network Management research activities will include work in several areas related to key management infrastructure. This work will include investigations of key generation, certificate management, key recovery, trusted time stamps, and directory services. Additional studies will include covering secure binding of X.509 certificates to security attributes, certificate revocation, cross-certification from multiple security domains, and key recovery techniques.

FY 2000 Plans

Future research will produce security-enhanced Internet protocol specifications, reference implementations, and support in worldwide standards bodies.

Contacts

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Related Web Links

Not Applicable

NSA

Secure Operating System Development

Budget	PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
	HECC	0.00	0.00	0.00	0.00
	LSN	0.00	0.00	0.00	0.00
	HCS	4.50			0.00
	HuCS	0.00			
	ETHR	0.00			
	TOTALS	**4.50**	**0.00**	**0.00**	**0.00**

Description

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 was developing an ` open architecture, along with secure distributed system prototypes, based upon security policy-flexible, operating system microkernels. Synergy aimed to provide a means for commercial vendors to address a wide variety of security markets with a single architecture, thus lowering everyone's costs.

Projected FY99 Accomplishments and Plans

This program activity has been absorbed into new activities defined in FY99 and onward.

FY 2000 Plans

Not Applicable

Contacts

Not Applicable

Related Web Links

Not Applicable

NSA

Supercomputing Research

Budget	PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
	HECC	24.20	21.67	21.67	24.90
	LSN	0.00	0.00	0.00	0.00
	HCS	0.00			0.00
	HuCS	0.00			
	ETHR	0.00			
	TOTALS	**24.20**	**21.67**	**21.67**	**24.90**

Description

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:

MARQUISE/SOLITAIRE - This effort repackages a High Performance Computer (HPC) using diamond-based Multi-Chip Modules (MCMs) and thin film spray cooling. The SOLITAIRE computer prototype will demonstrate binary software code compatibility with the commercial product it is based on. This prototype will also demonstrate the maturity of high density packaging technologies incorporating die last MCMs, diamond substrates, and spray cooling. The integrated system will be subjected to environmental testing to demonstrate reliability.

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 - The spray cooled power converter research program will develop a high density, high efficiency power converter using spray cooling and planar laminated transformers. Investigations will include a novel approach of applying isothermal spray cooling to overcome the fundamental co-efficient of thermal expansion mismatch encountered during hybrid integration of Silicon or Gallium Arsenide (GaAs) devices with Diamond substrates.

FIBER-OPTIC LOGIC - Optical techniques can theoretically support data rates of several hundred Gb/s for future communications and computing systems. This is accomplished by providing logical functions that expedite the data routing

NSA

Supercomputing Research

process. Transmission at high data rates demands techniques that can restore data signals so that low bit error rates can be maintained without compromise of signal quality.

OPTOELECTRONIC CIRCUITS - this project supports research into a high performance spectrometer on a chip, and a semiconductor optical amplifier.

PROGRAMMING METHODS AND LANGUAGES - This project supports research in computational methods and languages for massively parallel, distributed heterogeneous computing platforms, and special-purpose processors. Specific work includes the ongoing development of the compiler AC (which targets the T3D and T3E architectures, among others) and the implementation of the 'futures' model of message-passing programming.

QUANTUM COMPUTING - Some of the future plans proposed within the QC research community include demonstrating 1-qubit operations and performing experiments to achieve 2-qubit operations using the optical-lattice method of trapping atoms, and simulation of the dynamics of a set of qubits in finer detail than previously achieved. Experimental research on quantum dots and Josephson junctions as possible qubits will be started in-house. Another project will investigate individual nuclear spins implanted in a silicon crystal as qubits; this will be partly in-house and partly performed by external teams.

Projected FY99 Accomplishments and Plans

The MARQUISE/SOLITAIRE project was completed in FY99. The miniaturized high performance computer architecture was condensed onto a 500 Watt, 8-inch by 8-inch double-sided printed wiring board. The operating system was successfully booted on this prototype board, and several of the NSA High Performance Computing benchmarks were successfully executed, giving identical results to the commercial system--without software modification to the source codes. The SOLITAIRE rack system was assembled with a 500 Watt load board and tested successfully. Testing included successful operation of the rack system over a wide range of environmental conditions, including low and high altitude testing, high and low temperature testing, and vibration testing along all three axes.

MICRO SPRAY COOLING - A compliant diamond substrate was designed and analyzed. Successful direct die attachments of Gallium Arsenide (GaAs) and Silicon were achieved on diamond substrates. No cracking of the devices was observed. Studies of available power switches were performed and measurements made.

FIBER-OPTIC LOGIC - The data rate for the wavelength converter was increased to 80 Gb/s. A solid state optical amplifier was employed in an interferometric configuration as a switched converter to give pulse reshaping. Demonstrated wavelength conversion in a DFB laser through the cross grain modulation which is observed in the solid state optical amplifier.

NSA

Supercomputing Research

QUANTUM COMPUTING - More than nine universities and companies will be conducting research in this field during FY99. Some of the projected accomplishments include: developing the quantum analogues of classical information and communication theory which should help in QC design and evaluation in the future; the application of the "hidden subgroup" problem to the design of new quantum algorithms; studies of the computational power achievable in models in between classical and quantum computing; experiments to verify a new pulsed-laser technique for implementing quantum logic gates between photons; attempts to create entanglements of three photons; achievement of coherent quantum state manipulations of a few ions; and creation of clear evidence of quantum superposition, entanglement, multi-qubit operations, and characterization of the resulting quantum coherence. Another open competition will be held in collaboration with the Army Research Office; winning proposals will be funded for three years starting in late FY99.

PROGRAMMING METHODS AND LANGUAGES - UPC and AC are language extensions to ANSI C that embody a model of shared memory parallel computation which is both easily programmable and scalable to very large systems. In FY99 efforts related to AC and UPC have resulted in efficient compilers for the SGI T3D and T3E multiprocessors which are widely used in the high performance computing user community. The major technical advances are in the areas of code optimization and efficient memory system interface. In addition, effort was devoted to establishing relationships with several system vendors to obtain UPC support on a wide variety of platforms.

OPTOELECTRONIC CIRCUITS - Fabricate and test a fully integrated 4 X 4 semiconductor optical amplifier cross-connected switch. Fabricate and test 10 GHz transimpedance amplifiers on WDM receivers. Fabricate 1.55 micron VCSELs and modulators using Sb based mirror stacks.

FY 2000 Plans

MICRO SPRAY COOLING - A structural and process design methodology will be defined. The power circuit requirements will be refined, and a power converter topology will be selected. A single-level assembly will be built and tested.

QUANTUM COMPUTING - Some of the future plans proposed within the QC research community include demonstrating 1-qubit operations and performing experiments to achieve 2-qubit operations using the optical-lattice method of trapping atoms, and simulation of the dynamics of a set of qubits in finer detail than previously achieved.

PROGRAMMING METHODS AND LANGUAGES - UPC and AC are language extensions to ANSI C that embody a model of shared memory parallel computation which is both easily programmable and scalable to very large systems. In FY00 NSA plans to continue to support and enhance the compilers

NSA

Supercomputing Research

developed for the SGI T3D and T3E multiprocessors and develop capabilities for a large clustered platform which will become available to users. In addition, NSA plans to continue joint efforts it is establishing with multiple system vendors to provide support for UPC in their native compilers.

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Related Web Links http://www.sainc.com/arpa/ultrascale/slides/index.htm

NSA

Superconducting Research

Budget

PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
HECC	2.22	2.30	2.30	2.60
LSN	0.00	0.00	0.00	0.00
HCS	0.00			0.00
HuCS	0.00			
ETHR	0.00			
TOTALS	**2.22**	**2.30**	**2.30**	**2.60**

Description

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.

HYBRID TECHNOLOGY MULTITHREADED ARCHITECTURE (HTMT) - This program is evaluating the feasibility of constructing a computer capable of performing at a sustained rate of a Petaflops: 10**15 floating point operations per second. Preliminary evaluations using conventional architectures and expected technologies, mainstream ones, established the necessity of a radical departure from the present paths. A multithreaded architecture has been postulated which is enabled by a blend of modified semiconductor technology with the necessary addition of components demonstrated at the research laboratory level. These hybrid technologies--superconductive, optical, semiconductor, and magnetic--are configured to produce the necessary memory and processor elements to satisfy the architecture requirements. The fundamental drivers are multi-gigahertz speeds, exceptional bandwidths, and very large--cost effective--memory size. Given a positive result from this evaluation, a program is expected to build major sections of a prototype to then lead to a full machine.

SUPERCONDUCTIVE CROSSBAR SWITCH - This work will demonstrate by construction a 128 x 128 crossbar switch which operates at 2.5 Gb/Sec per port for use in supercomputing and network applications. Its unique properties are: - Self-routing - Skew per port less than 10 ps - Scalability in size from 32 x 32 to > 1024 x 1024 - latency < 4 ns Althœgh the crossbar electronics operate at 4K, its input and output ports are at room temperature, and the cryogenic elements are cooled by a refrigerator, thus providing the user with standard room temperature support. Extended to higher speed and size, this switch is a candidate element for use in HTMT.

OPTICAL TAPE DEVELOPMENT - Within the Government, existing mass store data capabilities are woefully inadequate to meet near term demands for data

NSA

Superconducting Research

storage. In addition, data rates fall very short of what is required to support advanced computing requirements. A higher capacity medium which is compatible with existing mass-store systems would save the Government millions of dollars that would otherwise be spent to expand floor space to house additional mass storage. SMART MEMORIES - A project to produce a flexible computing architecture that is more power efficient than the current evolutionary path of RISC architectures and still programmable in a high level language. This architecture will be adaptive and able to reconfigure itself to be optimal for the computation currently executing. In this way, the computer architecture can accommodate a wide class of algorithms, ranging from coarse to fine grain.

Projected FY99 Accomplishments and Plans

HTMT - A complete report on all the subelements will be produced. This will include preliminary tests, data, simulations, sizing, produceability, and performance estimates for a full system. It will also contain cost estimates and recommendations, if warranted, for the follow-on work.

SUPERCONDUCTIVE CROSSBAR SWITCH - The room temperature electronics and support connections have been specified. Layout of the 24-chip multi-chip module is almost (95%) complete. Circuit modifications to increase operating margins have been made. The cooling system has been characterized, and preliminary design of the physical housing for the crossbar is complete.

OPTICAL TAPE DEVELOPMENT - This project will design, build and test a 25 MByte/sec alpha level prototype of an optical tape drive. Accomplishments will include the design of a prototype tape transport, the integration of optical path modules and the packaging of modulator drivers, detection array and pre-amps in final form factors.

SMART MEMORIES - Key accomplishments in FY99 include a definition of a streaming applications benchmark set, a VLSI wire design study, a smart memory study incorporating fabrication and OS constraints.

FY 2000 Plans

HTMT - If the report of FY99 so indicates, a program will begin in FY2000 to construct a significant portion of a machine to allow test and verification of all elements. This would take approximately three years of funding.

SUPERCONDUCTIVE CROSSBAR SWITCH - Construction and assembly of the 128 x 128 will begin. The chips will be built, electronics completed, housing of the MCM and cables completed.

SMART MEMORIES - Plans include the design and fabrication of a reconfigurable wiring test chip, the development of programming models for smart memories, and completion of a proposed Smart Memory Architecture

NSA

Superconducting Research

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Related Web Links	http://htmt.cacr.caltech.edu/

NSA

Very High Speed Networking

Budget	PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
	HECC	0.00	0.00	0.00	0.00
	LSN	2.18	3.00	3.00	1.72
	HCS	0.00			0.00
	HuCS	0.00			
	ETHR	0.00			
	TOTALS	**2.18**	**3.00**	**3.00**	**1.72**

Description

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.

Projected FY99 Accomplishments and Plans

In FY99 NSA demonstrated ATM over a wavelength, without any intervening SONET infrastructure (e.g., intervening SONET terminals). This is the first step in trying to reduce the layers, make the networks less complex, and move the control back to the endpoints of the network. NSA, working with partners at the Naval Research laboratory (NRL) and the Defense Intelligence Agency (DIA), transmitted an HDTV 720 progressive digitized signal, at 1.5 Gb/s through the equivalent of 400 Km and 8 ATM switches (by suitably fixing the route tables on two switches between NSA and NRL over a static-wave division multiplexed link). For the remainder of FY99, NSA will field an all-optical transparent internet on the ATDnet in the Washington, DC, area, employing two optical network technologies. These are prototype wavelength routers from Lucent Technologies provided under the DARPA-funded MONET Consortium project, and NSA's Optical Cross Bar Network from Optical Networks, Inc. NSA will demonstrate end-to-end communication with no intervening electro-optical conversion. The transparency of the network permits the switches to operate independent of the protocol, or the data rate, on the traffic-bearing channels. On this network, NSA will demonstrate the concept of "just in time signaling" with "optical burst switching," as a means to provide both packet service and circuit service on the same infrastructure. This issue is not "voice/circuit-switched network versus data/packet-switched network," but rather how one provides both quality services on a single network? This attacks the key issue of Gb/s networks of the future, which will not be availability of bandwidth, but latency of the communication.

NSA

Very High Speed Networking

NSA will also demonstrate optical multicasting, employing the "drop and continue" feature of the wavelength routers acting as a public network, and the natural multicasting capability of an optical crossbar switch, acting as a private all-optical network. Participating ATDnet sites will be NSA (at its new Laboratory for Telecommunications Science), NASA Goddard Space Flight Center, NRL, and DIA. Various performance and functionality/viability experiments will be conducted to try to determine the limitations, if any, of these new approaches.

FY 2000 Plans

Work is needed to advance the definition of a signaling, routing, addressing, and multicasting architecture. These are all interrelated, and while they may actually function separately in a network, they need to be addressed simultaneously. NSA needs an addressing structure which not only addresses multicasting, but provides for a single unambiguous address representing end nodes (ITU standard NSAPs, as in ATM, are not unique across a network), and at the same time is scaleable (IP unique addresses are not easily scaleable without redefinition) and acceptable to ITU (needing to preserve some form of the international multiple address domain control). Routing approaches of today's voice and Internet networks are both expected to be insufficient for networks supporting multi-Gb/s connections. With data becoming the predominant traffic volume, the predictive algorithms of well behaved voice traffic do not apply. (Data is self-similar and does not smooth when aggregated, as voice traffic does.) But the fully distributed Internet routing approach is unlikely to keep an adequately timely view of the state of the network when 10Gb - 100 Gb files are transmitted at 1 Gb/s - 10 Gb/s all optically. Thus some salient combination of the two approaches seems in order for these new networks. Based on the results of the experiments in FY99, NSA will study the new characteristics that are expected for congestion control. One theory that will be tested is that in an all-optical network with no buffering and judicious use of wavelength translation, one might not even see congestion in an all-data subnetwork during the brief time that a channel is held at any individual switch when "just in time signaling" is used.

NSA will also address multi-domain network management. Approaches from both the voice and Internet networks can be helpful, but they are not the answer. Carriers of voice traffic carefully isolate themselves from the carriers that they hand off connections to. There is little network management information sharing, as such information is considered to be highly proprietary information that forms the basis for their competitive advantages for providing user services. On the other hand, while Internet permits "read only SNMP access" across network boundaries for access to selected Management Information Base (MIB) data, this is not usually sufficient to debug a connection end to end, nor is the approach for access likely to be acceptable to carriers. NSA will look at a peer relationship between network management centers, which exchange information in a controlled way, that will enable end to end monitoring and fault isolation of connections. New techniques are essential for transparent networks, as the carrier would no longer have access to control fields within the data channel to determine

NSA

Very High Speed Networking

whether a line is acceptable or not.

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Related Web Links

http://www.bell-labs.com/project/MONET
http://www.darpa.mil/ito/Summaries97/B517_ 0.html

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.

NIST

FY 1999-2000 Budget (Dollars in Millions) Comparison by PCAs

Program Activity	Budget				President's Budget by HPCC PCAs						
					FY 1999 Request		FY 1999 Estimate		FY 2000 Request		
	FY98 Estimate	FY99 Request	FY99 Estimate	FY 00 Request	HECC	LSN	HECC	LSN	HECC	LSN	HCS
Information Technology Metrology, Testing and Applications	12.40	6.70	6.70	12.20	3.50	3.20	3.50	3.20	3.50	3.20	5.50
Systems Integration for Manufacturing Applications	12.70	2.00	2.00	2.00	-	2.00	-	2.00	-	2.00	-
Totals	**25.10**	**8.70**	**8.70**	**14.20**	**3.50**	**5.20**	**3.50**	**5.20**	**3.50**	**5.20**	**5.50**

NIST

Information Technology Metrology, Testing and Applications

Budget

PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
HECC	3.50	3.50	3.50	3.50
LSN	3.20	3.20	3.20	3.20
HCS	2.50			5.50
HuCS	3.20			
ETHR	0.00			
TOTALS	**12.40**	**6.70**	**6.70**	**12.20**

Description

Collaborate with industry and other agencies to support development of measurement methods and standards to promote interoperability, common user interfaces and enhanced security for computer and communications systems; develop prototype implementations; establish testbeds and support advanced technology demonstrations. Develop, enhance and demonstrate methods for measuring performance of scalable, high performance systems, and identification of performance bottlenecks in systems and software.

Promote the research, development and application of measurement sciences to assess and enhance the performance of human-computer interface technologies. Conduct collaborative research and development of algorithms, recognition methods, and reference materials to promote commercial viability of the results of R&D in spoken natural language recognition, image recognition, information search and retrieval, and advanced collaboration technologies.

Develop advanced algorithms, software, methodology and tools to support the efficient application of computationally intensive science to key problems arising in the industrial sector. 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.

Projected FY99 Accomplishments and Plans

(*) Develop and demonstrate remotely-accessible, network-based conformance and interoperability test engines built on a standard network interface.
(*) Integrate emerging search, retrieval and network computing technologies into World Wide Web services for the computational science community.
(*) Establish the Information Technology Security Test Center and associated capabilities.
(*) Develop evaluation methodologies and test corpora for measuring scalability

NIST

Information Technology Metrology, Testing and Applications

and usability of visual interfaces that support access to large collections of complex documents.
(*) Develop characterization and instrumentation methods that support and advance the engineering and application of heterogeneous networked computing.
(*) Develop new metrics and software tools for evaluating the quality of linerar algebra software.
(*) Develop and release a portable high-performance parallel package for core sparse matrix computations.

FY 2000 Plans

(*) Continue development and demonstration of remotely-accessible, network-based conformance and interoperability test engines built on a standard network interface.
(*) Develop new designs and prototypes for a software library of mathematical functions based on network client-server transactions for medium-scale computational problems such as the solution of linear systems and eigenvalue problems.
(*) Develop a unified system that supports testing and evaluation of mathematical software, and dissemination of related reference data sets for the areas of linear algebra, special functions and statistics on the Web.
(*) Continue research in computational tools developed for modeling the micro-magnetic properties of materials.
(*) Adopt an Advanced Encryption Standard that satisfies the need for a successor to the Data Encryption Standard, DES FIPS 46-2.
(*) Provide conformity assessment methods to ensure consistency and accurate use of the Java specification, develop formal description of the Java Virtual Machine specification, and release a Java SmartCard simulator.
(*) Develop conformance tests for advanced functionality of Virtual Reality Modeling Language (VRML) browsers.
(*) Develop recommended practices to make VRML worlds accessible to the disabled.
(*) Develop standard reference data and guidelines for a more reliable means of identifying and matching persons based on facial data and a more reliable means of identifying, exchanging, and storing fingerprint information; distribute face recognition data to developers; and develop a standard interface between fingerprints and NIST's digital signature standard to enable authentication of data.
(*) Develop multilingual versions of existing English tests in each domain of study, and develop larger test sets. Provide a neutral forum for organizations interested in comparing text retrieval results; develop metrics for assessing search results for multimedia information.
(*) Extend BACnet and UCA to allow for secure and reliable communications across the utility meter.
(*) Organize task groups by major industry groups and prioritize applications specific requirements to be addressed by Security for Supervisory Control Systems.

NIST

Information Technology Metrology, Testing and Applications

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Related Web Links

Information Techology Laboratory:
www.itl.nist.gov/product2.htm
Human-Computer Interaction:
www.itl.nist.gov/div894/
Scalable System Performance Analysis:
www.scheck.nist.gov/group.html
Networking:
www.antd.nist.gov/antd/html/itg.html
Computational Science and Mathematics
http://math.nist.gov/mcsd/#Projects
Software Testing:
www.nist.gov/itl/div897/sdctprod.htm

NIST

Systems Integration for Manufacturing Applications

Budget

PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
HECC	0.00	0.00	0.00	0.00
LSN	2.00	2.00	2.00	2.00
HCS	0.00			0.00
HuCS	10.70			
ETHR	0.00			
TOTALS	**12.70**	**2.00**	**2.00**	**2.00**

Description

Emphasis is on the development of interfaces providing information interchange between manufacturing applications and virtual reality environments, on the application/augmentation of virtual reality and simulation environments to manufacturing specific problems, on the development and provision of authoritative, internet-accessible repositories of scientific and engineering knowledge, and on the development of mechanisms enabling the deployment of collaboratories supporting manufacturing-related research and development.

Research efforts will be conducted in the context of industry needs leveraging strong partnerships with commercial organizations, academic collaborators, and related government efforts. Next Generation Internet (NGI) capabilities are particularly necessary to enable collaborative activities with geographically dispersed partners; collaborative activities over the NGI will also provide a means for validating NGI infrastructure efforts. Results stemming from interface development efforts will be measured by successful standardization of interface specifications and commercial implementations of those specifications. Results stemming from development of scientific and engineering knowledge repositories will be measured by external usage of those repositories, citations, and transfer of the implementation mechanisms to industrial users. Results stemming from collaboratory development will be measured by significance of the evaluation methods applied, by the significance of the improvements to the human interaction processes, and by the identification of unfulfilled interface needs supporting engineering and manufacturing processes in a collaborative environment.

Additional research activities associated with the application of HPCC technology include:
(1) remote operation of scanned probe microscopy systems for collaborative measurement and diagnostic purposes using standardized data representations and controller interfaces, and
(2) characterization, remote access, and simulation of a new class of parallel-actuated machine tools that present new possibilities for high-speed, high-accuracy, high-stiffness, multiaxis machining.

NIST

Systems Integration for Manufacturing Applications

Projected FY99 Accomplishments and Plans

(*) Experimental collaboratory supporting robotic arc welding research
(*) Experimental multi-user robotic arc welding virtual reality environment
(*) Prototype manufacturing visualization language specification for control of virtual reality environments
(*) Internet-accessible chemical property repository with search capabilities based on species substructure
(*) Initial version of internet-accessible macromolecular protein structure repository
(*) Revised version of internet-accessible high-temperature superconducting material data repository
(*) Internet-accessible engineering statistics handbook
(*) Demonstrate remote operation, data collection, and simulation of a new class of parallel-actuated machine tools
(*) Demonstrate remote operation of scanned probe microscopy systems for collaborative measurement and diagnostic purposes using standardized data representations and controller interfaces

FY 2000 Plans

(*) Conference focusing on virtual reality for manufacturing
(*) Virtual reality environment for visualization of milling machine error data
(*) Initial evaluation of manufacturing collaboratory environment in industrial use
(*) Initial specification enabling integration of human ergonomic simulations with manufacturing simulations
(*) Initial internet-accessible repository of full structural crystallographic data for inorganic materials
(*) Initial version of internet-accessible molecular recognition knowledge repository

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Related Web Links

http://www.nist.gov/sima/
http://www.mel.nist.gov/namt/

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.

NOAA

FY 1999-2000 Budget (Dollars in Millions) Comparison by PCAs

Program Activity	Budget				President's Budget by HPCC PCAs						
					FY 1999 Request		FY 1999 Estimate		FY 2000 Request		
	FY98 Estimate	FY99 Request	FY99 Estimate	FY 00 Request	HECC	LSN	HECC	LSN	HECC	LSN	HCS
Advanced Scalable Computation	4.30	9.30	8.80	10.30	9.30	-	8.80	-	10.30	-	-
Information Dissemination Pilots	0.50	-	-	-	-	-	-	-	-	-	-
Networking Connectivity	2.70	2.70	2.70	2.70	-	2.70	-	2.70	-	2.70	-
Totals	**7.50**	**12.00**	**11.50**	**13.00**	**9.30**	**2.70**	**8.80**	**2.70**	**10.30**	**2.70**	**-**

NOAA

Advanced Scalable Computation

Budget	PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
	HECC	4.30	9.30	8.80	10.30
	LSN	0.00	0.00	0.00	0.00
	HCS	0.00			0.00
	HuCS	0.00			
	ETHR	0.00			
	TOTALS	**4.30**	**9.30**	**8.80**	**10.30**

Description

Advanced Scalable Computation is NOAA's program to make possible major improvements in the Nation's ability to forecast the weather and predict climate change by taking full advantage of scalable highly parallel 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 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. GFDL has also redesigned the Modular Ocean Model using advanced software technologies to support efficient use of massively parallel computers.

NOAA/NMC's collaborative efforts with NASA and DOD/NRL have resulted in execution of a parallel, adiabatic version of the NMC global spectral model with excellent scalability at high resolution.

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.

The Forecast Systems Laboratory has developed and published the first modules in the Scalable Modeling System, a suite of advanced modules which take advantage of advanced software technologies to support rapid development of atmospheric models.

Projected FY99 Accomplishments and Plans

Develop parallel versions of GFDL models, such as the Limited-Area Nonhydrostatic (LAN) Model and the atmospheric spectral core model, to run on scalable high-performance computers.

Modernize the FSL's High Performance Computing System to support further enhancements to the Scalable Modeling System.

NOAA

Advanced Scalable Computation

Complete the distributed memory version of NCEP global analysis and evaluate the NCEP Regional 4-Ddata assimilation system

FY 2000 Plans

NOAA will use advanced technology, including the new computing system at FSL, to develop software that will ease the conversion of numerical software routines to be able to rum on a number of massively parallel, scalable machines. The system will be used to conduct data sensitivity analyses necessary to test and evaluate observing systems design for identifying the most cost-effective mix of sensors and measurements for next generation weather observing systems, and to work toward implementing highly parallel state-of-the-art numerical models for weather prediction, especially a national domain mesoscale high resolution model. NOAA will also develop the next-generation NOAA coupled research model using more realistic physics, higher resolution, and full ocean-atmosphere-soil coupling and evaluate its skill for seasonal-interannual climate prediction and its capability for elucidating the processes controlling El-Niño-Southern-Oscillation events.

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Related Web Links

www.hpcc.noaa.gov
www.gfdl.gov
www.ncep.noaa.gov
www.fsl.noaa.gov

NOAA

Information Dissemination Pilots

Budget

PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
HECC	0.00	0.00	0.00	0.00
LSN	0.00	0.00	0.00	0.00
HCS	0.00			0.00
HuCS	0.50			
ETHR	0.00			
TOTALS	**0.50**	**0.00**	**0.00**	**0.00**

Description

Information Dissemination Pilots is NOAA's program activity to begin pilot dissemination through the Internet of the vast amount of environmental data and information for which NOAA is responsible using advanced technologies for the discovery, integration and presentation of the data and information. 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.

Projected FY99 Accomplishments and Plans

Developed a prototype 3D representation of El Niño and La Niña, using advanced Internet modeling languages, and including near-real-time data, available on the Web. This representation demonstrates the power of 3D modeling languages to improve understanding of the formation and evolution of this important climate phenomenon.

Web versions of several documents from the NOAA Coastal Zone collection available on the NOAA Coastal Services Center Library Web site using advanced data base tagging which provides greatly enhanced ability to adapt information to the needs of the user.

FY 2000 Plans

Work in FY 2000 will include further experimentation and evaluation of innovative information dissemination systems for NOAA data both in routine and emergency situations. These systems will continue to push toward making access to NOAA data easier amd more transparent to the user while ensuring timely, robust dissemination of critical public data and information. NOAA anticipates building on the work of other agencies such as the NSF sponsored habenero tools, and DOE's collaboratories.

Contacts

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NOAA

Information Dissemination Pilots

Related Web Links

www.hpcc.noaa.gov
www.pmel.noaa.gov
www.csc.noaa.gov

NOAA

Networking Connectivity

Budget	PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
	HECC	0.00	0.00	0.00	0.00
	LSN	2.70	2.70	2.70	2.70
	HCS	0.00			0.00
	HuCS	0.00			
	ETHR	0.00			
	TOTALS	**2.70**	**2.70**	**2.70**	**2.70**

Description

Networking Connectivity is NOAA's program activity to greatly increase its ability to disseminate high volumes of 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 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.

Projected FY99 Accomplishments and Plans

NOAA is leveraging the high performance wide area networks developed under the Next Generation Internet to enhance the productivity of many of our advanced researchers.

Very high speed (OC12) advanced technology network has been implemented in NOAA Boulder laboratories providing virtual LAN capability and support for ATM-based video throughout the building. The system is also interoperable with nation-wide ISDN-based conferencing systems.

Evaluated an HPCC-based mobile/wireless emergency response/crisis management system which includes mobile on-scene data, voice and video for the evaluation of hazardous materials spills.

FY 2000 Plans

In FY 2000 NOAA will continue to enhance its information dissemination capabilities by expanding access to high-speed networks, developing advanced techniques to efficiently and effectively use the existing bandwidth, and develop tools to support advanced network monitoring features. Experimentation with and evaluation of advanced wireless technologies will continue as we work toward the ability to provide managers and decision makers with the capabilities of teleimmersion for the evaluation of hazardous materials spills.

NOAA

Networking Connectivity

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www.hpcc.noaa.gov
www.boulder.noaa.gov
www.pmel.noaa.gov
www.csc.noaa.gov

Agency for Health Care Research & Quality

The Agency for Health Care Research and Quality (AHRQ, formerly 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, patient care data standards, information access and telehealth. 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 AHRQ 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.

AHRQ

FY 1999-2000 Budget (Dollars in Millions) Comparison by PCAs

Program Activity	Budget				President's Budget by HPCC PCAs						
					FY 1999 Request		FY 1999 Estimate		FY 2000 Request		
	FY98 Estimate	FY99 Request	FY99 Estimate	FY 00 Request	HECC	LSN	HECC	LSN	HECC	LSN	HCS
Computer-based Patient Records	5.50	3.10	3.10	2.75	-	3.10	-	3.10	-	2.75	-
Information Technology	-	-	-	2.75	-	-	-	-	-	2.75	-
Totals	**5.50**	**3.10**	**3.10**	**5.50**	**-**	**3.10**	**-**	**3.10**	**-**	**5.50**	**-**

AHRQ

Computer-based Patient Records

Budget

PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
HECC	0.00	0.00	0.00	0.00
LSN	0.00	3.10	3.10	2.75
HCS	0.00			0.00
HuCS	5.50			
ETHR	0.00			
TOTALS	**5.50**	**3.10**	**3.10**	**2.75**

Description

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.

Projected FY99 Accomplishments and Plans

Have put in place projects that support the computerized decision support program. They link clinical practice guidelines developed in the private sector with computer-based patient record systems using web technology. The projects include expert advice for babies with newborn jaundice, post-hospitalization care for atologous bone marrow transplant patients, depression treated in an ambulatory care setting, and prevention services for children and adults in a primary care setting. Additionally, AHCPR (AHRQ) will support the US Technical Advisory Group to the the ISO Technical Committee 215, Health Informatics, that was formed in 1998 to coordinate the development of ISO standards in health informatics, and the ANSI Health Informatics Standards Board to coordinate health informatics standards developing organizations in the U.S.

FY 2000 Plans

The published results from the computer-based patient record program will be flowing to the public and additional grant projects in decision support systems will be initiated.

AHRQ

Computer-based Patient Records

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Related Web Links

http://www.ahcpr.gov/

AHRQ

Information Technology

Budget	PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
	HECC	0.00	0.00	0.00	0.00
	LSN	0.00	0.00	0.00	2.75
	HCS	0.00			0.00
	HuCS	0.00			
	ETHR	0.00			
	TOTALS	**0.00**	**0.00**	**0.00**	**2.75**

Description

The health information technology program of AHCPR (now AHRQ) supports research into the uses of information technology to improve the medical effectiveness and cost effectivenes of health care. Studies in this program will emphasize improvements in the quality of care and in informed decisionmaking by purchasers of health care.

Projected FY99 Accomplishments and Plans

To improve the quality tools needed for better decisions in health care, AHCPR (AHRQ) will produce an improved set of clinical performance measures for health care, investigate their validity, develop a relational data base of population characteristics and disease prevelance, and make this information available in automated format. It is expected that purchasers of health care for selected populations will use this tool, CONQUEST, to fomulate a quality indicator set of clinical performance measures tailored specifically to their populations and to the diseases that are prevalent in those populations.

To obtain information about the medical knowledge base that has been presented for health provider access, AHCPR (AHRQ) will partner with the American Medical Association and the American Association of Health Plans to produce a clinical practice guideline clearinghouse, using web technology. It is expected that computer-based patient record vendor companies will develop software that enables physicians to access the guidelines through the National Guideline Clearinghouse. When publically available, the complete text of the guidelines will be available through the Internet. When not publically available, information for obtaining the guidelines and their licenses will be presented.

FY 2000 Plans

The quality tools that enhance health care decisionmaking will be enhanced to use the latest technology for Internet access.

Research that investigates the uses and the resulting changes in health care processes and patient outcomes will be supported, along with pilot studies in specific sites of patient care.

AHRQ

Information Technology

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Related Web Links

http://www.ahcpr.gov/

Environmental Protection Agency

The Environmental Protection Agency's Computing, Information, and Communications Research and Development (CIC R&D) program is an integral part of a research strategy to improve human and ecological health risk management through advancement and use of high-end computing and information technologies. EPA's CIC R&D program promotes research toward a community problem solving approach to facilitate multi-discipline ecosystem modeling, risk assessment, and environmental decision making. Technology research includes scalable parallel numerical methods, reusable component technologies, rapid intelligent data access and synthesis, integrated visualization and geographical information systems capabilities closely tied to environmental modeling. Integration of technology enables more effective, scientifically defensible, and timely environmental decision making resulting in health and economic benefits for states, industry, and local communities. The EPA research program includes grants at universities and research institutions throughout the country as well as EPA intramural research laboratories.

EPA

FY 1999-2000 Budget (Dollars in Millions) Comparison by PCAs

Program Activity	Budget				President's Budget by HPCC PCAs						
					FY 1999 Request		FY 1999 Estimate		FY 2000 Request		
	FY98 Estimate	FY99 Request	FY99 Estimate	FY 00 Request	HECC	LSN	HECC	LSN	HECC	LSN	HCS
Environmental Modeling	2.18	2.20	2.20	2.26	2.20	-	2.20	-	2.26	-	-
Numerical and Data Manipulation Techniques	2.00	1.98	1.97	1.97	1.98	-	1.97	-	1.97	-	-
Totals	**4.18**	**4.18**	**4.17**	**4.23**	**4.18**	**-**	**4.17**	**-**	**4.23**	**-**	**-**

EPA

Environmental Modeling

Budget	PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
	HECC	2.18	2.20	2.20	2.26
	LSN	0.00	0.00	0.00	0.00
	HCS	0.00			0.00
	HuCS	0.00			
	ETHR	0.00			
	TOTALS	**2.18**	**2.20**	**2.20**	**2.26**

Description

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, inter-module communication and synchronization, 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.

Projected FY99 Accomplishments and Plans

Demonstrate the potential of same-time different place immersive visualization of environmental data.

Space-time tool kit allowing "on-the-fly" transformation of multi-source

EPA

Environmental Modeling

(disparate in space & time) environmental data into an interactive integrated visual display.

Award grants for research on a software framework for reusable cross-media air, water, and ecological modeling components for ecosystem management.

FY 2000 Plans

Begin a new program to explore the use of problem-solving environments and component architectures for ecosystem modeling

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Related Web Links

http://www.geog.psu.edu/apoala
http://www.geog.psu.edu/tempest
http://www.geog.psu.edu/geovista
http://www.iceis.mcnc.org/projects/kedaa/index.html
http://birch.cit.cornell.edu/ebp/projects/eclpss/eclpss.info.html
http://es.epa.gov/ncerqa_ abstracts/grants/96/high/
http://www.epa.gov/HPCC/homep.html
http://www.epa.gov/asmdnerl/models3/

EPA

Numerical and Data Manipulation Techniques

Budget	PCAs	FY98 Estimate	FY99 Request	FY99 Estimate	FY00 Request
	HECC	2.00	1.98	1.97	1.97
	LSN	0.00	0.00	0.00	0.00
	HCS	0.00			0.00
	HuCS	0.00			
	ETHR	0.00			
	TOTALS	**2.00**	**1.98**	**1.97**	**1.97**

Description

The primary objective of the numerical and data manipulation 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.

Projected FY99 Accomplishments and Plans

Demonstrate the diagnostic phase of automatic parallelization for legacy finite difference codes

Demonstration implementation of genetic algorithms on a heterogeneous distributed network of computers as a computational basis for decision support

FY 2000 Plans

Award grants for scalable parallel algorithms for subsurface geohydraulic modeling and visualization of geologic substructure

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EPA

Numerical and Data Manipulation Techniques

Related Web Links	http://es.epa.gov/ncerqa_ abstracts/grants/96/high/ http://www.ldeo.columbia.edu/eeg/Research/EPA4D/epa4d.html http://www.isc.tamu.edu/EPA/parallelcomp.html http://www4.ncsu.edu/eos/users/d/dhloughl/public/HTML/hpcc.htm http://www.iceis.mcnc.org/projects/dashmm/index_ archive.html#abstract http://www.iceis.mcnc.org/EDSS/ppar/doc/report.0697.html http://www.epa.gov/HPCC/homep.html

Glossary

ABCC	Advanced Biomedical Computing Center
AC	Language Extension to ANSI C, a parallel C language
ACTS	Advanced Computational Testing and Simulation
ACIR	NSF's Advanced Computational Infrastructure and Research
ACRF	Advanced Computing Research Facilities
AHRQ	Agency for Healthcare Research and Quality (formerly, Agency for Health Care Policy and Research (AHCPR))
ANIR	NSF's Advanced Networking Infrastructure and Research
ANSI	American National Standards Institute
ANL	DOE's Argonne National Laboratory
API	Applications Programming Interface
ASCI	DOE's Accelerated Strategic Computing Initiative program
ATDNet	Advanced Technology Demonstration Network
ATM	Asynchronous Transfer Mode
BB	Blue Book
BAA	Broad Area Announcement
BIT	Broadband Information Technology
CAN	Cooperative Agreement Notice
CAS	Computational Aerosciences
CIC	Computing, Information, and Communications
CISE	NSF's Directorate for Computer and Information Science and Engineering
CCR	NSF's Computing-Communications Research
CGAP	Cancer Genome Anatomy Project
CIT	Center for Information Technology
CPR	Computer-based Patient Records
CRADA	Cooperative Research and Development Agreement
CT	Committee on Technology
DARPA	Defense Advanced Research Projects Agency
DB	Database
DES	Data Encryption Standard
DFB	Distributed Feedback
DL	Digital Library
DNA	Deoxyribonucleic Acid
DOC	Department of Commerce
DoD	Department of Defense

DOE	Department of Energy
DP	Defense Programs, a part of DOE
ED	Department of Education
EIA	NSF's Experimental and Integrative Activities
EPA	Environmental Protection Agency
EPSCoR	Experimental Program to Stimulate Competitive Research
ER	Energy Research, a part of DOE
ESnet	DOE's Energy Sciences Network
ESS	Earth and Space Sciences
Est	Estimate
ETHR	Education, Training, and Human Resources
FFT	Fast Fourier Transforms
FIPS	Federal Information Processing Standard
FISAC	Federal Information Services and Applications
FSL	NOAA's Forecast Systems Laboratory
FY	Fiscal Year
GaAs	Gallium Arsenide
Gbps	Gigabits (billions of bits) per second
GC	Grand Challenge
GFDL	NOAA's Geophysical Fluid Dynamics Laboratory
GloMo	Global Mobile
HCS	High Confidence Systems
HDTV	High Definition Television
HECC	High End Computing and Computation
HEC	High End Computing
HENP	High Energy and Nuclear Physics
HiPPI	High Performance Parallel Interface
HPC	High Performance Computer
HPCC	High Performance Computing and Communications
HPNAT	High Performance Network Applications Team
HPSS	High Performance Storage System
HTMT	Hybrid Technology Multithreaded Architecture
HuCS	Human Centered Systems
IA	Information Assurance
IAIMS	Integrated Academic Information Management System
IETF	Internet Engineering Task Force
IGM	Internet Grateful Med

I/O	Input/Output
INFOSEC	Information Security
IRC	INFOSEC Research Council
IP	Implementation Plan
ISAKMP	Internet Security Association and Key Management Protocol
ISDN	Integrative Services Digital Network
ISO	International Standards Organization
IST	Internet Security Team
ISV	Independent Software Vendor
IT	Information Technology
IT^2	Information Technology for the Twenty-first Century
IWG	Interagency Working Group
JET	Joint Engineering Team
KDI	NSF's Knowledge and Distributed Intelligence program
LAN	Local Area Network
LANL	Los Alamos National Laboratory
LBNL	Lawrence Berkley National Laboratory
LSN	Large Scale Networking
MAD	Multiple-wavelength Anomalous Diffraction
Mbps	Megabits or Millions of Bits per second
MBps	Megabits or Millions of Bits per second
MCM	Multi-Chip Module
MEII	Minimum Essential Information Infrastructure
MPI	Message Passing Interface
NASA	National Aeronautics and Space Administration
NC	National Challenge
NCAR	National Center for Atmospheric Research
NCBI	National Center for Biotechnology Information
NCEP	National Centers for Environmental Prediction
NCI	National Cancer Institute
NCO	National Coordination Office
NCRR	National Center for Research Resources
NCSA	National Computational Science Alliance
NERSC	National Energy Research Scientific Computing
NGI	Next Generation Internet
NHSE	National HPCC Software Exchange
NIGMS	National Institute of General Medical Sciences

NIH	National Institutes of Health
NII	National Information Infrastructure
NIST	National Institute of Standards and Technology
NLANR	National Laboratory for Applied Network Research
NLM	National Library of Medicine
NMC	National Meteorological Center
NMR	Nuclear Magnetic Resonance
NOAA	National Oceanic and Atmospheric Administration
NPACI	National Partnership for Advanced Computational Infrastructure
NREN	NASA Research and Education Network
NRT	Network Research Team
NSA	National Security Agency
NSE	Network Security Engineering
NSF	National Science Foundation
NSTC	National Science and Technology Council
NTON	National Transparent Optical Network
OMB	Office of Management and Budget
OMIM	Online Mendelian Inheritance in Man
ORNL	Oak Ridge National Laboratory
OSTP	Office of Science and Technology Policy
PACI	Partnerships for Advanced Computational Infrastructure
PCA	Program Component Area
PIM	Processor in Memory
PITAC	President’s Information Technology Advisory Committee
POOMA	Parallel Object-Oriented Methods and Applications
Pres	President's or Presidential
QC	Quantum Computing
QoS	Quality of Service
R&D	Research and Development
RFP	Requests for Proposal
Req	Request
RISC	Reduced Instruction Set Chip
RHIC	Relativistic Heavy Ion Collider
SAN	Storage Area Network
SDSC	San Diego Supercomputing Center
SIMA	Systems Integration for Manufacturing Applications
SLAC	Stanford Linear Accelerator Center

SMI	Security Management Infrastructure
SMP	Symmetric Multiprocessor
SLAC	Standard Linear Accelerator Center
UMLS	Unified Medical Language Systems
UPC	A programming language that combines features of AC with features of Split-C and PCP, two other parallel C languages
U. S.	United States
VA	Department of Veterans Affairs
VCSEL	Vertical Cavity Surface-Emitting Laser
vBNS	very high performance Backbone Network Services
VIA	Virtual Interface Architecture
VLSI	Very Large Scale Integration
VR	Virtual Reality
WDM	Wavelength Division Multiplexing
WWW	World Wide Web

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Acknowledgements

Many people contributed to this Implementation Plan, and we thank them for their efforts. This especially includes the Agency contributors and other Agency points of contact who provided budget numbers and program descriptions. We also thank the staff of the National Coordination Office for their help in preparing this document for publication, especially Cathy McDonald for carefully proofreading the manuscript.