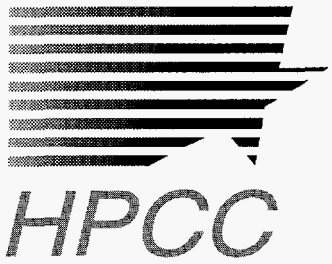

HIGH PERFORMANCE COMPUTING AND COMMUNICATIONS

FY 1996 Implementation Plan

MAY 1995

National Coordination Office for HPCC

EXECUTIVE OFFICE OF THE PRESIDENT
Office of Science and Technology Policy

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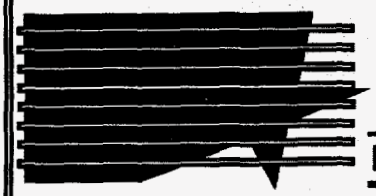

HIGH PERFORMANCE COMPUTING AND COMMUNICATIONS

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FY 1996

Implementation Plan

May 16, 1995

National Coordination Office for HPCC
Executive Office of the President
Office of Science and Technology Policy

HIGH PERFORMANCE
COMPUTING AND
COMMUNICATIONS

National Coordination Office for High Performance Computing and Communications

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May 14, 1995

Dr. John H. Gibbons
Director, Office of Science and Technology Policy
Executive Office of the President
Old Executive Building
Washington, DC 20500

Dear Dr. Gibbons:

I am proud to convey to you the Implementation Plan covering FY 1996 for the High Performance Computing and Communications Program.

This document covers in detail the plans formulated by the HPCC Agencies to implement the overall objectives of the Program. These objectives were embodied in the FY 1996 Annual Report entitled "High Performance Computing and Communications: Foundation for America's Information Future" (the Blue Book). The Blue Book accompanied the President's budget, with your endorsement and that of the Committee on Information and Communications R&D of the National Science and Technology Council.

The detail with which the budgetary commitments are described is similar to last year's plan. The organization of the material is according to a format of Accomplishments and Objectives worked out with considerable OMB guidance and help. This document, covering R&D activities through FY 1996 based on the President 's budget request, will be made available to the public.

On behalf of all the HPCC agencies, the fine professionals who serve in these agencies, and the many helpers and advisors from industry, academia, and the public, please accept my thanks for your leadership of this effort.

Respectfully yours,

John C. Toole
Director

Enclosure

HPCC FY 1996 Implementation Plan

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High Performance Computing and Communications Program

FY 1996 Implementation Plan

1. Executive Summary

The implementation plan for the High Performance Computing and Communications Program (HPCC) for FY 1996 is based on the President's request of $1.142 B. The Program is carried out by 12 Federal agencies[1] and covers both HPCC base activities that were in place prior to the beginning of the official Program in FY 1992 and activities begun as a part of the Program's new funding. The HPCC Program is responsible for some extraordinary results accomplished relative to the goals set out in 1992. This plan focuses on the efforts needed to continue to meet those goals. The process for reporting the agencies' HPCC plans continues to evolve; this report is the second year that material is being disseminated at this level of detail.

Computing and communications are ongoing, strategic, enabling technologies. Timely progress in these technologies

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

The current Federal HPCC Program provides essential stimulation and coordination to accelerate progress in crucial areas of computation, information, and communications. Success is measured both in terms of quantitative metrics and qualitative issues that influence the use of information technology in industrial practices and the information-based activities of the general public. Examples of quantitative metrics include sustained computer performance (measured in billions of floating point operations per second, "gigaflops"), network communication bandwidth (measured in billions of bits per second, "Gb/s or Gbps"), network deployment (number of nodes accessible to the network), and data storage capacity (trillions of bytes on-line, "terabytes"); indeed, these metrics are used by the Program management to gauge progress in the developing technologies.

However, these metrics do not tell the complete story. An equally important benefit of the Program is the manner in which it has accelerated progress by enabling the easy use of advanced information technology. U.S. industry has been able to maintain its competitive edge and has enhanced the public's access to information. HPCC will continue to achieve its goals as long as it provides significant enabling technology improvements that are used by industry and the public.

The HPCC Program has shown considerable progress in each of its five components. In the High-Performance Computing Systems (HPCS) component, several computer vendors, supported in part by HPCC, have demonstrated several hundred-gigaflops-class processors and systems. The computing industry and users have recognized that high performance systems of the future can be scalable, ranging from desktop systems to supercomputers based on the same processors and software; this recognition represents a significant change in the commonly accepted wisdom in less than three years.

The National Research and Education Network (NREN) component continues to expand over the Internet. A large number of new connections to the Internet have been supported since the start of the Program, including medical and public health institutions, educational institutions, and agricultural extension offices. Connections to the Internet system are growing at over 10 percent per month. Adding connections is well ahead of schedule. Network performance continues to improve: six gigabit testbed sites are operational; in addition, deployment of high-speed (up to 2.4 Gb/s) SONET network facilities has been accomplished. Testbed teams consist of Federal agencies, universities, computer companies, and telecommunication companies that participate both as service providers and experimenters. The best measure of success of NREN is the current recognition that an "Information Superhighway" is a facility available for use by everyone.

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[1] ARPA, NSF, DOE, NASA, NIH, NSA, NIST, NOAA, EPA, ED, AHCPR, and VA.

In Advanced Software Technology and Applications (ASTA), Grand Challenge teams are developing scientific and engineering applications on high performance computer systems. The Program funds a dozen high performance computer research centers (HPCRCs), serving over 12,000 users. New software tools are being provided to users, including message passing libraries, a parallel linear algebra library, 3D visualization tools, World-Wide-Web browsers, and performance monitoring and instrumentation toolkits. For example, these ASTA efforts enable detailed study of physical phenomena that affect everyone, such as weather and climate modeling, drug design, and chemical and biomedical processes.

The HPCC Program's original focus of enhancing the Nation's computing and communications capabilities now extends to address a broader set of technologies and applications that have an immediate and direct impact on critical information capabilities affecting everyone. The Information Infrastructure Technology Applications (IITA) component is designed to produce enabling technologies important to developing the National Information Infrastructure. It will demonstrate feasible solutions to information-intensive aspects of problems of national importance, such as health care and agile manufacturing. The IITA component activities will create the underlying scalable computing technologies for advanced communication services and applications support services, create an intelligent service layer, and develop an effective software development technology base. The IITA component builds on the research goals of the existing HPCC components. HPCS will integrate the IITA developments in real-time transaction processing, information storage services, highly-reliable software, and mechanisms for enhanced privacy and security. To respond to the IITA needs for universal network services, new capabilities in NREN will provide far greater numbers of connections, higher volume traffic, greater reliability, more diversity among the communication bitways (e.g., satellite, wireless, and cable), and more asymmetry to the communications media (e.g., using cable to broadcast services to customers, but using phone lines for return responses). ASTA efforts will continue to focus on developing specialized software tools, environments, and libraries for computational applications while leveraging wherever possible the new IITA developments in the areas of software for secure, reliable communications, user-friendly interfaces, interoperable software building blocks, and tools for the access and use of large diverse data sets.

The Basic Research and Human Resources (BRHR) component continues to produce critical research results along a broad spectrum of topics (e.g., molecular dynamics, RNA and DNA structures, coherent laser sources, correctness proofs for VLSI processor design, parallel numerical algorithms, and virtual environments). BRHR also expands educational opportunities and training for all academic levels (e.g., SuperQuest, EarthVision, the National High School Honors Program, Adventures in Supercomputing, outreach to historically black colleges and universities, graduate assistantships, and post-doctoral research grants). Several major universities have acknowledged the long-term importance of high performance computing by instituting cross-disciplinary Computational Sciences curricula. These studies train people to use computation effectively to enhance research efforts in other scientific disciplines.

The HPCC Program is well on its way toward meeting its original goals. Nevertheless, the HPCC Program has identified areas in which progress must be accelerated in order to keep the Program on schedule. This Implementation Plan includes adjustments to address these areas. In HPCS, performance analysis techniques are not yet adequate to assess how various applications will scale up from small prototype systems. HPCC agencies will continue to deploy prototype systems and stress efforts to find better performance prediction techniques. For computation-intensive problems, agencies will continue evaluation and development work on larger systems that have the potential to be expanded into full production systems. This Implementation Plan reaffirms the importance of the networking component and revises milestone timetables. In ASTA, efforts are expanding to establish stronger ties with independent software vendors. The objective is to reduce the risks and costs associated with moving onto scalable, high performance computing systems those applications that are critical to research issues in HPCC for the missions of Federal agencies.

To achieve its objectives, the HPCC Program will continue and expand its interactions with the Administration's National Science and Technology Council (NSTC). The NSTC Committee on Information and Communications R&D (CIC) has oversight responsibility for the HPCC Program. The High Performance Computing, Communications, and Information Technology (HPCCIT) Subcommittee which is responsible for coordinating agencies' activities in the Program, will work closely with CIC to enhance oversight activities related to HPCC (including efforts to name an HPCC Advisory Committee). The Program is coordinated by the National Coordination Office for HPCC, John C. Toole, director.

2. Introduction

The High Performance Computing and Communications (HPCC) Program was formally authorized by passage of the High Performance Computing Act of 1991 (Public Law 102-194), signed on December 9, 1991. Twelve federal agencies, in collaboration with scientists and managers from U.S. industry, universities, and research laboratories, have developed the Program to meet the challenges of advancing computing and associated communications technologies and practices. This plan provides a detailed description of the agencies' HPCC implementation plans for FY 1995 and FY 1996.

Since its inception, the HPCC Program has undergone changes that make it difficult to track funding against the originally planned funding profile. New agencies have been added, major new responsibilities have been added, and some agencies' activities not originally defined within HPCC have now been moved under this funding category.

In FY 1991 before the formal start of the program, the estimated HPCC-related activities among the original eight agencies totaled $489.4 M. The original funding profile for the HPCC Program began with this base level. The Program goals justified a level of funding that was expected to grow to roughly $1,500 M over five years. This expectation has not been met, although the Program remains a healthy and vital program providing insights and knowledge into the enabling technologies required for computation, information, and communication.

The current funding profile for HPCC shows:

- $ 654 M, FY 1992 Actual
- $ 796 M, FY 1993 Actual
- $ 912 M, FY 1994 Actual
- $1,095 M, FY 1995 Estimated appropriations.
- $1,166 M, FY 1996 modified President's request.[2]

The various factors involving these budget figures include the addition of new agencies and new activities in the existing agencies into the HPCC Program. The activities are validated by the duly constituted High Performance Computing, Communication, and Information Technology (HPCCIT) Subcommittee of the Committee on Information and Communications R&D, one of the nine committees of the National Science and Technology Council.

This Implementation Plan contains three additional sections. Section 3 provides an overview of the HPCC Program definition and organization. Section 4 contains a breakdown of the five major components of the HPCC Program, with an emphasis on the overall directions and milestones planned for each one. Section 5 provides a detailed look at HPCC Program activities within each agency.

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[2] The original budget numbers reported by OMB in February, 1995 are $762M for FY 1993, $1,080M for FY 1995 and $1,142M for FY 1996. Also, previously the budget reported for FY 1994 was $938M. Several adjustments have been made to these numbers to better reflect the agencies' actions concerning the HPCC Program.

3. Program Overview

This section provides a broad overview of the definition, organization, and management used to implement the HPCC Program. The HPCC goals and objectives provide the focus for the member agencies' management, planning, and organization of activities. Through a process of collaborative coordination, the participating agencies seek to leverage each other's activities wherever possible and to minimize redundancy in programs. However, funding for the Program flows directly to each agency participating in the Program. Each agency has its own mechanisms and approach to select and evaluate projects funded under this Program. Published reports, workshops, and continuously updated "home pages" on the World Wide Web are used to distribute the results of HPCC activities and to evaluate the overall progress of the Program.

3.1. Goals and Objectives

The High Performance Computing and Communications Program goals are to:

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

These goals will be realized by accelerating and focusing the HPCC activities within each of the Federal agencies charged with carrying out this Program and coordinating those activities among the participating agencies. Many important applications in industry, national security, and the environment require far greater computing capability than is currently available. The HPCC Program will accelerate the development of scalable computing systems that will have the capability and capacity to address more of these critical applications. It will also accelerate development of the necessary supporting technologies, such as file storage systems, computing environments, and network communications required to support the effective use of these systems. The Administration's vision for an NII places unprecedented demands for network connectivity, capacity, database availability, information management, access security, and ease of use. The HPCC Program will work with industry to help create important elements of the technology base needed for a universally accessible NII and will use this technology to develop and demonstrate prototype "National Challenge" applications. All of these activities depend heavily on the development of more cost-effective approaches to developing and maintaining software and the development of a larger pool of highly-trained professionals to use these computers and networks. The Program will develop and deploy software, tools, and improved algorithms to meet these programmatic needs. It will also establish sufficient human resources of educators, scientists, and other trained professionals in computational science and engineering to permit effective use and application of the HPCC technologies.

The HPCC Program is organized into five components with the following key aspects:

High Performance Computing Systems (HPCS):

- Accelerated development of scalable computing systems, with associated software, including networks of heterogeneous systems ranging from affordable workstations to large scale high performance systems
- Technology advances in component packaging, mass storage, and communications that support the design and use of scalable computing systems

National Research and Education Network (NREN):

- Broadened network connectivity of the research and education communities to high performance computing and research resources
- Accelerated research, development, and deployment of networking technologies

Advanced Software Technology and Algorithms (ASTA):

- Prototype solutions to Grand Challenge problems
- Improved algorithms, software technologies, and software tools for more efficient use of scalable computing systems
- Deployment of advanced high performance computing systems for R&D

Information Infrastructure Technology and Applications (IITA):

- Prototype solutions to National Challenge problems using HPCC enabling technologies
- Accelerated development and deployment of NII enabling technologies

Basic Research and Human Resources (BRHR):

- Support for research, training, and education in computer science, computer engineering, and computational science; and infrastructure enhancement through the addition of HPCC resources

3.2. HPCC Management, Planning and Organization

The HPCC Program is implemented as a partnership among Federal agencies and other organizations. The Program reports to the Director of the Office of Science and Technology Policy (OSTP). Program oversight and budgetary review are provided by the Committee on Information and Communications R&D (CIC) of the National Science and Technology Council (NSTC). The National Coordination Office (NCO) for High Performance Computing and Communications provides a central focus for the Program. The Office coordinates the activities of the HPCC agencies, other organizations participating in the Program, and organizations providing services to it. The Office also provides an interface to Congress, industry, academia, and the public. Donald A. B. Lindberg served as the NCO Director and Chair of the High Performance Computing and Communications Information Technology Subcommittee (HPCCIT) (and concurrently Director of the National Library of Medicine) from September, 1992, through February, 1995, when he returned to full time direction of NLM. John C. Toole, current Director of NCO and Chair of HPCCIT, reports to John H. Gibbons, the Director of OSTP and the President's Science Advisor.

The HPCCIT Subcommittee meets monthly to coordinate agency HPCC Programs through information exchanges, common development of interagency programs, and the review of individual agency plans and budgets. HPCCIT charters a variety of Working Groups to coordinate activities in specific areas, Task Groups to carry out specific limited duration studies, and Task Forces to make various planning recommendations. In most cases, individual agencies are assigned responsibility to lead these groups. Currently active groups include:

The Scientific and Engineering Computing Working Group, led by NASA, has the mission to identify, promote, transfer, and coordinate software developed under HPCC.

The NREN Group, led by NSF, coordinates network integration activities and works closely with the Federal Networking Council (FNC), which consists of representatives from Federal agencies that use Federally supported networks. The FNC is responsible for coordinating the efforts of government HPCC participants and other NREN government constituents, in addition to providing a liaison to non-Federal communities interested in the Federal program. A Federal Networking Council Advisory Committee of non-Federal scientists and network users has been created to support the FNC.

The IITA Task Group, led by ARPA, was chartered to acquire information on IITA-related activities planned and in progress within the HPCC agencies, to develop a plan for coordinating IITA activities among those agencies, to assist HPCCIT in reporting requirements related to IITA, and to provide advice to HPCCIT and its parent committees on technology and policy related to IITA .

The Task Force on Working Groups, led by DOE, is evaluating the current structure and coverage of HPCCIT Working Groups and will make suggestions for changes in modes of operation and coverage.

3.3. Selecting Projects for Funding

To minimize redundancy and encourage adequate funding of all HPCC areas, the HPCCIT Subcommittee works with the agencies to define complementary areas of responsibility. Within each agency, the actual mechanisms used to evaluate and fund activities differ. The HPCC agencies support R&D conducted by agency staff and researchers at national laboratories, universities, and industry. Each agency that funds external R&D activities has a program to review and fund competitive, merit-based awards that are consistent with agency mission. Calls for proposals for these grants receive wide distribution, including both electronic means (e.g., electronic bulletin boards and World Wide Web servers on Internet) and traditional media (e.g., Commerce Business Daily).

3.4. Progress Measures

The primary method of measuring progress of the Program is the establishment and subsequent review of yearly milestones described in the next section. The FY 1995 milestones for the overall Program are firm expectations, based on funding that has been estimated for this fiscal year. The FY 1996 milestones describe tentative expectations for the Program, based on the anticipated funding at the President's requested level. Achievement of these high level milestones depends on specific program activities that take place within each agency. Section 5 gives a more detailed look at each program activity. The combined successful completion of these activity-specific milestones across all agencies translates into meeting the various HPCC Program milestones.

The nature of these milestones (and hence the definition of "measuring progress") depends on the activity undertaken. In some cases, clear quantifiable measures accurately convey progress (e.g., the number of colleges and universities connected to NREN, the speed of network communications, and the computational time needed to solve a specific application problem). In these cases, the HPCC Program and Project Activity milestones use these quantifiable measures as the primary measure of progress. In other cases, a number of different quantifiable measures have been proposed, but their use does not always accurately reflect progress. For example, developing a new computer system with a peak execution speed of 100 gigaflops may not be progress if that rate can only be achieved on artificially constructed test cases. In these cases of uncertain quantifiable measures, a critical aspect of the HPCC research activity is to identify and define useful measures. Finally, in cases when quantifiable measures are unavailable or not necessarily reflective of the progress achieved, the HPCC Program relies on qualitative measures. The HPCC Program combines the advice and recommendations of technical reviewers and advisory committees with program managers' reviews to assess progress.

3.5. Reporting Results and Interactions

The HPCC Program uses a variety of vehicles to convey its results. At the individual projects level, investigators present their results in workshops, conferences, and journal publications. In addition, investigators rely on electronic means (such as the National HPCC Software Exchange and file transfer services) to quickly share and distribute their tools. At the agency level, periodic reports summarize the results of the HPCC Program. In addition, the HPCC agencies established electronic information servers to provide direct access to the results of their research projects. The NCO has also established its own information server that is linked to all of the agency-level servers. Anyone with access to the Internet can access project descriptions and technical results throughout the HPCC Program.

3.6. Program Oversight

The High Performance Computing Act of 1991 (Public Law. 102-194) requires the President to select a High Performance Computing Advisory Committee of non-Federal members, including representatives of the research, education, and library communities, network providers, and industry, who are specially qualified to provide advice and information on high performance computing and communications. Although this Advisory Committee has not yet been appointed, representatives of industrial companies, organizations, and associations have met with the HPCCIT in public sessions to advise the agencies.

Detailed program reviews are also carried out by individual agencies via their management review structures, including official advisory committees. This section highlights oversight and review activities that have been carried out recently and describes existing review mechanisms within each of the agencies.

The HPCCIT Subcommittee encourages broad comment and external recommendations on the HPCC Program. For example, the Subcommittee has devoted portions of its meetings to hosting visitors. Outreach conferences and workshops play an important role in reporting results of the HPCC Program and receiving feedback. Two recent meetings included representatives from academia, government and computer systems and mass storage vendors, the telecommunications industry, and the software industry:

- Mass Storage Meeting, October, 1994
- Software Tools, Pasadena II, January, 1995

Similar HPCCIT Subcommittee meetings are in the planning stages to acquire feedback from academia. To further the feedback process from these meetings, the HPCCIT Subcommittee will actively seek participants' comments on this Implementation Plan.

A variety of reviews, studies, and hearings on various aspects of the HPCC Program have taken place in the past 15 months and others are in the planning stages. They include:

- Computer Science and Technology Board of the National Academy of Science commissioned study of the Federal HPCC Program entitled "Evolving the High Performance Computing and Communications Initiative to Support the Nation's Information Infrastructure," National Academy Press, February, 1995.
- General Accounting Office study of the ARPA, NSF, DOE, and NASA HPCC Programs entitled "High Performance Computing and Communications: New Program Direction Would Benefit From a More Focused Effort," GAO/AIMD-95-6, November, 1994.
- The National Science and Technology Council's Committee on Information and Communications R&D Strategic Implementation Plan (March 1995).
- Congressional Staff briefing (May 1995)
- Congressional Staff briefing (possibly September 1995)
- The National Science Board commissioned Blue Ribbon Panel Report on the NSF HPC program.

Each of the HPCC agencies has its own program evaluation and reporting techniques.

The Advanced Research Projects Agency (ARPA) reviews its HPCC efforts at many different levels to insure 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. Site visits, project meetings, principle investigator meetings, and regular interactions using the Internet as an information infrastructure enable ARPA staff to keep up with their program management responsibilities. In addition, contracting details are handled by contracting agents that work with ARPA as part of the program 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 ARPA and DoD, senior ARPA 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, ARPA Comptroller, DoD Comptroller, senior ARPA 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 HPCC reviews, there are Congressional Briefings, HPCC Agency crosscuts, technical working groups, DoD advisory panels, and several National Academy of Science studies that contribute to the planning process.

The National Science Foundation (NSF) HPCC Program long-term goals and objectives consists of numerous processes and mechanisms that contribute to the definition and review of the projects supported. In addition, more specific goals and objectives are established for each of the activities within the Program. The National Science Board, panels and committees commissioned to study and recommend program activities, and external advisory committees contribute primarily to the more general, long-term goals. The establishment of goals, objectives,

implementation mechanisms, evaluative measures and the broader value of specific activities is accomplished through such means as: external peer review (mail reviews, panel reviews, and site visits), workshops for developing research agendas, program committees of visitors, technical oversight teams, ongoing site visits by program staff and outside experts, program officer review of final project reports, and the bodies of opinion held by the community of researchers themselves. Evaluation of progress is integrated into the management process as appropriate to each class of HPCC activities. Examples are:

- Blue Ribbon Panel on High Performance Computing
- Federal Networking Council Advisory Committee for parts of the NSFNET
- Directorate Advisory Committees
- Committee of Visitors for each research program

The Department of Energy (DOE) HPCC program focuses on basic mathematics and computational research and on developing and delivering technology for use by other scientists and engineers in DOE and related U.S. 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 Steering Committee and the ER Supercomputer Users Group to evaluate the effectiveness of the access and networking programs. Many of the education programs established under the DOE HPCC Program have evaluation built in. In the area of software technology, the use of prospective users of technologies as reviewers has ensured that the technology developed is that required by users. In FY 1995 and beyond, DOE will further formalize these procedures to include program-wide reviews of the basic technology components of the program by significant prospective users of those technologies. These will include reviews of effectiveness in all categories as well as specific numerical targets.

The National Aeronautics and Space Administration (NASA) HPCC Program evaluations take place at several levels. At the agency level, the NASA Advisory Council (NAC) has established the Ad Hoc Task Force on Supercomputing, which completed a review and report on the NASA HPCC Program. It is expected that other such bodies will be permanently chartered under the Aeronautics Advisory Committee to advise the NASA HPCC program. Within the program, comprehensive reviews are conducted for each of the projects annually. In addition to appropriate NASA personnel, representatives from other federal agencies, academia, and industry may be invited to participate. Annual reviews of program progress and plans will also be conducted by the NASA HPCC Working Group. In addition, quarterly reviews of the NASA HPCC Program are conducted by program managers, the associate administrator of aeronautics, and the director of the NASA HPCC Office.

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

The National Security Agency (NSA) reviews its HPCC support efforts on a yearly basis in several separate reviews. A steering group comprised 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 to the NSA program. 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 being 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, performance measures, and achievements. Consequently, programs and activities that are a part of the Federal HPCC Program are subject to review and comments of an external panel of experts from academia and industry. A written report is presented to the Director of NIST, the Administration, and Congress. Selection of individual projects and subsequent progress reviews are conducted by the program manager. These are reviewed by an inter-operating unit panel comprised of senior managers for relevance to agency mission and the Program, and for continued acceptable performance.

The National Oceanic and Atmospheric Administration (NOAA) HPCC Program supports and enhances NOAA programs in environmental prediction and stewardship. Comprehensive NOAA science reviews of these programs are held periodically, with a review cycle completed as of April 1995. Quarterly reviews of NOAA HPCC Program progress are conducted as an integral part of NOAA-wide quarterly reviews by the NOAA Administrator and other NOAA senior line and program managers. Overall NOAA HPCC Program goals and plans are reviewed annually as part of the NOAA strategic planning process.

The Environmental Protection Agency (EPA) HPCC Program is 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 review the EPA HPCC Program annually to assess its relevance to the agency mission and program achievements. Agency guidelines require an external peer review of the EPA HPCC Program every two years. The external review panel is composed of representatives from other Federal agencies, academia, and industry. The first EPA HPCC external review was scheduled for summer 1994. Within the program, each major project is reviewed at least twice a year to evaluate progress toward the program objectives.

The Department of Education (ED) HPCC Program is focused on several areas relating to developing resources for and skills within the Education community.

The Agency for Health Care Policy Research (AHCPR) HPCC Program focuses on health care technology applications of computer based patient records, computerized clinical decision support systems, and patient care data standards. These HPCC activities are predominantly technology applications support for promoting the development and evaluation of systems to foster their economic and medical feasibility.

The Department of Veterans Affairs (VA) HPCC Program focuses on data capture, information systems, local area and wide area networks connecting a significant number of its member facilities, which includes 171 VA medical centers, 362 outpatient clinics, 129 nursing homes, and 35 domiciliaries.

3.7 HPCC Planning Beyond FY 96

Computing and communications are *ongoing*, strategic enabling technologies. The current HPCC Program provides additional stimulation to accelerate the progress of these technologies and the benefits that accrue from their use. This Program was initiated as a five year effort, covering FY 1992 through FY 1996. Since in-depth planning for the FY 1997 budget will begin in the Spring of 1995, preparations for that planning must begin now.

Two activites are being assimilated into the planning process. The first is the complete external review[3] of the HPCC Program carried out by the Computer Science and Technology Board of the National Research Council, National Academy of Sciences, to ascertain its likelihood of meeting or exceeding its goals and an assessment of options and benefits that could accrue from continued efforts to stimulate the technology.
The second provided an integration of the HPCC Program into other research and development activities is described in a report[4] issued by the CIC. The following description of the relationship between HPCCIT and CIC is given in the FY 1996 Blue Book "HPCC: Foundations for America's Information Future:"

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[3]"Evolving the High Performance Computing and Communications Initiative to Support the Nation's Information Infrastructure," National Academy Press, 1995.
[4]"Strategic Implementation Plan: America in the Age of Information," Committee on Information and Communications, National Science and Technology Council, March, 1995. (Printed by the National Coordination Office for HPCC, and also kept current on the World Wide Web under the NCO home page -- www.hpcc.gov)

"The CIC developed a Strategic Implementation Plan that was released in March, 1995. This plan will be revised and extended through interchanges among government, industry, and academic researchers. Building on the successes of the HPCC Program, the plan sets forth a strategy for Federal government research and development investment in Information and Communications technologies...."

In addition, the HPCCIT Subcommittee will continue to seek input and comment from industry, academia, and other segments of the government at its meetings. To further the feedback process from these meetings, the HPCCIT Subcommittee will actively seek participants' comments on this Implementation Plan.

The assessment of options and benefits that accrue from continued efforts to stimulate computing and communications technology will be investigated by sponsoring a variety of workshops with technical experts to engage in discussions with potential users of these technologies. In FY 1995, five HPCC-related workshops are a part of that process:

- Gigabit workshop, sponsored by ARPA and NSF in October, 1994
- Mass storage workshop at NCO in November, 1994
- System Software Tools for High Performance Computing Environments, Pasadena II, January, 1995.
- The CIC Forum in July, 1995
- Computer systems vendors workshop in September, 1995

Through broad input and extensive discussions, the HPCCIT Subcommittee expects to develop a plan and detailed proposals that will merge naturally into the budgetary planning process.

4. Program Components

This section presents an overall HPCC Program view of the Implementation Plan for each of the five components. The discussion begins by identifying the agency-level funding assumptions on which these plans are based. Each HPCC component discussion provides the following information:

- A brief description of the types of activities included,
- A list of Milestones set for FY 1995 and FY 1996,
- A table of the agency activities supporting the component, and
- A short status report reflecting progress and potential issues for the future.

4.1. Budget Planning Assumptions by Component

Table 1 provides the basic financial planning information used by each of the HPCC agencies in preparing this Implementation Plan. The "FY 94 Actual" column refer to the actual funds appropriated during that year. The "FY 95 Pres." and "FY 96 Pres." columns refer to the amounts requested by the President in his budget request to Congress each year. The "FY 95 Est." column is the amount each agency has been authorized to spend on HPCC as a result of Congressional appropriations, barring any late rescissions.

The last five columns break down the FY 1996 Presidential Request into the planned spending level for each of the five HPCC components. The breakouts by component are estimates, in that many activities span a variety of components and categorization of efforts includes subjective judgment.

For this plan, the FY 1994 Milestones reflect actual accomplishments, and the FY 1995 Milestones assume the FY 1995 Estimated funding level for each agency. The FY 1996 Milestones assume the FY 1996 Presidential Request funding level in each agency. Likewise, all discussions of program status assume these numbers.

Table 1: **HPCC FY 1996 IP Budget Summary**

Agency	Budget (BA, $ M)				HPCC Components by 1996 Pres. Req.				
	FY 94 Actual	FY 95 Pres.	FY 95 Est.	FY 96 Rqst.	HPCS	NREN	ASTA	IITA	BRHR
ARPA	297.67	357.40	344.20	363.04	95.07	70.19	33.91	157.92	5.95
NSF	262.49	328.62	296.94	313.64	23.48	54.72	132.63	42.69	60.12
DOE	114.70	125.37	122.72	123.76	8.70	17.00	74.56	3.00	20.50
NASA	111.00	124.40	131.40	136.30	7.62	20.85	77.05	26.80	3.98
NIH	56.66	81.34	68.47	78.83	4.10	2.32	28.18	32.58	11.65
NSA	40.25	39.93	39.93	40.03	16.80	10.40	12.40	0.23	0.20
NIST	18.10	47.00	25.10	34.10		2.20	3.60	28.30	
NOAA	0.95	13.90	6.40	15.40		7.50	7.40	0.50	
EPA	7.90	14.67	12.50	12.00		0.69	9.28	1.02	1.01
ED	2.00		15.87	16.95			11.40	2.25	3.30
AHCPR			7.00	8.40				8.40	
VA			24.20	23.40		0.18		23.22	
Totals	**911.72**	**1132.63**	**1094.73**	**1165.85**	**155.77**	**186.05**	**390.41**	**326.91**	**106.71**

4.2. HPCS -- High Performance Computing Systems

4.2.1. HPCS Definition

Technological leadership in computing and the solution of critical application problems requires continuous enhancement of the computational capabilities of computing systems including both hardware and software. New generations of systems must solve problems that were previously computationally intractable and reduce the time to solution for time-critical problems. The HPCS program addresses both of these objectives, using large computational science problems (Grand Challenges) and large information-based problems (National Challenges) as the primary application targets. The Implementation Plan for HPCS focuses on producing scalable parallel computing systems through the development and evaluation of prototype systems.

This plan contains several crucial aspects. *Scalable* computing systems permit incremental expansion of hardware resources to meet the needs of large-scale application problems. They also permit the use of the same design in smaller scale workstation-size systems. The focus on computing *systems* reflects the need to develop a balance among all of the components that impact the solution of application problems, including the processors, memory hierarchies, interconnection networks, I/O subsystems, and the interplay of hardware and software. This component of the Program focuses on the development and deployment of innovative systems that will provide up to a 10,000 fold increase (from 100 megaflops to 1 teraflops, or 0.1 gigaflops to 1,000 gigaflops) in sustained computing capability compared to computing systems that were in conventional use at the start of the program in FY 1992. This is an order of magnitude greater than the original goal of HPCS.

HPCS focuses on technological challenges in the earliest stages of the product development cycle. Critical underlying technologies are developed in prototype form along with associated design tools. Early evaluation of systems throughout the design cycle provides important feedback for the refinement of successive generations. Larger projects that are closer to yielding commercial products are funded on a cost-sharing basis with industry. HPCS contains four elements: Research for Future Generations, System Design Tools, Advanced Prototype Systems, Evaluation of Early Systems.

Table 2 identifies the major program activities that contribute to the HPCS component. ARPA provides most of the HPCS funding and management for designing and building prototype systems as well as for supporting design tools. NSF and NSA carry out related efforts, with a greater focus on various application-specific needs. NSF, DOE, NASA, NIH, and NSA acquire and evaluate early prototype systems. The evaluations generally take the form of implementing important agency applications (or critical computational kernels) on these systems and comparing performance against the expected potential of the system.

Agency Total (BA $M)	Agency / Program Activity	FY 96 Pres. (BA $M)
95.07	ARPA	
	Scalable Systems and Software	27.24
	Microsystems	31.87
	System Environments	12.77
	Defensive Information Warfare	4.10
	Defense Technology Integration and Infrastructure	11.11
	Integrated Command and Control Technology	6.00
	Information Sciences	1.98
23.48	NSF	
	Computing Systems and Components	21.83
	Engineering (non-NC/GC)	1.65
8.70	DOE	
	Advanced Prototype Systems	1.00
	Evaluation of Early Systems	7.70
7.62	NASA	
	Testbeds	7.62
4.10	NIH	
	DCRT High Performance Biomedical Computing Program	3.30
	NCI Frederick Biomedical Supercomputing Center	0.80
16.80	NSA	
	Supercomputing Research	14.80
	Superconducting Research	2.00
155.77	HPCS FY 1996 Total	155.77

Table 2: HPCS Program Activity Summary for FY 1996 Presidential Budget

4.2.2. HPCS Status

The HPCS component continues to make substantial progress toward meeting the above goals and milestones. The previously identified FY 1993 milestone, 100 gigaops systems ready for deployment, was achieved on schedule. This milestone was met as part of joint projects with Cray Research, Intel, Thinking Machines, Kendall Square Research, and IBM. New concepts in secondary storage systems have been developed that are revolutionizing the U.S. mass storage industry and have increased potential for finding information in large, unstructured databases. Technologies for advanced design and packaging tools have also been recently demonstrated. Acquisition of potential teraflops prototype systems include: CRAY T3D, Intel Paragon, MasPar MP-2, and the IBM SP-2. Results of large applications running on these machines have produced new results and new capabilities for modeling physical phenomena.

Management of the HPCC Program is optimistic that the milestones identified above and the overall goal of demonstrating sustained teraflops performance on selected Grand Challenge problems can be achieved on schedule, assuming no major changes in the anticipated funding profile.

However, the HPCC Program is concerned about the slowed progress in Evaluation of Early Systems, due to funding limitations and priorities. Funds are scarce for early acquisition by the mission agencies of many small prototype systems for quick testing and early feedback. Agencies have adjusted by buying fewer, moderately-sized "starter systems." They began testing and evaluation on these systems, with the intent of upgrading them to larger sizes later (assuming that the initial evaluation results are favorable). While generally reducing costs, this approach also reduces the number of different prototype systems acquired by mission agencies. This choice reduces opportunities for cross-platform comparisons of important agency applications. Within the funding limitations, the HPCC Agencies will continue to investigate prototype systems for early evaluation and testing of some applications.

4.2.3. HPCS Milestones

HPCS Milestones are identified that provide clearer intermediate progress toward the HPCC Program goals. These milestones highlight aspects related to acquisition and evaluation of high performance computing systems.

FY 1995 Milestones

- Demonstrate the first single processor node operating at one gigaflop per second.
- Demonstrate systems tools for on-line analysis of a real-time operating system for scalable, distributed HPC systems.
- Demonstrate scalable, high performance, low-latency switch technology for workstation clusters.
- Upgrade two systems to larger computational power for medical and energy applications.
- Produce the reference implementation for a message-passing interface on massively parallel processors.
- Initiate a joint agency project in scalable I/O for parallel computers.
- Deploy and evaluate a massively parallel computer system capable of providing 10-20 gigaflops for biomedical applications
- Produce a prototype of a large-scale PIM-based system integrated into a commercial high performance vector computer (the Cray 3)
- Demonstrate derivation of electrical parameters from 3-D process models using early computational prototyping methods

FY 1996 Expected Milestones

- Demonstrate high availability systems scalable in performance to one teraflop per second.

- Demonstrate an extensible modular operating system framework supporting real-time, distributed, and limited fault-tolerant scalable computing applications.

- Demonstrate I/O enhancements to a scalable operating system that overcome identified bottlenecks leading to significant improvements in throughput.

- Perform early demonstration of parallel, fully-hierarchical Automatic Test Generation for both combinational and sequential circuits.

- Evaluate small-scale teraops class systems and individual gigaops processors.

- Evaluate first generation of fully scalable OS software and programming environments on small-scale versions of teraops computing systems.

- Complete testing of the Super Massively Parallel Processor Computer System and make the system available to other users.

4.3. NREN -- National Research and Education Network

4.3.1. NREN Definition

The principal objectives of the NREN component are to:

- *Establish and encourage wide use of gigabit networks by the research and education communities to access high performance computing systems, research facilities, electronic information resources, and libraries.*

- *Develop advanced high performance networking technologies and accelerate their deployment and evaluation in research and education environments.*

- *Stimulate the wide availability at reasonable cost of advanced network products and services from the private sector for the general research and education communities.*

- *Catalyze the rapid deployment of a high-speed, general purpose digital communications infrastructure for the Nation.*

The underlying strategy of the HPCC Program has been to support the solution of important scientific and technical problems of broad national significance in collaboration with all interested sectors in government, industry, and academia. In the networking component of the program this strategy has led to a unique collaboration in both the research and operational aspects of the NREN activity.

The goal is to acquire the most advanced networking services that support the ever-increasing networking demands of high performance computing, while assuring a stable and consistent level of services for its users. The routine purchase of generally available technology is not a goal of the program, although off-the-shelf technology may be integrated with advanced technology.

The NREN component has two elements — Interagency Internet and Gigabit Research and Development. Both elements foster participation of the private sector to maximize the leverage of Federal funds. Although the NREN is a research and educational network program, a deliberate consequence of including substantial private sector activity is that the technology and services developed, and even the facilities themselves, may be the model for a more ubiquitous network offering developed under private, or other public efforts. Many industrial research organizations and commercial establishments supporting the nation's scholarly enterprise are connected. In fact, the commercial network segment is the fastest growing segment of the Internet. Federal operation and ownership of network facilities and services, already minimal, are being reduced even further as the program develops. Nevertheless, HPCC Program priorities remain the central focus of the NREN component. Although other Federal and private sector participants are encouraged, the degree of their participation must be contingent on several factors, such as program focus, cost sharing, and technology leverage.

Currently, and at the end stage of this development, the Interagency Internet program activity will result in a comprehensive service offering to the nation's community of researchers and educators at all levels. The network will connect them to each other and to the facilities and other resources they use in their scholarly endeavor, such as databases and libraries, laboratories, scientific instruments, and computation centers. As a facilitator and enabler of intellectual activity, the Interagency Internet system will allow connectivity to supporting organizations such as publishers and hardware and software vendors. International connections that serve the national interest are also included.

Important features of the Interagency Internet NREN element are:

- Use of commercial facilities, and not the laying of fiber optic cables or building of a physical network; and
- Driving technology and broadly seeding the market, while avoiding competition with the private sector.

Because of this latter aspect, success of this part of the program inevitably leads to tension and concerns that government services not remain in place once a technology offering has been demonstrated and seeded. The policy of the NREN component is to accelerate this transition to the private sector, while not compromising the need for stable and consistent services by the research and education communities.

Table 3 identifies the major program activities that contribute to the NREN component. NSF coordinates the broad deployment of the Interagency Internet element in support of the HPCC Program. NIH, NOAA, and EPA activities within NREN focus on expanding connectivity. NSF, DOE, and NASA continue dual roles of expanding connectivity and development of future generations of faster and more robust networks. ARPA and NIST also contribute extensively in this latter role of future generations of networks. NSA concentrates primarily on enhancing secure communications over these networks.

Agency Total (BA $M)	Agency / Program Activity	FY 96 Pres. (BA $M)
70.19	ARPA	
	Defense Information Enterprise Technologies	15.20
	Networking	31.43
	Defensive Information Warfare	3.30
	Global Grid Communications	20.26
54.72	NSF	
	NSFNET	40.92
	Ubiquitous Computing and Communication	4.80
	Education and Training	9.00
17.00	DOE	
	Energy Sciences Network (ESnet)	15.00
	Gigabit Research and Development	2.00
20.85	NASA	
	NREN	20.85
2.32	NIH	
	NLM Medical Connections Program	0.62
	DCRT High Performance Biomedical Computing Program	0.80
	NCI Frederick Biomedical Supercomputing Center	0.40
	NCI High speed networking and distributed conferencing	0.50
10.40	NSA	
	Very High Speed Networking	3.00
	Secure Operating System Development	4.70
	High Speed Data Protection Electronics	2.70
2.20	NIST	
	Networking & Information Infrastructure Services	2.20
7.50	NOAA	
	Networking Connectivity	7.50
0.69	EPA	
	State Network Connectivity	0.69
0.18	VA	
	Improve Telecommunications Infrastructure and Internet Connectivity	0.18
186.05	NREN FY 1996 Total	186.05

Table 3: NREN Program Activity Summary for FY 1996 Presidential Budget

4.3.2. The NREN and the NII

Because it is anticipated that the NREN will be the testbed for many NII applications and services, the NII has a significant impact on the direction of the NREN component. This impact increases the importance of alternative bitway physical models (e.g., mobile systems, adaptive bandwidth systems, and systems with asymmetrical bandwidth) to support a variety of connectivity requirements. In addition, this impact increases the importance of developing an infrastructure of network services, such as security and authentication, with standard interfaces, which can be used to build Information Infrastructure Services available uniformly to government and non-government users of the network. It is of critical importance to the NII that it not have to duplicate such services. This requirement increases the importance of standard service interfaces that can be implemented over a variety of physical bitways and is transparent to the applications that require its services.

4.3.3. NREN Status

The goals of the NREN may be grouped into:

- Improved network connectivity,
- Improved network capabilities, and
- Improved manageability and controllability of the network.

Improved network connectivity and improved network capabilities are both critical to the success of the NREN. The usefulness of the network derives from the number of interesting resources (libraries, experiments, computational resources, other people) that are available on it and from the range of ways in which the network enables one to use those resources (electronic mail, distributed computing, desktop video-conferencing, computer mediated collaboration). However, improved manageability and controllability of the network are also critical to the success of the NREN and to its usability as a prototype for the NII bitways. Improved connectivity and capabilities are useless unless the network can be managed and controlled to ensure stable operation. This must include a realistic, scalable, deployable national and international security architecture. Increased commercial operation of the network or of network components, especially in a multi-service provider environment, demands improved manageability and controllability.

In terms of network connectivity, the NREN component is well ahead of schedule, at least for services at T1 and lower speeds. The Interagency Internet forms the core of a nation- and world-wide infrastructure whose size in terms of number of computers attached is growing at over ten percent per month. However, this growth poses important challenges for manageability and controllability. The current IP addressing infrastructure is now predicted to be able to support this growth for about seven years, provided Classless InterDomain Routing (CIDR) continues to be deployed.

In terms of increased capability, there have been significant advances in network speed and throughput. Work on very high speed networks is proceeding on schedule as is work on all-optical networks and advanced network components. Equally important, network capable applications and tools have been developed (e.g., Mosaic, Gopher, desktop video-conferencing, whiteboards, wide area collaborative environments, and image transport) which have dramatically expanded the usefulness and the capabilities of the network. To a significant degree, because of these services connections to the Internet are growing at an astounding rate. There has also been significant progress, on a technical level at least, in such areas as authentication and security, distributed file systems, and privacy-enhanced mail. The ongoing and planned activities in these areas will permit substantially greater trust of the network by users. Intra-gigabit testbed connectivity has slipped one year due to technical problems with the local telecommunications companies as well as a slow start in terms of some advanced technologies. Finally, there has been some progress, both technical and administrative, in establishing information directory services to guide users, although this is still a formidable problem.

In terms of increased manageability, there has been some progress; however, significant challenges remain. Each advance in the network in the other two areas complicates this third area. Rapid expansion in the number of hosts attached to the net requires re-engineering the addressing and routing architecture of the net in the near future, while ensuring that the net remains manageable and stable throughout the transition. New services such as desktop video require enhanced multicast services, which must be designed and managed. Even in authentication and security the administrative issues of key management and choice (either dynamic or static) of algorithms for digital signature and

encryption must be settled. It is a significant weakness of the current infrastructure that it requires an irreducible core of "network wizards" to manage the routing between the providers to avoid disaster (e.g., major network portions isolated from the rest of the network). In addition, a deployable architecture to support realistic, manageable network usage accounting and statistics gathering does not currently exist.

4.3.4. NREN Milestones

Previous HPCC documents have identified a key milestone for NREN:

- By 1996, gigabit research will lead to an experimental nationwide network able to deliver speeds up to 2.4 billion bits per second to individual end user applications.

Even though intra-gigabit testbed connectivity has slipped one year, the HPCC Program expects to achieve this milestone on time. Other NREN milestones follow.

FY 1995 Milestones

- Demonstrate bandwidth, delay, and service reservation guarantees for networks in support of real-time control and critical services.
- Demonstrate advanced network capabilities, including multicast-based services and next generation Internet protocols with improved ease of use.
- Demonstrate Synchronous Optical Network (SONET) and Asynchronous Transfer Mode (ATM) encryption technologies at 155 Mb/s (OC-3c).
- Deploy small-scale, initial prototype of gigabit-per-second class, nation-spanning infrastructure in support of high performance computing applications.
- Integrate DoD and commercial networks and demonstrate services and network management in support of 'crisis management' applications.
- Demonstrate advanced optical network capability and multi-wavelength reconfigurable network architecture.
- Demonstrate prototypes of gigabit per second technology over combined fiber and satellite media.
- Upgrade network links at all the HPCC agencies, including NSFNet, ESnet, and other video and voice capabilities, and complete transition to the new NSFNET architecture.
- Scalable communications library will be completed by mid 1995.
- Packetization of commercial coded video/audio output will be completed and will allow ESnet to carry packetized video encapsulated in IP.
- Initiate development of wave division optical switching and multiplexing devices to support Gb/s data rates.
- Demonstrate a 3 Gb/s optical interconnection system.
- Establish an interoperability testing program including laboratory facilities for Internet security technologies (e.g., firewalls, authentication mechanisms), IPv.6, network management and NII Services.
- Collaborate with the ATM Forum and industry to develop standardized conformity tests for ATM-based technology; conduct experiments and tests of evolving products.

FY 1996 Expected Milestones

- Prototype networks at greater than 40-gigabit-per-second speed using optical technologies and experimentally validate scalable network protocols at the higher speeds.
- Deploy reference implementation of protocol-independent, multicast-capable infrastructure as basis for development of advanced services.
- Demonstrate robust and secure network-level infrastructure protocols to include directory services and resource allocation.
- Demonstrate end-to-end secure transmission and signaling at gigabit per second rates.
- Demonstrate high bandwidth operation of critical multi-wavelength components.
- Field test local area network application of multi-wavelength analog and digital signal transmission.
- Support connection of 50 additional institutions to the Internet.
- Pilot deployment of emerging privacy and security tools for the Internet.
- Demonstrate a small scale prototype of network resource management and congestion control for the Internet .
- Demonstrate interoperability between independently managed NREN networks that are based on ATM technology supplied by multiple vendors.
- Bring the top 3,000 health care institutions in the U.S. onto the NREN.
- Demonstrate electronic switching of individual data flows at 2.4 Gb/s data streams.
- Extend R&D related to the reliability of ATM-based networks, especially in the area of optoelectronics.
- Expand the number of major environmental databases accessible through Internet to greater than 30.

4.4. ASTA -- Advanced Software Technology and Algorithms

4.4.1. ASTA Definition

The computing systems that will be developed by the HPCC Program are not simply faster versions of current computer designs. They represent new architectures for which fundamentally new algorithms and software development are required. Dramatic improvements in algorithm design and software technology are essential to achieve sustained teraflops computing system performance. Scalable parallel and distributed systems provide new opportunities and challenges to developers of software and algorithms. The Advanced Software Technology and Algorithms component of the HPCC Program has three broad objectives:

- Enable significant progress toward the solution of Grand Challenge application problems in science and engineering;
- Improve system user-friendliness, reliability, software productivity and effectiveness; and
- Use experience from leading edge applications to help guide new software efforts.

These broad objectives are the framework for more specific ASTA objectives adopted by the agencies and used as a basis for the design and conduct of their specific HPCC programs. The ASTA component has four key elements, each with a set of objectives .

- Support Grand Challenges
  - Support a wide variety of computational applications in fields such as: biological sciences, geosciences, engineering, computational mathematics, physical sciences, aeronautics, environmental sciences, and energy research.
  - Demonstrate large-scale, multidisciplinary computational research (e.g., accurate molecular structure predictions by multidisciplinary scientific teams) on heterogeneous, distributed systems using the Interagency Internet to access distributed file systems and national software libraries.
  - Project the performance of full Grand Challenge applications on teraflops computing systems through controlled testbeds of prototype environments.
- Software Components and Tools
  - Establish portable, scalable libraries that enable accelerated transition from one generation to the next and across different system structures, and improve overall portability of applications code and establish software reuse libraries.
  - Support the evolution of parallel operating systems and the development of a suite of software tools that enhance productivity and effectiveness of both human and machine (e.g., tools for load-balancing, data partitioning, compilers, run-time optimizers, performance monitoring, visualization, and virtual environments).
  - Reduce the entry barrier to high performance computing by providing scalable software technologies and environments in desktop class computing systems.
- Computational Techniques
  - Support for improvement and parallelization of algorithms and data structures.
- High Performance Computing Research Centers (HPCRCs)
  - Increase access to HPCRCs in research communities.
  - Acquire advanced prototype and early production HPCS for use and evaluation.
  - Provide HPCS, links to NREN, computer operation and facilities support and related resources for enabling Grand Challenge applications and as support for the other elements of ASTA.

Agency Total (BA $M)	Agency / Program Activity	FY 96 Pres. (BA $M)
33.91	ARPA	
	Scalable Systems and Software	19.46
	System Environments	11.85
	Information Sciences	2.60
132.63	NSF	
	Supercomputer Centers	72.90
	Research Centers	6.00
	Grand Challenge Applications Groups	7.25
	Software Systems and Algorithms	19.30
	Human-Machine Interaction & Information Access	6.80
	Biological Sciences (non-NC/GC)	10.40
	Engineering (non-NC/GC)	1.70
	Geosciences (non-NC/GC)	3.19
	Computational Mathematics (non-NC/GC)	2.00
	Physical Sciences (non-NC/GC)	3.09
74.56	DOE	
	Enabling Energy Grand Challenges	7.60
	Software Components and Tools	11.40
	Computational Techniques	1.30
	Supercomputer Access	35.84
	HPC Research Centers	11.80
	Collaboration	2.00
	Florida State University - SCRI	1.62
	Domestic Oil & Gas (ACTI)	3.00
77.05	NASA	
	Testbeds	7.19
	Grand Challenge Support	59.84
	Systems Software	10.02
28.18	NIH	
	NLM Biotechnology Informatics	4.35
	NLM Electronic Imaging	2.03
	NCRR Biomolecular Computing	6.60

Table 4: ASTA Program Activity Summary for FY 1996 Presidential Budget

Agency Total (BA $M)	Agency / Program Activity	FY 96 Pres. (BA $M)
	NCRR Software Tools for Receptor-Based Drug Design	2.20
	NCRR Modeling/Simulation	5.80
	DCRT High Performance Biomedical Computing Program	3.30
	NCI Frederick Biomedical Supercomputing Center	3.50
	NCI High speed networking and distributed conferencing	0.40
12.40	NSA	
	Supercomputing Research	12.40
3.60	NIST	
	Development and Dissemination of Scientific Software for HPCS	3.60
7.40	NOAA	
	Advanced Computation	7.40
9.28	EPA	
	Environmental Modeling	5.78
	Computational Techniques	3.50
11.40	ED	
	National Institute on Disability and Rehabilitation Research	11.40
390.41	ASTA FY 1996 Total	390.41

Table 4: ASTA Program Activity Summary for FY 1996 Presidential Budget

4.4.2. ASTA Status

The ASTA component has aggressively pursued development of large scientific applications and the acquisition of HPC systems on which to run them. Currently, 34 Grand Challenge scientific teams are developing applications on high performance computer systems. In addition, numerous other application codes are being developed and/or ported to HPC systems. Probably the most significant ASTA result to date is the dramatic increase in the number of research areas that are beginning to develop new applications for HPC systems. These applications all need substantial computing resources. At present, HPCC runs over a dozen high performance computer centers, serving over 12,000 users. However, recent estimates indicate that such resources must expand further to meet the existing requirements for the mission-oriented applications currently under development (especially new IITA needs).

As expected, the reports of progress vary depending on the complexity of the algorithms and the disparity between the natural data layout in the code and the type of machine organization present in the target architecture. The most successful applications to date contain large amounts of computation with inherent data parallelism that map quickly and easily onto the selected architecture. New software tools are getting into users' hands, including performance monitoring and instrumentation toolkits, 3D visualization tools, message passing libraries, parallelizing compilers, and a parallel linear algebra library. These tools help to make the task of application development easier and more reliable. However, automated tools for partitioning and mapping programs onto HPC systems need substantially more effort.

Table 4 lists agency activities that contribute to the ASTA component of the HPCC Program.
Two issues require more attention. First, HPCC agency managers must take steps to get greater involvement of independent software vendors (ISV) in the Program. ISV's represent a critical sector of the computing community that provides user-friendly applications platforms for public and industrial use. These applications will, in the near future, depend on HPC systems for providing meaningful results. Second, HPCC managers must push for greater progress in the area of automated and integrated software tool platforms.

4.4.3. ASTA Milestones

FY 1995 Milestones

- Demonstrate prototype integrated HPC programming environment for Fortran and C++ on which applications run transparently on several distinct scalable computer architectures without change.
- Demonstrate tools for performance tuning of application software using dynamically-collected statistics.
- Demonstrate portable scalable software libraries across three major computer architectures applied to semiconductor device simulation.
- Install new systems and upgrades of current systems at Supercomputer Centers to provide more powerful parallel computing systems needed by the academic computing community.
- Add additional Regional Alliances (4-6) to enhance computing and communications expertise of individuals in university, education, public and private sectors.
- Release a set of software tools for the support of experimental analysis in discrete mathematics and theoretical computer science.
- Release a portable prototype library for sparse direct matrix computation that can be optimized for different computing systems.
- Demonstrate with biological modeling, a fluent, physically-based modeling language that extends geometric modeling languages and operators.
- Release a second version of High Performance Fortran that provides support for adaptive, dynamic computations.

- Demonstrate the utility of direct sensitivity analysis in air quality models such as those for the Los Angeles basin or the Northeast Corridor.

- Demonstrate the integrated AIM microscope system for monitoring biomedical experiments and develop capability to automatically detect events of interest.

- Demonstrate on high performance platforms a simulation of a watershed using a discrete event dynamic model coupled to a geographic information system data base with visualization.

- Demonstrate software engineering techniques for developing and analyzing designs and software with real-time or other critical dependability constraints.

- Establish the Center for Ecological Analysis and Synthesis, prototyping the linking of heterogeneous databases.

- Demonstrate Earth Simulation models simultaneously running on MPP, clustered and shared memory computers and connected by "flux-coupler" software and high speed networking technology.

- Demonstrate the 256 Kbps data transmission between the U.S. and South Pole Station.

- Produce and distribute algorithms and software to solve problems in molecular sequence analysis, especially for analysis of DNA, RNA, and protein sequences.

- Establish distributed computing and experimental collaboration testbed for evaluating security, resource management, program monitoring, and other computational science tools in the HPCRC environment.

- Organize second workshop on systems software and tools for High Performance computing environments.

- The complete data set for the Visible Human Male will be mounted and distributed both over the Internet, and as a published volume of 8mm and 4mm tapes.

- The acquisition of a complete sample-based anatomical data set for a representative normal human female will be completed.

- Complete an on-line electronic radiological atlas and training set for spine images. Begin standardized readings of the cervical and lumbar spine images.

- Demonstrate a reliable and useful GAMS service for the discovery and access of reusable math software;

- Complete procurement of a scalable HPC to support major improvements in climate change and weather forecasting.

- Implement portable parallel meteorological testbed model to support advanced air quality models.

- Establish two major research teams to pursue work in technology related to the National Information Infrastructure access and productive use by persons with disabilities.

FY 1996 Expected Milestones

- Establish National Metacenter as a seamless national computing environment across all four NSF Centers and other affiliates.

- Provide access to computer systems with capacity approaching a teraflop.

- Release of Scientist's Visual Workbench to astronomers, with development versions of interactive, distributed visualization and remote rendering of very large images.

- Global Climate Models -- demonstrate successful coupling of atmospheric-ocean-sea ice models on MPPs.

- Deliver beta versions of high performance scalable I/O libraries.

- Extend greatly the capabilities of DOE laboratory storage systems through the implementation of the network-centered parallel HPSS storage system management software now being developed.

- Demonstrate cost effective high performance computing at performance and reliability levels equivalent to 1994 Vector Supercomputers at 25% of the capital cost.

- Demonstrate multidisciplinary aeroscience and Earth and Space Science applications on 10-50 gigaflops testbeds.

- The complete data set for the Visible Human Female will be mounted and distributed both over the Internet, and as a published volume of 8mm and 4mm tapes.

- Procure a scalable HPCS for NOAA/NMC to advance improvements in operational weather forecasting for the Nation.

- Complete conversion of important climate models in support of Arctic Fisheries and Oceanography programs and the Climate and Global Change Program.

- Prototype a modular, scalable air quality modeling decision support system with integrated sensitivity-uncertainty analysis.

- Demonstrate an enhanced capability to deliver useful government information to persons with disabilities.

4.5. IITA -- Information Infrastructure and Technology Applications

4.5.1. IITA Definition

Information Infrastructure Technology and Applications (IITA) activities will demonstrate feasible solutions to problems of national importance, such as health care or 21st century manufacturing, using the full potential of the nation's rapidly evolving high performance communications and information processing capabilities. The HPCC Program will produce enabling technologies critical to developing the National Information Infrastructure (NII). With the incorporation of IITA activities, the HPCC Program will advance intelligent system interfaces, real environments augmented with virtual environments, image understanding, language and speech understanding, intelligent agents for augmenting human capabilities, and next generation data and object bases for electronic libraries and commerce. This will be coupled with a vigorous program of testbed experimentation that will ensure the continued leadership of the United States in critical information processing technologies.

IITA will strengthen the HPCC technology base, broaden the markets for these technologies, and accelerate industry development of the NII. Federal HPCC agencies will work closely with industry and academia in pursuit of these objectives. These objectives are to be accomplished, in part, by accelerating the development of readily-accessible, widely-used, large-scale applications with significant economic and social benefit. The HPCC Program's original focus of enhancing the Nation's computing and communications capabilities is thus extended to address a broader set of technologies and applications that have an immediate and direct impact on critical information capabilities affecting every individual in the Nation.

The development of such applications will be predicated on (1) creating the underlying scalable computing technologies for advanced communication services over diverse bitways, effective partitioning of applications across elements of the infrastructure, and other applications support services that can adapt to the capabilities of the

available infrastructure; and (2) creating and inserting an intelligent service layer that will significantly broaden the base of computer information providers, developers, and consumers while reducing the existing barriers to accessing, developing, and using advanced computer services and applications. In parallel with these activities, a more effective software development paradigm and technology base will be developed. This will be founded on the principles of composition rather than construction, solid architectures rather than ad hoc styles, and more direct user involvement in all stages of the software life cycle. The entire technology base developed in this program, including services and software, will be leveraged across the National Challenges, leading to significant economies of scale in the development costs.

The IITA program component consist of the following four elements: Information Infrastructure Services, System Development and Support Environments, Intelligent Interfaces, and National Challenges. Table 5 shows a list of the agency activities that contribute toward IITA.

4.5.2. IITA Status

Although the IITA program component was first established in 1994, it builds upon diverse efforts already well underway in the HPCC agencies. For example, ARPA and NASA had already begun to explore high speed satellite-based extensions to the gigabit testbeds in 1993. Mosaic, developed under NSF support at the National Center for Supercomputer Applications (NCSA) at the University of Illinois, provided a network-aware global hypermedia interface in 1993, and has swept the HPCC research community (and beyond) in the last twelve months. ARPA, NASA, and NSF are already funding virtual reality and telepresence research projects like the CAVE developed at the University of Illinois at Chicago. Several critical National Challenge applications efforts were already underway at the HPCC agencies: crisis management at ARPA, advanced manufacturing at ARPA, NIST, NASA and NSF, environmental monitoring at NASA, NOAA, and EPA; health care at NIH and NASA; and energy-demand management at DOE. Several of the NSF-ARPA-sponsored gigabit testbeds are coupled to National Challenge applications, such as the North Carolina VistaNet testbed, which is being used to support radiation treatment planning in collaboration with NIH.

ARPA, NASA, and NSF initiated a research program on digital libraries for FY 1994 through FY 1998. The program will incorporate new knowledge and technologies, testbeds to demonstrate results of the research, and university/industry/user partnerships.
The Information Infrastructure Technology and Applications Task Group met during the first half of 1995 to refine the technologies that contribute to information infrastructure, to develop a common terminology across the participating agencies, and to inventory on-going and planned projects within these agencies that are associated with IITA. A report describes the work of the committee and its recommendations.

Agency Total (BA $M)	Agency / Program Activity	FY 96 Pres. (BA $M)
157.92	ARPA	
	Defense Information Enterprise Technologies	42.41
	Defensive Information Warfare	2.60
	Defense Technology Integration and Infrastructure	12.14
	Health Information Infrastructure	10.24
	Information Sciences	13.19
	Intelligent Systems and Software	77.34
42.69	NSF	
	NSFNET	5.30
	Supercomputer Centers	2.00
	Research Centers	0.68
	Research Infrastructure	2.94
	Computing Systems and Components	0.50
	Ubiquitous Computing and Communication	1.00
	Human-Machine Interaction & Information Access	4.15
	Biological Sciences (non-NC/GC)	1.03
	Engineering (non-NC/GC)	0.63
	Geosciences (non-NC/GC)	0.40
	Computational Mathematics (non-NC/GC)	0.59
	Physical Sciences (non-NC/GC)	4.00
	Social, Behavioral & Economic Sciences (non-NC/GC)	2.14
	National Challenges	17.33
3.00	DOE	
	Information Infraservices	2.00
	National Challenges	1.00
26.80	NASA	
	Information Infrastructure Technology	8.80
	Information Infrastructure Applications	18.00
32.58	NIH	
	NLM Intelligent Agent DB searching	5.37
	NLM HPCC Health Care Applications	20.21
	NCRR Virtual Reality/Environments	4.20

Table 5: IITA Program Activity Summary for FY 1996 Presidential Budget

Agency Total (BA $M)	Agency / Program Activity	FY 96 Pres. (BA $M)
	DCRT High Performance Biomedical Computing Program	1.50
	NCI High speed networking and distributed conferencing	0.70
	NCI High Perf. Comms for PDQ, CancerNet, and Electronic Publishing	0.60
0.23	NSA	
	Technology Based Training	0.23
28.30	NIST	
	Networking & Information Infrastructure Services	10.10
	Metrology for Human-Machine Interfaces & Scalable HPCS	2.00
	Systems Integration for Manufacturing Applications	12.26
	Electronic Commerce and Digital Libraries	3.94
0.50	NOAA	
	Information Dissemination Pilots	0.50
1.02	EPA	
	Public Data Access	1.02
2.25	ED	
	AskERIC Service	1.25
	OERI Institutional Communications Network (INET)	1.00
8.40	AHCPR	
	Computer-Based Patient Records	8.40
23.22	VA	
	Computerized Patient Record and Telemedicine	1.40
	Clinical Workstations and Medical Imaging	3.61
	Hybrid Open Systems Technology (HOST)	14.50
	VA/DoD Sharing	3.71
326.91	IITA FY 1996 Total	326.91

Table 5: IITA Program Activity Summary for FY 1996 Presidential Budget

4.5.3. IITA Milestones

FY 1995 Milestones

- Demonstrate prototypes of distributed digital library technology including techniques for scalable storage management and data repositories, persistent object bases, and multimedia objects.
- Demonstrate copyright management system, providing proof of concept including fully electronic copyright registration, recordation, rights transfer, and management.
- Demonstrate mobile computing system Computer Aided Design (CAD) environment through the design of early prototype, high bandwidth, pico-cellular, and wireless access points to the wireline infrastructure.
- Demonstrate network-based access to Multichip Module fabrication services.
- Complete proof-of-concept Asynchronous Transfer Mode (ATM) encryption units for use in experimental ATM networks.
- Begin operation of certification authority supporting privacy enhanced mail and other secure services.
- Complete prototype implementation of digital signature hierarchy toolkit and domain name system enhancements.
- Demonstrate operating system capability for strict process separation.
- Demonstrate prototype signature/timestamp server with associated access tools for location-independent object security.
- Demonstration of a prototype system capable of collecting, compiling and delivering information in mixed media and modalities: sound, speech, texts, images, graphics.
- Demonstrate preliminary models and data developed by the research teams under the cross-agency Digital Libraries initiative.
- Establish a Remote Sensing Public Access Center for serving the Internet communities' requirements with regard to accessing NASA Earth and space science data.
- Demonstrate electronic procurement and publish application guidelines for government; continue to develop and integrate security services.
- AskERIC becomes truly nationwide (worldwide?) service.

FY 1996 Expected Milestones

- Demonstrate prototype of information services through a testbed incorporating electronic commerce and digital libraries, including experimental charging mechanisms.
- Initial prototype of adaptive extensions to Internet services in support of mobility.
- Initial prototypes of untethered node hardware/software architectures for mobile computing.
- Demonstrate design environments supporting simulation and synthesis of wireless systems spanning integrated circuits to network applications.

- Demonstrate initial capabilities for intelligent information services for resource description, registration, and retrieval.
- Demonstrate prototype of secured routing protocols.
- Complete development of a prototype toolkit supporting secure distributed applications over a single administrative domain.
- Demonstrate shared patient-record planning for distributed health and human services.
- Demonstrate hands-free capture of patient data during emergencies.
- Demonstrate preliminary results of research and the experimental testbeds developed under the Digital Libraries initiative.
- Establish a second round of Digital Library Technology cooperative agreements and grants with industry and academic partners, similar to those initiated in FY 94.
- Initiate R&D related to passive optical, non-ATM networks.

4.6. BRHR -- Basic Research and Human Resources

4.6.1. BRHR Definition

The BRHR component is designed to encourage investigator-initiated, long-term research on computational and experimental projects, and to maintain the flow of innovative ideas and talented people into high performance computing and communications areas. This component also addresses long-term national needs for more skilled personnel, enhancement of education, training, materials, and curriculum development in HPCC areas. The BRHR component contains four elements: (1) Basic Research, (2) Research Participation and Training, (3) Infrastructure, and (4) Education, Training, and Curriculum. Table 6 identifies the major program activities that contribute to the BRHR component.

Although the primary goal of basic research is to generate new knowledge, it is simultaneously possible to increase the odds that the knowledge will result, ultimately, in products useful to a broad constituency and to expedite the transformation of new ideas into new technologies. This can be achieved by steering the directions of inquiry into promising areas and assigning increased priorities and resources to research projects addressing recognized needs. The HPCC Program places particular value on this dimension of basic research. At the same time, the Program will continue to nourish those larger processes and capabilities that underlie successful basic research generally. These include research infrastructure and tools, communications technologies, mechanisms and models for enhanced multidisciplinary collaboration, and the development of new conduits and occasions for technology transfer between sectors.

4.6.2. BRHR Status

BRHR continues to produce critical research results in enabling technologies such as system software, programming languages and compilers, tools, virtual reality, algorithms and models, and in a broad spectrum of topics (e.g., modeling molecular dynamics, RNA structure prediction, coherent laser sources, correctness proofs for VLSI processor design). BRHR has expanded educational opportunities and training for all academic levels (e.g., SuperQuest, EarthVision, the National High School Honors Program, Adventures in Supercomputing, graduate assistantships, and post-doctoral research grants). Funding in this category has also helped expand the research infrastructure for parallel computing, high speed networks, and virtual reality. In addition, efforts to define and implement a cross-disciplinary computational science curriculum are beginning to show acceptance at a number of major universities.

Since the beginning of the HPCC Program, there has been building a stronger call that strategic research principles and practices be adopted for a larger fraction of sponsored basic research programs. For the BRHR component this

means focusing investments and efforts more closely around national goals deemed important to economic growth and improvements in the quality of the everyday life. It means that for individual research projects, efforts should be made in advance to identify goals to be achieved, to establish performance benchmarks and progress milestones, to develop appropriate evaluation methodologies and to expend additional effort to ensure that research results be carried beyond publication in scholarly journals to application to practical problems. Each participating HPCC agency has been asked to implement these steps by integrating these principles and practices into their HPCC management approach.

4.6.3 BRHR Milestones

FY 1995 Milestones

- Demonstrate software engineering techniques for developing and analyzing designs and software with real-time or other critical dependability constraints.
- Development of new and extended thrusts and directions for the Science and Technology Center on Cognitive Science at U. Penn to provide shareable resources in human language technology over the NREN to the larger research community and the industry.
- Initiate pilot studies for educational applications of Digital Library awards.
- Produce a science textbook, using techniques developed in producing the computational science textbook.
- Initiate networking technology assessment project to determine appropriate educational technology tools and curricula for a wide variety of schools and to produce a catalog of effective technologies for use by teachers, administrators and local and state education officials.
- Host fifth annual summer school in High Performance Computational Physics.
- The National Education R&D Network gopher will be made publicly available.

FY 1996 Expected Milestones

- Demonstrate graphical program environments for embedded systems.
- Complete networking technology assessment project to determine appropriate educational technology tools and curricula for a wide variety of schools and to produce a catalog of effective technologies for use by teachers, administrators and local and state education officials.
- Initiate an industrial postdoctoral program in which postdoctoral researchers work at industrial and laboratory sites on problems of common interest.
- Host sixth annual summer school in High Performance Computational Physics.
- Publish Final Report of Round-1 Basic Computer Science Research in key ESS technical areas.
- Provide NRSA awards for formalized training for biomedical scientists in the use of high performance computing; awards not limited to NCRR resource centers.
- Award grants for exploration and development of high school level educational environmental software, and multimedia tutorial and help approaches for use of environmental modeling tools over the Internet.

Agency Total (BA $M)	Agency / Program Activity	FY 96 Pres. (BA $M)
5.95	ARPA	
	Information Sciences	5.95
60.12	NSF	
	Research Centers	4.40
	Research Infrastructure	18.65
	Software Systems and Algorithms	9.71
	Ubiquitous Computing and Communication	9.00
	Human-Machine Interaction & Information Access	3.60
	Computational Mathematics (non-NC/GC)	3.52
	Education and Training	11.24
20.50	DOE	
	Research Participation and Training	2.00
	Education, Training and Curriculum	2.50
	Basic Research for Applied Mathematics Research	16.00
3.98	NASA	
	BRHR	3.98
11.65	NIH	
	NLM HPCC Training Grants	3.04
	NLM IAIMS grants	3.39
	NCRR HPCC Training	3.50
	NCI Frederick Biomedical Supercomputing Center	0.70
	NCI High speed networking and distributed conferencing	0.10
	National Coordination Office	0.92
0.20	NSA	
	Supercomputing Research	0.20
1.01	EPA	
	Education/Training	1.01
3.30	ED	
	Regional Education Laboratory Program	1.50
	Teacher Networking Project	1.80
106.71	BRHR FY 1996 Total	106.71

Table 6: BRHR Program Activity Summary for FY 1996 Presidential Budget

5. Agency Plans

Implementation of the HPCC Program takes place within each of the twelve HPCC agencies, where the final decisions are made on the funding, management, and evaluation of program activities. This section organizes HPCC activities by agency to better reflect the operational structure of the funding. The level of information does not reflect individual projects. Since many grants are at the level of $100-300 K, a full breakout of each project in a $1.2 B program is impractical to assemble and maintain for this plan. Instead, agencies group together projects that are technically related toward reaching similar goals and objectives. Each grouping constitutes a "program activity," most of which range in size from $0.5 M to $40 M.

While this structure tracks funds clearly, it has several drawbacks. Interagency collaborations are often difficult to recognize and may in fact appear as duplication of effort since similar efforts will be repeated within different agency activities. Also, while the HPCC Program broadly describes its activities under the heading of five major components, actual program activities often span multiple components, thus making some of the actual funding impossible to categorize. In fact, since program activities need not follow strict guidelines of funding within each component, better decisions are made, at finer levels of program implementation, as to the most effective use of the funds to meet Program objectives.

Each agency contribution contains three parts:

- Brief overview of the agency's perspective on HPCC efforts,
- Table summarizing financial data and collaborative ties for its program activities, and
- One-page form for each program activity that describes it.

The individual program activity form contains some fields that require explanation. The "Budget Code" field is an internal label used by some agencies to track HPCC funding. The budget fields provide actual spending (Act.), estimated spending based on Congressional appropriations and rescissions (Est.), and Presidential requests (Pres.) for various fiscal years. The numbers below the HPCC component labels estimate the breakdown of the FY 1996 request into the five HPCC components. These numbers are estimates, in that many activities span a variety of elements and categorization of efforts includes subjective judgment.

The "Agency Ties" section of the form permits two labels. A "Partner" label indicates that the corresponding agency is a funding and research partner in this activity. Note that two different agencies may view partnering differently (e.g., developing a scalable system in ARPA would be HPCS, but its use for Grand Challenges could be inside ASTA in DOE or NSF). A "User" label indicates that the corresponding agency needs the results of this program activity for another, related activity. The large field in the center of the form gives an overview description of each activity. The remaining fields provide highlights of major accomplishments and milestones planned for future years. While these entries highlight significant objectives and results, they should not be viewed as complete descriptions of any activity.

The table at the beginning of each agency's section of the report summarizes the financial data and collaborative ties described above. Component numbers should be considered as estimates and include subjective judgment. The "Partner/User Agencies" field summarizes the Agency Ties material in each activity; however, due to space limitations, not all agencies may be listed in this field for a given activity.

Advanced Research Projects Agency

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

ARPA's HPCS program focuses on developing scalable high performance technologies (both hardware and software) in which a single element can be used as the basis for a workstation while clustered and arrayed elements yield ever higher performance, up to the largest and most powerful systems. While transitioning the technology to reach prototype teraops processing in 1996, foundations are being laid for the next generation of systems, petaops and beyond.

The NETS program develops both high performance networking and hybrid networking schemes that incorporate a wide diversity of transmission modes, including cable TV and wireless.

The ASTA program seeks to unify the diverse models of computation for parallel machines to reduce the complexity of parallel software development.

The IITA program focuses on developing a robust information infrastructure services architecture through a strategy of technology development and testbed activities.

The BRHR program supports foundational research activities and extends the HPCC community to a more diverse population of researchers and users supporting education, training, and historically black colleges and universities.

Advanced Research Projects Agency

Program Activity	Budget Account Code	Partner/User Agencies	Budget (BA, $ M)				HPCC Components by 1996 Agency Req.				
			FY 94 Actual	FY 95 Pres.	FY 95 Est.	FY 96 Rqst.	HPCS	NREN	ASTA	IITA	BRHR
Scalable Systems and Software	ST-19	All HPCC Agencies	58.78	44.70	53.78	46.70	27.24		19.46		
Microsystems	ST-19	NSF, NSA	40.87	45.70	33.60	31.87	31.87				
System Environments	ST-19	All HPCC Agencies	30.27	31.60	36.49	24.62	12.77		11.85		
Defense Information Enterprise Technologies	ST-19	NSF, NASA, NIST	12.50	33.80	28.49	57.61		15.20		42.41	
Networking	ST-19	NSF, DOE, NASA, ...	41.90	33.90	37.69	31.43		31.43			
Defensive Information Warfare	ST-24	NSF, DOE, NASA, ...		11.30	10.00	10.00	4.10	3.30		2.60	
Defensive Information Warfare (continued)	ST-24										
Defense Technology Integration and Infrastructure	ST-19	NSF	11.73	24.30	24.01	23.25	11.11			12.14	
Integrated Command and Control Technology	IC-03		6.00	6.00	6.00	6.00	6.00				
Health Information Infrastructure	MPT-07	NIH		9.80	9.37	10.24				10.24	
Information Sciences	CCS-02	NSF	20.72	21.00	21.81	23.72	1.98		2.60	13.19	5.95
Information Sciences (continued)											
Intelligent Systems and Software	ST-11		66.39	72.30	60.82	77.34				77.34	
Intelligent Systems and Software (continued)											
Global Grid Communications	EE-45	NSA	8.51	23.00	22.14	20.26		20.26			
		Totals:	297.67	357.40	344.20	363.04	95.07	70.19	33.91	157.92	5.95

ARPA	Scalable Systems and Software	Budget Code:	ST-19

The Scalable Systems and Software program supports the development of computing and advanced software technologies needed to enable the development, introduction, and effective use of secure scalable and distributed high performance computing technologies. The program accelerates the evolution of computing and communications technologies. The high performance computing technologies developed by this program drive national defense capabilities in areas that benefit from the ability to do complex modeling and secure distributed communication.

Prototype Scalable Systems is focused on developing, demonstrating, and transferring the scalable computing systems technology base. Projects in this area cover a broad range of computing systems technology issues from research into future generation computing systems technology to the validation of scalable concepts through supporting the incorporation of advanced technology into industrial prototypes.

Operating Systems and Services supports the development of advanced software technologies to enable the development, introduction, and effective use of secure, scalable and distributed high performance computing technologies. In the past, it was sufficient to develop a "fast" computer system in the absence of a software environment. This is no longer the case as the time between generations of advanced hardware has been reduced from many years to less than two years, making it essential to maintain a stable software development environment that can span several generations of computer hardware. This is an absolutely mandatory need for DoD which cannot afford to redevelop software for each new generation of computers.

Budget (BA, $ M)	
FY 94 Actual	58.78
FY 95 Pres.	44.70
FY 95 Est.	53.78
FY 96 Rqst.	46.70

FY 96 Request by Component	
HPCS	27.24
NREN	
ASTA	19.46
IITA	
BRHR	

Agency Ties	
ARPA	
NSF	Partner
DOE	Partner
NASA	Partner
NIH	Partner
NSA	Partner
NIST	Partner
NOAA	Partner
EPA	Partner
ED	
AHCPR	
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Developed foundations for petaoperations (10^{15}) per second and terabits (10^{12}) storage systems. Demonstrated first multicomputer system containing multiprocessor nodes. Developed 10 gigaflops/cu.ft. militarized, embedable scalable computing system.	Design system architectures incorporating components such as programmable protocol engines to support scalability and high performance. Demonstrate systems tools for on-line analysis of a real-time operating systems for scalable, distributed HPC systems. Demonstrate operating system ability to confine processes to isolated domains. Demonstrate first HPC single node operating at 1 Gflop.	Demonstrate high-availability systems scalable in performance to 1 teraflop/s. Demonstrate extensible modular operating system framework supporting real-time, distributed, and limited fault-tolerant scalable computing applications. Demonstrate user-extensible microkernel operating system technology, integrating compiler and run-time support services. Demonstrate computing node architectures that dramatically increase internal memory and communications bandwidths. Demonstrate I/O enhancements to a scalable operating system that overcomes identified bottlenecks leading to significant improvements in throughput.	The Embedable HPC component has been moved to Defense Technology Integration and Infrastructure description.

ARPA	Microsystems	Budget Code:	ST-19

This program activity is responsible for critical aspects of the science and technology that enable the design, development, manufacture, and application of advanced microsystems from basic research through small-scale prototyping. Microsystems refers to single or multiple integrated components that can enable innovative computing systems. A key focus is high performance, densely packaged, low power, scalable components that can be accurately simulated, realized in advanced implementation technologies, and rapidly designed into candidate architectures, considering both hardware and software. Technology investments include tools, techniques, and algorithms enabling design of complex digital microsystems, the application of scalable computing and communications technology to accelerate system design, the creation of distributed virtual research and design infrastructures supporting the broad hierarchy of digital design from integrated circuit processes to complex computing systems, and architectural exploration leading to the creation of fundamental scalable components for next generation HPC and Embedable HPC systems.

Design Technology provides the CAD tools and environments to support the program goals of Microsystems. Specifically, Design Technology focuses on simulation, synthesis, co-design, verification, dependability, and testability of digital electronic systems.

Computational Prototyping exploits the HPC technology base to enable and accelerate design verification, modeling, simulation, synthesis, and testing of complex digital systems. Computational Prototyping addresses the immense gap between existing CAD capabilities and existing system design requirements.

Microarchitectures explores innovative microarchitectural (hardware and software) concepts and fundamentally new models of computing through small-scale experiments. These experiments provide a vehicle for innovative leading edge, university-based architectural investigation to develop and prove new approaches without increased risk to ongoing larger-scale efforts. These early validations of architectural concepts provide the basis of future larger-scale HPC efforts.

Budget (BA, $ M)	
FY 94 Actual	40.87
FY 95 Pres.	45.70
FY 95 Est.	33.60
FY 96 Rqst.	31.87

FY 96 Request by Component	
HPCS	31.87
NREN	
ASTA	
IITA	
BRHR	

Agency Ties	
ARPA	
NSF	Partner
DOE	
NASA	
NIH	
NSA	Partner
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Developed and demonstrated semiconductor virtual process design coupled to actual fabrication line for real-time process control. Enhanced and demonstrated direct support of rapid prototyping of MCM technology. Fabricated operational sub-micron diameter vertical Field Effect Transistor (FET) for ultra high density read-only memory. Demonstrated 200 Mhz super-pipelined processor as part of continuing architectural exploration of high performance system. Developed and demonstrated tools and environments to support the design of low power and wireless computing system. Demonstrated enhanced fabrication services integrated with library management tools and extended system synthesis capabilities.	Demonstrate derivation of electrical parameters from 3-D process models using early computational prototyping methods. Demonstrate prototype secure distributed design environment for electronic systems. Initial demonstration of microarchitectures for advanced packaging and scalable units of replication. Demonstrate scalable, high performance, low-latency switch technology for workstation clusters.	Perform early demonstration of parallel, fully-hierarchical Automatic Test Generation for both combinational and sequential circuits. Demonstrate fault-tolerant and reliability design tools supporting large-scale HPC systems developments. Demonstrate message-passing/shared-memory hybrid architecture protocol accelerator component. Demonstrate distributed computing architectures based on low-cost, low-latency switching technology. Prototype emulation-enhanced system simulation capabilities for microsystem design. Demonstrate integrated module-level synthesis capability.	Description and Milestones reflect a redefinition of program in FY 95. Experimental Microsystems Services, e.g. MOSIS, have been moved to National-Scale Information Enterprise.

ARPA	System Environments	Budget Code:	ST-19

The Systems Environments Program supports the development of advanced software technologies needed to enable and accelerate the development, introduction, and effective use of scalable high performance computing technologies. This program supports the Advanced Software and Algorithms component of the Federal HPCC Program. It is motivated by the need for a stable scalable software environment to enable defense mission agencies to leverage scalable systems and preserve their software investments across multiple generations of computing systems. The Systems Environments Program seeks to address this problem in each of three areas: Languages and Runtime Services, Scalable Software Library Technology, and Experimental Applications.

Languages and Runtime Services focuses on the technologies to develop high performance, cross architecture services for application programs. The project is coordinating three aspects: minimal extensions to well-known programming languages, compiler technologies that automate exploitation of concurrency and data locality, and advanced languages such as ORCA and ML in which concurrency is explicit.

Scalable Software Library Technology develops a suite of compatible library routines for major classes of HPC architectures and for major application areas. This enables application writers to simply link in the appropriate library for each class of machine. This project's initial focus is on demonstration of application portability and high performance using libraries that contain versions of major algorithms for several architectures.

Experimental Applications develops scalable versions of defense critical applications leveraging the HPC environments developed by the Languages and Runtimes Services project and Scalable Software Library Technology components. The Experimental Applications component is coordinated with other ARPA offices, the Defense HPC Modernization office, other defense agencies, and other government agencies, as appropriate.

Budget (BA, $ M)	
FY 94 Actual	30.27
FY 95 Pres.	31.60
FY 95 Est.	36.49
FY 96 Rqst.	24.62

FY 96 Request by Component	
HPCS	12.77
NREN	
ASTA	11.85
IITA	
BRHR	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Demonstrated scalable libraries for Defense-critical problems, such as computational physics and image processing. Developed and distributed HPC software, documentation, performance measurements, and prototype applications using a wide area file system. Demonstrated distributed ADA on scalable HPC systems. Prototyped HPC programming environments for standard languages like C++ and Fortran, while developing new languages like Dataflow, advanced functional languages, and advanced object-oriented languages. Demonstrated microkernel operating systems with performance comparable to integrated operating system, with new mechanisms for better scalability, real-time support, and extensibility.	Demonstrate prototype integrated HPC programming environment for Fortran and C++ on which applications run transparently on several distinct scalable computer architectures without change. Complete detailed study of I/O characteristics of scalable computers under real application load, identifying significant bottlenecks. Demonstrate tools for performance tuning of application software using dynamically-collected statistics. Demonstrate portable scalable software libraries across three major computer architectures applied to semiconductors device simulation.	Evaluate small-scale teraops class systems and individual gigaops processors. Evaluate first generation of fully scalable OS software and programming environments on small-scale versions of teraops computing systems. Define second generation of High Performance Fortran with extensions for task parallelism and support for scalable I/O. Demonstrate extensions of portable scalable libraries to incorporate object-oriented technology and a broader set of applications. Enhance and experimentally evaluate advanced software environment that supports composition tools for software creation, integration, development, and testing using animation techniques.	Activities associated with wide area computing services moved to National-scale Information Enterprise program starting FY96.

Agency Ties	
ARPA	
NSF	Partner
DOE	Partner
NASA	Partner
NIH	Partner
NSA	Partner
NIST	Partner
NOAA	Partner
EPA	Partner
ED	
AHCPR	
VA	

ARPA	Defense Information Enterprise Technologies	Budget Code:	ST-19

This program activity develops the underlying computer systems technology to enable applications developers to demonstrate prototype solutions to national- and global-scale problems. The technology is based on those developed for High Performance Computing and Communications, but exhibiting more extensive capabilities for ubiquitous information access, dynamic discovery of and adaptation to new resources, linkage of objects and their dissemination and distribution over inter networked distributed systems, and trusted system operation on behalf of users and applications. To drive the development of these technologies, this activity supports integrated systems technology projects. In particular, this activity will develop the underlying technology base for the fundamental enabling applications of Digital Libraries and Electronic Commerce.

The underlying program elements are:

(1) Information Infrastructure Software and Services;
(2) Information Infrastructure Applications Demonstrations;
(3) Global Mobile Information Systems; and
(4) Experimental services.

The first element is developing service technologies available to applications developers, built upon bitways, that provides a ubiquitously available, network-aware, adaptive interface upon which to construct national- and global-scale applications. Information Infrastructure Applications Demonstrations are focused efforts for fundamentally enabling applications, such as Digital Libraries and Electronic Commerce. The technologies developed in support of these will enable other applications that require extensive capabilities for large-scale repositories of network-linked objects, adaptation to the surrounding resource environment, usage metering-accounting-payment mechanisms, and privacy-enhanced, secure, and trusted processing. The Global Mobile Information Systems activity is developing the technologies to support applications that must operate in the presence of platform mobility, sporadic connectivity, and dynamically varying bandwidths. Experimental services support experimental design for computational and physical prototyping.

Budget (BA, $ M)	
FY 94 Actual	12.50
FY 95 Pres.	33.80
FY 95 Est.	28.49
FY 96 Rqst.	57.61

FY 96 Request by Component	
HPCS	
NREN	15.20
ASTA	
IITA	42.41
BRHR	

Agency Ties	
ARPA	
NSF	Partner
DOE	
NASA	Partner
NIH	
NSA	
NIST	Partner
NOAA	
EPA	
ED	
AHCPR	
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Extended Privacy Enhanced Mail (PEM) to include abilities for multimedia attachments, multiple encryption methods, and alternative digital signature algorithms. Developed prototype suite of advanced data storage and access tools, such as distributed and replicated file systems supporting intermittent communications, trusted and secure operations, more sophisticated access semantics, and multilevel storage management. Demonstrated initial national-level digital library for exchange of technical reports between five major universities, ARPA, and the Library of Congress. Initiated, in conjunction with NSF and NASA, a broader initiative to expand digital library technology in the areas of information indexing, remote access, and storage management.	Develop initial prototype of common authentication, authorization, and accounting services infrastructure based on security mechanisms in Defensive Information Warfare (ST-24) program. Demonstrate prototypes of distributed digital library technology including techniques for scalable storage management and data repositories, persistent object bases, and multimedia objects. Demonstrate copyright management system, providing proof of concept including fully electronic copyright registration, recordation, rights transfer, and management. Demonstrate mobile computing system Computer Aided Design (CAD) environment through the design of early prototype, high bandwidth, pico-cellular, and wireless access points to the wireline infrastructure. Demonstrate network-based access to Multichip Module fabrication services.	Demonstrate prototype toolkits supporting development of applications adaptive to changes in the computing and communication environment. Demonstrate prototype of information services through a testbed incorporating electronic commerce and digital libraries, including experimental charging mechanisms. Initial prototype of adaptive extensions to Internet services in support of mobility. Initial prototypes of untethered node hardware/software architectures for mobile computing. Initial prototype of active catalogs for commodity electronics brokering service. Demonstrate design environments supporting simulation and synthesis of wireless systems spanning integrated circuits to network applications. Demonstrate initial capabilities for intelligent information services for resource description, registration, and retrieval. (Continued in next column)	Experimental Microsystems Services, e.g. MOSIS, have been moved from Scalable Systems and Software. FY 1996 Agency Request Continued Complete the experimental evaluation of the integration of multiple advanced intelligent systems and software technologies in autonomous applications.

ARPA	Networking	Budget Code:	ST-19

This program activity is developing high performance networking technologies as enablers of a world-wide ubiquitous information infrastructure. The driving forces are the need to provide enabling technology in support of global climate simulation, high resolution remote imagery exploitation, telemedicine as well as national- and global-scale applications requiring high data rate wide and local area communication and information services. This program activity will produce networking technologies needed to enable the effective interconnection of the high performance computing systems produced by the other parts of the HPCC Program.

The Internetworking component develops technology in four areas: Internet Protocols, Communication Services, Routing and Scaling, and Network Security. Internet Protocols insure that differing types of network "bitways" work together as a cohesive system in order to build networks from a local to global scale and from slowest to fastest. Research in this area also insures that integration of the newest high performance technology continues to interwork with existing and slower/older technology in a systematic manner. Routing and Scaling technologies insure that networks continue to provide reliable services as the number of networks and number of connected endpoints continue to rapidly increase. Communication Services builds on the basic transmission capability of the underlying technology to provide additional services, such as multicast and guaranteed Quality of Service, to applications. Finally, the Network Security area collaborates with the Defensive Information Warfare program to integrate security techniques into the evolving network infrastructure.

The High Performance Networking component is concerned with increasing the performance of underlying network technologies and developing innovative ways of delivering bits to the customer. Special issues include satellite, broadcast communication, switching technology, telecommunications standards, optical transmission, and affordable local area designs. The component develops technology to reduce latency and increase bandwidth by focusing on new techniques to interface computers and their applications to networks, to provide distributed computing services that enables high application-to-application performance, and to evaluate and measure performance through continual experimental applications. The objective is to create a suite of complementary communication systems which can be integrated into an overall system with all of the strengths and none of the weaknesses of individual systems. Through the use of testbeds, a continually escalating level of performance for application development is provided while validating the effectiveness of the supporting technologies.

Budget (BA, $ M)	
FY 94 Actual	41.90
FY 95 Pres.	33.90
FY 95 Est.	37.69
FY 96 Rqst.	31.43

FY 96 Request by Component	
HPCS	
NREN	31.43
ASTA	
IITA	
BRHR	

Agency Ties	
ARPA	
NSF	Partner
DOE	Partner
NASA	Partner
NIH	Partner
NSA	Partner
NIST	Partner
NOAA	
EPA	
ED	
AHCPR	
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Demonstrated C3 systems technology with scalable high performance network technology enabling full multimedia real-time information exchange using early gigabit networks. Demonstrated prototypes of Gb/s SONET and ATM technology operating over fiber and satellite media. Conducted demonstration of all-optical Local Area Networks (LANs). Demonstrated medical, terrain visualization, and modeling applications on 100 Mb/s and Gb/s class networks. In-laboratory demonstration of 30 Gb/s wave division multiplexing.	Demonstrate bandwidth, delay, and service reservation guarantees for networks in support of real-time control and critical services. Demonstrate Synchronous Optical Network (SONET) and Asynchronous Transfer Mode (ATM) encryption technologies at 155 Mb/s (OC-3c). Deploy small-scale, initial prototype of gigabit-per-second class, nation-spanning infrastructure in support of high performance computing applications. Demonstrate advanced network capabilities, including multicast-based services and next generation Internet protocols with improved ease of use.	Demonstrate higher level communication services that coordinate distributed computing resources across the network environment. Prototype networks at greater than 40-gigabit-per-second speed using optical technologies and experimentally validate scalable network protocols at the higher speeds. Prototype secure nomadic computing architecture integrated into existing wide area networks. Deploy reference implementation of protocol-independent, multicast-capable infrastructure as basis for development of advanced services. Demonstrate robust and secure network-level infrastructure protocols to include directory services and resource allocation. Demonstrate technology for autonomous, node-level network management.	Milestones dealing with security have been moved to the Defensive Information Warfare program starting in FY95.

ARPA	Defensive Information Warfare	Budget Code:	ST-24

The Defensive Information Warfare Program creates advanced security technologies for emerging NII and national- and global-scale computing and communications systems. It is developing technologies to prevent unauthorized entrance to systems, protect the network infrastructure, and protect information in repositories and in transit. Security tools and services will be developed that can be used by commercial carriers, by third-party providers of security services to make available scalable value-added security support, or by end-system applications to embed security functions. The program provides the security capabilities needed for key elements of other ARPA programs, including Networking Systems, Scalable Software and Systems, Microsystems, National Information Enterprises, and Health Information Infrastructure. The program is organized into four areas: Tools for Network Security, Secure Computing Systems, Assurance and Integration, and Survivability and Vulnerabilities.

Tools for Network Security develops the technologies to create a transmission fabric resistant to external and internal attack, where the infrastructure is intended to support wireless, mobile, and fixed location hosts. Solutions will be scalable for use in national-scale wide-area networks and high-performance communications technologies, and interoperable to allow multiple solutions to coexist.

Secure Computing Systems develops technologies to support dynamically instantiated secure enclaves by allowing specific computing resources within a computer system to be assigned to specific security domains. These security domains correspond to a distributed set of users who are participating in a secure enclave to share designated information resources for a specific purpose.

Assurance and Integration develops tools for the development of trusted systems. A set of common "middleware" services will help developers build secure distributed applications across heterogeneous platforms to provide a set of mechanisms to transparently handle the secure synchronization of replicated objects, secure distributed concurrency control, and secure reliable message passing. A common set of abstractions will deal with security concepts that may have heterogeneous implementations. (continued on next page)

Budget (BA, $ M)	
FY 94 Actual	
FY 95 Pres.	11.30
FY 95 Est.	10.00
FY 96 Rqst.	10.00

FY 96 Request by Component	
HPCS	4.10
NREN	3.30
ASTA	
IITA	2.60
BRHR	

Agency Ties	
ARPA	
NSF	Partner
DOE	Partner
NASA	
NIH	
NSA	Partner
NIST	Partner
NOAA	
EPA	
ED	
AHCPR	
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
	Develop basic authentication and authorization mechanisms based on digital signatures, cryptography, and privacy-enhanced mail for use in a common infrastructure. Complete proof-of-concept Asynchronous Transfer Mode (ATM) encryption units for use in experimental ATM networks. Begin operation of certification authority supporting privacy enhanced mail and other secure services. Complete prototype implementation of digital signature hierarchy toolkit and domain name system enhancements. Demonstrate operating system capability for strict process separation. Demonstrate prototype signature/timestamp server with associated access tools for location-independent object security.	Demonstrate prototype of secured routing protocols. Demonstrate cryptographic applications programming interface to allow secure applications to be built independent of the cryptography used. Release initial prototype of system security checking tools for use in security monitoring and incident response. Small-scale demonstrations of techniques for survivability and recoverability in electronic, communications, and information systems of critical importance to DoD. Demonstrate extensions of system design and analysis tools that provide increased robustness for application to defense-wide distributed systems. Techniques for permitting real-time tradeoffs between security, reliability, and recoverability ready for validation in critical defense experimental systems. (Continued on next page)	Defensive Information Warfare is shown as a separate program activity starting in FY 95. Funding has been moved to ST-24. Milestones in FY 95 represent on-going projects that are being transferred from Networking Systems to Defensive Information Warfare.

ARPA	Defensive Information Warfare (continued)	Budget Code:	ST-24

(continued)
The Survivability and Vulnerabilities area studies other vulnerabilities in the nation's computing infrastructure and in emerging critical technologies that could be exploited by an information warfare enemy. These other vulnerabilities are related to reliability, fault tolerance, timeliness, and correctness, and their relationship with security.

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
		(continued) Demonstrate high-assurance microkernel for use in secure operating systems. Complete development of a prototype toolkit supporting secure distributed applications over a single administrative domain.	

Budget (BA, $ M)	
FY 94 Actual	
FY 95 Pres.	
FY 95 Est.	
FY 96 Rqst.	

FY 96 Request by Component	
HPCS	
NREN	
ASTA	
IITA	
BRHR	

Agency Ties	
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NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

ARPA	Defense Technology Integration and Infrastructure	Budget Code:	ST-19

Advanced technologies sponsored by ARPA become of value when they are integrated into usable systems in support of national defense capabilities. The Defense Technology Integration and Infrastructure program (DTII) is intended to help transition advanced technologies into the defense mainstream by:

- Developing the unifying integration technology that can brings technologies together into common systems frameworks
- Demonstrating the integration of specific technologies and applications using integration technology
- Adapting high performance scalable computing technologies to embedded computing and other defense environments
- Improving the accessibility to new technologies by improving their human interfaces and the ability to use them in collaborative situations
- Driving technology integration experiments of particular significance to defense.

The Embedable Systems component focuses on leveraging and extending the commercial scalable computing technology base to support present and future defense embedded computing applications. This program element makes strategic embedded-specific investments through leveraging advanced systems packaging technology to achieve system "smallness" with regard to power, weight, and size.

The Integrated Testbed Technologies component devises technologies that facilitate bringing two or more systems or technologies together into a common systems framework. In practice we expect this subprogram to learn by doing. Emerging technologies developed by ARPA and other agencies will be matched with advanced defense application ideas through the Enterprise Systems subprogram described later.

The Hiper-D program terminates in FY 1995. Hiper-D is a successful collaborative program between ARPA and the AEGIS community that has facilitated the development, evaluation, and deployment of computing technology from ARPA to the AEGIS community.

Enterprise Systems brings together and demonstrates emerging advanced technologies and accelerates the transition of ARPA technology to the defense community. They bring defense users and requirements into contact with one or more advanced technologies in a fertile and supportive setting. In many cases a successful demonstration will require the development of a testbed using novel integration technology of the kind generated by the Testbed Integration Technologies subprogram.

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Initiated program in support of information-intensive applications of HPCC technologies in health care, digital libraries, manufacturing, and education and training. Established local pilot projects. Demonstrated coast-to-coast video workshops on high performance Internet. Initiated FY 94 HBCU participation through BAA solicitation, evaluation, and selective awards. Invited HBCU's to participate in program reviews and promote teaming efforts between schools.	Demonstrate use of advanced visualization environment in a defense application. Develop a set of communication benchmarks, communication protocols, and prototype for embedded, scalable military systems. First Message-Passing Interface (MPI) demonstration of cross-architecture application portability. Demonstrate integrated access to several different special, classified defense and intelligence information systems. Demonstrate 10 gigaflops/cu.ft. militarized HPC System.	Develop and provide experimental testbed services employing advanced high performance computing technologies for special defense users. Prototype embedded computing system modules with scalability concepts containing memory hierarchy and power on a single unit of replication. Perform integration tests in key defense applications such as advanced distributed simulation, advanced distributed collaboration, advanced communications and control, and advanced human computer interfaces. Demonstrate improved solutions to two major classified, special computational challenges. Demonstrate first fine-grained high performance embedded and scalable computer system. Demonstrate graphical program environments for embedded systems.	This program has been refocused starting in FY 95 to reflect emphasis on the integration of HPCC technologies.

Budget (BA, $ M)	
FY 94 Actual	11.73
FY 95 Pres.	24.30
FY 95 Est.	24.01
FY 96 Rqst.	23.25

FY 96 Request by Component	
HPCS	11.11
NREN	
ASTA	
IITA	12.14
BRHR	

Agency Ties	
ARPA	
NSF	Partner
DOE	
NASA	
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NIST	
NOAA	
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AHCPR	
VA	

ARPA	Integrated Command and Control Technology	Budget Code:	IC-03

This program activity develops technology and manufacturing capability for high definition displays and scalable image processing systems.
Major components of this activity include:

Projection, head-mounted, and direct-view displays based on multiple technologies;
Display architectures and processors;
Compression algorithms; and
High speed data transmission.

These efforts will establish a domestic technical capability and demonstrate the manufacturing of components necessary for military systems that capture, process, store, and distribute and display high resolution images.

Budget (BA, $ M)	
FY 94 Actual	6.00
FY 95 Pres.	6.00
FY 95 Est.	6.00
FY 96 Rqst.	6.00

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Developed imaging systems and processes needed to realize high information throughput.	Continue developing enabling component technologies for performance and cost goals for high definition image processing systems.	Establish testbed for interoperability standards for display interfaces. Demonstrate prototype high-resolution progressive scan digital camera.	

FY 96 Request by Component	
HPCS	6.00
NREN	
ASTA	
IITA	
BRHR	

Agency Ties	
ARPA	
NSF	
DOE	
NASA	
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

ARPA	Health Information Infrastructure	Budget Code:	MPT-07

This program activity will develop an intelligent, agent-based clinical associate software system and demonstrate its application in Ambulatory Care and Combat Casualty and Trauma Care. The program vision is to greatly improve the tools that support decision-making by clinical users and patients-consumers. The objectives of this activity are to:

(1) conduct visionary pilot projects of CLASS that demonstrate significant impact in health care; and

(2) develop a health care-specific information infrastructure that promotes use and reuse of component-based architectures for health information systems.

Models of the health care domain are constructed using a scenario-based engineering process. Domain-specific software architecture tools are used to derive reference architecture and requirements and to generate instances of user-based evaluation systems (visionary pilots). Important features and attributes of the sub-domain pilots are generalized to produce an associate systems reference architecture for health care (health care specific tools). The key functional components of this intelligent systems architecture include:

(1) The human-computer interaction manager;

(2) The task and context manager; and

(3) The information broker.

This architecture stresses multi-modal user interfaces, information integration from heterogeneous sources, multi-modal information acquisition, communication, and presentation, intelligent on-line support for medical personnel, logistical planning and resource allocation, and simulation-based systems for decision-makers in health care management. It provides a unique environment for developing tools and techniques for integrating and leveraging existing and emerging HPCC technologies. A key criterion for success is the transfer of the associate system and health care reference architectures into operational use in the Nation's industrial base. Technology transfer plans include: development of generic technology that migrates to diverse platforms; work in partnership with users; developmental consortia and functional managers; and use of actual clinical scenarios and operational environment for developing, testing, and evaluating; and providing

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
	Develop domain models for ambulatory and trauma-combat casualty care. Demonstrate CLASS -- Composite Health Care System mediator. Pilot CLASS components in one clinic at National Naval Medical Center. Develop CLASS reference architecture for ambulatory care. Capture clinical data directly from physicians in two different clinics.	Extend CLASS architecture to provide trauma guidelines directly to medics. Demonstrate shared patient-record planning for distributed health and human services. Integrate user-task models and knowledge-based decision support tools. Demonstrate hands-free capture of patient data during emergencies. Provide one-stop shopping for geographically dispersed human services clients. Create reference architecture for generalized associate system.	Program activity start delayed to FY95.

Budget (BA, $ M)	
FY 94 Actual	
FY 95 Pres.	9.80
FY 95 Est.	9.37
FY 96 Rqst.	10.24

FY 96 Request by Component	
HPCS	
NREN	
ASTA	
IITA	10.24
BRHR	

Agency Ties	
ARPA	
NSF	
DOE	
NASA	
NIH	Partner
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

ARPA	Information Sciences	Budget Code:	CCS-02

The HPCC Information Sciences program activity leverages basic software technology research supporting military, mission-oriented needs. More specifically, this software technology research develops advanced concepts for methods and tools to produce high assurance software, language concepts that facilitate the rapid specification and evolution of software intensive defense systems, and techniques to manage shared complex-structured data objects in larger heterogeneous, distributed information systems.

Intelligent systems technology focuses on advanced techniques for knowledge representation, reasoning, and machine learning to enable computer understanding of spoken and written language and to advance methods for planning, scheduling, and resource allocation.

Human-computer interaction technology focuses on design methods and enabling technology for more natural interaction between people and computers.

Microelectronic science calibrates fundamental concepts to produce reliable, testable, and high performance design.

High Performance Computing (HPC) science generates concepts and methods for validating and verifying design components, and unique approaches to rapidly develop high performance libraries across multiple HPC architectures.

Budget (BA, $ M)	
FY 94 Actual	20.72
FY 95 Pres.	21.00
FY 95 Est.	21.81
FY 96 Rqst.	23.72

FY 96 Request by Component	
HPCS	1.98
NREN	
ASTA	2.60
IITA	13.19
BRHR	5.95

Agency Ties	
ARPA	
NSF	Partner
DOE	
NASA	
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Developed benchmark problems and metrics for advanced research in information sciences. Developed advanced concepts for machine learning, automated reasoning, knowledge representation, and advanced information processing for human language understanding and large-scale planning, scheduling, and resource allocation methods. Developed design concepts for interactive, dialogue-based human computer interaction. Developed process models for prototyping large-scale systems. Developed advanced concepts for understanding software, high assurance software, and software system composition. (Milestones continues onto the next page.)	Provide Internet access to benchmark problems, metrics, and test data sets and conduct experimental evaluations involving multiple intelligent systems and software technologies. Develop initial prototype of reusable machine learning, reasoning, and knowledge representation methods and experimentally evaluate advanced information processing methods for human language understanding, planning, scheduling, and allocation. Develop initial tool kits for interactive, dialogue-based human computer interaction. Develop initial language-based methods for software understanding, high assurance, and software system composition. (Milestones continues onto the next page.)	Evaluate and enhance prototype implementations of reusable machine learning, automated reasoning, and knowledge representation methods for human language understanding, and large-scale planning, scheduling, and resource allocation methods. Evaluate tool kits for interactive, dialogue-based human computer interaction. Evaluate language-based methods for software understanding, high assurance, and software system composition. Evaluate prototypes for heterogeneous, distributed software system architectures and tools to support construction and maintenance of advanced intelligent systems.	

ARPA	Information Sciences (continued)	Budget Code:	

Budget (BA, $ M)

FY 94 Actual	
FY 95 Pres.	
FY 95 Est.	
FY 96 Rqst.	

FY 96 Request by Component

HPCS	
NREN	
ASTA	
IITA	
BRHR	

Agency Ties

ARPA	
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NASA	
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NIST	
NOAA	
EPA	
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AHCPR	
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
(continued) Developed design concepts of advanced components needed for highly reliable computing systems, including mobile, high performance, and graphical systems. Developed advanced concepts for high performance libraries to support multiple parallel architectures that are integrated with compiler technology.	(continued) Develop initial prototypes for heterogeneous, distributed software system architectures and tools to support construction and maintenance of advanced intelligent systems. Evaluate library research that supports multiple parallel architectures.		

ARPA	Intelligent Systems and Software	Budget Code:	ST-11

This HPCC Program activity leverages exploratory intelligent systems and software technology development that supports military, mission-oriented needs. It develops new information processing technology concepts that lead to fundamentally new software and intelligent systems capabilities. This will enable advanced information systems (involving both humans and computers) to more effectively accomplish decision-making tasks in stressful, time-sensitive situations and create efficient software systems supporting computer and software-intensive defense systems.

Major areas of technical emphasis are in:

(1) Intelligent systems (artificial intelligence), including autonomous systems, interactive problem solving, and intelligent integration of information from heterogeneous sources;

(2) Software development technology including languages, algorithms, data and object bases, domain specific software architectures, software prototype technology, software design tools, software reuse, and advanced software engineering environments; and

(3) Manufacturing automation and design engineering, including the development of advanced software systems that support sharing of engineering knowledge, advanced product and process design representations, integrated product and process design, software tools for design process management, manufacturing process planning, manufacturing process control and demonstrations.

Budget (BA, $ M)	
FY 94 Actual	66.39
FY 95 Pres.	72.30
FY 95 Est.	60.82
FY 96 Rqst.	77.34

FY 96 Request by Component	
HPCS	
NREN	
ASTA	
IITA	77.34
BRHR	

Agency Ties	
ARPA	
NSF	
DOE	
NASA	
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Developed test cases and testbeds for autonomous systems, command and control, and manufacturing systems. Evaluated the integration of intelligent systems and software in autonomous vehicles. Released the beta version of the Image Understanding Environment and developed advanced methods for vision guided navigation. Developed initial capabilities for human-aided machine translation, document understanding, and speech understanding in adverse conditions. Developed advanced real-time planning and control algorithms. Developed knowledge-based decision aids to support crisis action planning.	Evaluate the integration of advanced intelligent systems and technologies in multiple autonomous vehicles. Upgrade the Image Understanding Environment and develop prototype implementations of advanced methods for vision guided navigation and cartographic modeling. Develop initial prototype implementations for human-aided machine translation, document understanding, and robust speech understanding in adverse acoustic conditions. Develop initial prototype implementations of advanced real-time planning and control algorithms.	Enhance test case scenarios and Internet accessible software testbeds. Enhance and evaluate advanced methods for vision guided navigation and cartographic modeling. Evaluate implementations of real-time planning and control. Evaluate knowledge-based decision aids. Evaluate methods for information fusion, aggregation, summarization, and explanation. Evaluate scalable machine intelligent methods for machine learning, automated reasoning and real time problem solving.	
(Milestones continue on the next page.)	(Milestones continue on the next page.)	(Milestones continue on the next page.)	

ARPA	Intelligent Systems and Software (continued)	Budget Code:	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
(continued) Developed advanced methods for information fusion, aggregation, summarization, and explanation. Developed initial language-based methods for describing and composing domain-specific software. Developed initial software environment supporting composition tool integration and software development and testing. Developed evaluation and design concepts to support highly distributed, wide bandwidth information processing applications. Enhanced agent based architectures for sharing design knowledge, manufacturing process planning, and manufacturing control.	(continued) Enhance knowledge based decision aids to support the rapid construction of multiple-crisis action plans. Develop concepts and implementations of scalable machine intelligent algorithms for autonomous associate systems. Develop initial prototype implementations of advanced methods for information fusion, aggregation, summarization, and explanation. Evaluate language-based methods for describing domain specific software architectures. Develop information infrastructure services for manufacturing, e.g., access to engineering analysis and rapid prototyping.	(continued) Enhance and evaluate advanced software environment that supports composition tool integration. Enhance agent based architectures to include machine learning techniques and advanced information processing. Demonstrate feasibility of authoring tools in creating domain-specific multimedia curricula. Expand network design and manufacturing services to include factory simulation and reusable product and process design libraries. Continue the activities in human computer interaction heterogeneous testbed product development and insertion. Test, evaluate, and demonstrate to the user community enhancements of the testbed.	

Budget (BA, $ M)	
FY 94 Actual	
FY 95 Pres.	
FY 95 Est.	
FY 96 Rqst.	

FY 96 Request by Component	
HPCS	
NREN	
ASTA	
IITA	
BRHR	

Agency Ties	
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NOAA	
EPA	
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AHCPR	
VA	

ARPA	Global Grid Communications	Budget Code:	EE-45

This program activity develops and demonstrates advanced communications technologies needed for defense and intelligence operations for the 21st century. This program activity will demonstrate that commercial communications resources and technologies can be integrated with advanced optical components developed in this program as well as DoD tactical and satellite technology developed elsewhere.

The key elements are:

- Demonstration networks that validate the R&D and enable early application development and technology transition into DoD efforts;
- Development of network controls pertaining to management and security software technologies to enable end-to-end applications combining all network media;
- Development of advanced optoelectronic network component technology and network architecture for scalable and modular networks. The aggregate network bandwidth will be in the range of terabits per second and the network will handle multimedia service for both digital and analog signals.

Budget (BA, $ M)	
FY 94 Actual	8.51
FY 95 Pres.	23.00
FY 95 Est.	22.14
FY 96 Rqst.	20.26

FY 96 Request by Component	
HPCS	
NREN	20.26
ASTA	
IITA	
BRHR	

Agency Ties	
ARPA	
NSF	
DOE	
NASA	
NIH	
NSA	Partner
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Initiated network management, control, signaling efforts and demonstrated interoperability between commercial and DoD network assets. Initiated optoelectronic network component technology development: switch, multiplexer, filter, amplifier, and synchronizer.	Integrate DoD and commercial networks and demonstrate services and network management in support of 'crisis management' applications. Demonstrate advanced optical network capability and multi-wavelength reconfigurable network architecture. Demonstrate prototypes of gigabit per second technology over combined fiber and satellite media.	Demonstrate evolving software development practices and the migration of software applications and information services to higher bandwidth networks. Demonstrate integration on a CONUS and International scale of all networks. Demonstrate end-to-end secure transmission and signaling at gigabit per second rates. Demonstrate high bandwidth operation of critical multi-wavelength components. Field test local area network application of multi-wavelength analog and digital signal transmission.	

National Science Foundation

The NSF HPCC program supports and elaborates upon Federal 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 forward toward achieving programmatic goals. For the NSF HPCC program, 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;

Introducing 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 HPCC research;

Small group research teams studying single, broader problems;

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

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

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

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

National Science Foundation

Program Activity	Budget Account Code	Partner/User Agencies	Budget (BA, $M)				HPCC Components by 1996 Agency Req.				
			FY 94 Actual	FY 95 Pres.	FY 95 Est.	FY 96 Rqst.	HPCS	NREN	ASTA	IITA	BRHR
NSFNET		All HPCC Agencies	39.11	46.16	45.22	46.22		40.92		5.30	
Supercomputer Centers		ARPA, NASA, NIH	66.90	76.43	70.90	74.90			72.90	2.00	
Research Centers		ARPA, NASA	10.93	10.55	10.68	11.08			6.00	0.68	4.40
Research Infrastructure			19.05	20.95	20.05	21.59				2.94	18.65
Grand Challenge Applications Groups		ARPA, EPA	7.75	10.75	9.25	7.25			7.25		
Computing Systems and Components			18.76	20.70	20.31	22.33	21.83			0.50	
Software Systems and Algorithms			23.46	25.35	25.46	29.01			19.30		9.71
Ubiquitous Computing and Communication		ARPA, DOE, NASA	10.00	11.30	11.52	14.80		4.80		1.00	9.00
Human-Machine Interaction & Information Access		ARPA	10.40	11.00	11.00	14.55			6.80	4.15	3.60
Biological Sciences (non-NC/GC)			8.80	11.50	11.53	11.43			10.40	1.03	
Engineering (non-NC/GC)			3.10	4.23	4.76	3.98	1.65		1.70	0.63	
Geosciences (non-NC/GC)		NASA, NOAA	2.37	3.84	4.68	3.59			3.19	0.40	
Computational Mathematics (non-NC/GC)			6.68	7.59	7.66	6.11			2.00	0.59	3.52
Physical Sciences (non-NC/GC)		NIST	5.32	9.77	8.73	7.09			3.09	4.00	
Social, Behavioral & Economic Sciences (non-NC/GC)			1.15	3.01	2.09	2.14				2.14	
Education and Training		ARPA, ED	17.29	20.24	17.98	20.24		9.00			11.24
National Challenges		ARPA, NASA	11.42	35.25	15.12	17.33				17.33	
Totals:			262.49	328.62	296.94	313.64	23.48	54.72	132.63	42.69	60.12

NSF	NSFNET	Budget Code:	

The purpose of the NSFNET program activity is to provide for the data networking needs of the U.S. research and education community. This program activity supports operation of the worldwide Internet, and also funds enhancements to and participation in it.

More than 1,100 U.S. colleges and universities have been connected to the Internet through the NSFNET program activity, and well over a 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.

A new, quasi-operational very high speed network backbone service (the "vBNS") will link NSF-supported high performance computing centers, and links are being established competitively to scientific applications that demand the performance available. 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 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.

Budget (BA, $ M)	
FY 94 Actual	39.11
FY 95 Pres.	46.16
FY 95 Est.	45.22
FY 96 Rqst.	46.22

FY 96 Request by Component	
HPCS	
NREN	40.92
ASTA	
IITA	5.30
BRHR	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Extended Merit award for transitioning to new NSFNET architecture. Made awards for Regional Network Providers, NAP Managers, and Routing Arbiters.	Complete transition to new NSFNET architecture including: Overseeing Merit's audit of subcontract award to ANS; Closing out Merit cooperative agreement for old NSFNET architecture. Complete initiation of award for vBNS. Begin vBNS to NSF supercomputer centers at ≥ 155 Mb/s. Connect vBNS to four NAPs at ≥45 Mb/s. Issue solicitations: for vBNS; for connections to qualifying high-bandwidth applications; and for additional International Internet Services. Make targeted awards in the network theory initiative. Support connection of 50 additional institutions to the Internet. Make two awards in vBNS Connections Program.	Continue to expand connection of qualifying scientific applications to the vBNS. Participate with other Federal agencies and the private sector in implementing new network-layer protocol on the Internet. Support connection of 50 additional institutions to the Internet. Pilot deployment of emerging privacy and security tools for the Internet.	The vBNS award and the solicitation for vBNS connections for high bandwidth applications were delayed to FY 1995 during GAO resolution of challenges. The solicitation for additional International Internet Services was delayed to FY 1995 due to lack of funds.

Agency Ties	
ARPA	Partner
NSF	
DOE	Partner
NASA	Partner
NIH	Partner
NSA	User
NIST	User
NOAA	User
EPA	User
ED	User
AHCPR	User
VA	User

NSF	Supercomputer Centers	Budget Code:	

The four NSF Supercomputer Centers are
Cornell National Supercomputer Facility at Cornell University
National Center for Supercomputing Applications at the University of Illinois
Pittsburgh Supercomputing Center at Carnegie Mellon University, University of Pittsburgh, and Westinghouse
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 8000 users from 49 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 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 strategic goals of the Centers are:

Provide access to state of the art equipment to academic community;
Research emerging technologies; interact with vendors;
Develop tools and software for all aspects of HPCC;
Lead in computational science applications (Grand Challenges);
Provide education and training in the use of High Performance Computing (vector & scalable systems, workstation access);
Act as a resource for State and local Centers;

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Implemented Andrew File System as cross-center national single user name space file system creating metacenter software infrastructure. Completed initial evaluation phase of scalable parallel computers, jointly with three NASA centers. Emphasized exploration of scalable computing by major segments of scientists, engineers, and students to utilize the Centers' resources in production mode. Initiate cooperative efforts with State and Regional Centers to broaden the base of usage of HPCC, and expand education and training activities. Established six Regional Alliances.	Install new systems and upgrades of current systems at Supercomputer Centers to more powerful parallel computing systems needed to support the academic computing community. Enhance metacenter activities, especially in the area of mass storage for the national file system being developed at the Centers. Add additional Regional Alliances (4-6) to enhance computing and communications expertise of individuals in university, education, public and private sectors. Host annual Supercomputing meeting in San Diego, with Center Directors as General Chair and Program Chair (5,000 attendees anticipated).	Renew Supercomputer Centers cooperative agreements. Establish National Metacenter as a seamless national computing environment across all four NSF Centers and other affiliates. Establish parallel computing as production method in computational research. Provide access to computer systems with capacity approaching a teraflop. Support demonstration of National Challenge applications.	.

Budget (BA, $ M)	
FY 94 Actual	66.90
FY 95 Pres.	76.43
FY 95 Est.	70.90
FY 96 Rqst.	74.90

FY 96 Request by Component

HPCS	
NREN	
ASTA	72.90
IITA	2.00
BRHR	

Agency Ties

ARPA	Partner
NSF	
DOE	
NASA	Partner
NIH	Partner
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

NSF	**Research Centers**	Budget Code:	

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

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

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

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

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

Budget (BA, $ M)	
FY 94 Actual	10.93
FY 95 Pres.	10.55
FY 95 Est.	10.68
FY 96 Rqst.	11.08

FY 96 Request by Component

HPCS	
NREN	
ASTA	6.00
IITA	0.68
BRHR	4.40

Agency Ties

ARPA	Partner
NSF	
DOE	
NASA	Partner
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Evaluated the expressibility of High Performance Fortran using Grand Challenge applications in order to identify areas of emphasis for second round of development. Disseminated and supported a Message Passing Interface Standard that will provide vendors with a standard that they can implement efficiently for performing message passing among processors in MIMD distributed-memory computing systems. Enhance operational toolkit for construction of 3-D objects with improved interactive capabilities.	**Release a set of software tools for the support of experimental analysis in discrete mathematics and theoretical computer science.** **Release a portable prototype library for sparse direct matrix computation that can be optimized for different computing systems.** **Develop an object-oriented multi-disciplinary analysis and design tool set to solve optimization problems in industrial design.** **Demonstrate with biological modeling, a fluent, physically based modeling language that extends geometric modeling languages and operators.** **Release a second version of High Performance Fortran that provides support for adaptive, dynamic computations.** **Begin a special year on Mathematical Support for Molecular Biology at DIMACS focused on the application of discrete mathematics and theoretical computer science on problems in DNA sequencing and in protein structure.**	Build models that are visually and measurably indistinguishable from real-world entities. Provide universal Fortran-based language for which vendors can provide efficient compilers and which will assure program portability. Identify and exploit applications areas where discrete mathematics and theoretical computer science developments can lead to more accurate and efficient computations. Begin a special year on Logic and Algorithms at DIMACS focused on the relationship between mathematics and computational algorithms.	The start of the special year on Mathematical Support for Molecular Biology at DIMACS was delayed until FY 1995 to allow better organization and participation.

NSF	Research Infrastructure	Budget Code:	

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

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

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

Budget (BA, $ M)	
FY 94 Actual	19.05
FY 95 Pres.	20.95
FY 95 Est.	20.05
FY 96 Rqst.	21.59

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Developed several distributed, heterogeneous facilities to address high speed networking needs of scalable parallel computing research. Supported infrastructure for virtual manufacturing research. Developed infrastructure to support networked digital libraries research. Supported infrastructure for distributed multi-media systems research.	Support infrastructure for research on the input/output problems with scalable parallel systems. Develop infrastructure to support networked applications in education and advanced manufacturing. Provide infrastructure support for gigabit network research. Provide infrastructure support for virtual manufacturing. Provide infrastructure support for multi-media systems research. Continue support of identified infrastructure needs for basic experimental research. Participate in the Network Infrastructure for Education program supporting infrastructure for education applications of the NII.	Conduct formal evaluation of existing programs to adjust to the infrastructure needs of experimental research in computing disciplines supporting the HPCC. Develop infrastructure support for basic research necessary for educational uses of the NII. Continue infrastructure support for virtual manufacturing, and the other IITA components of the HPCC initiative. Increase participation in the NIE program.	Support for research on the input/output problems was postponed to FY 1995 so that the support for the infrastructure needs of digital libraries intended for FY 1995 could be provided in FY 1994. Additional support for the Network Infrastructure for Education program will be added in FY 1995.

FY 96 Request by Component	
HPCS	
NREN	
ASTA	
IITA	2.94
BRHR	18.65

Agency Ties	
ARPA	
NSF	
DOE	
NASA	
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

NSF	Grand Challenge Applications Groups	Budget Code:	

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

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

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Simulated 130,000 atom acetylcholinesterase system, using a molecular dynamics code, to study the process of drug binding. Developed and incorporated compiler enhancements for automatic generation of the equations for sensitivity analysis applied to the physical and chemical processes involved in air pollution. Demonstrated an intuitive user interface for an integrated system combining a microscope, CCD camera, controllers, and an SGI workstation interfaced to a C-90. Demonstrated a pose-invariant recognition system on the CM-5 with a 98% success rate on a database of 1000 images of 68 people. Demonstrated on the CM-5 a version of the molecular dynamics code EGO optimized using the Charm parallel programming system.	Demonstrate the utility of direct sensitivity analysis in air quality models such as those for the Los Angeles basin or the Northeast Corridor. Demonstrate the integrated AIM microscope system for monitoring biomedical experiments and develop capability to automatically detect events of interest. Demonstrate on high performance platforms such as the CM-5 a simulation of a watershed using a discrete event dynamic model coupled to a geographic information system data base with visualization on a SGI-based system. Bring the real-time transfer of data from the BIMA telescope system in California to the NCSA data archive to full, routine operational status. Incorporate Fast Multipole type methods into molecular dynamics simulations of large biomolecular systems. Make five new Grand Challenge awards.	Extend face recognition system to larger data sets including recognition in groups. Release of Scientist's Visual Workbench to astronomers, with development versions of interactive, distributed visualization and remote rendering of very large images. Demonstrate effectiveness of Archimedes, a special purpose compiler for unstructured mesh computations, through simulation of the seismic response of Los Angeles Basin. Enhance the CM-5 watershed simulation model with hydrological/ecological relationships to demonstrate increased realism within reasonable run times. Begin work with industry to produce an affordable, stand- alone successor to AIM, with specialized high performance computing hardware built in.	Special purpose learning hardware for the CM-5 has been postponed.

Budget (BA, $ M)	
FY 94 Actual	7.75
FY 95 Pres.	10.75
FY 95 Est.	9.25
FY 96 Rqst.	7.25

FY 96 Request by Component	
HPCS	
NREN	
ASTA	7.25
IITA	
BRHR	

Agency Ties	
ARPA	Partner
NSF	
DOE	
NASA	
NIH	
NSA	
NIST	
NOAA	
EPA	User
ED	
AHCPR	
VA	

NSF	Computing Systems and Components	Budget Code:	

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

Included in this activity is research on:

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

Early prototyping and evaluation of hardware and software systems;

New tools for systems level automated design and prototyping;

Distributed design and intelligent manufacturing capabilities; and

Optical communications systems and devices.

Budget (BA, $ M)	
FY 94 Actual	18.76
FY 95 Pres.	20.70
FY 95 Est.	20.31
FY 96 Rqst.	22.33

FY 96 Request by Component	
HPCS	21.83
NREN	
ASTA	
IITA	0.50
BRHR	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Experiments in measurement and evaluation of new memory architectures were initiated at testbeds at USC and the University of Virginia. Conducted workshop on directions in optical computing research areas for high performance computing systems. Developed a program in virtual prototyping for manufacturing.	The high-performance rapid prototyping facility at the University of Michigan will be made available for use over the Internet, speeding development of new high performance computing systems. Initiate projects to design and analyze new memory architectures. Initiate projects applying high performance computing to manufacturing, in response to a program announcement on virtual prototyping. Initiate projects in optical computing as recommended by the workshop in FY 1994.	Start projects to integrate high-performance memory hierarchies into low-power machines for ubiquitous computing. Develop new research areas in high performance computing guided by progress in FY 1994 and FY 1995 and by workshops.	Additional planning and preparation of the facility by the University of Michigan delayed its availability until early FY 1995.

Agency Ties	
ARPA	
NSF	
DOE	
NASA	
NIH	
NSA	
NIST	
NOAA	
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ED	
AHCPR	
VA	

NSF	Software Systems and Algorithms	Budget Code:	

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

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

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

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

Budget (BA, $ M)	
FY 94 Actual	23.46
FY 95 Pres.	25.35
FY 95 Est.	25.46
FY 96 Rqst.	29.01

FY 96 Request by Component

HPCS	
NREN	
ASTA	19.30
IITA	
BRHR	9.71

Agency Ties

ARPA	
NSF	
DOE	
NASA	
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Developed efficient parallel algorithms for numeric and symbolic computations with structured matrices. Designed parallel algorithms exploiting randomization. Developed models and tools for reasoning about systems that are reactive, triggered by asynchronous events. Demonstrated applicability of algorithms based on computational geometry to flexible automation and advanced manufacturing. Developed artificial intelligence interfaces to guide dynamically a solution process by modifying certain characteristics and parameters of a parallel numerical algorithm. Developed a new research thrust in Problem Solving Environments to stimulate software development tailored to problem domains and user needs.	Develop compilers for high performance Fortran for several parallel machines. Develop scalable multiprocessing operating systems. Develop efficient probabilistic algorithms based on information-based complexity for important scientific problems. Demonstrate software engineering techniques for developing and analyzing designs and software with real-time or other critical dependability constraints. Demonstrate software to support transparent computations on a heterogeneous collection of computing systems that are geographically distributed. Develop program of Challenges in Computer Science to support research on technologies that will enhance the usability of high performance computing systems.	Increase the support for compiler and operating systems research focused on heterogeneous, geographically distributed collections of computing systems. Introduce a sabbatical program to support scientists and engineers to become more proficient in applying parallel computing technology to their disciplines. Initiate a program to bring promising computer science research to a point of maturity that will permit evaluation by the user community. Identify and exploit applications areas where discrete mathematics and theoretical computer science developments can lead to more accurate and efficient computations. Extend ongoing research in parallel and distributed computing to address problems for universal services including heterogeneity, interoperability, and real-time operating systems.	The last FY 1994 Accomplishment was previously reported in the IITA Activity Sheet of the FY 1995 Implementation Plan.

NSF	Ubiquitous Computing and Communication	Budget Code:	

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

Areas of currently funded research include:

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

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

Budget (BA, $ M)	
FY 94 Actual	10.00
FY 95 Pres.	11.30
FY 95 Est.	11.52
FY 96 Rqst.	14.80

FY 96 Request by Component	
HPCS	
NREN	4.80
ASTA	
IITA	1.00
BRHR	9.00

Agency Ties	
ARPA	Partner
NSF	
DOE	User
NASA	User
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Ran testbed applications on the gigabit testbed facilities. Explored gigabit network problems including characterizations of gigabit network traffic running on operational gigabit testbeds. VISTANET's Radiation Treatment Planning Application evaluated against standard treatment planning modes in use across the country. Conducted a workshop to explore the next steps in gigabit networking.	Report on the accomplishments of the gigabit testbed project, including lessons learned and the strengths and weaknesses of technologies deployed in the testbeds. Sponsor a conference in November to discuss testbed results. Hold workshops on Wireless Access, Open Bearer Service, and Network Storage.	Build on new gigabit research infrastructure by funding research aimed at more effective utilization of large information resources; specifically, enabling access to, distribution of, and effective interactions with these resources. Hold competitive program solicitation and make awards for wireless access testbeds. Continue collaboration with ARPA in 10 Gb/s testbed initiated under the Technology Reinvestment Program. Continue basic research in coding and coded modulation relevant to challenges in wireless access such as mobility management and channels of widely and rapidly fluctuating capacity. Examine convergence of computing, entertainment, and telecommunications from the standpoint of the Internet experience and the Open Bearer Service.	Workshop on the next steps in gigabit networking was held in FY 1994 to plan for future activities. Workshops on Wireless Access, Open Bearer Service, and Network Storage are now planned for FY 1995

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

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

Work supported in this area includes:

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

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

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

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

Budget (BA, $ M)	
FY 94 Actual	10.40
FY 95 Pres.	11.00
FY 95 Est.	11.00
FY 96 Rqst.	14.55

FY 96 Request by Component

HPCS	
NREN	
ASTA	6.80
IITA	4.15
BRHR	3.60

Agency Ties

ARPA	Partner
NSF	
DOE	
NASA	
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Developed of a generic model for multi-media information delivery aimed at the general public. The model is built on the research results from human computer interaction, virtual environments, and knowledge systems. Completed the first phase of research for the two testbeds in collaboration technology and demonstrated the methodologies and tools developed in these projects. Continued several research projects in computer vision and robotics jointly funded by ARPA to break new scientific grounds and explore new applications of these technologies. Established new research in Human Language Technology by ten research teams under the joint NSF and ARPA initiative, focusing on a range of topics ranging across new language models, speech pattern analysis, and human-computer discourse structures.	**Demonstration of a prototype system capable of collecting, compiling and delivering information in mixed media and modalities: sound, speech, texts, images, graphics.** **Initiation of a new research thrust in Virtual Environments with the aim of shifting the software development paradigm to a more distributed, user-centered, and domain-oriented focus.** **Development of new and extended thrusts and directions for the Science and Technology Center on Cognitive Science at U. Penn to provide shareable resources in human language technology over the NREN to the larger research community and the industry.** **Initiation of new research efforts to explore ways to provide better, intelligent interfaces for access of computing and communication devices by the disabled.**	Initiate new and extend ongoing research in user-centered design, including models, interfaces, and programming tools for rapid prototyping. Demonstrate results of research in coordination theory, collaboration technology, and group-oriented software tools. Initiate new and extend ongoing research in novel modalities of human-computer communications (e.g., face and gesture recognition and sensor-motor control), modeling and simulation, virtual reality, and problem-solving environments. Accelerate development of techniques to capture, store, access, refine, search distribute, preserve, and interactively use complex information over high capacity communication channels in very large knowledge repositories.	The last milestone in FY 94 was unanticipated. The last milestone in FY 95 enhances existing milestones.

NSF	Biological Sciences (non-NC/GC)	Budget Code:	

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

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

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

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

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

Budget (BA, $ M)	
FY 94 Actual	8.80
FY 95 Pres.	11.50
FY 95 Est.	11.53
FY 96 Rqst.	11.43

FY 96 Request by Component	
HPCS	
NREN	
ASTA	10.40
IITA	1.03
BRHR	

Agency Ties	
ARPA	
NSF	
DOE	
NASA	
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Developed tools for ecology on parallel architectures, in particular for multi-species models. Developed tools for "on-line" high performance computing (e.g., real-time 3-D imaging of biological specimens during experimentation). Developed algorithms for molecular dynamics with more atoms and longer time steps than previously possible.	Develop collaborative internet research environments (e.g., Khoros). Establish the Center for Ecological Analysis and Synthesis, prototyping the linking of heterogeneous databases. Continue development and distribution of computational tools for molecular dynamics, neural simulators, and ecological simulation studies, with aims of increasing size and realism of simulations.	Develop prototype information workplace of the 21st century including tools for use and accessibility of heterogeneous (multimedia) distributed databases. Develop search tools for databases of images. Develop postdoctoral and training programs in the use of high performance computing and information technology. Begin partnerships with other agencies regarding information infrastructure support and maintenance, e.g., the Network of Networks. Continue development of the Center for Ecological Analysis and Synthesis, and of models and tools to make computer simulations of biological phenomena more realistic over temporal and spatial scales.	Continue increased emphasis on information processing (collaborative research environments and "on-line" high performance computing). Establishment of the Center for Ecological Analysis and Synthesis was delayed until FY 1995 in order to allow more thorough review..

NSF	Engineering (non-NC/GC)	Budget Code:	

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

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

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

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

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

Budget (BA, $ M)	
FY 94 Actual	3.10
FY 95 Pres.	4.23
FY 95 Est.	4.76
FY 96 Rqst.	3.98

FY 96 Request by Component	
HPCS	1.65
NREN	
ASTA	1.70
IITA	0.63
BRHR	

Agency Ties	
ARPA	
NSF	
DOE	
NASA	
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Began initiative, with CISE and EHR participation, for multidisciplinary group research on national challenges relating to IITA, including health care delivery, civil infrastructure systems, advanced manufacturing, and engineering education. Expanded optical communications systems research directed at high connectivity, multi-gigabit interconnection of remote processors. Seed funding provided to establish interagency support for US users in US/Japan Joint Optoelectronics Project, to expand the user base in optoelectronics fabrication, and to stimulate growth of a domestic optoelectronics industry.	Continue and expand scope of the FY 1994 ENG initiative on National Challenges in IITA, to include other engineering emphases such as environmental research. Continue support of innovative approaches to computationally complex engineering problems utilizing parallel and distributed computing environments. Continue research that bridges the interface between devices and systems in optical and optoelectronic technologies for computing and communications. Provide seed funding to establish interagency support for US users in US/Japan Joint Optoelectronics Project, to expand the user base in optoelectronics fabrication, and to stimulate growth of a domestic optoelectronics industry.	Develop the basic tools, methodology, and information technologies in engineering that underlie an expanded National Information Infrastructure Continue support of innovative approaches to computationally-complex engineering problems. Initiate research in wireless network architectures and their interface with optical networks for ultra-high-capacity computing and connectivity environments. Continue research at the device and systems level of advanced optical and optoelectronic technologies. Continue interagency support for US users in US/Japan Joint Optoelectronics Project.	Seed funding to establish interagency support for US users in US/Japan Joint Optoelectronics Project, to expand the user base in optoelectronics fabrication, and to stimulate growth of a domestic optoelectronics industry delayed from FY 1994 to FY 1995.

NSF	Geosciences (non-NC/GC)	Budget Code:	

Geosciences and the Office of Polar Programs HPCC activities build on a substantial infrastructure within the directorate. Incremental funds are used to enhance present activities and to synergistically integrate existing efforts into a geosciences program and the Global Change Research Program that is responsive and effective in using emerging technologies.

The acquisition and testing (using Geoscience codes) of parallel computers of various architectures is being carried out to determine which technology offers the most promising capabilities. This initial work will guide the acquisition of a massively parallel machine in the FY 95-97 time frame.

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

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

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

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

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Completed major computing upgrade at NCAR by augmenting the IBM SP-1 with a cluster of CRAY EL 8 processor systems. Enhanced MPP computers available at NCAR by the installation of 64 node CRAY T3D for exclusive use for climate simulation. Supported continued geophysical model conversion to MPP computers and continued development of parallel algorithms and techniques for effective use of MPP machines on geophysical codes. Conducted Beta test of Internet data distribution of real time environmental data. Held workshops on earth and ocean sciences to target activities to be carried out under the HPCC program.	Demonstrate Earth Simulation models simultaneously running on MPP, clustered and shared memory computers and connected by "flux-coupler" software and high speed networking technology. Upgrade Climate Simulation Laboratory 5 processor CRAY Y-MP/T3D machine to 8 processor CRAY Y-MP. Complete partial implementation of internet data distribution. Together with NASA and NOAA demonstrate the 256 Kbps data transmission between the U.S. and South Pole Station.	Replace shared memory computer at NCAR and upgrade MPP machines. Complete final development phase of Earth Simulation models running on different computers. Establish preliminary Volcano Network and fully implement geophysical data distribution. Establish an HPCC graduate and postdoctoral program for geosciences and revise exiting postdoctoral program to add HPCC thrust. Six to eight people will be supported. Enhance Mass Store software to effectively work with high performance MPP computers. Bring to operation 1.5Mbps link at Palmer Station, Antarctica using ACTS satellite.	Shift away from SP-1 to clusters of workstations and T3D architectures on the basis of extensive performance testing with geophysical codes. The development and use of Internet for data transmission to replace satellite delivery. Unanticipated technological problems are being resolved and have delayed the milestones regarding transmission between the U.S. and the South Pole Station. Continued evaluation of computing systems led to better cost performance on alternative systems. Strategic change with respect to climate simulation towards a dedicated computer system with greater performance on specific problems rather than a general system of wider applicability.

Budget (BA, $ M)	
FY 94 Actual	2.37
FY 95 Pres.	3.84
FY 95 Est.	4.68
FY 96 Rqst.	3.59

FY 96 Request by Component	
HPCS	
NREN	
ASTA	3.19
IITA	0.40
BRHR	

Agency Ties	
ARPA	
NSF	
DOE	
NASA	Partner
NIH	
NSA	
NIST	
NOAA	Partner
EPA	
ED	
AHCPR	
VA	

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

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

Use of high performance computer systems and architectures as a testbed for research;

Innovative approaches to development of new algorithms, especially involving parallel and distributed, heterogeneous environments;

Information-intensive activities, such as wide-area data exchanges, interaction services, and electronic collaborations;

Unusual developments involving symbolic and numeric computation;

Mathematical questions involving the preparation of suitable tools for visualization.

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

Budget (BA, $ M)	
FY 94 Actual	6.68
FY 95 Pres.	7.59
FY 95 Est.	7.66
FY 96 Rqst.	6.11

FY 96 Request by Component	
HPCS	
NREN	
ASTA	2.00
IITA	0.59
BRHR	3.52

Agency Ties	
ARPA	
NSF	
DOE	
NASA	
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Software developed under this program, such as LAPACK, was distributed, upgraded, and will be maintained. Connectivity and modes of accessing and sharing data and resources among the mathematical sciences community were expanded. Building on user-friendly interfaces, workable and usable codes targeted at high performance computing systems for group theorists, biologists, and other scientists were developed.	Distribute and develop software with a user-friendly interface to provide information on and to solve problems involving finitely-presented groups. Produce and distribute algorithms and software to solve problems in molecular sequence analysis, especially for analysis of DNA, RNA, and protein sequences. Develop algorithms and supported software for problems in fluid flow with particular emphasis on improved versions of "immersed boundary method" for fluid dynamics in regions with complicated moving boundaries. Examples of applicable problems are blood flow in a beating heart and flows in porous media..	Expand activities in algorithm research and development. Expand development of computational tools exploiting new HPCC technologies. Support development of, access to, and transmission of large complex databases, and development of specialized electronic libraries. Enhance and disseminate software for geometric visualization and analysis. Develop new algorithms blending statistical and geometric features to solve partial differential equations arising from problems with moving interfaces.	

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

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

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

Budget (BA, $ M)	
FY 94 Actual	5.32
FY 95 Pres.	9.77
FY 95 Est.	8.73
FY 96 Rqst.	7.09

FY 96 Request by Component

HPCS	
NREN	
ASTA	3.09
IITA	4.00
BRHR	

Agency Ties

ARPA	
NSF	
DOE	
NASA	
NIH	
NSA	
NIST	partner
NOAA	
EPA	
ED	
AHCPR	
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Parallelized the PRISM algorithm for integral calculations in GAUSSIAN suite of *ab initio* molecular orbital programs for the CRAY T3D. Optimized the parallelized version of the PS-GVB software for the TMC CM5 and Intel Paragon computers, and ported it to the IBM SP2 and CRAY T3D. Real-time acquisition, analysis, and distribution of the data from particle accelerator experiments were demonstrated using new software and networking capabilities. Homopolar semiconductor liquids such as germanium and heteropolar liquids such as gallium arsenide were simulated using an improved quantum molecular dynamics code. Also, simple metals (sodium, potassium) with intrinsic defects were modeled.	Demonstrate the efficacy of parallelized CMM/MD codes by using them to predict glass transition temperatures of polymer blends and copolymers. Extend the Newton-Euler Inverse Mass Operator method to fast dynamics on periodic systems with up to one million atoms. A new project to enable scientists in physics and other disciplines to acquire and distribute information easily and rapidly in the form of electronic preprints will be initiated. The interdisciplinary CARM program that supports high performance computing research in the material sciences will be expanded to include a wider variety of materials, algorithms and computing platforms. Linkages between NSF and NIST will be explored in the area of computational materials.	Working parallelized versions of GAUSSIAN, CHARM, or other molecular dynamics codes will be available for public use at all of the NSF Supercomputer Centers. Through the Supercomputer Centers and the parallelized versions of codes supported for public use, strengthen the ties between academic researchers and industrial affiliates. As appropriate, establish interactions between NSF and NIST in applications of HPCC to computational modeling of materials. Expand the CARM program to include computation for materials engineering problems. Develop rapid, open, and widespread access to electronic preprints over a broad spectrum of physics, chemistry, astronomy, and materials science.	A collaborative effort with NIST involving computational materials will be added in FY 1995.

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

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

1. Cognitive, Psychological, and Language Sciences cluster: "Cognitive Science" workshop;
2. Anthropological and Geographic Sciences cluster: "Computational Geography" workshop;
3. Economics, Decision and Management Sciences cluster: "Computational Economics" workshop;
4. Social and Political Sciences cluster: Artificial Social Intelligence" workshop; and
5. Science, Technology and Society cluster: "Electronic Networks" workshop.

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

Budget (BA, $ M)	
FY 94 Actual	1.15
FY 95 Pres.	3.01
FY 95 Est.	2.09
FY 96 Rqst.	2.14

FY 96 Request by Component	
HPCS	
NREN	
ASTA	
IITA	2.14
BRHR	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Conducted a comprehensive review of software tools required to manage large socio-economic databases as part of the National Information Infrastructure. Established a systematic plan to develop methods of advanced computing in the social, behavioral and economic sciences. Continued exploration of scientific opportunities for artificial intelligence in psychology, sociology, and economics.	Establish distributed processing geographic information systems for the National Information Infrastructure. Adapt genetic algorithms, neural networks, and symbolic processors to a wide range of problems in the social sciences. Demonstrate new methods for providing wide access to previously unavailable government statistics, while preserving data integrity and preventing misuse.	Launch new competition for multi-disciplinary research groups to conduct research in advanced computing for the social, behavioral, and economic sciences. Support work on software and mathematical tools for the National Information Infrastructure. Develop Cognitive Science activity in a partnership of the programs in Linguistics and in Human Cognition and Perception.	

Agency Ties	
ARPA	
NSF	
DOE	
NASA	
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

NSF	Education and Training	Budget Code:	

The education and training effort in the HPCC consists of existing activities that focus more directly on HPCC and of new activities begun as part of the HPCC initiative. Many of these activities are interdisciplinary in nature, drawing on the resources of all of NSF's directorates. In particular, the pilot testbed projects are collaborative projects between the EHR directorate and the CISE directorate drawing on scientific expertise from throughout NSF. Specific examples follow:

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

Undergraduate Education -- An existing activity that provides some funding for new HPCC course and curriculum development;

Research Experiences for Undergraduates -- An expanded activity to provide more opportunities for undergraduates to perform research in HPCC areas;

Superquest -- An expanded activity that provides for high school student research experiences at Supercomputer Centers;

Postdoctoral Research Associates -- A new activity to provide postdoctoral training in computational science and engineering and experimental computer science;

Pilot Educational Networks -- An activity to provide networks to develop, implement, test, and evaluate applications of computer and communications to education; and

Network Infrastructure for Education -- A joint CISE-EHR activity, started in FY 1994, that addresses issues of large-scale networking for education.

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Created a Native American Telecommunications Technical Assistance think tank. Supported with ED and NTIA a workshop on the role of state networks in developing statewide networking infrastructure. Developed museum-based networking support activities in urban centers. NSF education case study in the FY 1994 HPCC Book "Toward a National Information Infrastructure," featured on Good Morning America as a paradigm of NII in education. Under the NIE program, initiated in coordination with ED and NTIA, several demonstration projects, planning grants, national testbeds, and policy studies to address issues of large-scale networking for education.	Monitor and evaluate existing projects and create new testbeds to demonstrate scalability, cost/benefits, policy, effective applications, educational impact, and other characteristics of successful user-driven models of computer networking in education. Coordinate the results from existing NIE projects and establish a base of knowledge for new applicants to the NIE and programs. Coordinate NIE activities with ED Goals 2000 planning grants and with NTIA infrastructure awards. Initiate pilot studies for educational applications of Digital Library awards.	Evaluate and analyze ongoing educational networking projects to create a base of knowledge for successful user-driven model transfer and expansion. Support large-scale models for educational applications of Digital Libraries. Monitor and evaluate existing projects that demonstrate scalability, cost/benefits, policy, effective applications and other characteristics of successful user-driven models of computer networking in education. Develop plans for technology transfer of networked-based educational materials.	The first four FY 1994 Accomplishments were not anticipated in the previous submission. The last three FY 1995 Milestones were not anticipated in the previous submission.

Budget (BA, $ M)

FY 94 Actual	17.29
FY 95 Pres.	20.24
FY 95 Est.	17.98
FY 96 Rqst.	20.24

FY 96 Request by Component

HPCS	
NREN	9.00
ASTA	
IITA	
BRHR	11.24

Agency Ties

ARPA	Partner
NSF	
DOE	
NASA	
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	Partner
AHCPR	
VA	

NSF	National Challenges	Budget Code:	

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

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

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

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Established six major research teams to pursue work in Digital Libraries, each to develop an experimental testbed for demonstration of new technologies and potential for National Challenge applications, including education. Developed a new research thrust in Virtual/Rapid Prototyping for Manufacturing to accelerate progress in applying information technology and distributed computing and communications capabilities. Began efforts to provide coordinated management among Federal agencies for using networked tools (e. g., Mosaic) for delivering government information. Established six major research teams to pursue work in Health Care Delivery, Advanced Manufacturing, and Civil Infrastructure Systems. Established three Physical, Biological, and Geological Network Centers.	Develop a supplemental program for additional institutions to participate in the Digital Libraries initiative. Demonstrate preliminary models and data developed by the research teams under the cross-agency Digital Libraries initiative. Implement a cross-disciplinary research program on Virtual Prototyping for Advanced Manufacturing. Develop and implement a program on Reliable Computer Controlled Systems to accelerate progress in providing safe and reliable computing and communication devices and systems for National Challenge application areas. Develop laboratories as part of the new institutional infrastructure needed for investigating effective human utilization of massive information stores. Conduct a new round of competition for National Challenges.	Demonstrate preliminary results of research and the experimental testbeds developed under the Digital Libraries initiative. Demonstrate results of research from National Challenges through workshops and symposia. Initiate new research to accelerate development of enabling technologies (e.g., wireless, lightwave) for the NII to help provide universal access to diverse bitways, including high speed networks. Expand programs in National Challenges.	The last two FY 1994 Accomplishments were not anticipated in the previous submission.

Budget (BA, $ M)	
FY 94 Actual	11.42
FY 95 Pres.	35.25
FY 95 Est.	15.12
FY 96 Rqst.	17.33

FY 96 Request by Component	
HPCS	
NREN	
ASTA	
IITA	17.33
BRHR	

Agency Ties	
ARPA	Partner
NSF	
DOE	
NASA	Partner
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

Department of Energy

The Department of Energy (DOE) HPCC Program is a diverse applied mathematical sciences and high performance computing and communications program that spans the spectrum of activities from strategic fundamental research to technology development. Its mission is:

To improve the ability of DOE to solve scientific and engineering problems that are crucial to its mission, to the Energy Policy Act (EPACT), and to the national interest, through research and development in and application of advanced mathematical, computational, computer, and communications sciences and information technologies and, as authorized, to meet the requirements of the HPC Act of 1991 and the Administration's program for the `NII: Agenda for Action.`

Because of the computationally intensive nature of energy related applications and problems, DOE depends on advancements in computational techniques and in computer and networking technologies to accomplish its mission. As a result, DOE has a long history of computational research and development, with strong industrial and university cooperation. DOE's Applied Mathematical Sciences (AMS) Program (a forerunner of the HPCC program) was initiated in the early 1950's to enhance understanding of the use of digital computers in nuclear sciences and other energy research applications. DOE has been prominent in maintaining the U.S. leadership in high performance computing and communications, in encouraging and providing innovation in HPCC and other information technologies, and in supporting U.S. economic, scientific, and technological competitiveness and productivity through its extensive use of these technologies.

The DOE HPCC Program covers all five components of the HPCC Initiative. DOE's original HPCC Program results from its role as a pioneer in the use of supercomputers for numerical simulation of complex systems. This program reduces substantially the cost, and the adverse effects on the environment, of experimentation and testing of nuclear weapon systems. The revised HPCC Program includes R&D in advanced communications technologies that could radically transform the way Americans work. The newest initiative in IITA may provide the most important economic benefits of the HPCC Program. The R&D activities in high performance computing technologies, including telecommuting (or telework in general), are also one of the EPACT objectives. These R&D efforts are aimed at advancing the enabling technologies for telecommuting and other telework that will provide for reduced oil dependency, reduced pollutants, better productivity for disabled and other workers, and other societal benefits. In the nearer, term these activities are crucial to DOE's efforts to provide geographically distributed access to its many important experimental facilities and computational resources.

The Division of Mathematical, Information, and Computational Sciences (MICS) in the Office of Energy Research manages DOE's HPCC Program and participates within the Department to formulate and coordinate the Department's National Information Infrastructure (NII) initiative. The MICS HPCC Program supports the underlying mathematical concepts and information technology needs of all DOE mission areas (e. g., Defense, Energy Efficiency, Environmental and Fossil programs, etc.). MICS's plan promotes U.S. economic and technological competitiveness in many critical technology areas and involves many industrial partnerships. The DOE collaborates closely with other agencies that are HPCC users, such as NASA, to produce software that will be generally useful. The DOE HPCC program also complements ARPA basic technology research and NSF basic research programs. Within DOE, MICS manages and provides communications and computational resources for investigators supported by Energy Research. Users meetings (e.g., Energy Research Supercomputer Users Group, ESnet Steering Committee, and ESnet Site Coordinator Committee) help ensure that the developing technologies will support the DOE mission. In jointly funded projects (with other Energy Research Offices) such as the Grand Challenge applications projects, MICS maintains active communications with partners for selecting projects and monitoring progress.

Department of Energy

Program Activity	Budget Account Code	Partner/User Agencies	Budget (BA, $ M)				HPCC Components by 1996 Agency Req.				
			FY 94 Actual	FY 95 Pres.	FY 95 Est.	FY 96 Rqst.	HPCS	NREN	ASTA	IITA	BRHR
Advanced Prototype Systems	KC 07 01	ARPA, NASA, NSF	1.00	1.00	1.00	1.00	1.00				
Evaluation of Early Systems		ARPA	7.90	8.29	8.30	7.70	7.70				
Energy Sciences Network (ESnet)	KC 07 02 KC 35 07	ARPA, NSF, NASA, NIS	14.60	16.00	15.00	15.00		15.00			
Gigabit Research and Development	KC 07 02	ARPA, NSF, NASA	2.00	2.00	2.00	2.00		2.00			
Enabling Energy Grand Challenges	KC 07 01	NSF, NASA	7.01	8.16	8.20	7.60			7.60		
Software Components and Tools	KC 07 01	ARPA, NSF, NASA	12.49	10.84	10.80	11.40			11.40		
Computational Techniques	KC 07 01	EPA	1.35	1.40	1.29	1.30			1.30		
Supercomputer Access	KC 07 02, AT 05, KC 35 07		34.32	36.60	34.00	35.84			35.84		
HPC Research Centers			9.49	12.15	12.20	11.80			11.80		
Collaboration	KP 05		2.00	2.00	2.00	2.00			2.00		
Information Infraservices	KC 07 02		0.22	1.00	2.00	2.00				2.00	
National Challenges	KC 07 02	NASA, EPA, NIH, NOAA	0.00	0.00	0.50	1.00				1.00	
Research Participation and Training	KC 07 01		2.00	2.00	2.00	2.00					2.00
Education, Training and Curriculum	KC 07 01		2.82	2.43	2.40	2.50					2.50
Basic Research for Applied Mathematics Research	KC 07 01	NSF	15.50	16.50	16.50	16.00					16.00
Florida State University - SCRI	KC 07 02		2.00	2.00	1.53	1.62			1.62		
Domestic Oil & Gas (ACTI)	KC 07 01		0.00	3.00	3.00	3.00			3.00		
		Totals:	114.70	125.37	122.72	123.76	8.70	17.00	74.56	3.00	20.50

DOE	**Advanced Prototype Systems**	Budget Code:	KC 07 01

This activity funds research into advanced computer architectures and novel commercial prototypes suitable for scientific computing. Funding for development of new prototype architectures has been deemphasized in favor of providing feedback to commercial vendors of novel systems. This activity does include funding to develop a message passing interface for an MPP system, which is critical for easily porting codes among massively parallel computers.

Budget (BA, $ M)	
FY 94 Actual	1.00
FY 95 Pres.	1.00
FY 95 Est.	1.00
FY 96 Rqst.	1.00

FY 96 Request by Component	
HPCS	1.00
NREN	
ASTA	
IITA	
BRHR	

Agency Ties	
ARPA	Partner
NSF	Partner
DOE	
NASA	Partner
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
A 128-node IBM Scalable POWER parallel SP1 at Argonne National Laboratory (ANL) was acquired (with NASA). Supported the Joint Agency Workshop on Enabling Technologies for Peta(FL)OPS Computing (Pasadena I). Solved the Kajiya rendering equation for scalable parallel systems at extremely high speed and fidelity to put a firm scientific basis under the art of performance analysis for parallel systems.	Produce the reference implementation for a message-passing interface on massively parallel processors (deliverable from IBM-ANL collaboration using SP1). A joint agency project (with NASA, NSF, and ARPA) was initiated in scalable I/O for parallel computers.	Upgrade switches and processors in IBM SP1. Upgrade, enhance, or replace high performance computing system capabilities at one HPCRC.	

DOE	Evaluation of Early Systems	Budget Code:	

This program activity helps fund the acquisition of large prototype computers for testing and evaluation. Grand Challenge-class problems require large prototype systems because they cannot be scaled down without removing essential aspects of their physics.

Budget (BA, $ M)	
FY 94 Actual	7.90
FY 95 Pres.	8.29
FY 95 Est.	8.30
FY 96 Rqst.	7.70

FY 96 Request by Component	
HPCS	7.70
NREN	
ASTA	
IITA	
BRHR	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Upgraded the Intel XP/S 35 Paragon to 512 nodes at Oak Ridge National Laboratory (ORNL). Extensive performance and functionality analysis of the Intel Paragon was performed. Overhauled the 1024-node CM-5 at Los Alamos National Laboratory (LANL). Convened Industrial Computing Requirements Forum led by Ames Laboratory. This brought together computer technology vendors, independent software vendors, and applications scientists to discuss methods for reducing time-to-market for computing equipment and applications software.	Install Intel XP/S 150 Paragon (1024 nodes, 3072 processors) at ORNL. Have full-scale CM-5 and Paragon systems operational and supporting Grand Challenge research projects. Start investigation of next-generation computational technology for architectures, computational environments, and applications.	Continue funding for advanced prototype systems at: 1. Argonne National Laboratory as part of a cooperative effort to implement a standard reference message passing interface; 2. Ames Laboratory for use in developing performance measurements and benchmarking capabilities; and 3. Oak Ridge National Laboratory as part of the HPCRC supporting a number of the DOE Grand Challenges teams. No new advanced prototype systems are likely to be acquired in FY 1996.	Follow-on of ORNL Intel XP/S 150 Paragon was delayed till FY 1995. Extend greatly the capabilities of DOE laboratory storage systems through the implementation of network-centered parallel HPSS storage system management software. LANL CM-5 overhauled in FY 1994.

Agency Ties	
ARPA	Partner
NSF	
DOE	
NASA	
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

DOE	Energy Sciences Network (ESnet)	Budget Code:	KC 07 02 KC 35 07

ESnet is DOE's network component of the National Research and Education Network (NREN) and is an integral part of the National Information Infrastructure (NII) connectivity. It provides worldwide access to Energy Research facilities, including:

Advanced Light Sources;
Neutron Sources;
Particle Accelerators;
Fusion Reactors;
Spectrometers;
High Performance Computing Research Centers (HPCRC);
Genome Centers;
Data banks; and
Other leading-edge science instruments and facilities.

Future upgrades will allow for remote experimentation and collaboratory access to these facilities.

The ESnet project, using laboratory-industry partnerships, provides advanced services through the early acquisition and testing of commercially-supplied communications and network services. Funding covers acquisition of services and advanced network capabilities and integration of these with other services, primary rate ISDN for video, video multiport/services, hardware to expand network capabilities (routers, international links), personnel to develop tools for network use (e.g., communication, authentication, privacy protocols), advanced network information services, and maintenance.

Budget (BA, $ M)	
FY 94 Actual	14.60
FY 95 Pres.	16.00
FY 95 Est.	15.00
FY 96 Rqst.	15.00

FY 96 Request by Component	
HPCS	
NREN	15.00
ASTA	
IITA	
BRHR	

Agency Ties	
ARPA	Partner
NSF	Partner
DOE	
NASA	Partner
NIH	
NSA	
NIST	Partner
NOAA	
EPA	User
ED	
AHCPR	
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Began upgrade of ESnet to 45 Mbs fast packet services. Extended video/voice conferencing capabilities to permit transmission of conventional video systems over ESnet and dedicated a portion of ESnet for packetized video conferencing. Evaluated Asynchronous Transmission Mode (ATM) services on each site's local area networks. Continued the KERBEROS-based authentication pilot project to investigate technical and administrative issues for deploying national scale authentication. Began to deploy new KERBEROS authentication services to five sites out of approximately 25 total. Proposed the creation of the Federal Internetworking Requirements Panel (FIRP) and funded NIST to support the FIRP. An announcement was issued for Distributed Environments R&D to lay the foundations for and testbeds to provide science facility access over ESnet. The proposals were competed through LBL.	Complete ESnet upgrade to 45 Mbs fast packet services. Initiate the upgrade of a maximum of four sites to 155 Mbs service. Upgrade links to KEK, Japan (512Kbs) add an additional link to Garching, Germany (128Kbs), install data compressors on the Italy link, and add links to Russia to support multi-national science collaborations, such as the International Thermonuclear Engineering Reactor. Add additional video systems interoperability within ESnet, including production quality video and voice capabilities.	Support for ESnet infrastructure at T3 capabilities at approximately 20 of 28 sites and for several site upgrades to higher capabilities and integration of remote experimentation facilities for collaborative research.	Upgrade of ESnet to 45 Mb/s has slipped two years (from 93 to 95) due to procurement delays and funding constraints. Initial upgrades to 155 Mb/s have been deferred from 94 to 95. More detailed milestones added since previous IP.

DOE	Gigabit Research and Development	Budget Code:	KC 07 02

This component funds the gigabit and advanced networking research activities of the NREN. It includes gigabit test bed activities (HIPPI, CASA, BLANCA, MAGIC, BAGABITS, National Storage Lab, Electronic Telescope, and more), packetized video and voice, collaborative workspace, telecommuting projects, technologies and mechanisms for supporting energy demand and supply management, next-generation IP deployment, and scalable communication libraries for distributed memory computing environments that offers the user a Single Program Multiple Data programming paradigm.

Funding will be provided for research and development on ATM issues with regard to High Performance Parallel Interface (HiPPI), standards implementation, interfaces, and LAN to WAN ATM interoperability. Funding will also be used to investigate the network resource reservation and management for isochronous traffic. Further work in security (such as providing secure information retrieval and search mechanisms and interoperable authentications realms), intelligent user interfaces for accessing the network, interoperable video systems, high speed LANs, telecommuting, protocols and services to support energy demand and supply management, and collaborative work environments will be funded. In addition, work must begin on identifying the real issues with inter-network peering and routing. Research on routing and addressing (e. g., end system identifiers, network versus geographical addressing, automatic host configuration, multi-level peering, etc.) for the growth of the Internet on a multi-protocol dimension must be conducted.

Budget (BA, $ M)	
FY 94 Actual	2.00
FY 95 Pres.	2.00
FY 95 Est.	2.00
FY 96 Rqst.	2.00

FY 96 Request by Component	
HPCS	
NREN	2.00
ASTA	
IITA	
BRHR	

Agency Ties	
ARPA	Partner
NSF	Partner
DOE	
NASA	Partner
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Video Audio Transport (VAT) and Whiteboard are being used on the network now. MBONE, the virtual Multicast backbone used to support IP based audio visual traffic, is a major success, with the IETF meetings being regularly videocast. Video, output from commercial codecs and encapsulated in IP packets, will be used across ESnet. This work is being done in cooperation with the commercial codec vendor who is expected to market the results in the near future. HiPPI is the dominant HPCS interface to networks. Two DOE telecommuting studies were released this year.	Scalable communications Library will be completed by 6/95. LBL will be releasing beta code of collaborative technologies to the Advanced Research Projects Agency (ARPA) and other agencies for further refinement and development. Packetization of commercial codec video/audio output will be completed and will allow ESnet to carry packetized video encapsulated in IP.	Design and prototype protocols and services to support energy demand and supply management. Small scale prototype of network resource management and congestion control for the Internet will be demonstrated. Design and prototype protocols,techniques, and mechanisms for support of enhanced network and workstation based audio/video capabilities. ATM to HiPPI capabilities will be developed.	The National Academy of Sciences Telecommuting Study will be released in early FY 1995.

DOE	Enabling Energy Grand Challenges	Budget Code:	KC 07 01

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

1. Computational Chemistry (CC) -- parallelize key chemistry codes that permit researchers to study environment problems, using techniques such as self-consistent field (SCF), second order many-body perturbation theory (MP2), and Configuration interaction (CI) codes;
2. Computational Structural Biology -- develop methods for modeling components of genomes and a parallel programming environment for structural biology;
3. Mathematical Combustion Modeling (MCM) -- develop adaptive parallel algorithms for computational fluid dynamics and apply these methods to key problems;
4. Quantum Chromodynamics Calculations -- develop lattice gauge algorithms on massively parallel machines for high energy and particle physics applications;
5. Oil Reservoir Modeling -- construct efficient algorithms for parallel systems to model fluid flow through permeable media for better oil recovery methods from wells;
6. The Numerical Tokamak Project -- develop and integrate particle and fluid plasma models on MPPs as part of a study of Tokamak fusion reactors;
7. Global Climate Modeling (GCM) -- develop and implement versions of large-scale atmosphere and ocean general circulation models for MPPs;
8. Groundwater Transport and Remediation (GTR) -- design and implement a multiphase groundwater transport code with interface tracking, fracture flow, microtransport; and
9. First Principles Simulation of Materials Properties -- develop scalable parallel algorithms for performing local density approximation simulations of materials to novel properties for the Materials Properties Grand Challenge (MPGC).

Budget (BA, $ M)	
FY 94 Actual	7.01
FY 95 Pres.	8.16
FY 95 Est.	8.20
FY 96 Rqst.	7.60

FY 96 Request by Component	
HPCS	
NREN	
ASTA	7.60
IITA	
BRHR	

Agency Ties	
ARPA	
NSF	Partner
DOE	
NASA	Partner
NIH	
NSA	
NIST	
NOAA	
EPA	User
ED	
AHCPR	
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
CC -- implemented parallel code for SCF and MP2 electronic structure calculations that incorporate fully distributed data structures. MCM -- made available production quality code capable of simulating low-speed 3D combustion flows used in designing commercial burners. GCM -- Optimized the Sempter-Chervin global ocean model for coupled ocean- atmosphere simulations that predict large- scale eddies in the Gulf of Mexico; this was used to carry out the highest resolution global simulations to date. Achieved a 250-day simulation in a single run of the PCCM2 global climate modeling code on 512 nodes of the Intel Paragon XP/S 35. GTR -- Add to the transport code capabilities for 2D front-tracking, subsurface heterogeneity estimation, and reservoir flow resolution. New parallel algorithms are being developed for the MPGC. Applications involve aluminum-based alloys, high temperature intermetallics, and silicon carbide	CC -- develop scalable nonlinear optimization techniques and solution schemes for SCF, MP2 and CI codes. Expand interactions and benchmarking with industrial collaborators. MCM -- extend code to simulate low-speed, 3D combustion flows in complex geometries, such as internal combustion engines. GCM -- apply differential sensitivity analysis and employ a barotropic closure model to resolve large-scale ocean dynamics. Improve strategies for coupling ocean and atmospheric models. GTR -- test bioremediation and radionuclide decay strategies; incorporate two-phase and three-phase flow with relative permeabilities, additional chemical reactions, and simple mass transfer between phases and components into GCT. Develop a tight-binding molecular dynamics production code for more than 2000 atoms; implement a full large-system multiple scattering method code on the Paragon in the MPGC.	CC -- develop scalable approaches for evaluation of multi-configuration wavefunctions like Multi-configuration SCF and CI. Develop parallel algorithms for analytic SCF second derivatives and MP2 gradients. Integrate scalable input/output techniques into these codes. GCM -- demonstrate successful coupling of atmospheric-ocean-sea ice models on MPPs. GCT -- 3D front- tracking and simple fracture modeling will be incorporated into the GCT code in the Groundwater Remediation Grand Challenge. This will permit studies of three-phase flow in fractured regimes and the role of geostatics in obtaining bounding calculations for uncertainties of remediation strategies. Classical Molecular Dynamics, Tight-Binding Molecular Dynamics, *ab initio* Pseudopotential, and Large Scale Multiple Scattering codes will be ported to the Intel Paragon XP/S 150. Unified graphical pre- and post-processing tools for major codes will be developed.	CC -- Interaction with industrial collaborators accelerated into FY 1995. GCM -- On the LANL CM-5, performed highest resolution simulation in FY 1994. Develop coupling strategies in FY 1995. Demonstrate atmospheric-ocean-sea ice models on MPPs in FY 1996.

DOE	Software Components and Tools	Budget Code:	KC 07 01

Developing advanced software to facilitate the use of high performance systems to scientific problems, including:
Constructing, maintaining, and monitoring scientific software;
Understanding and managing the input and output of scientific software; and
Facilitating and enhancing scientific and engineering collaborations.

This program is focused on fulfilling the needs of users who are a critical part of the review process. This activity will also support an interagency consortium, to develop standard scalable I/O interfaces for MPP's and to extend this work to network based distributed computing. In addition, some work at this level will be invested in making archival storage systems, such as the National Storage Laboratory, a part of this transparent high performance architecture.

Budget (BA, $ M)	
FY 94 Actual	12.49
FY 95 Pres.	10.84
FY 95 Est.	10.80
FY 96 Rqst.	11.40

FY 96 Request by Component	
HPCS	
NREN	
ASTA	11.40
IITA	
BRHR	

Agency Ties	
ARPA	Partner
NSF	Partner
DOE	
NASA	Partner
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Evaluated near and long-term strategies for developing portable codes and benchmarks for parallel computers using user-scale codes. Evaluated the scalability of parallel operating systems, I/O and message passing schemes for user applications. A new network I/O library (DONIO) was developed which dramatically reduces disk I/O time by eliminating a bottleneck in the Intel parallel file system. A parallel version of the 3D visualizer VolVis was developed. XPVM, an XWindow-based graphical interface for PVM, was awarded first prize for best user interface at the Heterogeneous Computing Challenge at the Supercomputing '93 Conference. The PVM software package initially developed at ORNL, that has become the worldwide de facto standard for heterogeneous distributed computing, received the 1994 `R&D 100` Award.	Establish distributed computing and experimental collaboration testbed for evaluating security, resource management, program monitoring, and other computational science tools in the HPCRC environment. Develop flexible, interoperable tools for portable parallel program creation, testing and performance monitoring, and interpretation of output on advanced architectures. Evaluate the performance of operating system software on advanced computers and message passing software for networks on large scale scientific applications. Detailed evaluation of requirements of large scale scientific applications for parallel I/O. Performance measurements of current approaches on at least two different architectures. Identify major issues to be resolved in integrating parallel, distributed, and archival I/O.	Transfer improved operating systems and message passing models to U.S. computer vendors. Deliver high performance data management and archival storage software to users of DOE high performance computer centers. Introduce advanced tools for parallel program diagnosis and tuning in preproduction versions. Prototype integrated, distributed multimedia scientific visualization environment for DOE researchers. Investigate scalability of existing performance analysis tools. Deliver beta versions of high performance scalable I/O libraries. Develop plan to integrate scalable I/O with distributed and archival file and data systems	

DOE	Computational Techniques	Budget Code:	KC 07 01

Continue application of innovative computational mathematics and computer science to key scientific and engineering applications, including:
Computational design of materials and molecules;
Global ocean modeling; and
Algorithm and grid design for both solid and fluid mechanics problems.

Emphasize resolving algorithmic bottlenecks to effectively using high performance systems to solve full-scale application problems. This activity is focused on delivering robust versions of advanced algorithms that are important for Grand Challenge Problems:
Improved Fast Fourier Transforms;
Molecular dynamics solvers;
Particle pushers, etc.

Budget (BA, $ M)	
FY 94 Actual	1.35
FY 95 Pres.	1.40
FY 95 Est.	1.29
FY 96 Rqst.	1.30

FY 96 Request by Component	
HPCS	
NREN	
ASTA	1.30
IITA	
BRHR	

Agency Ties	
ARPA	
NSF	
DOE	
NASA	
NIH	
NSA	
NIST	
NOAA	
EPA	Partner
ED	
AHCPR	
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
External evaluation of the activity on computational design of materials and molecules was carried out. Initiated research on common problems in computational aerodynamics and global ocean modeling Tested advanced mesh generation techniques in support of both solid and fluid dynamics applications. The matrix inversion methods used in the LSMS materials code have been replaced by a new approach that speeds up the computation and improves its accuracy.	*Explore new parallel algorithms for* Grand Challenge problems. Develop a production version of PRE. A prototype graphical preprocessor for data input and automatic gridding is being developed.	*Demonstrate a prototype* computational steering tool in a Grand Challenge area.	

DOE	Supercomputer Access	Budget Code:	KC 07 02, AT 05, KC 35 07

This activity provides funding for equipment and personnel for the Supercomputer Access Program at the National Energy Research Supercomputer Center (NERSC), which provides high performance production computing for investigators supported by the Office of Energy Research. Mission areas include:

Material Sciences;
Chemistry;
Geosciences;
Biosciences;
Engineering;
Health and Environmental Research;
High Energy and Nuclear Physics;
Fusion Energy; and
Applied Mathematics and Computational Science.

The Center serves more than 4,000 users working on about 700 projects, of which about 35% university are based, 60% are in National Laboratories, and 5% in industry. NERSC operates 4 CRAY computers: a C-90 with 16 processors, with 256 Million words (Mw) of memory, a CRAY-2 with 8 processors with 128 Mw, and a CRAY-2 with 4 processors and 128 Mw, and the National Education Supercomputer, a single processor CRAY X-MP donated by Cray Research, which is available over the Internet to high schools for educational programs.

The components of the Supercomputer Access program funded from the Office of Fusion Energy budget (AT 05) include $11.08 M for FY 94 actual, $10.00 M for FY 95 Pres., $10.00 M for FY 95 Est., $8.50 M for FY 96 Rqst., and $8.50 M for FY 96 Flat.

Budget (BA, $ M)	
FY 94 Actual	34.32
FY 95 Pres.	36.60
FY 95 Est.	34.00
FY 96 Rqst.	35.84

FY 96 Request by Component	
HPCS	
NREN	
ASTA	35.84
IITA	
BRHR	

Agency Ties	
ARPA	
NSF	
DOE	
NASA	
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
The Special Parallel Processing Program expanded from 20,000 Computer Resource Units (CRUs) to 50,000 in FY 1994. Central User Bank (CUB) was brought into production environment. CUB provides a single accounting for usage of the three production CRAYs at the Center and the gives the user the ability to shift resources to the machine most optimal for her purposes. Instituted archival storage quota system. This provides better utilization of the most scarce of resources at the Center, the Central File System and other storage. These improvements and other efficiencies provided a 30% increase in CRUs delivered to ER programs. Initiated procurement for National Storage Laboratory (NSL) archival storage system. Began rewriting archival storage media at a higher density with the potential to double the existing capacity . Initiated procurement of MPP system for production use.	Implement massively parallel computer in the production environment. Deliver 576,000 Computer Resource Units (CRUs) to ER Programs. Supply an additional 3 Terabytes of archival storage to ER programs. The Special Parallel Processing Program will expand to 70,000 Computer Resource Units by 4Q95. SPP workshops will be held for winning proposals. Bring the NSL technology-based archival storage system into limited production use. Bring up the Portable Batch System (PBS) to provide a uniform batch environment across all major platforms.	Enhance massively parallel computer to fully configured production status. Expand the NSL technology system with increased disk and tape storage with robotics. KERBEROS-based security for all NERSC services. Distributed File Services support for all NERSC compute servers.	Began rewriting archival files in FY 1994. All milestones other than first for FY 1995 and all FY 1996 milestones are new.

DOE	HPC Research Centers	Budget Code:	

Support the operation of two HPCRCs (at Oak Ridge and Los Alamos), which provide critical resources for enabling Grand Challenge applications. To this end, the HPCRC's acquire large, full-scale, high performance computers exploiting innovative architectures for use by computational scientists working on Grand Challenge applications. The centers integrate these early high-performance computing systems into prototype heterogeneous computing configurations and make them available through the NREN. This allows for a wide spectrum of experiments for scalability studies, as well as an opportunity to provide Grand Challenge researchers access to the largest possible advanced systems. To carry out this program the centers also support researchers in areas such as algorithm development, software components and tool development, mass storage, scientific visualization, basic research, and education programs.

Los Alamos National Laboratory (LANL) operates a 1024-node CM-5 with 32 Gigabytes of memory and 128 Gigabytes of Scalable Disk Array using 4 HiPPI channels. This machine has a theoretical capacity of 128 Gigaflops and several codes have achieved 50 Gigaflops.

Oak Ridge National Laboratory (ORNL) operates an nCUBE 2 Model 640, a distributed memory hypercube machine used by high school students in the Adventures in Supercomputing program, a Kendall Square KSR-1- 64 used to study shared memory algorithms, and an Intel Paragon XP/S 35, a 512-node 35 Gigaflops machine.

Budget (BA, $ M)	
FY 94 Actual	9.49
FY 95 Pres.	12.15
FY 95 Est.	12.20
FY 96 Rqst.	11.80

FY 96 Request by Component

HPCS	
NREN	
ASTA	11.80
IITA	
BRHR	

Agency Ties

ARPA	
NSF	
DOE	
NASA	
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
ORNL successfully brought the 512 node 38 GigaFLOPS Intel Paragon XP/S 35 through a rigorous set of acceptance tests that covered functionality, reliability, and performance. Researchers of the CHAMMP Grand Challenge effort achieved a 250-day simulation in a single run of the PCCM2 global climate modeling code on 512 nodes of the Paragon XP/S 35. Version 1.0 of the PICS Groundwater Grand Challenge code GCT was successfully scaled to run on 512 processors on the XP/S 35. A test run was completed with 1.3 million grid points. A production code version of the KKR-CPA materials code was successfully ported to the XP/S 35 and run on all 512 nodes.	**Implement a 150 Gigaflops machine at ORNL running in single user mode 4Q 1994.** **Upgrade machine at ORNL to multiple user/simple partition - 1Q 1995** **Upgrade machine at ORNL to multiple user/overlap partition - 4Q 1995** **Bring advanced architecture MP-node Intel Paragon with 1024 nodes to a state of scientific readiness.** **Upgrade memory on the CM5 from 32 to 128 Gigabytes at LANL.**	Extend greatly the capabilities of DOE laboratory storage systems through the implementation of the network-centered parallel HPSS storage system management software now being developed.	

DOE	Collaboration	Budget Code:	KP 05

DOE's Office of Health and Environmental Research contributes direct support through its CHAMMP and Atmospheric Radiation Measurements programs and waste water monitoring programs. These funds support Grand Challenge work in these areas at the two HPCRCs.

Budget (BA, $ M)	
FY 94 Actual	2.00
FY 95 Pres.	2.00
FY 95 Est.	2.00
FY 96 Rqst.	2.00

FY 96 Request by Component	
HPCS	
NREN	
ASTA	2.00
IITA	
BRHR	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
The ARM/CCS National Storage Laboratory UniTree system was implemented at ORNL, providing over 4.7 terabytes of online storage. Researchers of the CHAMMP Grand Challenge effort achieved a 250-day simulation in a single run of the PCCM2 global climate modeling code on 512 nodes of the Intel Paragon XP/S 35. The resolution of GCM was increased to support global CO2 modeling. Direct experimental tests of waste water amelioration strategies developed in FY 1993 were carried out.	Continue R&D on Grand Challenge projects at the HPCRCs. These projects are co-funded by other DOE programs and by industrial partners. Participants include DOE laboratory, university, industry and other HPCC agency researchers. They are: Computational Chemistry; Computational Structural Biology; Mathematical Combustion Modeling; Quantum Chromodynamics; Oil Reservoir Modeling; Numerical Tokamak Project; Global Climate Modeling; Groundwater Transport, Remediation; Simulation of Materials Properties	Continue R&D on Grand Challenge projects at the HPCRC. These projects are cofunded by other DOE programs and by industrial partners. Participants include DOE laboratory, university, industry and other HPCC agency researchers.	

Agency Ties	
ARPA	
NSF	
DOE	
NASA	
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

DOE	Information Infraservices	Budget Code:	KC 07 02

This element supports research in the basic technology and services that underlie a number of IITA applications including energy demand management and environmental monitoring and waste minimization.

The basic services being explored include authentication, privacy and security, distributed resource management, and distributed collaboration tools.

Much of this work is done in close cooperation with U.S. computer manufacturers and potential users in industry.

Budget (BA, $ M)	
FY 94 Actual	0.22
FY 95 Pres.	1.00
FY 95 Est.	2.00
FY 96 Rqst.	2.00

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Developed protocols and interfaces (GUI) for shared drawing and writing spaces, version and document control, a common spreadsheet interface, digital library, multimedia, and object databases. These resources must work at both high speeds and over slow, serial dial-up lines.	Establish security for remote access to resources (smart cards, authentication, etc.) such as libraries, digital and object databases, video conferences, robots in hazardous areas, etc. Develop underlying technologies that are required to implement an energy demand and supply management National Challenge in close collaboration with U.S. power utility companies.	Telework support including standard file systems, graphics, spreadsheets, serial interfaces for access and configuration, and sliding bar control of video interaction. Merge FAX, e-mail, telephone, and video facilities into one resource. These tools and technologies must work on many platforms and work at speeds from 2400 Baud to 19.2 KiloBaud, N-ISDN, and higher speed technologies to satisfy all levels of users. Establish resource consumption monitoring tools, accounting, and management tools as well as resource discovery techniques. Provide support for privacy and security, with respect to audio and video conferencing for energy demand and supply management applications.	

FY 96 Request by Component

HPCS	
NREN	
ASTA	
IITA	2.00
BRHR	

Agency Ties

ARPA	Partner
NSF	
DOE	
NASA	
NIH	
NSA	
NIST	
NOAA	
EPA	Partner
ED	User
AHCPR	
VA	

DOE	National Challenges	Budget Code:	KC 07 02

In conjunction with other DOE programs and with EPA, NASA, and NOAA, develop data integration techniques for multi-spatial scales to integrate local site specific data into a regional context. Working with EPA, NASA, and NOAA, add remote monitoring of environmental conditions at DOE sites.

Work with DOE Energy Efficiency to build on existing Energy Demand and Supply Management pilot projects by implementing advanced telecommunications technologies to provide the capability for real time energy consumption control by both the consumer and the utility company.

Perform information infrastructure technology R&D within the framework of the National Science and Technology Council's NII and HPCC program in information: in information navigation and analysis tools; in hierarchical distributed information storage; in collaborative technologies; and in information surety.

In conjunction with the Federal Network Council, integrate security technologies and mechanisms in a distributed and multi-telecommunications services base architecture, and develop a Common Object Request Broker Architecture to enhance the distributed or collaborative work and telepresence environments.

Demonstrate these capabilities by working with other ER programs to make selected advanced ER facilities (e. g., the Advanced Light Source) available via the Internet and NII.

Budget (BA, $ M)	
FY 94 Actual	0.00
FY 95 Pres.	0.00
FY 95 Est.	0.50
FY 96 Rqst.	1.00

FY 96 Request by Component	
HPCS	
NREN	
ASTA	
IITA	1.00
BRHR	

Agency Ties	
ARPA	
NSF	
DOE	
NASA	Partner
NIH	Partner
NSA	
NIST	
NOAA	Partner
EPA	Partner
ED	
AHCPR	
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Initiated a joint industry-DOE study on Energy Demand and Supply Management.	**Complete a joint-industry DOE study on Energy Demand and Supply Management.** **Complete additional studies on the issues: `Do Electric Utilities have legal authority to build the National Information Infrastructure?` and `How Electric Utilities can contribute to Universal Telecommunications Service.`** **Initiate one or more pilot programs in cooperation with industry to further refine NII architectural requirements of these National Challenges**	Evaluate pilot projects and develop a reference document on NII requirements to support National Challenge applications.	

DOE	Research Participation and Training	Budget Code:	KC 07 01

The Computational Science Graduate Fellowship program supports over 50 doctoral students in computational science and engineering.

Budget (BA, $ M)	
FY 94 Actual	2.00
FY 95 Pres.	2.00
FY 95 Est.	2.00
FY 96 Rqst.	2.00

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Maintained current numbers of fellows. Conducted second workshop for fellows.	Evaluate quality of first group of fellows as they enter the professional computational science career path.	Continue evaluation of the effectiveness of the program.	

FY 96 Request by Component	
HPCS	
NREN	
ASTA	
IITA	
BRHR	2.00

Agency Ties	
ARPA	
NSF	
DOE	
NASA	
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

DOE	Education, Training and Curriculum	Budget Code:	KC 07 01

Support for kindergarten through graduate school educational programs. Adventures in Supercomputing (AiS) trains in-service teachers in the use of computers and networks. AiS also encourages the participation of women and minorities in computational science.

The National High School Honors Program provides summer enrichment in supercomputing for gifted high school students.

Textbook projects develop instructional materials for undergraduate and graduate courses in computational science.

A curriculum enhancement project is developing approaches for effecting permanent changes in university curricula at both the undergraduate and graduate levels. This activity also addresses the issue of engaging university administrators in the process of advocating computational science and engineering education.

Budget (BA, $ M)	
FY 94 Actual	2.82
FY 95 Pres.	2.43
FY 95 Est.	2.40
FY 96 Rqst.	2.50

FY 96 Request by Component

HPCS	
NREN	
ASTA	
IITA	
BRHR	2.50

Agency Ties

ARPA	
NSF	
DOE	
NASA	
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Held the first K-12 Administrators Workshop. Expanded the AiS program from New Mexico and Tennessee to Alabama, Colorado, and Iowa. Initiated a undergraduate textbook project.	Make second general release of electronic computational science text available. Continue AiS program at reduced level, but extend computing and networking activities from high school students to middle school students at selected sites. Produce a science textbook, using techniques developed in producing the computational science textbook. Hold a workshop on the role of schools of education in computational science education. Initiate networking technology assessment project to determine appropriate educational technology tools and curricula for a wide variety of schools and to produce a catalog of effective technologies for use by teachers, administrators and local and state education officials.	Complete electronic computational science text project through commercialization Continue AiS program at reduced level, but extend computing and networking activities from high school students to middle school students at selected sites. Produce and commercialize a science textbook, using techniques developed in producing the computational science textbook. Complete networking technology assessment project to determine appropriate educational technology tools and curricula for a wide variety of schools and to produce a catalog of effective technologies for use by teachers, administrators and local and state education officials.	

DOE	**Basic Research for Applied Mathematics Research**	Budget Code:	KC 07 01

This program activity supports applied mathematics, computer science, and computational science research that develops tools for enabling solutions to large scientific problems. DOE supports leading-edge research at ten DOE laboratories and over 30 universities.

Current activities include research in applied mathematics and computational science, the studies of the National Academy of Science's Board on Mathematical Sciences, over 40 postdoctoral associates at laboratories and universities, and over 60 university graduate students. Applied mathematicians and computational scientists supported by basic research are also active in Grand Challenge projects.

The applied mathematics program was reviewed in FY 1993 by panels of outside experts. It received uniformly high marks for scientific excellence and relevance to the DOE mission.

The panel also identified new areas for possible funding:

Inverse scattering;
Nondestructive evaluation;
Discrete mathematics; and
Spatio-temporal chaos.

Budget (BA, $ M)	
FY 94 Actual	15.50
FY 95 Pres.	16.50
FY 95 Est.	16.50
FY 96 Rqst.	16.00

FY 96 Request by Component

HPCS	
NREN	
ASTA	
IITA	
BRHR	16.00

Agency Ties

ARPA	
NSF	Partner
DOE	
NASA	
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
A new materials science algorithm was developed based on a quasi-minimal residual iterative solver that allows the execution time of the Materials Science Grand Challenge codes to scale linearly with problem size. A code that can resolve fluid dynamic instabilities produced by shock waves was developed and made available. It was demonstrated that simulation results agree with experiments in one and two dimensions. Researchers designed and implemented numerical algorithms for controlling in real time the behavior of chaotic responses in low dimensional mechanical and electrical systems. Researchers developed software and computer networking tools to enable chemists and material scientists to visualize complex geometric structures found in commercially important natural and synthetic materials.	Make available codes based on adaptive mesh refinement techniques for resolving 3D fluid flow phenomena in complex geometries. Design security procedures for voice and data transmission based on sending the data encapsulated in a chaotic signal and decoding the signal using techniques for controlling chaos. Make available codes for resolving large-scale stochastic programming problems of the type found in large commercial electric power distribution systems, data transmission networks, and airline crew equipment scheduling operations. Develop and integrate sparse matrix techniques for finite element codes that perform crash simulation and analysis.	Increase support for laboratory and university research in inverse scattering, nondestructive evaluation, and discrete mathematics applied to parallel programming and genome sequencing and mapping. Strengthen ties among laboratory, academic and industrial researchers working on Grand Challenge problems in chemistry, physics, biology, meteorology for applications in enhanced oil recovery and environmental restoration Initiate an industrial postdoctoral program in which postdoctoral researchers work at industrial and laboratory sites on problems of common interest.	An environmental remediation modeling project at Oak Ridge National Laboratory was canceled following a recommendation from the 1993 Program Review Panel that the researchers lacked the appropriate physics and numerical expertise to model realistic groundwater contaminant transport phenomena. Two applied mathematics projects at Sandia National Laboratories were canceled. In a project on combustion modeling, the researcher had perfected his bifurcation analysis techniques to the point where further support was deemed unnecessary. In a project on developing adaptive numerical schemes, the researcher became involved in another project and was unable to continue working on this one.

DOE	Florida State University - SCRI	Budget Code:	KC 07 02

This activity provides limited support for a Congressionally-mandated program in computational and computer science at the Supercomputer Computations Research Institute (SCRI) at Florida State University in Tallahassee, FL.

Budget (BA, $ M)	
FY 94 Actual	2.00
FY 95 Pres.	2.00
FY 95 Est.	1.53
FY 96 Rqst.	1.62

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
This project was reviewed along with other DOE supported computational and computer science efforts. The computational science efforts in computational high energy physics had good ratings.			

FY 96 Request by Component	
HPCS	
NREN	
ASTA	1.62
IITA	
BRHR	

Agency Ties	
ARPA	
NSF	
DOE	
NASA	
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

DOE	Domestic Oil & Gas (ACT)	Budget Code:	KC 07 01

Support for Domestic Oil and Gas Advanced Computation Technologies Initiative. This initiative seeks to transfer DOE expertise in high performance computing to the domestic oil exploration and production industry.

Budget (BA, $ M)	
FY 94 Actual	0.00
FY 95 Pres.	3.00
FY 95 Est.	3.00
FY 96 Rqst.	3.00

FY 96 Request by Component	
HPCS	
NREN	
ASTA	3.00
IITA	
BRHR	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
A process for the evaluation of proposals was developed and Commerce Business Daily notice published. The process for proposal evaluation involves a panel of industry experts.	Initial projects started.	First joint results from initial projects. Evaluation of second set of proposals.	

Agency Ties	
ARPA	
NSF	
DOE	
NASA	
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

National Aeronautics and Space Administration

NASA's primary role in the HPCC Program includes leading the development of applications software and algorithms for scalable parallel computing systems that will increase system performance to the sustained teraFLOPS (10^{12} floating point operations per second) level for NASA applications. As HPCC technologies are developed, NASA will use them to solve its Grand Challenge research problems. These are fundamental problems whose solutions require significant increases in computational power and are critical to meeting national needs.

NASA's Grand Challenges include:

Improving the design and simulation of advanced aerospace vehicles;
Enabling people at remote locations to communicate more effectively and share information;
Increasing scientists' abilities to model the Earth's climate and forecast global environmental trends; and
Improving the capabilities of advanced spacecraft to explore the Earth and solar system.

NASA has initiated a program component to broaden the reach of the HPCC Program and begin the development of a National Information Infrastructure by supporting research and development in education, digital library technology, and access to Earth and space science data. The FY 1995 NASA HPCC Program has been organized into three vertically integrated computing projects:

The Computational Aerosciences (CAS) project;
The Earth and Space Sciences (ESS) project;
The Remote Exploration and Experimentation (REE) project; and
The Information Infrastructure Technology and Applications (IITA) component.

The REE project will not be active from FY 1993 through FY 1995, but will resume activities in FY 1996, beginning with program definition and planning.

In cooperation with other participating Federal agencies, NASA's HPCS component involves deployment of experimental, scalable supercomputer capabilities essential for computational design of integrated aerospace vehicle systems and for predicting long-term global changes.

NASA leads the coordination of the ASTA component among government, academic, and industry partners. This includes conducting a series of workshops that address Federal HPCC Program needs in software technologies and algorithms, computational aerosciences, and supercomputing testbeds. NASA is responsible for implementing the Software Sharing Experiment to foster software sharing and reuse across the Federal HPCC Program. NASA also is acquiring hardware for computational science testbeds and developing software tools to enhance productivity, including load balancing tools, run time optimizers, monitors, parallelization tools as well as data management and visualization tools.

The agency's NREN activity provides high-speed network connections among NASA, industry, and academic researchers.

NASA's Basic Research and Human Resources component encourages research into the underlying theory and concepts of high performance computing and will foster research in high performance computing at NASA centers, research institutes and universities.

The new IITA component consists of critical information technologies and the application of these technologies to "National Challenges," problems where the application of HPCC technology can provide huge benefits to all Americans.

National Aeronautics and Space Administration

Program Activity	Budget Account Code	Partner/User Agencies	Budget (BA, $ M)				HPCC Components by 1996 Agency Req.				
			FY 94 Actual	FY 95 Pres.	FY 95 Est.	FY 96 Rqst.	HPCS	NREN	ASTA	IITA	BRHR
Testbeds	509-10,509-20,509-30,234,536	ARPA, NSF, DOE	22.60	26.40	25.12	14.81	7.62		7.19		
Grand Challenge Support	509-10,-20,-30,505,535-538,212,232,233,306,65	NSF, DOE, NOAA, EPA	53.80	55.30	54.20	59.84			59.84		
Systems Software	509-10 509-20 509-30	EPA, NOAA, NSA, NIH, ...	8.20	9.20	8.04	10.02			10.02		
NREN	509-10,-20,428.538	DOE, ARPA, ED, NOAA,	13.10	12.70	19.12	20.85		20.85			
BRHR	509-10,-20, 233	NSF, NIH, NOAA, EPA	3.30	3.80	3.59	3.98					3.98
Information Infrastructure Technology	509-40	ARPA, NSF, DOE, NIH, ED,	2.50	5.80	7.20	8.80				8.80	
Information Infrastructure Applications	509-40	NOAA, EPA, ED	7.50	11.20	14.13	18.00				18.00	
		Totals:	111.00	124.40	131.40	136.30	7.62	20.85	77.05	26.80	3.98

NASA	Testbeds	Budget Code:	509-10,509-20,509-30,234,536

The objective of this activity is to encourage and accelerate U.S. commercial development of high performance computing systems that will support the Grand Challenges. To accomplish this, NASA will fund and encourage the commitment to early acquisition, access and placement of such advanced systems by:

Acquiring some advanced prototype and early production model high performance computing systems for use and evaluation;

Providing network access to understand execution of full Grand Challenge applications on TeraFLOPS systems;

Providing a testbed control environment to assist in the collection of data about testbed operations that are needed to project the eventual performance of Grand Challenge applications on TeraFLOPS computing systems;

Developing a set of parallel benchmark codes based directly on the Grand Challenge applications to evaluate disparate architectures.

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

NASA also will develop tools and techniques to project the execution performance of the Grand Challenge applications. High performance computing research facilities will be established to accelerate transition to new generations of high performance computing technology by enabling researchers to explore applications of these new technologies. This will provide early access to advanced computing facilities for advanced application experiments and facilitate the creation and evaluation of new computing technology. Advanced high performance processors will be integrated into a prototype TeraFLOPS computing facility that will include access to the National Research and Education Network (NREN), early systems or advanced prototypes of important storage hierarchy subsystems, and sufficient advanced visualization facilities to allow system scalability experiments to be conducted. This will provide a spectrum of experiments for scalability studies as well as access to the largest possible advanced system by the Grand Challenge researchers.

Budget (BA, $ M)	
FY 94 Actual	22.60
FY 95 Pres.	26.40
FY 95 Est.	25.12
FY 96 Rqst.	14.81

FY 96 Request by Component	
HPCS	7.62
NREN	
ASTA	7.19
IITA	
BRHR	

Agency Ties	
ARPA	Partner
NSF	Partner
DOE	User
NASA	User
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Installed 10-50 GigaFLOPS sustained testbeds (scalable to 100 GigaFLOPS) for Computational Aerosciences (CAS) Grand Challenge teams. Fostered teaming of independent software vendors, aerospace industry, and computer manufacturers through access to 10-50 GigaFLOPS testbed. Awarded Cooperative Research Agreement to IBM consortium for implementation of SP-2 parallel computer testbed. Worked closely with Cray Research Inc., MasPar Computer Corporation, Intel Parallel Systems Division, and Convex Computer Corporation in the development of their scalable parallel systems and installed major testbeds at JPL and GSFC and made them available to the ESS Investigators for evaluation. Began testing ATM-based local area network components in preparation for connection of NASA Goddard and JPL testbeds to the 155 megabits/second inter center network to be provided by NREN.	Grand Challenge Investigator Teams to be provided access to the following testbeds for evaluation of applications: 128 node CRAY T3D at JPL, 16,384 node MasPar MP-2 and 8 processor Convex SPP-1 at NASA Goddard, 528 node Intel Delta at Caltech, Thinking Machines CM-5 scalable machines at NASA Ames and Naval Research Lab, Kendall Square Research scalable system at University of Washington, IBM SP-1s at NASA Lewis and Argonne National Lab, and IBM SP-2 at NASA Ames.	Install third generation 50-100 GigaFLOPS sustained scalable ESS testbed. Demonstrate cost effective high performance computing at performance and reliability levels equivalent to 1994 Vector Supercomputers at 25% of the capital cost. Foreseeing severe future budget limitations, NASA is seeking to devise methods of achieving more cost effective computing through more efficient use of resources. To achieve this goal, NASA will exploit the existing infrastructure of design workstations, creating a seamless uniform computing environment that integrates all resources. A result of this research will be a recommendation relative to future upgrades. Make testbeds available to investigators for applications development and porting, and for system software development and evaluation. Demonstrate interoperation of the network infrastructure at NASA Goddard and JPL with NREN at 622 Mbps.	

NASA	Grand Challenge Support	Budget Code:	509-10,-20,-30,505,535-538,212,

This research area develops, enhances, and evaluates techniques for the multidisciplinary modeling and simulation required by Grand Challenge problems. The Computational Aeroscience (CAS) research will focus on understanding the high performance computing environment and how it can be used to solve a range of problems of importance in aerospace engineering at a cost that represents the value, flexibility, and short cycle time required by the aerospace community. This will be accomplished with the aid and focus provided by several representative aerospace design problems related to nationally important programs. These are: a High Speed Civil Transport (HSCT); an Advanced Subsonics Civil Transport (ASCT); High-Performance Aircraft (HPA), and Rotorcraft.

Earth and Space Science (ESS) research will cover 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. Research will focus 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 are supported by shared computational and experimental facilities. Technical accomplishments will include development of application-specific codes for innovative high- performance computing systems, design and analysis of algorithms, and architecture and performance assessment of specific applications. NASA will evaluate the early research products and make the results 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. 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 are being re-implemented on a variety of architectures in order to understand how architecture affects efficiency and algorithm design.

Budget (BA, $ M)	
FY 94 Actual	53.80
FY 95 Pres.	55.30
FY 95 Est.	54.20
FY 96 Rqst.	59.84

FY 96 Request by Component	
HPCS	
NREN	
ASTA	59.84
IITA	
BRHR	

Agency Ties	
ARPA	
NSF	Partner
DOE	Partner
NASA	
NIH	
NSA	
NIST	
NOAA	User
EPA	User
ED	
AHCPR	
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
NASA pioneered the implementation of design and simulation software on parallel computers. Aeronautics industry reviewed and validated NASA aeroscience computational tools to promote industrial use. Multidisciplinary computational analysis of a multistage compressor was used to reduce substantially the design time of a large commercial aircraft engine that can achieve a 1.5% reduction in specific fuel consumption. Distributed workstation cluster simulation assisted the High Speed Research program select by determining inlet stability and performance. Developed and demonstrated parallel computational techniques in collaboration with Investigator Teams. Established metrics for the ESS Grand Challenge Teams. Used emerging highly parallel computing systems to model temperature fluctuations within a star for studying stellar evolution. Compared the results from a structure of the Universe model, run on a parallel computer, to structures inferred from observations by the COBE satellite.	Develop multidisciplinary Earth and space science applications on 10-50 GigaFLOPS testbed, including: Cosmology and accretion astrophysics, large scale structure and galaxy formation, convective turbulence and mixing in astrophysics, solar activity and heliospheric dynamics, atmosphere/ocean dynamics and tracers chemistry. The Earth and Space Science Team will evaluate testbed architectures, running their scientific problems, for usability and efficiency. Develop advanced subsonic civil transport analysis/optimization code and perform medium fidelity high speed civil transport modeling. Enhance the ability of aircraft manufacturers to quickly analyze different design options and accelerate the prototyping process, thereby reducing design cycle costs and producing vehicles with improved performance.	Demonstrate multidisciplinary aeroscience and Earth and Space Science applications on 10-50 GigaFLOPS testbeds. Demonstrate end-to-end reductions in cost and time to solution for aerospace design applications on heterogeneous systems. The approach will be to make a CAS testbed of heterogeneous workstations and high speed local networking openly accessible to software activities similar to existing HPCC work on TeraFLOPS systems. Design applications, oriented around the propulsion industry needs, will guide the system software. Select and award Round-2 ESS Investigators.	

NASA	Systems Software	Budget Code:	509-10	509-20	509-30

There are common needs in many areas of software technology including programming environments for code development and adaptation, 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 will have broad national impact resulting from the united efforts of NASA, other Federal agencies and industry. As the lead agency for coordinating advanced software technology and algorithm development, NASA will ensure that new systems software developments will involve broad communities. NASA is leading the effort to develop a HPCC Software Exchange to provide the infrastructure that encourages software reuse and the sharing of software modules across organizations through an interconnected set of software repositories.

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

Research also will be 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 will be 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 will be prototyped and evaluated. The portability of these methods to various high performance systems will be studied.

Human interfaces will be 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.

Budget (BA, $ M)	
FY 94 Actual	8.20
FY 95 Pres.	9.20
FY 95 Est.	8.04
FY 96 Rqst.	10.02

FY 96 Request by Component

HPCS	
NREN	
ASTA	10.02
IITA	
BRHR	

Agency Ties

ARPA	Partner
NSF	Partner
DOE	Partner
NASA	
NIH	User
NSA	User
NIST	
NOAA	User
EPA	User
ED	
AHCPR	
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Provided widely accepted universal performance tuning tools and defined a Universal Debugger. Demonstrated a single parallel Architecture Independent Computing Extensions code running on three dissimilar computing architectures. Demonstrated a general-purpose multigrid Helmholtz equation solver package possessing excellent scaling properties running on the Intel Delta and Paragon. Completed Version-1 of the turn-key Flow Analysis Software Toolkit (FAST) Virtual Reality System. Demonstrated a parallel whole Earth surface renderer on the Intel Paragon/Delta and CRAY T3D producing a frame rate of around 1 frame per second. Initiated an activity to evaluate High Performance Fortran as a portable parallel Fortran for ESS applications. Processed the first annual submission of software by the Investigators to the on-line ESS Software Exchange.	Improve portability and scalability of software components and tools to high performance computing systems. Organize second workshop on systems software and tools for High Performance computing environments. Complete aerospace industry validation of NASA computational fluid dynamics equation solvers. Develop a High Performance Computing Software Exchange prototype. Complete the turn-key Flow Analysis Software Toolkit (FAST) virtual reality system.	Demonstrate portability and scalability of software components and tools to TeraFLOPS systems. Demonstrate portability and scalability of aeroscience and ESS software components and tools to teraFLOPS systems. Implement the High Performance Computing Software Exchange. Demonstrate interactive parallel distributed visualization over T1 and T3 lines. Develop expert system-based simulation steering.	

NASA	NREN	Budget Code:	509-10,-20,428.538

The National Research and Education Network (NREN) effort will establish standards and provide working models for commercial communications infrastructure deployment. NASA's role is to deploy the advanced communications required by the Grand Challenge investigators in a manner that satisfies the immediate needs of researchers while simultaneously guiding commercial infrastructure development for the nation. NASA works with NSF, DOE, ARPA, 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 including provision of advanced network services for multi-media communications; and K-12 distance learning and outreach applications.

NASA has already deployed 45 Mb/s network services between two NASA centers and the NSFnet, significantly improving communications between remote investigators and NASA. An acquisition for advanced telecommunications services on an early availability basis will bring telecommunication and computational standards together to provide a low-cost computer network infrastructure over vendor facilities ultimately targeted at commercial availability. This will take advantage of the latest telecommunications technologies, such as Asynchronous Transfer Mode (ATM) over Synchronous Optical Network Transmission (SONET) services, initially at 45 Mb/s among five NASA centers.

NASA also is working with other Federal HPCC agencies to extend the reach of NASA's data resources and computing capabilities to K-12 schools, libraries, and teacher resource centers. Further development of digital libraries and other networking infrastructure technologies under the IITA component will promote remote access to NASA HPCC resources, enabling schools and resource centers to collaborate directly with each other over networks on distributed NASA education projects.

In order to incorporate satellite-based communications technology into the terrestrial gigabit highways of the future, two experiments are planned for coupling the NREN effort with the NASA's Advanced Communications Technology Satellite (ACTS).

Budget (BA, $ M)	
FY 94 Actual	13.10
FY 95 Pres.	12.70
FY 95 Est.	19.12
FY 96 Rqst.	20.85

FY 96 Request by Component	
HPCS	
NREN	20.85
ASTA	
IITA	
BRHR	

Agency Ties	
ARPA	Partner
NSF	Partner
DOE	Partner
NASA	
NIH	
NSA	
NIST	
NOAA	User
EPA	User
ED	User
AHCPR	
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Began deployment of ATM-based LAN's within GSFC and connecting to the DoD ATDnet 2.4 gigabit/second ring around Washington, D. C. Progress made relative to demonstrating satellite-based gigabit applications using the Advanced Communications Technology Satellite (ACTS). Defined distributed demonstration applications for the Keck and GCM experiments. Completed the conceptual network architecture for Hawaii, JPL, and GSFC. Began acquisition of required network components. Planned ATDnet configuration and system deployment with other 5 ATDnet agencies. Began checking out GSSFC equipment for initial OC-3 demonstration in May.	Complete T-3 (45 Mb/s) Level 3 HPCC interconnects of five NASA centers -- Ames Research Center (ARC), Goddard Space Flight Center (GSFC), Langley Research Center (LaRC), Lewis Research Center (LeRC) and the Jet Propulsion Laboratory (JPL) -- with switched packet network to serve research communities. Demonstrate satellite-based gigabit applications using the Advanced Communications Technology Satellite (ACTS) including: "A Performance Study of a SONET/ATM Satellite & Terrestrial Network for an Engine Inlet Simulation," and "High Data ACTS Experiments for Performing Global Science: Keck Telescope and Global Climate Model." Interconnect five NASA research centers using 155 Mb/s high speed communication: Ames Research Center (ARC), Goddard Space Flight Center (GSFC), Langley Research Center (LaRC), Lewis Research Center (LeRC) and the Jet Propulsion Laboratory (JPL).	Complete ACTS experiments. Operate NREN in support of ESS science investigators and aerospace industrial research partners. Demonstrate interoperability between independently managed NREN networks that are based on ATM technology supplied by multiple vendors. This capability is critical to NASA in order to meet growing internal requirements while maintaining compatibility with the evolving national network infrastructure that includes other Federal Agency networks as well as the private sector networks that will comprise the NII.	

NASA	BRHR	Budget Code:	509-10,-20, 233

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

NASA supports research institutes and centers of excellence engaged in computer science and computational science under the basic research and human resources component. These include: the Illinois Computer Laboratory for Aerospace Systems and Software (ICLASS) at the University of Illinois; the Research Institute for Advanced Computer Science (RIACS) at Ames Research Center; the Institute for Computer Applications in Science and Engineering (ICASE) at Langley Research Center, and the Center of Excellence for Space Data and Information Sciences (CESDIS) at Goddard Space Flight Center. In addition, NASA funds small university grants on HPCC topics at the individual principal investigator level.

The NASA HPCC program also focuses on the development of the next generations of computer and computational scientists. The resource potential to be developed will be concentrated at the graduate and postdoctoral level, but will extend to the baccalaureate and junior professor degree levels to a lesser extent. NASA's HPCC program will address the need to attract more talented scientists and engineers to computer and computational science in multiple ways by:

- Expanding ongoing NASA programs that support pre-baccalaureate and master's level training and research programs (e.g., ICLASS);
- Expanding doctoral degree research opportunities in High-Performance Computing (e.g., CESDIS, ICLASS);
- Expanding the ongoing NASA programs that support postdoctoral research and new professors (e. g., CESDIS, ICASE, RIACS, ICOMP).

In addition, new mechanisms for supporting students and new faculty interested in applying HPCC technology on NASA's applications have been initiated. This includes funding students directly at their institutions, provided they have an advisor interested in NASA applications, and expanding on the NASA Graduate Student Researchers Program at NASA centers.

Budget (BA, $ M)	
FY 94 Actual	3.30
FY 95 Pres.	3.80
FY 95 Est.	3.59
FY 96 Rqst.	3.98

FY 96 Request by Component	
HPCS	
NREN	
ASTA	
IITA	
BRHR	3.98

Agency Ties	
ARPA	
NSF	Partner
DOE	
NASA	
NIH	User
NSA	
NIST	
NOAA	User
EPA	User
ED	
AHCPR	
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Provided annual graduate and postdoctoral support for high performance computing research. A Workshop on Enabling Technologies for petaFLOPS Computing Systems held in February (Pasadena I). Fifteen researchers supported across five NASA Centers. NASA Goddard hosted fourth NASA summer school in High Performance Computational Physics to train 16 doctoral candidates in massively parallel techniques and algorithm development.	Provide annual graduate and postdoctoral support for high performance computing research. Host fifth annual summer school in High Performance Computational Physics.	Provide annual graduate and postdoctoral support for high performance computing research. Host sixth annual summer school in High Performance Computational Physics. Transfer results of scalable I/O research to commercial sector. Publish Final Report of Round-1 Basic Computer Science Research in key ESS technical areas.	

NASA	Information Infrastructure Technology	Budget Code:	509-40

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

NASA continues to participate in digital library technology research and development efforts begun under the NASA Cooperative Agreement Notice, "Public Use of Earth and Space Science Data Using the Internet," and the NSF/ARPA/NASA joint initiative "Research on Digital Libraries." A second Cooperative Agreement Notice for research and development in digital library technology was planned to be issued in conjunction with the applications of Remote Sensing Data project. Successful cooperative efforts resulting from this solicitation will complement ongoing work.

NASA will work with aircraft and propulsion companies to facilitate the transfer of NASA HPCC-developed technology to users in major U.S. aerospace companies. This will be accomplished through projects to implement tools facilitating transmittal of proprietary data over networks. NASA will enable aeronautics community collaboration with NASA facilities without jeopardizing the confidentiality of competitive or proprietary data. This will be accomplished through an Authentication and Privacy project using systems analysis, integration and technology transfer to implement secure transmittal of remotely acquired aeronautics data.

Budget (BA, $ M)	
FY 94 Actual	2.50
FY 95 Pres.	5.80
FY 95 Est.	7.20
FY 96 Rqst.	8.80

FY 96 Request by Component	
HPCS	
NREN	
ASTA	
IITA	8.80
BRHR	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Initiated cooperative agreements with Belcore, IBM, CSC, and University of Illinois at Urbana-Champaign for research into digital library technology supporting public use of Earth and space science data over the Internet. Initiated grants with Rice University and the University of Wisconsin for research into digital library technology supporting public use of Earth and space science data over the Internet. Completed Digital Library Technology (DLT) Home Page published on the World Wide Web, viewable using Mosaic, a hypertext browser. Jointly supported the research solicitation for Digital Library research with NSF and ARPA. Established remote sensing public access center through cooperative agreement with BDM.	Initiate a digital library technology cooperative agreement with Loral Aerosystems and Bowie State University as a follow-on of the FY 1994 Cooperative Agreement Notice. Jointly with ARPA and NSF establish a framework for cooperation among the agencies for coordinating digital library and related research. Co-sponsor a Digital Library workshop with NSF and ARPA to assess the state of the art and identify research directions. Demonstrate prototype server for network progressive image transmission and compression. Implement Planetarium, Space Update Kiosk at Houston Museum of Natural Sciences. Identify authentication and privacy requirements of aeronautics industry. Develop and issue a second Cooperative Agreement Notice for Digital Library Technology and Remote Sensing Database Applications.	Initiate cooperative agreements and grants for digital library technology resulting from the 1995 Cooperative Agreement Notice. Identify additional digital library technologies needed to support remote sensing applications. Implement Earth Forum Kiosk module at Houston Museum of Natural Sciences. Demonstrate Internet access over commercial cable television in 100 homes and schools in 3 cable districts in Maryland, Virginia, and Colorado. Demonstrate secure transmittal of proprietary simulations and wind tunnel test data between NASA installations and aeronautics industry partners.	

Agency Ties	
ARPA	Partner
NSF	Partner
DOE	User
NASA	User
NIH	User
NSA	
NIST	User
NOAA	User
EPA	User
ED	User
AHCPR	
VA	User

NASA	Information Infrastructure Applications	Budget Code:	509-40

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

NASA will build on its HPCC program, its aeronautics and space science research and engineering missions, and its existing education outreach infrastructure to facilitate the general development of the National Information Infrastructure to support mathematics, science, and engineering education in the K-12 levels. This will be done through both NASA field center 'outreach programs' and through open and competitive solicitations. In FY 95, NASA will issue a cooperative agreement notice open to public and private parties nationwide. The intent of this announcement will be address the National Challenge in "Education, Training, and Lifelong Learning" and will focus on doing this through the national aeronautics enterprise .

Cooperative agreements were initiated with Childhood Project (Passport to Knowledge), Gulf of Maine Aquarium (Surfing the Net) and SENTAR (Flood Management). Grants were initiated with University of Michigan (Windows to the Universe), University of California at Berkeley (Science Information Infrastructure-SII), University of Washington (The Puget Sound Project), University of Wisconsin (Wisconsin Agriculture), University of North Texas (Emergency and Crisis Management-ECM) and Smithsonian Astrophysical Observatory (SAO).

Budget (BA, $ M)	
FY 94 Actual	7.50
FY 95 Pres.	11.20
FY 95 Est.	14.13
FY 96 Rqst.	18.00

FY 96 Request by Component	
HPCS	
NREN	
ASTA	
IITA	18.00
BRHR	

Agency Ties	
ARPA	
NSF	
DOE	
NASA	
NIH	
NSA	
NIST	
NOAA	Partner
EPA	Partner
ED	User
AHCPR	
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Initiated cooperative agreements with Lockheed, TASC, SAIC, ECOLogic, Wheeling Jesuit College/Classroom of the Future, and WRC TV, and initiated grants with University of Minnesota, University of North Dakota, University of Hawaii for applications providing public use of Earth and space science data over the Internet. Developed through the Maryland-Goddard Science Teacher Ambassadors Program: a fully integrated state-wide plan in Maryland for taking Internet access into every school district. Joint ED, NSD, and NASA conference on networking in the classroom, for state Management Information Officials. Preliminary release of Multimedia Software for K-12 Space Mission simulation. Training, computers and networks provided to partner schools in: Maryland (24 schools), Ohio (5 schools), Virginia (7 schools), Tennessee (2 schools), Arkansas (2 Schools), Mississippi (2 schools).	Demonstrate public access and retrieval of NASA databases by traditionally under-served communities. Distribute the educational video for K-12 called "Connecting to the World." Evaluate initial IITA developed K-12 digital education material. Initiate 9 additional cooperative agreements and grants, for a total of 18. Develop and issue a second CAN for Digital Library Technology and Remote Sensing Database Applications. Provide a primary World Wide Web entry for the public to all the Digital Library Technology and Remote Sensing Database Applications projects. Highlights of FY 1994 CAN projects: January - Live from Antarctica on PBS March - Demonstrate acquisition and display of real-time Hawaii datasets May - Deploy application prototype in two museums: Windows to the Universe August - Teacher Summer Immersion Workshop, Year 2: ECOlogic September - Images from Internet used for on-air demonstration: WRC-TV	Award cooperative agreements and grants for public use of remote sensing data (RSD) applications as solicited in a Round 2 Cooperative Agreement Notice (CAN). Establish a World Wide Web server for GOES-8 data for use by funded projects and by the general public. Highlights of FY 1994 CAN projects: March - Prototype weather broadcast videotape production: WRC-TV April - Demo baseline maps and user interface: BADGER.	

National Institutes of Health

The National Institutes of Health (NIH) High Performance Computing and Communications (HPCC) initiatives address many of the challenges that are an integral part of the NIH biomedical research mission. These include the application of biomolecular sequence and structure analysis, software tools for receptor-based drug design, medical image reconstruction and processing, modeling and simulation of living systems, and the evaluation of advanced computing architectures to biomedical research problems. NIH also supports the cross-training of biomedical investigators in HPCC technologies. The NIH health care-related activities include the development of testbed networks linking hospitals, clinics, libraries, and medical schools, and the development of computerized patient records and telemedicine technologies.

The NIH pursues its HPCC 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 HPCC programs are administered by the National Library of Medicine (NLM), the National Center for Research Resources (NCRR), the National Cancer Institute (NCI), and the Division of Computer Research and Technology (DCRT).

NLM also serves as the host for the National Coordination Office for HPCC (NCO).

National Institutes of Health

Program Activity	Budget Account Code	Partner/User Agencies	Budget (BA, $ M)				HPCC Components by 1996 Agency Req.				
			FY 94 Actual	FY 95 Pres.	FY 95 Est.	FY 96 Rqst.	HPCS	NREN	ASTA	IITA	BRHR
NLM Medical Connections Program			0.60	0.60	0.61	0.62		0.62			
NLM Biotechnology Informatics		DOE	4.10	4.12	4.32	4.35			4.35		
NLM Electronic Imaging			2.22	2.46	2.03	2.03			2.03		
NLM HPCC Training Grants			2.90	3.40	3.01	3.04					3.04
NLM IAIMS grants			3.30	3.30	3.39	3.39					3.39
NLM Intelligent Agent DB searching			5.31	5.34	5.35	5.37				5.37	
NLM HPCC Health Care Applications		AHCPR	7.40	18.72	11.94	20.21				20.21	
NCRR Biomolecular Computing		NSF	6.60	6.60	7.60	6.60			6.60		
NCRR Software Tools for Receptor-Based Drug Design		NSF	2.20	2.20	2.50	2.20			2.20		
NCRR Modeling/Simulation		ARPA, NSF	2.20	4.80	4.80	5.80			5.80		
NCRR Virtual Reality/Environments		ARPA, NSF	2.50	4.00	4.00	4.20				4.20	
NCRR HPCC Training			2.30	5.00	1.40	3.50					3.50
DCRT High Performance Biomedical Computing Program		ARPA, NASA	8.40	11.00	8.90	8.90	3.30	0.80	3.30	1.50	
NCI Frederick Biomedical Supercomputing Center		NSA, NIST	6.10	6.40	5.40	5.40	0.80	0.40	3.50		0.70
NCI High speed networking and distributed conferencing				2.00	1.70	1.70		0.50	0.40	0.70	0.10
NCI High Perf. Comms for PDQ, CancerNet, and Electronic Publishing				0.60	0.60	0.60				0.60	
National Coordination Office		All HPCC Agencies	0.53	0.80	0.92	0.92					0.92
		Totals:	56.66	81.34	68.47	78.83	4.10	2.32	28.18	32.58	11.65

NIH	NLM Medical Connections Program	Budget Code:	

The Medical Connections grant program provides `jump start` funding to academic medical centers, community hospitals, and other health care organizations to allow them to connect to NREN. Funding by the National Library of Medicine is provided to offset the costs of digital communications equipment, digital circuits linking medical centers with academic and commercial mid-level networks, and personnel and services necessary to connect to the NREN. During 1992-94 this program was administered for NLM by the National Science Foundation, which has long had a similar program for non-medical goals, but in FY 1995 NLM managed the program itself.

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.

Budget (BA, $ M)	
FY 94 Actual	0.60
FY 95 Pres.	0.60
FY 95 Est.	0.61
FY 96 Rqst.	0.62

FY 96 Request by Component

HPCS	
NREN	0.62
ASTA	
IITA	
BRHR	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Seventeen Connections grants were awarded in 1994.	Approximately fifteen grants will be awarded.	Overall program goal is to bring the top 3000 health care institutions in the U.S. onto the NREN.	Due to funding limitations, 1994 grant targets were reduced from 100 to 17.

Agency Ties

ARPA	
NSF	
DOE	
NASA	
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

NIH	NLM Biotechnology Informatics	Budget Code:	

The NLM's National Center for Biotechnology Information (NCBI) has been given the legislative mandate to create automated systems for storing and analyzing the vast and growing ocean of data related to molecular biology, biochemistry, and genetics. This information science is an essential component of genome research and protein engineering and drug design, and seeks to develop analytical and predictive methods to identify key molecular patterns associated with health and disease as represented in a large number of related databanks encoding DNA, RNA, proteins, and other biologically important molecules.

NCBI is implementing an integrated sequence database of molecular sequence and structure which contains key linkages to the scientific literature and to existing biological data banks; the database is available to researchers nationally via the Internet, using several advanced client-server retrieval systems. Research on efficient and expressive data representation techniques for molecular sequence objects is a critical component of this effort, which complements basic research on the development of new sequence analysis and retrieval methods. Within this distributed database architecture, the Center builds and provides access to GenBank, the national DNA sequence data bank which is a key data resource of the Human Genome Project.

The Biotechnology Informatics program administered through NLM's Extramural Program also supports investigator-initiated research in computational biology via peer-reviewed grants.

Budget (BA, $ M)	
FY 94 Actual	4.10
FY 95 Pres.	4.12
FY 95 Est.	4.32
FY 96 Rqst.	4.35

FY 96 Request by Component

HPCS	
NREN	
ASTA	4.35
IITA	
BRHR	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Creation of software for automated direct submission methods of sequence data from laboratories was completed. Over 10,000 queries of GenBank processed daily. Established a GenBank Fellow program for training postdoctoral fellows in biological databases and computer analysis of genome data.	Tenfold increase in linkage of gene sequences to related scientific literature. Linkage of sequence data to three-dimensional protein structure data. Coordinated effort with Washington University and Merck to add over 200,000 human cDNA sequences to GenBank. Implementation of network-based sequence submission software.	Automated sequencing technology accelerates pace of input to database, from the current rate of doubling every 20 months. High throughput from cDNA sequencing may double size of database in one year. Increased user and network demands for sequence search and retrieval will require upgrading server software and hardware. Expansion of National Information Infrastructure requires improving network services.	

Agency Ties	
ARPA	
NSF	
DOE	Partner
NASA	
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

NIH	NLM Electronic Imaging	Budget Code:	

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

Visible Human Project: The National Library of Medicine has undertaken steps to build and evaluated digital image libraries of anatomical structures of the human body. Full use and understanding of the biological structures depicted in such libraries will exploit the integration of advance computer and communications technologies, with medical imaging systems for computer tomography (CT), and magnetic resonance imaging (MRI). 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 NLM is also working with industry and academic groups to develop standards for the representation and communication of such electronic images.

DPXNET Program: The NLM is engaged 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 effort has succeeded in digitizing and archiving about 15,000 cervical and lumbar spine x-ray films acquired as part of the second National Health and Nutrition Examination Survey (NHANES II) to create an electronic archive of this unique and nationally important collection. Accomplishments include: the development of high performance imaging work stations for quality control and standardized readings; the development of an electronic store implemented by a 144-platter optical disk jukebox and accessible over the Internet; the development of client/server software for general access to the images and collateral data over the Internet; the development of an electronic radiologic atlas and training set for the cervical and lumbar spine; started using these tools to perform the standardized readings of the NHANES II images; began the development of an integrated database with image and collateral data for general access over the Internet.

Budget (BA, $ M)	
FY 94 Actual	2.22
FY 95 Pres.	2.46
FY 95 Est.	2.03
FY 96 Rqst.	2.03

FY 96 Request by Component	
HPCS	
NREN	
ASTA	2.03
IITA	
BRHR	

Agency Ties	
ARPA	
NSF	
DOE	
NASA	
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
The acquisition of a complete sample-based anatomical data set for a representative normal human male has been completed.	The complete data set for the Visible Human Male will be mounted and distributed both over the Internet, and as a published volume of 8mm and 4mm tapes. A subset for the color data will be mapped with anatomical labels and graphical outlines to serve as a data structure model for object identification of the full male and female image data sets. A prototype image database will be designed to house the 2D and 3D data sets. The acquisition of a complete sample-based anatomical data set for a representative normal human female will be completed. Complete an online electronic radiological atlas and training set for spine images. Begin standardized readings of the cervical and lumbar spine images.	The complete data set for the Visible Human Female will be mounted and distributed both over the Internet, and as a published volume of 8mm and 4mm tapes. Continued research into automated image classification, and linkage of structural data with semantic labels. Implement the prototype for the complete image data base. Start full object identification of the Visible Human data sets. Expand general access to integrated database consisting of NHANES II and III data.	

NIH	NLM HPCC Training Grants	Budget Code:	

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

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Support for existing programs continued.	Support for existing programs continues.	Continued individual and program grants for HPCC training for health professionals.	Because of funding limitations the number of fellowships awarded was kept flat, instead of being increased as called for by the original award schedule.

Budget (BA, $ M)	
FY 94 Actual	2.90
FY 95 Pres.	3.40
FY 95 Est.	3.01
FY 96 Rqst.	3.04

FY 96 Request by Component	
HPCS	
NREN	
ASTA	
IITA	
BRHR	3.04

Agency Ties	
ARPA	
NSF	
DOE	
NASA	
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

NIH	NLM IAIMS grants	Budget Code:	

Academic Medical Centers are the backbone of the American biomedical research enterprise. These 120-plus institutions are comprised of health profession schools, their associated teaching and research hospitals, clinics and laboratories. Information related to patient care, research, education, and administration is the life blood of these complex centers; increasingly this information is in electronic form: databases of bibliographic and factual information, molecular databases, patient records, laboratory and clinical data. Currently, these electronic information sources (databases) are largely disconnected and isolated from one another, and communications among the various computerized systems in academic medical centers is primitive or non-existent.

The focus of the IAIMS program, initiated in 1984, is the development of the technical and organizational infrastructure necessary to link and retrieve conceptually related information from many disparate sources within the medical center, and to link medical centers. The administrative, clinical, educational, and research databases should be able to communicate, and to appear as one database to the user. The goal of the program is the development, testing, and implementation of generalizable systems of information flow management within university health science centers or major teaching hospitals. The expected outcomes of this program are greater research productivity, improved access to patient data for technology assessment and health outcomes research, and more efficient patient care leading to increased efficiency in the use of health care resources.The work is expected eventually to benefit all health delivery organization, including community hospitals and outpatient services.

Budget (BA, $ M)	
FY 94 Actual	3.30
FY 95 Pres.	3.30
FY 95 Est.	3.39
FY 96 Rqst.	3.39

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Ten IAIMS projects were supported by grant and contract mechanisms, including two implementation continuation awards, one continuing planning award, one new implementation award and six new planning awards.	In addition to continuation of four awards made previously, approximately seven new planning awards and two new implementation awards will be made; emphasis on sharing of information via the NREN will be a central focus of the program.	Continued progress toward integration of academic information management by American medical centers.	

FY 96 Request by Component	
HPCS	
NREN	
ASTA	
IITA	
BRHR	3.39

Agency Ties	
ARPA	
NSF	
DOE	
NASA	
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

NIH	NLM Intelligent Agent DB searching	Budget Code:	

With the large and rapidly growing number of computerized data base resources and services offering bibliographic, full text and factual data via the Internet, it is difficult for the user to locate and process needed information. One may not know where--in which data base-- to look, and the user must deal with the structured and unforgiving access protocols and retrieval languages that differ from one data base service to the next. An especially vexing problem arises if the user needs to search across several data bases or services containing information in multiple formats.

In biomedicine, the disparity in the biomedical terminology used to describe related concepts in different machine readable files also prevents practitioners and researchers from retrieving and integrating relevant biomedical information from separate sources, such as the biomedical literature, clinical records, medical data banks, and expert knowledge bases.

NLM's approach to these problems is to develop intelligent gateways among data base services, using a Unified Medical Language System (UMLS) to compensate for the dissimilarity in the ways related information is classified in different automated systems. Intelligent-agent-mediated gateways will provide users with a single point of access to needed information and free the user as much as possible from having to know the peculiarities of the various information sources. The UMLS will function as an electronic Rosetta Stone, making the myriad of classifications of medical knowledge invisible to the user and enabling retrieval of related biomedical information from many sources.

Budget (BA, $ M)	
FY 94 Actual	5.31
FY 95 Pres.	5.34
FY 95 Est.	5.35
FY 96 Rqst.	5.37

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Moved prototype of new NLM access model (gateway) that makes use of UMLS Knowledge Sources to Internet-based client-server architecture.	Deploy and evaluate new access model (gateway) architecture as one option for use of NLM's services by Internet users.	Fully operational intelligent-agent-mediated multi-database searching available to all NLM users with Internet access.	

FY 96 Request by Component	
HPCS	
NREN	
ASTA	
IITA	5.37
BRHR	

Agency Ties	
ARPA	
NSF	
DOE	
NASA	
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

NIH	NLM HPCC Health Care Applications	Budget Code:	

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

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

Budget (BA, $ M)	
FY 94 Actual	7.40
FY 95 Pres.	18.72
FY 95 Est.	11.94
FY 96 Rqst.	20.21

FY 96 Request by Component	
HPCS	
NREN	
ASTA	
IITA	20.21
BRHR	

Agency Ties	
ARPA	
NSF	
DOE	
NASA	
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	Partner
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Eleven additional contract awards were made in the health care-related research areas of the BAA. NLM and AHCPR announced a joint cooperative agreement program for developing and testing computer-based patient record systems. Five FY 1994 grants were awarded by this joint program. NLM explored the use of consortia of Federal agencies, Federal laboratories, universities, and commercial companies to speed the development of health care applications of HPCC technologies.	Continuation funding of the twelve initial HPCC BAA three-year awards and the initial cooperative agreements. Fund 3 additional cooperative agreements. (2 NLM; 1 AHCPR) Fund, possibly in conjunction with other agencies, a study by the Institute of Medicine of the National Academy of Sciences to identify the range of criteria appropriate to the evaluation of telemedicine projects.	Expand HPCC health care applications, with special emphasis on acceleration of R&D for computerized patient records systems in support of health care reform. Continue funding of 12 HPCC BAA awards and 8 (5.5 NLM; 2.5 AHCPR) cooperative agreements.	In FY 1995 milestones, the number of additional cooperative agreements was reduced from the 4-6 range to 3 due to insufficient funding. The IOM study was added due to the need to ensure that the telemedicine projects funded by NLM and others receive appropriate evaluation.

NIH	NCRR Biomolecular Computing	Budget Code:	

Biomolecular computing using high performance computing involves extensive, often complex calculations to determine or predict:

1. The structure of biologically relevant macromolecules, e.g., proteins;
2. Their structural and functional changes due to interactions with other molecules or drugs;
3. How they are made in the cell and how they fold;
4. How they interact with water and biological membranes; and
5. Especially for drugs, the energetics of molecules going into solution.

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

Budget (BA, $ M)	
FY 94 Actual	6.60
FY 95 Pres.	6.60
FY 95 Est.	7.60
FY 96 Rqst.	6.60

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Continued development of algorithms for protein folding simulations, calculation of free energy of solvation, potential evaluation, and sampling of conformational space. Added two additional high performance computer resource centers. Achieved breakthroughs in the protein folding problem including development of solutions to the multiple-minima problem and determination of protein structure from sequence for five test proteins including myoglobin, a protein of more than 150 residues. Developed improved method to calculate the energetics of molecules going into solution. Understanding DNA-protein complexes of hormone receptors and their role in cell development; these receptors are involved in reproductive diseases such as breast and prostate cancer.	Research on methodology to determine protein structure from sequence in conjunction with NMR experiments further developed to become available commercially. Improve methods to solve the multiple-minima problem. Complete study of a complex of phospholipase A2 with a membrane, involved in many disorders such as toxic shock after injury, asthma, and arthritis. Complete study of a related glucocorticoid receptor and initiate a related study on a DNA-binding protein, the estrogen receptor, and gene V protein. Study DNA binding protein p53, a key factor in human cancers. Apply integration of graphics and molecular dynamics to problems in protein design using massively parallel processors.	Fully developed methodology to predict protein structure from sequence ready for commercialization; if successful, pharmaceutical companies should obtain new structures at least five times faster than currently possible. At least a partial solution of the protein folding problem will have been achieved. A complete study of DNA binding protein p53 will be undertaken. Several resource centers operational to support computational technology, both hardware and software, capable of addressing very large complexes of proteins and DNA in a water environment. Support new investigator-initiated research project grants.	In FY 1994, NCRR's ASTA program activity was split into two components--NCRR Biomolecular Computing and NCRR Software Tools for Receptor-Based Drug Design. All items have been incorporated into the appropriate component.

FY 96 Request by Component

HPCS	
NREN	
ASTA	6.60
IITA	
BRHR	

Agency Ties

ARPA	
NSF	Partner
DOE	
NASA	
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

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

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

Budget (BA, $ M)	
FY 94 Actual	2.20
FY 95 Pres.	2.20
FY 95 Est.	2.50
FY 96 Rqst.	2.20

FY 96 Request by Component

HPCS	
NREN	
ASTA	2.20
IITA	
BRHR	

Agency Ties

ARPA	
NSF	Partner
DOE	
NASA	
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Developed an interface for viewing molecular dynamics and for influencing its course. Two new high performance computer-based resource centers became operational. Research demonstrated that large artificial membrane systems are surprisingly similar to natural membranes and can be used for pharmaceutical assays of drug-membrane interactions. Significant progress made in developing the core technologies including application of quantum mechanics, statistical mechanics, and simulation techniques required for the calculation of protein-drug binding energies.	**Continued refinement of high performance computer-based environments to include access to state-of-the-art massively parallel computers, new algorithms and software specifically tailored for use on these systems, and updated interfaces with high speed networks.** **Access to resource center facilities available to scientists nationally to conduct drug design research.** **Test ability to predict binding constants of known molecule-drug combinations, for example, a known HIV protease-drug inhibitor.** **Use of new methods for calculating solvation energies to determine the solubilities of candidate pharmaceuticals prior to chemical synthesis.**	Use of high performance resources accessible through high speed networks enables structure-based design of drugs to become a reality in the pharmaceutical industry. Design new molecule-drug combinations using capability to predict protein-drug binding energies. Support new investigator-initiated research project grants.	In FY 1994, NCRR's ASTA program activity was split into two components--NCRR Biomolecular Computing and NCRR Software Tools for Receptor-Based Drug Design. All items have been incorporated into the appropriate component.

NIH	NCRR Modeling/Simulation	Budget Code:	

As scientists strive to understand increasingly more complex biomedical processes, computer requirements, both hardware and software, increase disproportionately. These requirements extend to network capabilities which will be required to carry increasingly more data per unit time. The research resource centers are the focus for NCRR-supported simulation and 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 are epidemiological models, especially for pressing health problems such as AIDS and cardiovascular disease.

Budget (BA, $ M)	
FY 94 Actual	2.20
FY 95 Pres.	4.80
FY 95 Est.	4.80
FY 96 Rqst.	5.80

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Developed a very realistic three-dimensional model of the heart with valves and major blood vessels, which will enable design of new artificial heart valves and a greater understanding of heart disease. Developed integrated models for the transport of oxygen by blood, oxygen diffusion from blood to body tissues, and oxygen utilization by cells that are accessible and usable over the internet. Developed Monte Carlo simulation models that depict the transmission of disease among members of a defined population, especially virus epidemic occurrences such as HIV and influenza A. Simulations of molecular systems were carried out	Development of new programs specifically tailored for use on massively parallel computer systems to achieve very high performance on large biomolecular systems, such as proteins embedded in lipid membranes. Create combined transport and metabolism models to understand the dynamics of substances such as oxygen or metabolites in whole organs. Significant progress towards the realization of a safe, reliable hemoglobin-based blood substitute based on simulations of complex NMR data from hemoglobin. Extend the Monte Carlo models to cover even smaller populations such as cells. Begin new initiatives in simulation and modeling.	It is estimated that simulations of large molecular systems in excess of 100,000 atoms will be visualized and interactively controlled through the integration of improved parallel algorithms, faster numerical methods for longer integration steps, and the new generations of massively parallel computers. Capability to realistically model oxygen transport and metabolism for the whole body. Enhanced Monte Carlo models with the capability to provide dynamic visualization of epidemiological data. Extend initiatives in simulation and modeling. Progress from new initiatives begun in FY 1995.	In FY 1994, NCRR's IITA program activity was split into two components--NCRR Modeling/Simulation and Virtual Reality/Environments. All items have been incorporated into the appropriate component. In FY 1994, the national biomedical information `Kiosk` was not developed due to lack of funds.

FY 96 Request by Component	
HPCS	
NREN	
ASTA	5.80
IITA	
BRHR	

Agency Ties	
ARPA	Partner
NSF	Partner
DOE	
NASA	Partner
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

NIH	NCRR Virtual Reality/Environments	Budget Code:	

In certain areas of basic research, the ability to visualize large amounts of data in a `natural environment` is often crucial. In clinical care the ability to `see` deep inside the body, especially the brain, can determine whether a surgical procedure or other therapeutic intervention can be successfully performed with minimum trauma to the patient. These fundamental requirements are increasingly being provided by an evolving technology known as virtual reality or virtual environments. Among requirements for effective virtual reality is the need to provide realistic images--visualization--in real time, that is, these images change in a realistic fashion according to where the observer is looking in real time. All but the most simple cases require high performance computer capability. The NCRR effort in virtual reality is focused on applications for scientific instruments via basic research, molecular visualization, and well defined opportunities to support surgical and other therapeutic interventions such as radiation planning.

Budget (BA, $ M)	
FY 94 Actual	2.50
FY 95 Pres.	4.00
FY 95 Est.	4.00
FY 96 Rqst.	4.20

FY 96 Request by Component	
HPCS	
NREN	
ASTA	
IITA	4.20
BRHR	

Agency Ties	
ARPA	Partner
NSF	Partner
DOE	
NASA	
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Workshop on the use of virtual reality technologies and environments in areas such as surgical procedures which would minimize surgical trauma to areas of the body that are difficult to access. Developed a `Nanomanipulator` that approximates presence at the atomic scale. Remote access to and control of complex microscopy equipment, a demonstration project. Achievement of a room-filling molecule with virtual technology that one can walk around and through, and rotate it by hand as if it were a real (but colored) brass Kendrew model. Obtained the equipment to simulate real world environments in order to study the brain's behavior at sub-second time scales.	Extend the nanomanipulator approach to an atomic force microscope which will permit experimentation on biologically interesting macromolecules. Extend telemicroscopy using network capabilities. Extend the room filling molecule technology to permit more sophisticated interaction and better wayfinding, such as backbone high-lighting and the ability to identify residues at will. Enable chemists to use a new technology force-display arm of high resolution, accuracy, and frequency response for molecular docking and folding studies. Install virtual environment technology for brain behavior research, including the addition of virtual force capability. Begin new activities through investigator-initiated research project grant support	Obtain preliminary results on the value of coupling virtual visualization capabilities to instruments such as the atomic force microscope; access over wideband networks. Molecular scientists to experiment with an improved version of the room-filling molecule technology. Establish preliminary utility of force-arm technology for molecular docking and folding studies. Integrate kinetic and virtual displays to permit dissociation of visual and vestibular cues in the course of natural behavior for brain behavior research. Progress in specific basic and clinical research applications initiated in FY 1995	In FY 1994, NCRR's IITA program activity was split into two components--NCRR Modeling/Simulation and Virtual Reality/Environments. All items have been incorporated into the appropriate component.

NIH	NCRR HPCC Training	Budget Code:	

NCRR provides training in high performance computing mainly through its research resource centers that focus on the use of this technology. This training, which is generally integrated with the research and development activities of the resource centers, can involve undergraduate and graduate students, postdoctoral fellows, and established scientists from within and outside of the host institution. The primary focus of this training is to introduce biomedical scientists to high performance computing, make them aware of how to use available software tools for biomedical research, and instruct them on how to access high performance computer resources from their laboratories over the internet. NCRR plans to expand BRHR efforts to include science education and computer literacy programs for K-12 students and formal training programs for biomedical scientists.

Budget (BA, $ M)	
FY 94 Actual	2.30
FY 95 Pres.	5.00
FY 95 Est.	1.40
FY 96 Rqst.	3.50

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Provided hands-on training to scores of biomedical scientists at over 20 NCRR research resource centers working on a variety of research topics ranging from molecular dynamics to whole organ simulations. Held training workshops on Nucleic Acid and Protein Sequence, Computational X-Ray Crystallography, Heterogeneous Supercomputing Techniques, and Biomechanics Research. Solicitations received for science education and high performance computing projects.	Continue hands-on NCRR training programs. Fund one science education project from FY 1994. Train K-12 teachers to use interactive learning tools--computers, electronic communication, networks and other multimedia--in classroom activities and to enhance the scientific-computer literacy of the participants.	Continue hands-on training programs. Continue science education projects. Provide NRSA awards for formalized training for biomedical scientists in the use of high performance computing; awards not limited to NCRR resource centers.	For FY 1995, NRSA training has been delayed due to lack of funds.

FY 96 Request by Component	
HPCS	
NREN	
ASTA	
IITA	
BRHR	3.50

Agency Ties	
ARPA	
NSF	
DOE	
NASA	
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

NIH	DCRT High Performance Biomedical Computing Program	Budget Code:	

The goal of the Division of Computer Research and Technology (DCRT) High Performance Biomedical Computing Program is to make available to the NIH staff the benefits of high performance computing and communication systems in their scientific and clinical research efforts. To achieve this goal, DCRT determines which high performance parallel architectures are best for the classes of problems that arise in biomedical computing, develops parallel algorithms and computational techniques for advanced biomedical computing problems, and provides a high performance distributed computing environment that benefits the NIH staff in their scientific computing needs including the appropriate network and workstation technologies.

DCRT is developing methods and algorithms for a number of biomedical applications that can benefit from computational speedup including image processing of electron micrographs, protein and nucleic acid sequence analysis, nuclear magnetic resonance spectroscopy, x-ray crystallography, protein folding prediction, quantum chemical methods, molecular dynamics simulations, human genetic linkage analysis, medical imaging and radiation treatment planning.

Budget (BA, $ M)	
FY 94 Actual	8.40
FY 95 Pres.	11.00
FY 95 Est.	8.90
FY 96 Rqst.	8.90

FY 96 Request by Component	
HPCS	3.30
NREN	0.80
ASTA	3.30
IITA	1.50
BRHR	

Agency Ties	
ARPA	Partner
NSF	
DOE	
NASA	Partner
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Initiated the acquisition of a massively parallel computer system capable of providing 10-20 GigaFLOPS for biomedical applications. Continued developing parallel methods and algorithms for a variety of biomedical applications. Completed parallel methods for homology searching in large protein and nucleic acid sequence databases. Initiated the implementation of a distributed computing environment for radiation treatment planning containing a prototype high-speed ATM network, workstations for image display, and a shared high performance parallel computer for three-dimensional dose calculations. Investigated the implementation of high-speed network connections to other high performance computer centers in the Washington, D.C. metropolitan area.	Deploy and evaluate a massively parallel computer system capable of providing 10-20 GigaFLOPS for biomedical applications. Continue developing parallel methods and algorithms for a variety of biomedical applications. Develop new parallel computing methods for reconstructing Positron Emission Tomography (PET) images. Continue with the implementation of a distributed computing environment for radiation treatment planning including a prototype high-speed ATM network, workstations for image display, and a shared high performance parallel computer for three-dimensional dose calculations. Implement high-speed network connections to other high performance computer centers in the Washington, D.C. metropolitan area.	Continue to expand the massively parallel computer system initially deployed in FY 1995 and apply high performance parallel computing and communication methods to biomedical applications at NIH. Demonstrate a scalable parallel method for predicting the three- dimensional structure of proteins from their amino acid sequence. Develop a parallel software tools for NMR Spectroscopy and X-ray Crystallography. Continue to develop ATM network, multimedia workstation, and parallel computing technologies for medical imaging.	

NIH	NCI Frederick Biomedical Supercomputing Center	Budget Code:	

The NCI's Frederick Biomedical Supercomputing Center (FBSC) purpose is to provide high performance computing dedicated and available to the entire biomedical scientific community to develop basic knowledge for the diagnosis, treatment, understanding and prevention of cancer and other diseases. It employs advanced techniques in a fully integrated environment of workstations, mid-level, supercomputer and massively parallel computers connected by networks.

Activities are concentrated in those areas of biomedical research computation that are too demanding to be pursued on conventional or immature computers. Primary concerns are structure determination by x-ray and magnetic resonance, structure prediction of nucleic acids and proteins, computational biochemistry and problems that arise from modern molecular biology. Genomic sequence analysis, molecular mechanics, ab initio chemistry, linkage analysis, image analysis and mathematical modeling are primary problem areas. High production algorithms are adapted to vector-multiprocessor and massively parallel systems, entirely new algorithms are developed and leading-edge computer science discoveries from the areas of computer vision, robotics, deterministic and non-deterministic, algorithms.

Budget (BA, $ M)	
FY 94 Actual	6.10
FY 95 Pres.	6.40
FY 95 Est.	5.40
FY 96 Rqst.	5.40

FY 96 Request by Component	
HPCS	0.80
NREN	0.40
ASTA	3.50
IITA	
BRHR	0.70

Agency Ties	
ARPA	
NSF	
DOE	
NASA	
NIH	
NSA	Partner
NIST	Partner
NOAA	
EPA	
ED	
AHCPR	
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Improved the productive use of conventional vector-scalar supercomputing techniques through the development of optimized versions of heavily used biomedical applications. Expanded the introduction of parallel and distributed processing by continuing to explore use of open tools such as PVM. Applied high performance, parallel computing to diverse, challenging problems of biomedical importance, such as drug development for AIDS and other virus diseases, and cancer.	Use computational and structure-based techniques to design novel inhibitors of enzymes implicated in AIDS, cancer and tuberculosis. Adapt algorithms for motif detection in genomes and molecular structures to several parallel computer architectures. Implement client server technology to improve the system- investigator in interfaces.	Continue to attract important areas of research for the application of high performance computing to health-related basic research. Expand activities in use of distributed, heterogeneous computing for problems such as molecular mechanical calculations. Provide expanded scalable computing such as workstation farms, and distributed batch computing queues for rapid throughput of smaller tasks. Evaluate the advanced computational hardware and software available for productive, forefront application, especially those architectures showing promise of proven balanced performance in a research production environment.	

NIH	NCI High speed networking and distributed conferencing	Budget Code:	

Improve access methodologies for diverse members of the biomedical research community to the entire computational infrastructure of the NCI's Frederick Biomedical Supercomputing Center (FBSC) by improving the data communications and networking infrastructure through the implementation of evolving networking technologies and high speed interfaces.

Initiatives in this area cover a wide variety of data communications technologies including local area networking, wide area networking, requirements for multimedia data transmission, dedicated specialized high speed interfaces for local computer to computer connections (e.g. high speed crossbar switches, HIPPI, fiber channel, etc.), and the use of evolving data communications standards such as ATM and SONET.

Budget (BA, $ M)	
FY 94 Actual	
FY 95 Pres.	2.00
FY 95 Est.	1.70
FY 96 Rqst.	1.70

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Evaluated published and unpublished reports on use of high performance networking for local high speed interconnection. Tested original in-house methodology, public domain software and commercial products for client/server interfaces to image analysis and conferencing. Sought collaborators in remote sites for visual and computational analysis of biomedical research images.	Acquire and deploy high speed interconnects for the major components of the FBSC. Establish connections to other laboratories of the NIH and biomedical community for high speed data communication. Refine and develop software for access to experimental and computational data from world-wide sources.	Bring demonstrated capabilities in high performance computing to health research organizations of the public and private sector in open and efficient manner. Develop and expand high speed links between remote sites for access of the intramural and extramural biomedical research community for video and data conferencing, distributed collaborations and distributed database and computing.	

FY 96 Request by Component

HPCS	
NREN	0.50
ASTA	0.40
IITA	0.70
BRHR	0.10

Agency Ties

ARPA	
NSF	
DOE	
NASA	
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

NIH	NCI High Perf. Comms for PDQ, CancerNet, and Electronic Publishing	Budget Code:	

CancerFax and CancerNet are free services that allow users to access data from NCI databases. CancerFax allows users to dial into one of ICIC's computers from a fax machine and retrieve a faxed image of any of the Physician Data Query (PDQ) statements on cancer screening, prevention, treatment, or supportive care in English or Spanish, current CANCERLIT searches on over 60 topics, and over 100Fact Sheets from NCI's Office of Cancer Communications. CancerNet is a free e-mail service on the Internet, enabling users to obtain free access to the same information in CancerFax. Additional cancer information is being added to CancerFax and CancerNet, and utilization is increasing rapidly. Approximately 30% of CancerNet requests originate outside the U.S. This information is also available and highly used on Gopher servers at NIH, Tokyo, Japan, and Singapore.

ICIC strategic plans call for emphasis on the creation of multi-media in formation products to take advantage of technology advances and R&D in the areas of communications and personal multi-media/computing devices.

Budget (BA, $ M)	
FY 94 Actual	
FY 95 Pres.	0.60
FY 95 Est.	0.60
FY 96 Rqst.	0.60

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
ICIC made entire PDQ database accessible over Internet as part of its new Information Associates Program. Prototype for delivering interactive multi-media products was developed using the World Wide Web. Distribution of cervical cancer CD-I through Information Associates Program am was begun.	Begin to develop a series of digital information products that contain integrated text, graphics, sound, and full motion video over the Internet using the World Wide Web. Begin to develop the use of these complex data types in the ICIC information product. This will permit NCI to distribute multi-media products: PDQ, the Journal of the National Cancer Institute; the Journal of the National Cancer Institute Monographs; OCC educational booklets, and other special reports from the NCI using full multi-media capabilities. Script peer review and programming for CD-I on breast cancer screening a and treatment options will be completed and CD-I prepared for distribution. Begin facilitating electronic CancerNet delivery to community networks.	Continue to develop multi-media informational products for distribution via the Internet: Build a reliable network of sources for multimedia such as medical images, patient oriented videos, etc., and develop the ability to create these materials where not already available. Develop an infrastructure to maintain these media and to disseminate multimedia enhanced cancer information. Explore the dissemination of this information using cable TV and telephone lines. Continue working with community networks to utilize ICIC's electronic information products.	

FY 96 Request by Component

HPCS	
NREN	
ASTA	
IITA	0.60
BRHR	

Agency Ties

ARPA	
NSF	
DOE	
NASA	
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

NIH	National Coordination Office	Budget Code:	

The National Coordination Office for High Performance Computing and Communications was formed in 1992 to coordinate the Federal agencies participating in the HPCC Program authorized by the HPC Act of 1991, a bill written by then- Senator Al Gore. This program activity is for the operation of the NCO.

Activities are funded by participating agencies; the Director and staff are provided by the National Library of Medicine, National Institutes of Health. Personnel on assignment have been supported by the DOE, NASA; some equipment has been loaned by ARPA. The Director of NCO also chairs the HPCCIT Subcommittee of the Committee on Information Communications R&D, which is one of the nine committees of the National Science and Technology Council.

Budget (BA, $ M)	
FY 94 Actual	0.53
FY 95 Pres.	0.80
FY 95 Est.	0.92
FY 96 Rqst.	0.92

FY 96 Request by Component	
HPCS	
NREN	
ASTA	
IITA	
BRHR	0.92

Agency Ties	
ARPA	Partner
NSF	Partner
DOE	Partner
NASA	Partner
NIH	Partner
NSA	Partner
NIST	Partner
NOAA	Partner
EPA	Partner
ED	Partner
AHCPR	Partner
VA	Partner

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Publications: `High Performance Computing & Communications: Toward a National Information Infrastructure, 1994,` known as the `Blue Book;` `High Performance Computing and Communications: Technology for the National Information Infrastructure` as a Supplement to the President's Fiscal Year 1995 Budget; `FY 1995 Implementation Plan` for nine Federal HPCC agencies, including detailed program descriptions and budget details; `Information Infrastructure Technology and Applications;` `HPCC Program Successes;` a series of Fact sheets on various HPCC programs, such as Gigabit testbeds, Health Care, Digital Libraries. Produced a video detailing HPCC aspects of the National Challenge program, to complement a previous HPCC video on the Grand Challenges. Organized a meeting of major mass storage vendors for the HPCC community; Organized HPCC Booth at Supercomputing `93 in Portland, OR.	Publish the FY 96 Blue Book and the FY 96 Implementation Plan, this time including 12 HPCC Federal agencies. Publish the CIC Strategic Implementation Plan for NSTC. Produce a new video for the HPCC program. Publish a booklet of information on the mass storage meeting. Participate in the Pasadena II workshop on software tools. Organize the HPCC Booth at Supercomputing `94 in Washington, D.C.	Continue to publish documents relevant to the multi-agency HPCC Program. Continue to hold workshops, nondisclosure briefings, and open meetings on topics relevant to the HPCC Program. Organize a Booth at Supercomputing `95 in San Diego, CA and participate in the Teraflop Demonstration.	

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 the Supercomputing Research Center (SRC), a division of the Institute for Defense Analyses (an FFRDC), to do most of this research.

Program Activity	Budget Account Code	Partner/User Agencies	Budget (BA, $ M)				HPCC Components by 1996 Agency Rqst.				
			FY 94 Actual	FY 95 Pres.	FY 95 Est.	FY 96 Rqst.	HPCS	NREN	ASTA	IITA	BRHR
Supercomputing Research		ARPA, NASA, NIH	26.32	25.90	25.90	27.40	14.80		12.40		0.20
Superconducting Research		NASA	2.50	2.00	2.00	2.00	2.00				
Very High Speed Networking		ARPA	3.00	3.50	3.50	3.00		3.00			
Secure Operating System Development		NIST	5.50	5.70	5.70	4.70		4.70			
High Speed Data Protection Electronics		ARPA, NASA	2.70	2.60	2.60	2.70		2.70			
Technology Based Training			0.23	0.23	0.23	0.23				0.23	
		Totals:	40.25	39.93	39.93	40.03	16.80	10.40	12.40	0.23	0.20

NSA	Supercomputing Research	Budget Code:	

NSA has a perennial requirement for the highest performance computing technology in order to perform its mission, the national security "Grand Challenge." The Supercomputing Research Program is directed to the discovery and application of methods seeking order of magnitude improvements in the computer support required for deriving intelligence from mathematical and signal processing problems. Activities range from invention and prototyping of new concepts, to improvement in the ability to use leading edge commercial products. A current focus of the research is on parallelism, the ability to apply many processing elements simultaneously to a single problem.

The following projects are included within the Supercomputing Research Program:

PIM -- Processor in Memory;

CARNOT -- Project to develop heterogeneous data repository software;

SPLASH -- A field programmable gate array-based architecture;

Distributed Processing -- A `farm` of workstation-class systems with very high speed interfaces and switches;

CONDOR and RES -- Distributed operating systems;

Parallel language work -- AC (for CM-5, T3D), dbC (for clusters, MASPAR, SPLASH); implementation of `futures` model of message-passing programming;

Super Massively Parallel Processor -- A `next generation` machine that combines the general purpose vector parallel architecture of the CRAY-3 with .5 million single-bit processors, creating a very high performance massively parallel/vector parallel system.

Budget (BA, $ M)	
FY 94 Actual	26.32
FY 95 Pres.	25.90
FY 95 Est.	25.90
FY 96 Rqst.	27.40

FY 96 Request by Component	
HPCS	14.80
NREN	
ASTA	12.40
IITA	
BRHR	0.20

Agency Ties	
ARPA	Partner
NSF	
DOE	
NASA	Partner
NIH	User
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Terasys system developed and deployed with applications in image processing, computational physics, and fingerprint recognition. Began PIM chip development and manufacture. Began the PIM software development and simulation. Completed the assembly and test of the Cray-3 processors and regular memory. Began assembly and test of the PIM module prototype. Produced 5 demonstration CARNOT prototypes. Completed SPLASH development, deployed, and started commercialization. Demonstrated limited 2-D modulator and smart detector. C-based compilers developed for 6 systems. Extended Condor from workstation clusters to more general environments. Explorations of possibilities for delay-line optics based computing, and distributed storage models of computation, led to designs for specific devices of interest.	Demo Distributed Processing concept. Produce a prototype of a large-scale PIM-based system integrated into a commercial high performance vector computer. Complete the operating system. Begin system-level testing and begin making the system available to other users. Explore the use of massively parallel systems on large knowledge-based management applications with inferencing capabilities. Evaluate early parallel processing systems with other HPCC agencies and industry. Identify and develop two prototype CARNOT applications accessing operational databases. Complete SPLASH commercialization. Develop tools and standards to support the open systems concept. Conduct studies of strategies to manage extremely large data files and very high transfer data rates among many different systems.	Complete the testing of the Super Massively Parallel Processor Computer System. Make the system available to, and promote interest with, other users. Transfer technology for distributed processing to industry for commercialization. Integrate 64x64 spatial light modulator and photosensitive smart detector components into a prototype system that will serve to retire the technical risk associated with a full capability system.	Spatial light modulator and photosensitive smart detector demonstrated earlier than expected.

NSA	Superconducting Research	Budget Code:	

The program in superconducting electronics is aimed at providing high performance computing alternatives to current silicon and gallium arsenide technologies, which have speed and power limitations. Prior research suggests that superconducting supercomputers can deliver very high performance with very low power requirements. NSA would like to cooperate with industry to develop such a computer.

Budget (BA, $ M)	
FY 94 Actual	2.50
FY 95 Pres.	2.00
FY 95 Est.	2.00
FY 96 Rqst.	2.00

FY 96 Request by Component	
HPCS	2.00
NREN	
ASTA	
IITA	
BRHR	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Developed a prototype superconducting crossbar system.	Test functionality of prototype superconducting crossbar system. Develop and demonstrate packaging, cooling and interfaces for superconducting electronics technology which could be applied to commercial supercomputers in the future.	Demonstrate fully functional crossbar switch using commercially available Multi-Chip Modules (MCM) and commercially available refrigeration. Initiate feasibility study of building a general purpose computer using superconducting technology.	Delay Feasibility Study until FY 96. Delay initiating design of a superconducting supercomputer.

Agency Ties	
ARPA	
NSF	
DOE	
NASA	Partner
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

NSA	Very High Speed Networking	Budget Code:	

The National Security Agency has a perennial requirement for the fastest networking technology in order to perform its mission, the national security `Grand Challenge.` The Very High Speed Networking Program will provide NSA a high performance network infrastructure characterized by both multi-gigabit per second trunking speeds and the ability to support sustained data flows of at least hundreds of megabits per second each now, and ultimately, multi-gigabits per second each.

Budget (BA, $ M)	
FY 94 Actual	3.00
FY 95 Pres.	3.50
FY 95 Est.	3.50
FY 96 Rqst.	3.00

FY 96 Request by Component	
HPCS	
NREN	3.00
ASTA	
IITA	
BRHR	

Agency Ties	
ARPA	Partner
NSF	
DOE	
NASA	
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Installed a Gb/s electronic switched network testbed to explore compatibility of DoD private networks with commercial public networks. Collaborated with industry on the development of high-speed (electronic and optical) prototype switching equipment. Integrated prototype optical crossbar switch (capable of supporting up to 1.6 Gb/s) with in band network control. Initiated soliton research to explore application to high-speed networks (100 Gb/s aggregate) by developing soliton source and logic gates. Collaborated with industry on the development of operation, administration and management protocols for optically switched networks. Collaborated with industry and standards community (e.g., IETF, ATM Forum) on interoperational incompatibilities discovered between IP and ATM.	Install an in-house optical crossbar network testbed to explore high-speed optical network architectures and optical network management techniques. Install in-house ATM/SONET testbed equipment and begin experimentation on sustained data flows at hundreds of megabits per second. Initiate development of wave division optical switching and multiplexing devices to support Gb/s data rates. Conduct soliton research to explore application to high-speed networks by developing soliton source and logic gates. Continue collaboration with industry on the development of high-speed (electronic and optical) prototype switching equipment. Continue collaboration with industry on the development of operation, administration and management protocols for optically switched networks.	Demonstrate electronic switching of individual data flows at 2.4 Gb/s data streams. Continue the development of optical switching and wave division multiplexing devices to support up to 10 Gb/s data rates. Integrate and experiment with out of band network control in optical crossbar network. Begin preparations for WDM on testbed for exploring compatibilities of DoD private network with commercial public network, which will begin to show transition path from ATM/SONET cell switching to wave division switching and wave conversion network. Continue soliton research to explore application to high-speed networks by developing soliton source and logic gates. Continue collaboration with industry on the development of high-speed (electronic and optical) prototype switching equipment. Continue collaboration with industry	Delayed the installation of an in-house Gb/s network testbed to explore high-speed network architectures and network management techniques to FY95. Demonstration of electronic switching of individual data flows at 2.4 Gb/s data streams will be done in FY 96 vice FY 95. Initiated optical crossbar switching in FY 94 vice FY 95. Initiated soliton research to explore application to high-speed networks by developing soliton source and logic gates in FY 94 vice FY 95.

NSA	Secure Operating System Development	Budget Code:	

NSA is responsible for researching solutions to ensure the security of the nation's networks and distributed systems. In collaboration with NIST and DISA, NSA is identifying issues and researching security policy-flexible, cost- effective ways to ensure the security of both government and commercial enterprise systems. The Synergy research program at NSA is developing an `open architecture` along with secure distributed system prototypes based upon security policy-flexible, operating system microkernels. Synergy will provide a means for commercial vendors to address a wide variety of security markets with a single architecture, thus lowering everyone's costs. Synergy can be the foundation on which security solutions for major initiatives can be built, whether addressing government-peculiar needs or commercial-enterprise needs, from the Defense Department Global Grid to the National Information Infrastructure. Synergy will integrate the INFOSEC research work in computer misuse and anomaly detection (audit/intrusion detection), real-time and multimedia, availability, network security management, high speed networking, and secure database management systems.

Budget (BA, $ M)	
FY 94 Actual	5.50
FY 95 Pres.	5.70
FY 95 Est.	5.70
FY 96 Rqst.	4.70

FY 96 Request by Component	
HPCS	
NREN	4.70
ASTA	
IITA	
BRHR	

Agency Ties	
ARPA	
NSF	
DOE	
NASA	
NIH	
NSA	
NIST	Partner
NOAA	
EPA	
ED	
AHCPR	
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Established contracts and CRADAs with major commercial vendors and began to implement Synergy architecture on their microkernels to examine portability, performance, security policy flexibility issues. Prototyped Synergy security policy flexible file and network servers. Began experiment to run Synergy-based architecture over ATM high-speed network. Began integration of network management concepts to manage Synergy-based security components. Initiated 10 research contracts with universities to advance Synergy research and generate new ideas. Demonstrated Synergy prototype architecture's flexibility and applicability to commercial or NII applications.	Release Synergy proof of concept software to universities, commercial research labs, and secure system vendors. Continue university research program to advance Synergy arch. Fund 1-3 universities to develop course in secure distributed systems and perform Synergy research. Initiate internal and external research efforts to mitigate the risks and costs associated with high assurance product implementations of the Synergy architecture. Develop a centralized security management tool to be integrated with Synergy on a high-speed testbed. Establish a collaborative relationship via CRADA or contract with one or more commercial operating system vendors or consortia, to begin implementing the Synergy architecture in a commercial distributed system.	Second public release of Synergy software and initial evaluation documentation and experience, to encourage modular system design and evaluation. Continue research on Synergy architecture to improve security, assurance, performance, availability, and portability in distributed and real-time operating environments. Demonstrate and make available higher assured versions of security managers and Synergy components. Continue university research contracts, and ensure successful technology transfer of research results into Synergy architecture development efforts. Continue collaboration with commercial vendors to encourage the development of Synergy-based systems that can satisfy commercial enterprise security requirements and those of DoD and the government.	

NSA	High Speed Data Protection Electronics	Budget Code:	

Network data security is a requirement throughout the National community, from the financial community through the medical community to a wide range of research activities. NSA will take the lead in developing network security and information security techniques and products for high speed networks. It will establish high speed network testbeds to explore network security issues. Many of the research efforts have moved from protection of network trunks to protection of high speed individualized computer links. The focus of this effort is to develop a technology that will interface to network management systems that can be used with the high speed networks that are exemplified by the National Security Community and the NREN.

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Designed, fabricated, and tested ICs with complexities ranging from simple test structures to large scale integration (1,000 to 100,000 gates per chip). Developed the basic system design needed to secure networks at 622 Mb/s with extensibility to 2.4 Gb/s and developed test structures in areas determined to be high risk. Continued research in bulk and integrated optical technologies. Developed small arrays of smart pixels. Developed the optical interconnection system needed to route optical signals between smart pixel array planes.	Extend the density and IC complexity to very large scale integration levels of 100,000 to 1,000,000 gates. Develop the detailed design for secure communication applied to ATM (622 Mb/s system) including the design of all custom ICs needed. The first fabrication and testing of the system ICs will also take place. Begin development of a prototype 2.4 Gb/s front end processor for a high speed data encryption unit. Develop and demonstrate a 3 Gb/s optical interconnection system.	Revise the detailed design of the 622 Mb/s systems based upon the actual IC performance as previously tested. Fabrication, assembly, and testing will then take place. Develop larger arrays of smart pixels for a second generation demonstration with an order of magnitude increase.	

Budget (BA, $ M)	
FY 94 Actual	2.70
FY 95 Pres.	2.60
FY 95 Est.	2.60
FY 96 Rqst.	2.70

FY 96 Request by Component	
HPCS	
NREN	2.70
ASTA	
IITA	
BRHR	

Agency Ties	
ARPA	Partner
NSF	
DOE	
NASA	Partner
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

NSA	Technology Based Training	Budget Code:	

NSA considers lifelong access to education and training for all employees to be highly crucial in order to maintain and enhance their skills. NSA must ensure its viability in a world of rapidly changing technology. Traditional training approaches take too long and are too expensive. Consequently, NSA is developing a skill-based assessment and training model that will use emerging communications and computer techniques to sustain each employee's abilities at the levels required in today's constantly changing workplace. The key ingredient in this approach will be on-demand access to Technology Based Training (TBT) of known quality and relevance delivered directly to the workplace. Delivery over corporate LANs and the Internet, and the possible use of ISDN technology, will be addressed. Although initial offerings would consist largely of text-based TBT courseware, digital video and other media will be accommodated as they become available.

Placing existing TBT courseware on the network is something that can be accomplished quickly, but there are various conceptual, technical and procedural issues that must be addressed before it can be made generally accessible. Foremost among these issues are:

1 -- Definition of the skills needed to perform specific jobs and a process for certifying the efficacy of training modules that address those skills;
2 -- Storage, access, and maintenance of large numbers of TBT courses;
3 -- Cataloging of available courseware in a manner that minimizes the difficulty of identifying suitable courses or training modules;
4 -- Identifying and resolving the interoperability problems in delivering TBT courses over a network to a wide variety of computer terminals;
5 -- Defining and selecting appropriate user interfaces (special effort will be focused on interfaces for home-computer configurations);
6 -- Developing an EDI-based business model bringing market forces to bear on the availability and costs of Technology Based Training.

Budget (BA, $ M)	
FY 94 Actual	0.23
FY 95 Pres.	0.23
FY 95 Est.	0.23
FY 96 Rqst.	0.23

FY 96 Request by Component

HPCS	
NREN	
ASTA	
IITA	0.23
BRHR	

Agency Ties

ARPA	
NSF	
DOE	
NASA	
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Implemented pilot demonstration of TBT over the NSA corporate network Demonstrated delivery of TBT over Internet. Researched and selected a skill-based job performance model. Assembled executive-level government and industry group to establish certification processes for skill-based training modules	Perform skill-based certification of approximately 100 existing training modules. Build user-friendly catalog of available certified courses. Establish `digital warehouses` of TBT on-line via Internet and the NSA corporate network. Implement pilot of EDI-based business model.	Evaluate, modify, and extend EDI Pilot business model for online training modules. Establish effectiveness of automated skill-assessment tools for self evaluation. Design and pilot Individual Development Plan database and management software. Design methodology to automatically match available on-line training modules to self-assessed skill training needs.	

National Institute of Standards and Technology

Goals of NIST's Program are:

* Apply 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;
* Promote the development and deployment of advanced information and communications technology to support the education, research and manufacturing communities and to increase the availability of scientific and engineering data via the NII;
* Advance performance measurement methodologies and analytic tools for high performance computing and networking systems, system components, and human-machine interfaces; and to achieve improved system and application program performance;
* Develop efficient algorithms and portable, scalable software for the application of high performance computing systems to industrial problems, and to develop improved methods for the public dissemination of advanced software and documentation; and
* Support, promote, and coordinate the development of voluntary standards that provide interoperability and common user interfaces within the NII, and increase industrial competitiveness.

Objectives of NIST's Program are to accelerate the development and deployment of high performance computing and networking technologies and services required for the National Information Infrastructure, and to apply and test these technologies in a manufacturing environment.

NIST supports and coordinates the development of standards within the Federal government to provide interoperability, common user interfaces to systems, and enhanced security. NIST works with other agencies to promote open system standards and to aid in the commercialization of technology by U.S. industry. NIST promotes the development of communications infrastructure and through information technology research, development, and related activities to enhance basic communications capabilities. Supporting activities include metrology to assess network components for performance, interoperability and conformity; and collaboration with industry via cooperative research and development, sponsorship of workshops, other public fora, and laboratory-based technology demonstrations. NIST develops instrumentation and methodology for performance measurement of scalable, high performance computing and networking systems. Emphasis of the performance measurement component is on the development and use of low perturbation data capture hardware and simplified software-based approaches to performance characterization of these systems and software components.

NIST uses its experience in information technology and manufacturing engineering to accelerate the application of high performance computing and communication technology to manufacturing environments. NIST supports expanded programs in: advanced manufacturing systems integration technologies; development and test of prototype components and interface specifications for manufacturing systems; application of high performance computing and networking technologies to integrate the design and production processes; and testbeds for achieving cost-effective application of advanced manufacturing systems and networks. NIST also addresses key issues in electronic commerce, electronic libraries, and network security. NIST develops algorithms and generic software for advanced scientific, engineering and manufacturing applications. Common elements and techniques are encapsulated in software libraries to promote ease of use and application portability. NIST's Guide to Available Mathematical Software (GAMS) provides industry and the public with improved electronic access to reusable software.

Note: Program elements proposed in FY 1995 for metrology related to microelectronics and communications networks, and for the assurance and integrity of NREN objects did not receive funding under this program; other program elements were combined.

National Institute of Standards and Technology

Program Activity	Budget Account Code	Partner/User Agencies	Budget (BA, $ M)				HPCC Components by 1996 Agency Req.				
			FY 94 Actual	FY 95 Pres.	FY 95 Est.	FY 96 Rqst.	HPCS	NREN	ASTA	IITA	BRHR
Development and Dissemination of Scientific Software for HPCS	STRS for Computer Systems	NSF, DOE, NASA	3.60	7.60	3.60	3.60			3.60		
Networking & Information Infrastructure Services	STRS for Computer Systems	ARPA, DOE, VA ...	2.20	6.20	4.20	12.30		2.20		10.10	
Metrology for Human-Machine Interfaces & Scalable HPCS	STRS for Computer Systems	ARPA, NSA, NIH, ...	1.50	4.00	2.00	2.00				2.00	
Systems Integration for Manufacturing Applications	STRS for Computer Systems	ARPA, DOE	9.00	25.20	11.36	12.26				12.26	
Electronic Commerce and Digital Libraries	STRS for Computer Systems	ARPA, DOE, NASA	1.80	4.00	3.94	3.94				3.94	
		Totals:	18.10	47.00	25.10	34.10		2.20	3.60	28.30	

NIST	Development and Dissemination of Scientific Software for HPCS	Budget Code:	STRS for Computer Systems

This program activity focuses on the development of advanced mathematical, computational and visualization algorithms, software, methodology and tools which support the efficient application of computationally intensive science to key problems arising in the industrial sector. Current application areas of emphasis include the development of improved methods for computational chemistry and related advanced materials processing industries which are important for advanced product and process design and computationally derived fundamental data for environmentally sound competitive manufacturing processes. Technology areas of emphasis include the interactive visualization of complex structures and data, large-scale ab initio computational chemistry, Monte Carlo and molecular dynamics modeling and scientific database utilization. Includes the development of efficient, robust and flexible templates, class libraries and components for basic mathematical computation, such as the solution of large linear systems, which provide a foundation for applications such as these.

This program activity also supports the development of modern, network-based reusable software classification and distribution technology for making new computational software readily available to industry and the public. The focus of this activity is the Guide to Available Mathematical Software (GAMS) project. GAMS is a working cross index and virtual repository which provides users transparent access to thousands of reusable software modules accessible from a variety of network-accessible repositories.

Budget (BA, $ M)	
FY 94 Actual	3.60
FY 95 Pres.	7.60
FY 95 Est.	3.60
FY 96 Rqst.	3.60

FY 96 Request by Component	
HPCS	
NREN	
ASTA	3.60
IITA	
BRHR	

Agency Ties	
ARPA	
NSF	Partner
DOE	Partner
NASA	Partner
NIH	
NSA	
NIST	
NOAA	
EPA	User
ED	
AHCPR	
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Implemented and online with a client/server version of GAMS and a gateway to the World Wide Web (http://gams.nist.gov). More than 30,000 users and 300,000 transactions in first 9 months. Active links with National High Performance Software Exchange. Parallel quantum chemistry codes implemented with effective fragment potentials for describing molecular environmental perturbations. Initial parallel cooperative algorithms implemented for protein folding prediction from amino acid sequence. A scalable algorithm was developed and implementation initiated for computing spin-dependent electron transport properties of layered structures used in magnetic storage devices.	Develop and implement methods for applying quantum chemistry to the prediction of properties and reactivities of solvated systems, including the introduction of discreet and continuum solvent representations into modern quantum chemistry codes and the use of molecular dynamics and Monte Carlo methods to explore the energetics of solvent/solute clusters. Develop scalable quantum molecular dynamics software for modeling growth of metal films on semiconductor surfaces, and apply to optimizing the performance of x-ray multilayer mirrors. Demonstrate a reliable and useful GAMS service for the discovery and access of reusable math software; investigate alternate search and browsing mechanisms; develop and evaluate algorithms and design technologies for portability and performance improvements on scalable systems for linear algebra.	Develop algorithms for molecular dynamic and Monte Carlo simulation of cluster growth and deposition processes. Develop scalable algorithms for treatment of dissipative quantum systems and apply to the simulation of optical manipulation and confinement of atoms -- atom optics. Continue to provide a reliable and useful GAMS service, implement improved search and browsing mechanisms appropriate for software selection, and expand the variety of information on algorithms and software available from GAMS servers. Utilize modern software design technologies to implement portable and reliable mathematical software for common linear algebraic computations which provide significant performance improvements on scalable computing architectures.	Linear algebra portion of the program is being accelerated. Work planned for FY96 will begin this year.

NIST	Networking & Information Infrastructure Services	Budget Code:	STRS for Computer Systems

Under this program element, NIST collaborates with industry and other agencies to support development of standards to provide interoperablility, common user interfaces and enhanced security for computer and communications systems; and promotes the specification, development, testing and deployment of communications protocols and services within the National Information Infrastructure (NII). NIST conducts research and development in support of developing standards and services. NIST collaborates with industry and academia to conduct R&D, evaluate and apply methods to specify, verify, and test for conformity and interoperability of high-integrity, distributed systems, including formal description techniques, object oriented, computer aided design and analysis, and software engineering methodologies. NIST supports and contributes to the development of test methods and test suites for assessing conformity of products to standards and interoperation with other products; develops prototype implementations; establishes testbeds and supports technology demonstrations; hosts workshops and open fora to promote open standards and to aid in the commercialization and deployment of information technology by U.S. Industry. Examples of specific technologies and protocols which fall under this program element include networking protocols such as: Asynchronous Transfer Mode (ATM) and Broadband-Integrated Services Distributed Network (B- ISDN); routing and network management protocols; electronic mail; security protocols and technologies; data interchange, management and compression technologies; and their use in support of application programs.

Budget (BA, $ M)	
FY 94 Actual	2.20
FY 95 Pres.	6.20
FY 95 Est.	4.20
FY 96 Rqst.	12.30

FY 96 Request by Component	
HPCS	
NREN	2.20
ASTA	
IITA	10.10
BRHR	

Agency Ties	
ARPA	Partner
NSF	Partner
DOE	Partner
NASA	User
NIH	User
NSA	Partner
NIST	
NOAA	User
EPA	User
ED	User
AHCPR	User
VA	Partner

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Applied NIST's Multikron-based performance measurement instrumentation to Asynchronous Transfer Mode (ATM) based networks to identify bottlenecks and published results. Conducted simulation studies of ATM-based protocols and networks to ascertain dynamic behaviors and performance; identified 26 different design issues/flaws and contributed the results to appropriate standards bodies including the ATM Forum, Am. Nat. Standards Telecommunications Committee (T1S1), and the International Telecommunications Union, Telecom Sector Committee. Sponsored the N. American ISDN User's Forum, the OSE Workshop and other workshops/fora; facilitated the demonstration entitled: `ISDN Solutions -94-.`	Establish an interoperability testing program including laboratory facilities for Internet security technologies (e.g., firewalls, authentication mechanisms), IPv.6, network management and NII Services. Collaborate with the ATM Forum and industry to develop standardized conformity tests for ATM-based technology; conduct experiments and tests of evolving products. Conduct R&D related to media access and flow control for ATM protocols; and congestion control algorithm. Publish results and share in appropriate standards fora. Assess the security requirements and vulnerabilities of emerging wireless technologies. Initiate R&D to assess performance and establish benchmarks for wireless communications technologies.	Extend collaboration with industry and users on bitway and NII services testbed; conduct experiments and tests with evolving products. Extend R&D related to the reliability of ATM-based networks, especially in the area of optoelectronics. Initiate R&D related to passive optical, non-ATM networks. Initiate R&D related to coding and compression, and related testing technologies for wireless networks. Establish laboratory facilities to conduct R&D and assess candidate technologies which support formal specification, automated testing and integrated software engineering. Collaborate with industry and standards bodies to support the specification, development, validation and testing of standards and interoperation of conforming products.	Note: this element reflects the integration of two elements from the FY 95 plan: "NREN Deployment and Performance Measures for Gigabit Networks & MPP Sys." and "Specification and Testing of High Integrity Distributed Systems."

NIST	Metrology for Human-Machine Interfaces & Scalable HPCS	Budget Code:	STRS for Computer Systems

Under this program element, NIST promotes the research, development and application of measurement sciences to assess the performance of human-machine interface technologies, and to assess the performance of high-performance computing and communications systems. NIST conducts and promotes collaborative research and development of algorithms, recognition methods, and reference materials to assist industrial and academic researchers commercialize R&D in spoken natural language recognition, image recognition including printed or cursive handwritten text, and text search and information retrieval. NIST collaborates by developing and providing corpora of reference materials for speech and image recognition, and for text search and retrieval; and by developing related scoring protocols which use the reference materials in assessing performance of systems implementing these human-machine interface technologies.

This program element also focuses on instrumentation and methods for measuring performance of scalable, high performance systems, and identification of performance bottlenecks in systems and software. Emphasis is on the research, development and application of low perturbation, hardware-based instrumentation and simplified, statistical-based methods and software for performance characterization of both hardware and software components of scalable computer and communications systems; and developing easy- to-use software to analyze data and to present results.

Budget (BA, $ M)	
FY 94 Actual	1.50
FY 95 Pres.	4.00
FY 95 Est.	2.00
FY 96 Rqst.	2.00

FY 96 Request by Component	
HPCS	
NREN	
ASTA	
IITA	2.00
BRHR	

Agency Ties	
ARPA	Partner
NSF	
DOE	
NASA	
NIH	Partner
NSA	Partner
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Implemented a public domain prototype of a network-based information search and retrieval service using NIST's Probabilistic Ranking Information Search Engine (PRISE). The PRISE system is a search engine that has proven effectiveness in retrieving and rank ordering retrieved information from large collections of text. Initiated R&D for optical recognition techniques to segment bitmapped page images into components (text, figures, tables, etc.). Initiated R&D on dialogue management for a spoken-language query interface to library information databases.	Develop an initial dialogue management module which will provide a spoken-language query interface to library information databases. Develop initial algorithms for understanding of documents and their component parts, and associated metrics for judging algorithm performance. Develop a reference implementation of an enhanced wide area information service with appropriate protocol extensions for probabilistic search criteria (WAIS/Z39.50 Ver. 3). Establish a demonstration library to serve manufacturing interests, incorporating robust user searching methods, and providing access to Computer Aided Logistics Standards information.	Improve, extend and publish the scoring protocols and the reference materials for the activities identified above. Improve and extend the spoken language dialogue management module for accessing library information databases; develop public domain thesaurus building software and test databases for language recognition systems. Improve and extend the software and hardware based tools for performance measurement of scalable parallel systems, and publish the results. Develop and publish specifications for an open controller architecture providing imaging, compression and communications services for manufacturing applications.	R&D initially scheduled for FY95/96 will be extended into FY97. Metrology for scalable parallel systems is coupled with applications.

NIST	Systems Integration for Manufacturing Applications	Budget Code:	STRS for Computer Systems

Emphasis is on systems integration technologies that support flexible and rapid access to information for manufacturing applications. A standards-based effort for computer integrated manufacturing focuses on improving data exchange among design, planning and production activities; and on the integration of these and related activities within a standardized Enterprise Integration Framework (EIF). The program of work addresses activities which fall within standards efforts and development of technology within industry and government. Prototype systems and interface specifications will be communicated to standards organizations. Results will be made available to US industry through workshops, training materials, electronic data repositories and pre-commercial prototype systems that can be installed by potential vendors for test and evaluation in NIST and industry supported Advanced Manufacturing Systems and Networking Testbeds. NIST will distribute standard reference data, technical information, and digital product-data designs via digital library technologies.

NIST's advanced manufacturing testbeds support R&D in high performance manufacturing systems and support testing of computing and networking hardware and software in a manufacturing environment. The testbeds will include applications in the mechanical, electronics, construction, and chemical industries; electronic commerce applications in mechanical and electronic products; apparel manufacturing; integration of performance data of materials into computer aided design; harmonization of product data exchange and electronic data interchange standards; technology transfer of information for electronics and construction industries; and an integrated Standard Reference Data system. The testbeds will serve as a demonstration site for use by industrial technology suppliers and users, and assist industry in the development and implementation of voluntary standards.

The work will support cooperative research and development agreements with industry and academic researchers.

Budget (BA, $ M)	
FY 94 Actual	9.00
FY 95 Pres.	25.20
FY 95 Est.	11.36
FY 96 Rqst.	12.26

FY 96 Request by Component	
HPCS	
NREN	
ASTA	
IITA	12.26
BRHR	

Agency Ties	
ARPA	Partner
NSF	
DOE	Partner
NASA	
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Installed and evaluated state-of-the-art manufacturing systems for design and planning of mechanical part production. Implemented a prototype application protocol development environment for product data exchange standards. Published a report on a reference architecture for manufacturing control systems and interface specifications for production systems. Provided electronic technology transfer capabilities for NIST's manufacturing projects in response to industry request for online access to research information for advanced manufacturing systems. Established an operational testbed for mechanical parts production applications. Established collaboration with other agencies and industry to leverage manufacturing developments that support systems integration.	Evaluate scheduling and production control systems for mechanical parts. Publish: requirements for a CAM engineering tools environment; a report on manufacturing systems integration needs; a reference architecture for integrating applications; and a reference model for process plan design. Demonstrate: a minimum set of conformance testing capabilities for the Standard for the Exchange of Product Data (STEP); an operational testbed for mechanical and process plant industries; an integrated set of computer based process models for design and planning of mechanical parts; a visualization laboratory for manufacturing applications; conformance testing and accreditation procedures; a common approach for information location, and dissemination of standard reference data; and mapping of design representations into other systems. Make selected standard reference data available via an improved human-machine interface.	Demonstrate: integration of design and planning applications for mechanical parts production; level two application protocol development environment for STEP; and standard architecture controlling selected manufacturing applications in an operational production facility. Publish: interface specs for a virtual construction environment. Develop measurement methods and standards for high speed electronic and optical components. Conduct a series of workshops on Enterprise Integration Frameworks (EIF) to define requirements and publish a report for implementing EIF. Establish a facility where EIF tools and products can be demonstrated and tested.	Activities initiated in FY95 and FY96 will be extended into FY97 due to reduced funding. The following activities have been deferred: Implement a manufacturing testbed with the apparel industry. Specify application protocols for apparel and electronics manufacturing. Transfer interface specifications for production control systems into industry developed testbeds for verification purposes.

NIST	Electronic Commerce and Digital Libraries	Budget Code:	STRS for Computer Systems

Collaborate with industry and other agencies to develop, integrate and apply technologies which enable electronic commerce (EC) including electronic exchange of business transactions; information query, retrieval, and dissemination; and integration of product specifications into computer aided design and manufacturing tools. Establish laboratory facilities to support demonstrations, evaluation, and inter-operation testing. Conduct R&D to support development of tools which generate software for electronic commerce applications; develop an EC integration facility at NIST; develop requirements and prototype systems for handling complex data in Electronic Data Interchange (EDI); and design and develop prototype interfaces among EDI, Structured Query Language (SQL), and Remote Database Access (RDA). Also, conduct R&D leading to development of application programming interfaces for digital signature, authentication, and other security services required to support electronic commerce. Establish cooperative R&D agreements with researchers, vendors and users to better understand requirements and to acquire, test, interconnect and demonstrate prototype systems. Collaborations will include DOE: Lawrence Livermore and Sandia National Labs; DOD: ARPA, Defense Logistics Agency, NRaD; Dept. of Treasury; and other interested agencies.

Establish an electronic library pilot project which includes the creation, editorial review, production and dissemination of scientific and engineering papers, documents, data and other published information in a working, production environment via the library and scientific and engineering operating units at NIST. Within this environment provide for the organization, search and retrieval, and dissemination of information by electronic means using state-of-the-art definition and dissemination technologies for documents and multimedia objects, particularly device-independent exchange formats for information objects. Within this context, determine the adequacy of individual multimedia and database standards and possible extensions based on the application of object technology to multimedia; develop a profile or architectural framework describing the required standards and their interrelationships; develop standards, prototypes, and demonstrations in collaboration with industry, academia and other interested parties through cooperative research and development agreements.

Budget (BA, $ M)	
FY 94 Actual	1.80
FY 95 Pres.	4.00
FY 95 Est.	3.94
FY 96 Rqst.	3.94

FY 96 Request by Component	
HPCS	
NREN	
ASTA	
IITA	3.94
BRHR	

Agency Ties	
ARPA	Partner
NSF	
DOE	Partner
NASA	Partner
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Developed an EC integration facility at NIST and 26 vendors responded to a solicitation to collaborate. Integrated SQL and RDA into a client which enables query, retrieval and update of information within distributed relational database servers over the Internet. Assessed security services needed for EC; demonstrated integrated E-mail and security using smart-card technology for public key and secret key encryption and digital signatures. Demonstrated an intelligent agent to solicit RFQs from vendor lists using WWW/Internet services and present quotes sorted by price the purchaser. Initiated: R&D to evaluate alternates to traditional paper-based authoring, publishing and information dissemination; a CRADA with Adobe to assess Acrobat/ Portable Document Format (PDF) as a document interchange format; and collaboration with several other parties interested in digital libraries.	Initiate pilot project for public key security infrastructure. Demonstrate electronic procurement and publish application guidelines for government; continue to develop and integrate security services. Extend demonstration facilities to support ad hoc query and response to trading partner databases via EDI/SQL/RDA-based standards; integrate search, retrieval, browsing and data management functions; initiate demos with regional and national network initiatives such as Smart Valley and CommerceNet. With industry, publish a draft report describing a strategy to use the Standard for the Exchange of Product Model Data (STEP) and other data interchange standards. Integrate and demonstrate the use of PDF via network-based support tools like Mosaic; establish an integration process to enable authors to create and disseminate PDF-based documents via Mosaic.	Initiate development of conversion tools for electronic data interchange standards (X.12 to EDIFACT). Complete extension of the demonstration facilities for EDI with SQL database access, version control, and configuration management of product data and PHIGS presentation of product data. Revise the draft report on strategy for use of standards for product data management and presentation to reflect industry's comments; publish the report, and with the aid of industry, implement its recommendations in the NIST demonstration facility. Integrate into a network-accessible, intuitive system interface for information access, query, selection, ordering and dissemination of items from NIST's standard reference data and standard reference materials. Identify and publish a report describing the relationships between graphics, images, sound and video objects in multimedia document development and delivery systems.	This element combines the program elements from the FY 95 plan for electronic commerce, digital libraries and distributed multi-media applications.

National Oceanic and Atmospheric Administration

NOAA's Grand Challenge research in climate prediction and weather forecasting 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. Increased use of the Internet and follow-on networks of the National Information Infrastructure will enable NOAA to disseminate its vast holdings of real-time and historical information to all users more completely, in a more usable form, and in a much more timely manner.

Program Activity	Budget Account Code	Partner/User Agencies	Budget (BA, $ M)				HPCC Components by 1996 Agency Rqst.				
			FY 94 Actual	FY 95 Pres.	FY 95 Est.	FY 96 Rqst.	HPCS	NREN	ASTA	IITA	BRHR
Advanced Computation	ORF EI	ARPA, NSF, DOE	0.00	5.20	3.20	7.40			7.40		
Networking Connectivity	ORF EI	NASA	0.95	8.70	3.20	7.50		7.50			
Information Dissemination Pilots	ORF EI					0.50				0.50	
		Totals:	0.95	13.90	6.40	15.40		7.50	7.40	0.50	

NOAA	Advanced Computation	Budget Code:	ORF EI

Advanced Computation is NOAA's program to make possible major improvement in the Nation's ability to forecast the weather and predict climate change by taking full advantage of highly parallel, high performance computing systems that, over the long term, are expected to provide substantially greater computing power at lower cost.

NOAA/GFDL's collaborative efforts with DOE/LANL and the Naval Post Graduate School have resulted in an extremely high resolution global ocean model, based largely on the GFDL Modular Ocean Model (MOM) that shows detail not yet achieved using conventional computing resources and a global atmospheric grid-point model that is important for the study of climate, middle atmosphere dynamics, and atmospheric ozone.

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

The installation of the Intel Paragon being conducted at NOAA/FSL is in conjunction with the ARPA-sponsored National Consortium for High-Performance Computing and as a part of the Boulder Front Range Consortium involving NCAR, the University of Colorado, and FSL.

NOAA Northwest Center's collaboration efforts through the Cooperative Institute for Arctic Research (CIFAR) is a cooperative government-university-industry effort in environmental research utilizing the Alaska Regional Supercomputer Center (ARSC) CRAY T3D.

Budget (BA, $ M)	
FY 94 Actual	0.00
FY 95 Pres.	5.20
FY 95 Est.	3.20
FY 96 Rqst.	7.40

FY 96 Request by Component

HPCS	
NREN	
ASTA	7.40
IITA	
BRHR	

Agency Ties

ARPA	Partner
NSF	Partner
DOE	Partner
NASA	
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Completed preparations for a competitive procurement of a high performance computing system (HPCS) with scalable capabilities (NOAA/GFDL). GFDL completed high resolution atmospheric modeling experiments using a parallel atmospheric grid model to test model sensitivity to grid resolution. Redesigned and parallelized GFDL limited-area non-hydrostatic model to study the important climate problem of cloud-radiation interaction. Completed development of the physics for the global spectral model on the DOD/NRL CM-5 and made a comprehensive evaluation of its performance at very high resolution. Also, (NOAA/NMC) completed testing of the restructured ETA model on the DOD/NRL CM-5 . Designed a restructured ETA model using FSL's `nearest neighbor` tool for implementation on the FSL Intel Paragon (NOAA/FSL, NOAA/NMC).	Complete procurement of a scalable HPCS to support major improvements in climate change and weather forecasting. Begin scientific experiments using a parallel version of the SKYHI global atmospheric grid-point model, and experiments using the parallel GFDL limited-area non-hydrostatic model to support research on radiation and clouds. Develop parallel versions of global spectral model and ETA model on CRAY T3D. Begin extensive testing of restructured, parallel version of the NMC regional/mesoscale ETA Optimum Interpolation (OI) code. Complete preliminary implementation of the restructured ETA model on the Intel Paragon and begin extensive testing to evaluate its performance in terms of resolution and the potential impact for improved forecast guidance. Begin restructuring and testing the conversion of some of the most important climate models on the ARSC T3D in cooperation with CIFAR.	Procure a scalable HPCS for NOAA/NMC to advance improvements in operational weather forecasting for the Nation. Complete initial scientific experiments using the parallel limited-area non-hydrostatic model. Implement production versions of these redesigned models on HPCS. Complete development of CRAY T3D versions of NMC global spectral and ETA models. Complete conversion of important climate models in support of Arctic Fisheries and Oceanography programs and the Climate and Global Change Program. Complete experimentation and evaluate restructured parallel NMC ETA OI code. Implement ETA model on FSL's Intel Paragon; evaluate performance at various grid resolutions and assess potential for operational forecast purposes. Implement advanced visualization laboratory to support high-end climate and weather research.	FY 1995 Presidential Request milestone modified to remove: Implement an advanced visualization laboratory to support high end applications. Descope major portions of activities leading to implementation of weather and climate models on scalable HPCSs.

NOAA	Networking Connectivity	Budget Code:	ORF EI

Networking Connectivity is NOAA's program activity to greatly increase its ability to disseminate NOAA real-time and historical environmental data and information through the Internet to a broad range of users in the U.S. business community, government at all levels, research, education, and the general public.

Budget (BA, $ M)	
FY 94 Actual	0.95
FY 95 Pres.	8.70
FY 95 Est.	3.20
FY 96 Rqst.	7.50

FY 96 Request by Component	
HPCS	
NREN	7.50
ASTA	
IITA	
BRHR	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
The number of NOAA computing and data archiving facilities at least minimally connected to the Internet was increased by 10. One NOAA Center of Data was connected to the Internet through a T3 or greater connection. NOAA's Internet Network Information Center was made operational.	At least 22 NOAA National Data Centers and Centers of Data will be connected to the Internet through a T1 or greater connection. Two NOAA Centers of Data will be connected to the Internet through at least a 10 Mb/s communications link. A substantial amount of NOAA environmental data will be disseminated through the Internet to a wide range of users, using WAIS, Gopher, Mosaic servers and other advanced, user-supportive access tools.	Expand the number of major environmental databases accessible through Internet to greater than 30. Increase bandwidth to accommodate rapidly increasing user access. Expand the implementation of Internet tools such as Mosaic, WAIS, and Gopher toward development of NOAA's portion of the NII. Develop integrated view of NOAA's national distributed on-line environmental information systems.	First FY 1995 milestone reduced from 30 to 22 Centers to be connected. Second FY 1995 milestone reduced from Five to Two Centers. Descope implementation of Internet tools on environmental information systems

Agency Ties	
ARPA	
NSF	
DOE	
NASA	Partner
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

NOAA	**Information Dissemination Pilots**	Budget Code:	ORF EI

Information Dissemination Pilots is NOAA's program activity to begin pilot dissemination through the Internet of some of the vast amount of environmental data and information for which NOAA is responsible. This information is distributed geographically at NOAA data centers across the country as part of the emerging National Information Infrastructure, for use by the private sector, academic researchers, educators, and the general public.

Budget (BA, $ M)	
FY 94 Actual	
FY 95 Pres.	
FY 95 Est.	
FY 96 Rqst.	0.50

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
		Develop a data dissemination pilot that uses advanced data access tools on the Internet, and that makes selected heterogeneous NOAA environmental data distributed geographically at NOAA data centers accessible to users in a more timely and complete way.	

FY 96 Request by Component	
HPCS	
NREN	
ASTA	
IITA	0.50
BRHR	

Agency Ties	
ARPA	
NSF	
DOE	
NASA	
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

Environmental Protection Agency

EPA's High Performance Computing and Communications (HPCC) program is focused on incorporating science and technology advances into key environmental applications and transferring advanced tools to key State, Federal, and industrial users. HPCC technology enables more effective, scientifically defensible, and timely environmental decision making resulting in economic benefits for industry by reducing the cost of achieving legislated environmental standards and by increasing the market for HPCC technologies. To facilitate technology transfer of high performance environmental assessment tools to real world users, the program is conducting a series of pilot projects. These projects assess the needs of environmental scientists, analysts and decision makers, and develop supporting curriculum, training materials, and tools.

The integration of high performance technology also enables complex multi-pollutant and cross-media pollutant assessments that are currently not feasible due to computational limitations. Existing air, surface and ground water quality models for coastal estuaries are being linked together to explore feedback among the different contributions from cross-media (air and water) sources. The increased computational resources needed to resolve scale and resolution issues for cross-media assessments demand scalable parallel computing. Research in distributed computing provides for better access and management of large collections of environmental data and sharing of powerful computational resources needed to support advanced environmental problem solving.

EPA's HPCC program helps support EarthVision, a computational science educational program for high school students and teachers. Hands-on training on the use of visualization is provided to EPA researchers and collaborators across the country, and numerous undergraduate and graduate students are supported through research activities. The current EPA program combines the efforts of personnel at EPA research laboratories and program offices, universities, technology centers, State environmental groups, and industrial partners. Some co-funding is provided by EPA air and information management programs. An external peer review of the EPA's HPCC program is scheduled for 1995.

Program Activity	Budget Account Code	Partner/User Agencies	Budget (BA, $ M)				HPCC Components by 1996 Agency Rqst				
			FY 94 Actual	FY 95 Pres.	FY 95 Est.	FY 96 Rqst.	HPCS	NREN	ASTA	IITA	BRHR
Environmental Modeling	CC9, CC1	NSF	5.35	6.45	5.41	5.78			5.78		
Computational Techniques	CC9, CA2	DOE	1.11	5.25	5.13	3.50			3.50		
State Network Connectivity	CC9, CA2		0.67	0.70	0.69	0.69		0.69			
Education/Training	CC9		0.77	1.97	1.27	1.01					1.01
Public Data Access	CC9	NASA, NOAA	0.00	0.30	0.00	1.02				1.02	
Totals:			7.90	14.67	12.50	12.00		0.69	9.28	1.02	1.01

EPA	Environmental Modeling	Budget Code:	CC9, CC1

This program activity supports fundamental research at six universities and one State technology center on the systematic integration of advanced multi-pollutant 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 flexible environmental modeling and decision support system built upon emerging HPCC technology and capable of adapting to continuous advances in science and technology. The initial focus of the program is on oxidant, acid deposition, and particulate models, but will expand to encompass integration of more complex processes such as aerosols and visibility. Both research and rapid prototyping of system framework capabilities such as graphical user interface, intelligent system builders and data management, collaborative tools, interactive analysis and visualization, multimedia electronic `tutor and help`, and decision support are being performed to better define technology/user requirements and design alternatives for environmental modeling and decision support systems. The resultant modeling and decision support framework will have general applicability for use in air quality, surface and ground water quality modeling and ecosystem management. Advanced collaborative methods of analyzing and visualizing the multi-dimensional results 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.

Budget (BA, $ M)	
FY 94 Actual	5.35
FY 95 Pres.	6.45
FY 95 Est.	5.41
FY 96 Rqst.	5.78

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Developed the concept and design of an air quality modeling decision support system that is easy to use and responsive to Federal, State, and industrial environmental problem solving needs. Demonstrated linked air and water quality models to enhance cross-media decision making. Developed interactive visualization techniques for analysis of multivariate four-dimensional meteorological and air quality data. Evaluated video conferencing technologies to support environmental applications.	Prototype modular, scalable, air quality modeling decision support system in a distributed computing environment. Develop an interactive environment to facilitate the calibration, execution, and analysis of the Chesapeake Bay Watershed model for nitrogen eutrophication studies. Develop collaborative computing and visualization prototype for several air and water quality applications to enable distant researchers to co-examine data and effectively use remote visualization resources. Implement video conferencing to key agency and research sites.	Develop an operational air quality modeling and decision support system for regional and urban oxidant, regional acid deposition, and particulate issues. Prototype a modular, scalable air quality modeling decision support system with integrated sensitivity-uncertainty analysis. Implement linked air and water quality models in a distributed computing environment to facilitate cross-media assessment of water quality. Award grants for research to advance environmental decision support tools through integration of object oriented databases and Geographical Information Systems, artificial intelligence methods, uncertainty/risk analysis, and advanced multivariate visualization techniques.	The reduction in the EPA HPCC FY 95 budget and the FY 96 budget request eliminates coupled water-air modeling milestones.

FY 96 Request by Component

HPCS	
NREN	
ASTA	5.78
IITA	
BRHR	

Agency Ties

ARPA	
NSF	Partner
DOE	
NASA	
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

EPA	Computational Techniques	Budget Code:	CC9, CA2

The primary objective of the numerical and computational research is to develop and evaluate the performance of key algorithms that form the computational foundation of air, water, and molecular models on a variety of scalable parallel architectures. Numerical algorithm research includes grid generation and coordinate transformation techniques applicable to multiscale air quality modeling, comparative study of parallel programming models for gas-phase atmospheric chemistry solvers, parallel algorithm development and evaluation for several air and water quality, ground water, stream and lake sedimentation, meteorology, and molecular modeling processes. Fundamental research is also conducted on computational techniques for quantifying uncertainty as an integral part of the numerical computation.

The research evaluates combinations of hardware, software, algorithms, and communication capabilities to determine the most effective computational approach to support more complex multi-pollutant and cross-media modeling activities. This research, performed at eleven universities, the DOE's Argonne National Laboratory, and several EPA research laboratories, directly impacts the performance of environmental Grand Challenge applications and contributes to the shared software libraries and parallel testbed codes.

To fully integrate results of the research into the mainstream of EPA computational-based research activities, EPA plans to acquire a large scalable parallel computer.

Budget (BA, $ M)	
FY 94 Actual	1.11
FY 95 Pres.	5.25
FY 95 Est.	5.13
FY 96 Rqst.	3.50

FY 96 Request by Component	
HPCS	
NREN	
ASTA	3.50
IITA	
BRHR	

Agency Ties	
ARPA	
NSF	
DOE	Partner
NASA	
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Made available parallel codes for energy and force calculations for modeling chemical reactions and biological interaction of chemicals. Determined network bandwidth requirements for distributed environmental applications.	Develop and implement parallel codes for several gas-phase atmospheric chemistry solvers to evaluate performance of a variety of parallel architectures. Implement portable parallel meteorological testbed model to support advanced air quality models. Acquire a scalable parallel computing system to support HPCC research activities.	Develop a parallel analytic element method for ground water modeling. Implement parallel, distributed, gas-phase chemistry code for use in operational advanced air quality models. Upgrade scalable parallel computing system. Award grants for development of parallel methods for optimization problems, coupled air and water exchange processes, and adaptive grid approaches.	Acquisition of a scalable parallel computer was delayed until FY 95 due to line item budget elimination from the FY 94 President's budget request.

EPA	State Network Connectivity	Budget Code:	CC9, CA2

The main objectives of this program activity are to provide access to the Internet for a critical mass of key environmental problem-solving groups in State environmental communities in order to accelerate the wider use of more accurate and reliable environmental tools, and to provide capabilities for testing distributed computing approaches with complex multi- pollutant and cross-media environmental models. This activity supports network connections for four State and several federal pilot projects for evaluation of environmental assessment tools, Grand Challenge team research, and agency access to high performance computing.

This activity also provides high speed (45 million bits per second) interconnection through the Internet to the EPA's National Environmental Supercomputing Center in Bay City, Michigan with dedicated high speed connectivity to the EPA National Computing Center and HPCC research network in North Carolina. This interconnection establishes a basic foundation for the use of advanced environmental assessment tools throughout the agency and facilitates technology transfer to State environmental groups.

Budget (BA, $ M)	
FY 94 Actual	0.67
FY 95 Pres.	0.70
FY 95 Est.	0.69
FY 96 Rqst.	0.69

FY 96 Request by Component	
HPCS	
NREN	0.69
ASTA	
IITA	
BRHR	

Agency Ties	
ARPA	
NSF	
DOE	
NASA	
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Provided 45 megabits per second interconnection through the Internet to the EPA's National Environmental Supercomputing Center. Provided a minimum of 56 kilobits/sec connectivity to four State and one federal environmental groups to support HPCC pilot projects.	Demonstrate use of ATM technology for environmental applications. Maintain agency Internet and State connections.	Maintain agency Internet and State connections.	Expansion of State network connections and upgrade of agency meta-computing components were eliminated due to shifts in budget priorities.

EPA	Education/Training	Budget Code:	CC9

This program activity targets the dissemination of high performance computing and advanced environmental modeling capabilities to select groups from industry, State and federal sectors. The industrial group is represented by a consortium, the Consortium for Advanced Modeling of Regional Air Quality. The target groups of State users are selected from States with professionals involved in front-line environmental decision making and using models of regional and urban air quality. Pilot users gain first-hand experience on how high performance computing can alleviate many of their decision making constraints while at the same time they work with developers to ensure that system capabilities and interfaces address their needs. A high performance computing learning environment is created through workshops, involvement of professional trainers and curriculum developers, and establishment of a `virtual center` which functions remotely through Internet to support a distributed base of users of environmental models for decision making across the country.

Funding also supports EPA's EarthVision computational science educational program for high school students, graduate students, training fellowships, conferences and workshops.

Budget (BA, $ M)	
FY 94 Actual	0.77
FY 95 Pres.	1.97
FY 95 Est.	1.27
FY 96 Rqst.	1.01

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Continued co-sponsorship of EarthVision, a computational science educational program for high school students and teachers. Supported graduate students in computational and environmental science. Conducted a workshop to assess training and educational needs for use of high performance environmental decision support tools.	Prototype technology transfer methods for advanced air quality modeling systems and define concept for a distributed user/modeling support `center`. Conduct workshops to gather feedback from early use of prototype environmental decision support tools.	Prototype distributed modeling support `center`. Define infrastructure requirements for extending advanced modeling and training to a broad user community. Award grants for exploration and development of high school level educational environmental software, and multimedia tutorial and help approaches for use of environmental modeling tools over the Internet.	Shifts in EPA budget priorities limited the expansion of State pilot projects.

FY 96 Request by Component	
HPCS	
NREN	
ASTA	
IITA	
BRHR	1.01

Agency Ties	
ARPA	
NSF	
DOE	
NASA	
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

EPA	Public Data Access	Budget Code:	CC9

EPA plans to expand public access to a variety of environmental databases, such as ecological measurements, air and water quality model predictions, population exposure to pollutants, etc., through development of intelligent interfaces for interactive browsing, retrieval, analysis, and on-line multimedia tutorials for inexperienced users.

The research addresses fundamental technology issues associated with intelligent data access techniques, support for spatial, temporal, and multi-media data, object data bases, interoperability over heterogeneous hardware/software platforms, and synthesis of information for public use and education to satisfy the general public's earth science information needs.

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
		Award grants for research on intelligent interfaces and data management/analysis methods for interactive browsing, retrieval, analysis, and help facilities related to environmental data of public interest.	Shifts in EPA budget priorities delayed initiation of research in this area until FY-96.

Budget (BA, $ M)	
FY 94 Actual	0.00
FY 95 Pres.	0.30
FY 95 Est.	0.00
FY 96 Rqst.	1.02

FY 96 Request by Component	
HPCS	
NREN	
ASTA	
IITA	1.02
BRHR	

Agency Ties	
ARPA	
NSF	
DOE	
NASA	Partner
NIH	
NSA	
NIST	
NOAA	Partner
EPA	
ED	
AHCPR	
VA	

Department of Education

The U.S. Department of Education (ED) conducts research and development in a number of areas relating to developing resources for and skills within the Education community.

These activities are conducted within the Office of Educational Research and Improvement (OERI), the National Institute for Disabilities Research and rehabilitation (NIDRR) in the Office of Special Education and Rehabilitation Services, and GOALS 2000.

Program Activity	Budget Account Code	Partner/User Agencies	Budget (BA, $ M)				HPCC Components by 1996 Agency Rqst				
			FY 94 Actual	FY 95 Pres.	FY 95 Est.	FY 96 Rqst.	HPCS	NREN	ASTA	IITA	BRHR
AskERIC Service					0.75	1.25				1.25	
OERI Institutional Communications Network (INET)		NSF	2.00		0.50	1.00				1.00	
Regional Education Laboratory Program					1.42	1.50					1.50
Teacher Networking Project					1.80	1.80					1.80
National Institute on Disability and Rehabilitation Research		VA, NSF			11.40	11.40			11.40		
GOALS 2000 Technology Planning Grants to States											
		Totals:	2.00		15.87	16.95			11.40	2.25	3.30

ED	AskERIC Service	Budget Code:	

AskERIC is an online information service available free of charge to teachers, parents, and students. AskERIC provides its users with customized information on a vast array of educational topics, delivered via the Internet and commercial services such as America Online. Using state-of-the-art technology, AskERIC also provides a personal touch through trained specialists available to assist educators and parents in their search for information.

AskERIC has four components: a question answering (Q&A) service, the AskERIC Virtual Library, the National Parent Information Network, and a research and development (R&D) program.

For the Q&A service, information specialists draw on the resources of the Internet and the ERIC system to provide answers--within 48 hours-- to any question about education. Users can try the Q&A service by sending a question via e-mail to AskERIC@ericir.syr.edu.

The AskERIC Virtual Library is a collection of education resources that teachers have requested. These materials include lesson plans, print, and video materials (from organizations such as CNN, PBS and the Discovery Channel), research summaries, digests, Infoguides on key educational topics, frequently-asked questions, and discussion groups for practicing educators and librarians. This is immediately available electronically.

The National Parent Information Network (NPIN)-- developed in conjunction with the National Urban League, local housing authorities, and PrairieNet-- is an online collection of materials to help parents better support their children's educational, physical, and societal development.

AskERIC R&D applies emerging tools and technologies to deliver services and provide on-demand access to a full range of electronic media. Currently, the AskERIC R&D team is working on: expanding the AskERIC Virtual Library to provide image, sound, and video resources; providing free Internet access to the ERIC bibliographic database using friendly, high performance retrieval software; creating a full-text electronic collection of the documents in the ERIC database; and, experimenting with new Internet products to ascertain their value for serving educators.

Budget (BA, $ M)	
FY 94 Actual	
FY 95 Pres.	
FY 95 Est.	0.75
FY 96 Rqst.	1.25

FY 96 Request by Component

HPCS	
NREN	
ASTA	
IITA	1.25
BRHR	

Agency Ties

ARPA	
NSF	
DOE	
NASA	
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Ten states now have formal agreements to receive AskERIC services; question-answering sessions average 300+ each week. Gopher, WAIS and WorldWideWeb/ Mosaic access to AskERIC Virtual Library was established. Over 15,000 weekly users. AskERIC established parallel services on major commercial online networks, e.g. America Online, GTE Educational Network Services. AskERIC named a finalist in the Computerworld Smithsonian Awards program.	Complete ERIC bibliographic database available on Internet with capacity for 200 simultaneous users and state-of-the-art interface. Full text of the documents indexed in the ERIC database in 1995 available online in image database. AskERIC becomes truly nationwide (worldwide?) service.	Will dramatically expand access to multimedia and hypermedia materials. AskERIC will harness a nationwide network of information specialists, using two-way interactive telecommunications, to serve the needs of teachers, administrators, parents and students.	

ED	OERI Institutional Communications Network (INET)	Budget Code:	

The Institutional Communications Network (INet) was established in FY 93 by the Department of Education's Office of Educational Research and Improvement (OERI) to use the emerging National Information Infrastructure to accomplish the interrelated goals of: (1) improving collaboration and information sharing among the education R&D institutions funded by OERI, including the Regional Educational Laboratories, National Educational Research & Development Centers, Educational Resources Information Center (ERIC), and National Diffusion Network; and (2) disseminating relevant and useful research, statistics, information, products, and publications developed through or supported by the Department to schools, educators, parents, and policy makers throughout the United States.

In FY 94, INet initiated public access Gopher, FTP, and World Wide Web servers, which have rapidly become important resources to the education community. Although INet initially concentrated on disseminating OERI's research and statistical information, its coverage has expanded to include extensive information from other Department offices--press releases, grant announcements, and libraries of information about major initiatives such as GOALS 2000, Technology, School-to-Work, and Elementary and Secondary Education Schoolwide Programs. Dissemination activities are closely coordinated with other Department-funded entities that sponsor Internet services, including AskERIC, the Eisenhower National Clearinghouse for Mathematics and Science Education, and the Regional Educational Laboratories.

The GOALS 2000 legislation calls for increased emphasis on electronic networking and dissemination to support education reform. INet will continue to play a key role in the Department's efforts to make a significant, high quality collection of education information available on-line for the rapidly growing number of educators who are connecting to the NII.

Budget (BA, $ M)	
FY 94 Actual	2.00
FY 95 Pres.	
FY 95 Est.	0.50
FY 96 Rqst.	1.00

FY 96 Request by Component

HPCS	
NREN	
ASTA	
IITA	1.00
BRHR	

Agency Ties

ARPA	
NSF	Partner
DOE	
NASA	
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Gopher, FTP, World Wide Web, WAIS, and Mail Server access to on-line library established. Over one million file/menu accesses logged since October, 1993. Databases of research syntheses and Department programs implemented. Gopher Server selected by America Online as one of a 100 `exemplary databases` for AOL's initial Gopher gateway. Discussion forums and supporting on-line libraries established for Teachers of the Year, GOALS 2000 State Planning Panels, and State Technology Planning Panels. Department joins NSF/NCSA Mosaic Federal Consortium to explore and test enhancements to Mosaic useful to K-12 education and users with disabilities.	Plan and begin to implement core set of searchable databases, including current R&D activities, promising and exemplary programs, education statistics, and Department publications and products with links to on-line full text and on-line ordering. Implement community exchange service to support interchange and discussion of ideas by communities engaged in education reform. Expand participation of other Department's programs; coordinate linkages and organization of on-line libraries with other sites and systems. Through NSF/NCSA Mosaic Federal Consortium, continue to explore and test enhancements to Mosaic useful to K-12 education and users with disabilities. Pilot test enhanced document and data formats and their usability by teachers, administrators, parents, and students.	Continue implementation of core set of searchable databases. Enhance services to exploit emerging data, retrieval, and interface technology; expand content to incorporate enhanced document and data formats. Support Department's integration of clearinghouses, categorical and comprehensive technical assistance centers into a coordinated, unified customer service/technical assistance system. Expand participation of other Department programs; coordinate linkages and organization of on-line libraries with other sites and systems.	

ED	Regional Education Laboratory Program	Budget Code:	

The Regional Educational Laboratories conduct applied research and development, disseminate information, and provide technical assistance that supports educational improvement. Their principal clients are educators and policy makers. The ten Regional Educational Laboratories also work together as a network on problems that affect several regions. Under the direction of a representative governing board, each laboratory serves clients in a defined region consisting of four to seven states. Using the best available knowledge, the Laboratories identify solutions to educational problems, try new approaches, furnish research results and publications, and provide training to teachers and administrators. The laboratories support school restructuring with major efforts in curriculum, instruction, and assessment.

There is a growing effort by the Labs to use technology to link educators in schools and other educational agencies with educational R&D results. The Labs have created a Technology Task Force, which is developing an Internet-based communication and information system called the National Educational R&D Network. The Network will support the Labs' collaboration, dissemination, and constituent support activities. The goals of this network are: 1) To provide the staff of regional laboratories with the capabilities of electronic communication and data and information sharing for intra-Lab communication and collaboration purposes; 2) To provide clients of the Regional Educational Laboratories with easy access to a wide range of information and data services; 3) To provide for electronic communication, dissemination, and collaboration between individual Regional Educational Laboratories and their clients and constituents.

Budget (BA, $ M)	
FY 94 Actual	
FY 95 Pres.	
FY 95 Est.	1.42
FY 96 Rqst.	1.50

FY 96 Request by Component	
HPCS	
NREN	
ASTA	
IITA	
BRHR	1.50

Agency Ties	
ARPA	
NSF	
DOE	
NASA	
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Designed a three-phase strategy for electronic networking involving the ten Regional Educational Laboratories individually and as a network of labs. Operated and used an interim bulletin board and e-mail service (Phase I) for all labs on SERVE-Line (the electronic network of the laboratory in the Southeast Region). Established a set of basic Internet hardware and software standards to be supported by each Laboratory (Phase II). Installed a Unix system and full Internet connection at 9 of the 10 Laboratories. Made available three collaborative databases for searching by WAIS: Alternative Assessment, Promising Practices, and Collaborative Products. Established electronic mail groups for the major collaborative work groups in the Lab Network Program, and trained group leaders. Developed Gopher menus in three of the lab systems, and a national gopher menu for all the labs and research centers.	The tenth Lab Unix system and Internet connection will be completed. The National Education R&D Network gopher will be made publicly available. The pilot test of the Panda interface and system will be completed. Gopher menus will be available for nine Labs. Plans for Phase III system development and evaluation will be completed. Phase III will focus on integrating technology in all laboratory programs and developing new technology products and services for clients. A graphical system in World Wide Web (WWW) as a parallel to the gopher based menu will be completed. The evaluation report of the Phase II (Internet-based) Lab Network will be completed.	Complete work on the Phase III plan and evaluation. Continue support for projects funded under the laboratory contract and increased connectivity with constituents and OERI.	

ED	Teacher Networking Project	Budget Code:	

This activity provides support for model projects that demonstrate compelling applications of electronic networks in support of teacher professional development. It is intended to increase teacher participation in electronic networking to enhance teachers' access to resources for self- improvement, and provide information about how teachers can use electronic networks as an effective means of professional development. Priority is given to networks for teachers in schools serving high concentrations of students from poor families.

Budget (BA, $ M)	
FY 94 Actual	
FY 95 Pres.	
FY 95 Est.	1.80
FY 96 Rqst.	1.80

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Published the priorities announcing the availability of funding to support electronic networks for teacher professional development; within three weeks more than 10,000 requests were made for the application guidelines. Sponsored a major technology conference on electronic networking to support teacher professional development; representatives from all 50 states, the District of Columbia, and the territories attended the conference held in Washington, DC, in May 1994.	Continue second-year funding for projects receiving grants in FY 1994. Expand the project scope to include community networks and classroom applications of networking. Host a second technology conference that focuses on applications of networking to support education and training. Stimulate communities of learners electronically, ensuring that educators are aware of information about other federal agency- supported HPCC activities.	Continue support for projects funded under previous years and disseminate information about teacher outcomes and results. Conduct evaluation of projects funded under previous years and disseminate results of the evaluation study.	

FY 96 Request by Component

HPCS	
NREN	
ASTA	
IITA	
BRHR	1.80

Agency Ties

ARPA	
NSF	
DOE	
NASA	
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

ED	National Institute on Disability and Rehabilitation Research	Budget Code:	

The Education Department's National Institute on Disability and Rehabilitation Research, within the office of Special Education and Rehabilitative Services, funds several programs with projects related to High Performance Computing and Communication. These include the Rehabilitation Engineering Research Centers (RERC) program, the Technology-Related Assistance program (TRA), the Research and Demonstration program; the Field Initiated Research program, and interagency programs.

RERCs conduct coordinated programs of advanced engineering or technological research: to develop and test new engineering solutions to problems confronting individuals with disabilities; to develop systems for the exchange of technical and engineering information; and to improve the distribution of technological devices and equipment to individuals with disabilities. These Centers have been established in the following areas supporting universal access to HPCC technology: Adaptive Computers and Information Systems; Augmentative and Alternative Communication; Hearing Enhancement and Assistive Devices; Technology for Blind, Visually Impaired, and Multihandicapped Individuals; and for planning purposes only, Universal Access and Telecommunications. Funding for these activities is about $3 million per year.

The combined Research and Demonstration and Field Initiated Research programs yield about $1.7 million per year in HPCC relevant research activities.

The TRA program involves 52 entities (primarily states) with programs of systems change that include personnel, equipment, and a system to generate database information that could be network accessible. Approximately 14% of the funding for the TRA program or $4.9 million per year is allocated to this activity.

Dissemination and Utilization activities account for about $2.5 million per year allocated to production of information available for network access primarily through contract support of the National Rehabilitation Information Center (NARIC). NARIC collects the results of federally funded research projects related to disability and rehabilitation research.

Budget (BA, $ M)	
FY 94 Actual	
FY 95 Pres.	
FY 95 Est.	11.40
FY 96 Rqst.	11.40

FY 96 Request by Component	
HPCS	
NREN	
ASTA	11.40
IITA	
BRHR	

Agency Ties	
ARPA	
NSF	Partner
DOE	
NASA	
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	Partner

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Developed and disseminated software for computer accessibility for users with disabilities. The MS-DOS 6.0 manual now includes an appendix entitled `Accessibility for Individuals with Disabilities` that references resources developed with funding from NIDRR. AccessDOS, which was developed by the RERC at the University of Wisconsin Madison, is available on the MS-DOS Supplemental Disk, which is now available from Microsoft and can be downloaded by modem from CompuServe, GEnie or Microsoft on-line and other user-group bulletin boards. Sponsored work leading to the publication of the Trace Resourcebook on Assistive Technologies for Communications, Control and Computer Access. Sponsored consensus conferences to develop a research agenda for Universal Access and Telecomms. Developed a research initiative on computer access through an interagency agreement with the NSF for support Science Access for All Students.	Enhancement of continuing research centers and programs to include a focus on ethnic and cultural diversity and increased participation of persons with disabilities in policy research. Establish two major research teams to pursue work in technology related to the National Information Infrastructure access and productive use by persons with disabilities.	Demonstrate an enhanced capability to deliver useful government information to persons with disabilities.	

ED	GOALS 2000 Technology Planning Grants to States	Budget Code:	

GOALS 2000 offered $5 million for state planning for improving student achievement through integration of technology into the curriculum. Grants are to develop (or continue the development of) a systemic statewide plan to increase the use of state-of-the-art technologies that enhance elementary and secondary student learning and staff development in support of the National Education Goals and state content standards and state student performance standards.

Objectives of the plan are: the promotion of higher student achievement through the use of technology in education; the participation of all schools and school districts in the state, especially those schools and districts with a high percentage or number of disadvantaged students; the development and implementation of a cost effective, high speed, statewide, interoperable, wide area communication educational technology support system for elementary and secondary schools within the state, particularly for such schools in rural areas; and the promotion of shared usage of equipment, facilities, and other technology resources by adult learners during after school hours.

This project was a one-time project for planning purposes. It was funded in the FY 1994 CET budget and not in the HPCC budget.

Budget (BA, $ M)	
FY 94 Actual	
FY 95 Pres.	
FY 95 Est.	
FY 96 Rqst.	

FY 96 Request by Component

HPCS	
NREN	
ASTA	
IITA	
BRHR	

Agency Ties

ARPA	
NSF	
DOE	
NASA	
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
One half of the states submitted requests for planning grants under the GOALS 2000 activity during FY 94.	Approximately one half of the states will submit plans to improve student achievement through integration of technology into the curriculum.	States which did not submit plans in FY 95 are expected to submit their plans during this fiscal year.	

Agency for Health Care Policy and Research

The Agency for Health Care Policy and Research (AHCPR) contribution to the High Performance Computing and Communication initiative focuses on health care technology applications of computer-based patient records, computerized clinical decision support systems, and patient care data standards. These HPCC activities are predominantly technology applications support for promoting the development and evaluation of systems to foster their economic and medical feasibility. The HPCC program at AHCPR advances information technology that can provide significant benefits to all Americans by improving the quality, appropriateness, and effectiveness of health care, and improving their access to health care.

Program Activity	Budget Account Code	Partner/User Agencies	Budget (BA, $ M)				HPCC Components by 1996 Agency Rqst.				
			FY 94 Actual	FY 95 Pres.	FY 95 Est.	FY 96 Rqst.	HPCS	NREN	ASTA	IITA	BRHR
Computer-Based Patient Records		NIH			7.00	8.40				8.40	
Totals:					7.00	8.40				8.40	

AHCPR	**Computer-Based Patient Records**	Budget Code:	

The objective of the computer-based patient record program activity is to improve the uniformity, accuracy, and retrievability of data about patient care in the community and to promote its use for improved clinical decisions. It requires the development of clinical data standards and the integration of information systems in diverse locations within institutions and across institutions and health care providers. Testing the application of computer-based patient record systems, decision support algorithms, and knowledge servers in physicians' offices, hospitals, patients' homes and other locations is of national importance to bring rapidly the benefits of HPCC to the provider and consumer of health care throughout the U.S.

Budget (BA, $ M)	
FY 94 Actual	
FY 95 Pres.	
FY 95 Est.	7.00
FY 96 Rqst.	8.40

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
AHCPR completed an evaluation of a comprehensive hospital information system in place for twenty years compared with less comprehensive systems in two similar hospitals in place for a shorter time. AHCPR completed a feasibility study of overcoming the barriers to implementation and integration of clinical information management systems. The agency fostered collaboration of the major U.S. patient care data standards developers through AHCPR's support of the ANSI Healthcare Informatics Standards Planning Panel. Supported the transformation of electronically transmitted health insurance claims data into research data bases for use in studying the health care issues of cost, quality, and access.	Support scientific inquiry into applied research relevant to an electronic medical record. AHCPR and NLM will fund grant applications that extend computer-based patient record systems and show their incorporation of guidelines, decision aids, expert systems, and reminder systems. Support investigations into the uses of automated patient care data for patient care, payment, research, quality assessment, patient outcome analysis, and electronic transmission of such data among institutions and providers. Support development of and access to automated patient care data bases for research.	Support private sector development and testing of clinical patient care data standards for: (1) the definition and coding of medical terms, (2) the content of specific data sets for decision making, and (3) the electronic exchange of patient care data. Support the evaluation of electronic medical record applications to determine the extent to which they improve: clinical decision making; the delivery of health services; and patient outcomes. These evaluations should include: (1) how such systems are received by health care providers and patients; (2) how physician and patient behavior changes; and (3) how patient outcomes, productivity, and costs of care are affected.	

FY 96 Request by Component

HPCS	
NREN	
ASTA	
IITA	8.40
BRHR	

Agency Ties

ARPA	
NSF	
DOE	
NASA	
NIH	Partner
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

Department of Veterans Affairs

The Department of Veteran Affairs (VA) operates the largest centrally-directed health care system in the United States through 171 VA medical centers (VAMC), 362 outpatient clinics, 129 nursing homes, and 35 domiciliaries.

The VA has a coordinated, integrated automation program whose purpose is to improve patient care and administrative operations by introducing advanced automation to deliver the right information to the right person at the right time in an economical manner. More effective administrative operations emphasize automated administrative functions, procurement, and electronic commerce. Improved patient care emphasizes making the correct information and services available electronically to the clinician on the wards where they make decisions. This information is currently drawn from the facility based integrated patient based information system, local area network CD-ROM data bases, and other VA facilities on the VA's Wide Area Network (WAN). Plans include increased accessibility to other WAN resources such as Medline and Internet based digital libraries.

Various aspects of the program focus on integrating technologies to enhance the existing computer based patient record, as well as to improve methods of data capture, data presentation, and inter-facility data exchange. The projects concentrate on the technical areas of workstations, information system architectures, local and wide area networks, and appropriate security and privacy alternatives. Standards based solutions will be necessary to insure continued interoperability and meaningful data exchange. These systems are being developed using a blend of in-house resources, federal sharing initiatives, and private industry support.

Program Activity	Budget Account Code	Partner/User Agencies	Budget (BA, $ M)				HPCC Components by 1996 Agency Rqst				
			FY 94 Actual	FY 95 Pres.	FY 95 Est.	FY 96 Rqst.	HPCS	NREN	ASTA	IITA	BRHR
Computerized Patient Record and Telemedicine					1.40	1.40				1.40	
Clinical Workstations and Medical Imaging		ARPA, NIH, AHCPR, ...			7.66	3.61				3.61	
Improve Telecommunications Infrastructure and Internet Connectivity		NIST			0.18	0.18		0.18			
Hybrid Open Systems Technology (HOST)		NIST			14.46	14.50				14.50	
VA/DoD Sharing					0.50	3.71				3.71	
		Totals:			24.20	23.40		0.18		23.22	

VA	Computerized Patient Record and Telemedicine	Budget Code:	

The continued development of the VA computerized patient record will expand availability of patient data and images to health care providers. Computerized records ensure that data will be available at the point of care and accessible throughout the distributed network of VA and Federal health care facilities where patients are treated. Components of the record will include:

PDX - Exchange of patient demographics and health summary data between treating VA facilities;

Clinical Lexicon -- Integration and application of national and international standard nomenclatures, e.g., NLM's UMLS, to bring precision to the communication of clinical data across different health care organizations;

Patient Care Encounter -- A framework into which order information can be associated with a given visit. Orders can be linked to a given diagnosis or complaint and eventual outcome, so that the effectiveness of specific orders or order sets can be established;

Standards-based inter-application communications -- Includes a messaging system, HL7, SQL, and controlled vocabularies. Implementing these national and international standards will permit the exchange of data among the public and private sectors;

Telemedicine -- In FY 93 the National Library of Medicine funded a High Performance Computing and Communications contract to a consortium of West Virginia University, community, health care provider, and corporate institutions. The purpose of the 3-year award was to apply and evaluate advanced networking technologies to the delivery of health services in both rural and urban areas of West Virginia. At the end of FY 94 Veterans Affairs Medical Center (VAMC) Clarksburg joined as a participant in the statewide Mountaineer Doctor TV Network linking rural hospitals in West Virginia for telemedicine and educational purposes.

Budget (BA, $ M)	
FY 94 Actual	
FY 95 Pres.	
FY 95 Est.	1.40
FY 96 Rqst.	1.40

FY 96 Request by Component

HPCS	
NREN	
ASTA	
IITA	1.40
BRHR	

Agency Ties

ARPA	
NSF	
DOE	
NASA	
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Developed and tested PDX -- the Patient Data Exchange Package that allows VA Medical Centers to request and display patient demographic, clinical, and health summary information from other treating VA facilities. This package employs an intelligent interface to locate and extract desired information from the clinical record, compile, and transmit that information back to the requesting facility. Developed and tested the Clinical Lexicon -- Integration and application of national and international standard nomenclatures, e.g., NLM's UMLS, to bring precision to the communication of clinical data across different health care organizations. Imaging Telemedicine Tests began between Washington and Baltimore.	Connect Clarksburg VAMC to the HPCC supported statewide Mountaineer Doctor TV Network linking rural hospitals in West Virginia for telemedicine and educational purposes. Develop and test the Patient Care Encounter (PCE) -- the framework into which order information can be associated with a given visit. PCE links orders to a given diagnosis or complaint and the eventual outcome so that the effectiveness of specific orders or order sets can be established. Develop and test the HL7 Package -- a basic tool set for use by all applications that will assist in implementing standards based interfaces between clinical applications.	Develop and test Enhanced PDX- the Enhanced Patient Data Exchange package that will enable directly merging of patient data from multiple treating facilities.	

VA	Clinical Workstations and Medical Imaging	Budget Code:	

This program activity focuses on testing Clinical Workstations at pilot facilities. If these tests are successful, a non HPCC initiative could lead to installation of Clinical Workstations at all 171 VA facilities over a 4 year period beginning in 1995. There will be approximately three pilot sites implemented in FY 95, with additional sites being added in the subsequent years. Clinical workstations will extend and expand access to the computerized patient record by linking workstations to VA's Decentralized Hospital Computer Program (DHCP). These multi-media workstations will be capable of pulling down information from the hospitals LAN, the VA's WAN, and networks such as the Internet that link the VA with the outside. Portable workstations will ensure access to information at the point of care.

The DHCP Integrated Medical Imaging Project currently is a model of a clinical workstation. This program has been operational at the Washington and Baltimore VAMCs for several years. Multiple types of true color and black-and-white medical images are captured and retrieved as an integrated part of the computerized patient record. Additional functionality is constantly being added to the system, and additional sites are installing the system.

Budget (BA, $ M)	
FY 94 Actual	
FY 95 Pres.	
FY 95 Est.	7.66
FY 96 Rqst.	3.61

FY 96 Request by Component

HPCS	
NREN	
ASTA	
IITA	3.61
BRHR	

Agency Ties

ARPA	
NSF	
DOE	
NASA	
NIH	
NSA	
NIST	Partner
NOAA	
EPA	
ED	
AHCPR	Partner
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Kansas City VAMC became an operational site, and other sites began installation and system testing.	Install workstations and network at three sites for initial testing of clinical record system. Martinsburg, Mountain Home, Boston, and Milwaukee become operational. Washington and Baltimore update equipment and supplement the number of workstations. Enhanced Text Data Capture workstations become operational. AHCPR Clinical Guidelines are accessible electronically from the medical center wards at the Washington VAMC. Impact on clinicians activities is evaluated.	Initial phase of national workstation installation. Design and pilot test additional functionality for the clinical workstation.	

VA	Improve Telecommunications Infrastructure and Internet Connectivity	Budget Code:	

This program activity is to test expanded telecommunications configurations that will connect the clinicians desktop to Internet resources. Components to be tested include workstations at desktop, Local Area Network (LAN) connections, high speed facility communications backbones, routers connecting to the VA's Wide Area Network and interconnections with the Internet.

All VA facilities are currently connected to each other by an electronic packet switched wide area network (WAN). The network is used to exchange medical (text and image), administrative, central reporting, and electronic commerce data across the VA and through gateways to facilities outside the VA. Traffic has grown three fold between 1990 and 1993. This network currently transports 75 billion characters per month.

Basic nationwide Internet connectivity infrastructure is installed. An Internet gateway links the VA electronic mail systems to Internet and provides basic connectivity to VAMCs nationwide. All Medical Center computer users are able to send and receive Internet mail. The testing will investigate the feasibility of furnishing nationwide network connection to Internet. The goal will be to provide expanded functionality, improved access and upgraded performance with appropriate security.

Budget (BA, $ M)	
FY 94 Actual	
FY 95 Pres.	
FY 95 Est.	0.18
FY 96 Rqst.	0.18

FY 96 Request by Component	
HPCS	
NREN	0.18
ASTA	
IITA	
BRHR	

Agency Ties	
ARPA	
NSF	
DOE	
NASA	
NIH	
NSA	
NIST	Partner
NOAA	
EPA	
ED	
AHCPR	
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Installed testbed Internet Gateway with appropriate initial security.	Test upgraded Internet connectivity and enhanced security of the Internet gateway. Test feasibility of access to Internet resources from all facilities through the gateway.	Evaluate demand, performance, configuration and the impact of tools like Mosaic on the needs of the gateway(s). Test expanded Internet accessibility to support access from additional clinical workstations being installed throughout the VA. Evaluate capacity impact of multimedia data.	

VA	Hybrid Open Systems Technology (HOST)	Budget Code:	

The purpose of the VA Hybrid Open Systems Technology (VA HOST) program activity is to investigate the feasibility of interfacing commercial technologies with the VA's Integrated Hospital Information System called the Decentralized Hospital Computer Program (DHCP). This interfacing of commercial technologies is based on the development of standards-based interfaces in both the commercial technologies and in the VA DHCP.

The VA HOST program activity has enjoyed positive Congressional attention as a mechanism to support the VA in its efforts to continue to enhance the high level hospital information systems support currently installed at all VA Medical Centers. Traditionally, in-house developed, integrated software has provided the basis for the VA DHCP. As more commercial systems become available, and Open Systems standards and technologies evolve, investigation of commercial and Open System technologies for enhancement of the VA DHCP became the focus of this program activity. The VA HOST emphasizes a combination of the best of the in-house integrated system with the best of commercial technologies. Standards-based interfacing technologies are required in the VA HOST program.

Budget (BA, $ M)	
FY 94 Actual	
FY 95 Pres.	
FY 95 Est.	14.46
FY 96 Rqst.	14.50

FY 96 Request by Component	
HPCS	
NREN	
ASTA	
IITA	14.50
BRHR	

Agency Ties	
ARPA	
NSF	
DOE	
NASA	
NIH	
NSA	
NIST	Partner
NOAA	
EPA	
ED	
AHCPR	
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Established the HOST Program Office in Martinsburg, WV. Designed and implemented a field based project submittal process . Selected and funded 10 pilot projects at VA Medical Centers. Obtained a commercial integrator for multiple commercial applications integration to VA DHCP.	Initiate a second round of field-based project proposals. Select and fund 10 additional pilot projects. Establish a clearinghouse for VA HOST activities and standards-based integration with commercial technologies. Design and implement the VA HOST migration procurement strategy. Enhance standards based integration paths to VA DCHP for three additional commercial technologies. Establish a standards-based, Open systems Integration Laboratory for interoperability demonstrations.	Initiate a third round of field-based project proposals. Select and fund 10 additional pilot projects. Complete technical assessments of five pilot projects. Enhance standards based integration paths to VA HIS for three additional commercial technologies. Initiate three project demonstrations in the Open Systems Integration Laboratory.	

VA	VA/DoD Sharing	Budget Code:	

This program increases the sharing of Medical Information Resources between VA and DoD. Initiatives include:

Electronic standards based data exchange;

Investigate the feasibility of movement towards standard (common) data dictionary definitions;

Creation of a laboratory for VA, DoD, and Indian Health Service to partner the assessment of methodologies and technologies for data sharing;

Investigate the feasibility of shared software modules;

Examination of the feasibility of a standard Federal health care system software architecture;

Investigation of interfaces and prototypes for interoperability and Interconnectivity using common standards such as the medical HL-7 specification methodology;

Development of automated DoD Contingency Data Reporting systems for sharing bed availability, peace-time transportation of VA patients on DoD transportation, and the integration of VA DHCP to the DoD US TRANSCOM Regulating and Command & Control Evacuation System (TRACES);

Development of a generic VA/DoD medical imaging interface to allow both text and medical images to be exchanged between commercial radiology imaging systems and the Federal medical information systems (VA DHCP and DoD CHCS).

Goals include:

(a) Establish an integrated imaging system at VA/DoD Joint Venture sites that will provide high quality image and textural data exchange from cardiology, pulmonary and gastrointestinal endoscopy, pathology, radiology, hematology, and nuclear medicine to facilitate the clinician's task of correlating such data, as well as making patient care decisions in a timely and accurate way;

(b) Maximize use of Federal health care resources through systems integration as charged by Congress;

(c) Reduce redundant equipment and software requirements for DHCP and CHCS at VA/DoD Joint Venture sites;

(d) Facilitate implementation of the One Patient-One Record system at VA/DoD Joint Venture sites.

Budget (BA, $ M)	
FY 94 Actual	
FY 95 Pres.	
FY 95 Est.	0.50
FY 96 Rqst.	3.71

FY 96 Request by Component

HPCS	
NREN	
ASTA	
IITA	3.71
BRHR	

Agency Ties

ARPA	
NSF	
DOE	
NASA	
NIH	
NSA	
NIST	
NOAA	
EPA	
ED	
AHCPR	
VA	

Major Milestone Identification by Fiscal Year

FY 1994 Actual	FY 1995 Estimated	FY 1996 Agency Request	Milestone Changes from Prior IP
Developed, tested, and installed a VA gateway at Madigan Army Medical Center DoD facility to transfer text data in HL-7 and ACR-NEMA standard formats between DoD CHCS Hospital Information System and the DoD MDIS Radiology PACS system.	Install VA software and hardware in DoD Interconnectivity and Integration Laboratory in order to test standards based data interchange and interoperability. Test and demonstrate techniques for exchange of data between DHCP and TRAC2ES prototype system for use in wartime and national disaster. Install and test VA gateway at additional DoD facilities to transfer text data system in HL-7 and ACR-NEMA standard formats between CHCS and MDIS Radiology PACS system.	Imaging: Develop, test, and install enhanced gateway at two test facilities for exchange of both text and digitized images between VA and DoD Radiology systems at Joint Venture sites. Computerized patient record: continue development, testing, and collaboration with particular focus on the graphical user interface and a common approach to characterizing the clinician's view of the patient record. Support standardization of nomenclature for health care records. Integration Laboratory: Support a standards-based, Open Systems integration laboratory for testing interoperability of CHCS, DHCP, Indian Health Service HIS, and commercial computerized patient record software.	

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