OFFICE OF CYBERINFRASTRUCTURE $182,420,000

The FY 2007 Budget Request for the Office of Cyberinfrastructure (OCI) is $182.42 million, an increase of $55.30 million or 43.5 percent over the FY 2006 current plan of $127.12 million.

Office of Cyberinfrastructure Funding
(Dollars in Millions)

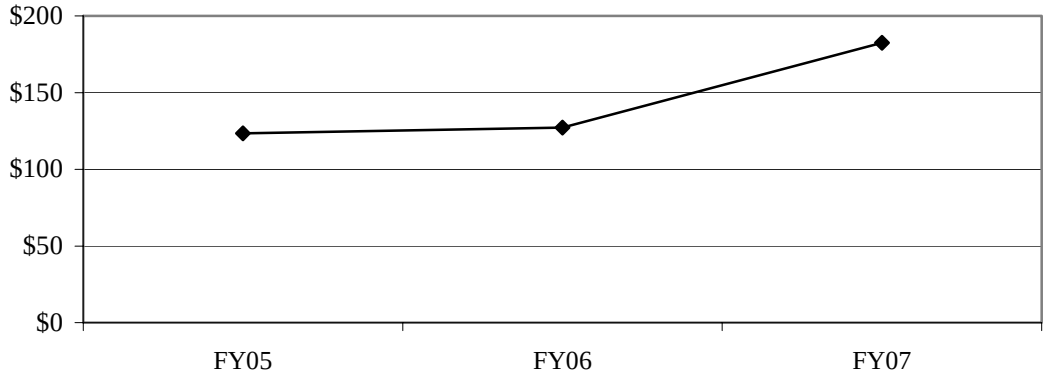
	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Percent
Office of Cyberinfrastructure	$123.40	$127.12	$182.42	$55.30	43.5%

The Office of Cyberinfrastructure supports the acquisition, development, and operation of state-of-the-art cyberinfrastructure resources, providing cyberinfrastructure services that promote otherwise unrealizable advances in 21st century science and engineering research and education. These state-of-the-art tools and services also serve as engines for innovation, seeding the development of innovative IT products in a range of application areas. OCI was created in July 2005 in an organizational realignment that moved the CISE Division of Shared Cyberinfrastructure (SCI) into the Office of the Director. All SCI funds and programmatic activities as described in the FY 2006 request were transitioned to OCI.

OCI-supported cyberinfrastructure includes IT-based resources and tools such as supercomputers, high-capacity mass-storage systems, system software suites and programming environments, scalable interactive visualization tools, productivity software libraries and tools, large-scale data repositories and information management systems, networks of various reach and granularity, and an array of software tools and services that enhance usability and accessibility. OCI also supports the scientific and engineering professionals who create and maintain these IT-based resources and systems, and who provide the nation's researchers and educators with essential cyberinfrastructure services.

OCI activities directly respond to the President's high-end computing and cyberinfrastructure priorities and are key components in the Networking and Information Technology Research and Development (NITRD) priority.

OCI Subactivity Funding
(Dollars in Millions)



RELEVANCE

How does a protein fold? What happens to space-time when two black holes collide? What impact does species gene flow have on an ecological community? What are the key factors that drive climate change? Did one of the trillions of collisions at the Large Hadron Collider produce a Higgs boson? Can we create an individualized model of each human being for targeted healthcare delivery? How does major technological change affect human behavior and structure complex social relationships? What answers will we find – to questions we have yet to ask – in the very large datasets that are being produced by telescopes, sensor networks, and other experimental facilities?

These questions – and many others – are only now coming within our ability to answer because of advances in cyberinfrastructure. Once used by a handful of elite researchers in a few research communities on select problems, powerful cyberinfrastructure tools have become essential to future progress across the frontier of science and engineering. Today, scientists and engineers need access to contemporary cyberinfrastructure capabilities, such as distributed wired and wireless observing network complexes, comprehensive services that facilitate collaboration and communication, advanced data tools for mining, analysis, and visualization, and sophisticated simulation tools that permit exploration of phenomena that can never be observed or replicated by experiment. Fewer and fewer researchers working at the frontiers of knowledge can carry out their work without cyberinfrastructure tools of one form or another.

Recognizing that cyberinfrastructure capabilities are essential to advances in all science and engineering fields, NSF is currently developing a comprehensive cyberinfrastructure strategic plan entitled, *NSF's Cyberinfrastructure Vision for 21st Century Discovery* (www.nsf.gov/dir/index.jsp?org=OCI). This plan describes the agency's commitment to support the deployment of a well-engineered, scalable, cyberinfrastructure designed to evolve as the academic community's science and engineering research and education needs change. In implementation, NSF is promoting the development of a government-wide approach to cyberinfrastructure development and deployment, including the use of service-exchange agreements designed to enhance cyberinfrastructure resource sharing across federal agencies.

On NSF's behalf, OCI supports the development and deployment of cyberinfrastructure that is shared by all scientific and engineering disciplines and that promotes cyberinfrastructure interoperability here in the U.S. and abroad. About two thirds of NSF's investments in cyberinfrastructure are made in the Tools portfolio of the directorates and offices responsible for fundamental research and education in science and engineering, with the remaining third provided by OCI. Through coordinated planning and investments facilitated by NSF's Cyberinfrastructure Council, OCI provides economies of both scale and scope, ensuring that NSF's whole cyberinfrastructure portfolio is greater than the sum of its parts.

Summary of Major Changes in OCI Investments *(Dollars in Millions)*

FY 2006 Current Plan, OCI…..……$127.12

Leadership Class High Performance Computing System Acquisition +$50.00

Increased funding will support the acquisition of a leadership-class High Performance Computing (HPC) system optimally configured to enable *petascale* (computing at rates on the order of 10^{15} floating point operations per second (petaflops) or working with very large datasets on the order of 10^{15} bytes (petabytes)) performance on important science and engineering problems. Complementing ongoing investments in mid-range HPC platforms,

OCI will begin the four-year acquisition of a leadership-class platform that will allow the U.S. to retain its position as a world leader in scientific computing. Over four years, NSF anticipates investing approximately $200 million in this acquisition.

As described in the document *NSF's Cyberinfrastructure Vision for 21st Century Discovery*, this system acquisition is critical to the agency's multi-year plan to deploy and support a world-class HPC environment comprising the most powerful HPC assets available to the academic community. With access to petascale computing capabilities, researchers will be able to develop models that more accurately predict the occurrence of extreme weather events and to simulate the development of structure in the early universe. They will probe the structure of novel phases of matter such as the quark-gluon plasma and will examine the way proteins fold and vibrate after they are synthesized inside an organism. In fact, sophisticated *petascale* numerical simulations will permit scientists and engineers to perform a wide range of *in silico* experiments that are otherwise too difficult, too expensive or impossible to perform in the laboratory.

This acquisition will be conducted in close collaboration with sister agencies with a stake in HPC, through coordinating mechanisms such as those provided by NITRD and the proposed Leadership Computing Council. This allows participating agencies to leverage expertise and promising practices, to minimize duplication of effort, and ultimately promises to increase the architectural diversity of leadership-class systems available to researchers and educators around the country.

Data- and Collaboration-Intensive Software Services +$25.70

Science and engineering research and education have become increasingly data- and collaboration-intensive, as a result of the proliferation of digital technologies and pervasive networks through which scientific data, information, and knowledge are collected, generated, shared, or analyzed. The enormous growth in the availability and utility of science and engineering data, information, and knowledge is increasing scholarly research productivity, accelerating the transformation of research outcomes into products and services, and enhancing the effectiveness of learning across the spectrum of human endeavor.

OCI will support the development and provision of production-quality software services focused on strategic data- and collaboration-intensive functionalities. For example, data and collaboration services supported will: help researchers maintain data formatting standards and include or create metadata in real time; provide for experimental planning, execution, and post-analysis; support system monitoring and management capabilities; provide accessible, easy-to-use interfaces such as web portals through which researchers can access simulation software and domain-specific community code repositories; and enable teleobservation and teleoperation to provide scientists and engineers with remote access to experimental facilities, instruments, and sensors.

Concepts such as software clearinghouses will be explored to provide support throughout the software lifecycle, from concept and design through deployment and usage. OCI will support projects to: conduct applied research and development; perform scalability/reliability tests to explore tool viability; develop, harden, and maintain software tools and services where necessary; and harvest promising research outcomes to facilitate

the transition of commercially-viable software into the private sector. Collectively, projects supported will be designed to provide for software interoperability.

Other Infrastructure and Tools -$20.40

Adjustments will be made in the current OCI portfolio to accommodate the strategic priorities described herein and in more detail in the document, *NSF's Cyberinfrastructure Vision for 21st Century Discovery*.

Subtotal, Changes +$55.30

FY 2007 Request, OCI……$182.42

QUALITY

OCI maximizes the quality of the projects it supports through the use of a competitive, merit-based review process. The percent of funds that were allocated to projects that undergo external merit review was 98 percent in FY 2005, the last year for which complete data exist.

To ensure the highest quality in processing and recommending proposals for awards, a Committee of Visitors (COV) was held in June 2005. The COV was composed of qualified external evaluators, to review its portfolio for three years. These experts assessed the integrity and efficiency of the processes for proposal review and provided a retrospective assessment of the quality of results of NSF's investments.

In partnership with NSF's directorates and offices, OCI will receive advice from the Advisory Committee for Cyberinfrastructure (ACCI) (in formation) on such issues as: the mission, programs, and goals that can best serve the science and engineering community; how OCI can promote quality graduate and undergraduate education in the computational sciences and engineering; and priority investment areas in cyberinfrastructure. The ACCI will meet twice a year. Members from both academe and industry will represent a cross section of the science and engineering field, with representatives from many different disciplines. The ACCI will include a balanced representation of women, underrepresented minorities, and individuals from a range of geographic regions and institutions.

PERFORMANCE

The FY 2007 Budget Request is aligned to reflect funding levels associated with the Foundation's four strategic outcome goals and the ten investment categories highlighted in the FY 2003-2008 Strategic Plan. These categories were designed as a mechanism to better enable assessment of program performance and to facilitate budget and performance integration.

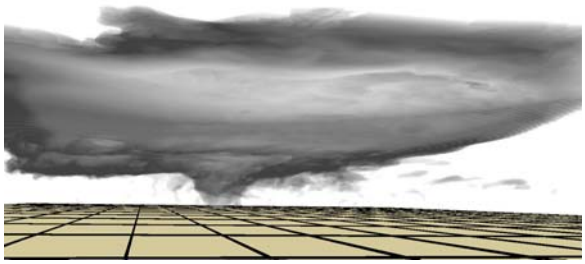
Office of Cyberinfrastructure
By Strategic Outcome Goal and Investment Category
(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006 Amount	Change over FY 2006 Percent
Ideas					
Fundamental Science & Engineering	$2.74	$9.85	$4.17	-$5.68	-57.7%
Centers	-	-	-	-	N/A
Capability Enhancement	-	-	-	-	N/A
	2.74	9.85	4.17	-5.68	-57.7%
Tools					
Facilities	-	-	-	-	N/A
Infrastructure and Instrumentation	113.01	103.74	164.72	60.98	58.8%
Polar Tools, Facilities and Logistics	-	-	-	-	N/A
FFRDCs	-	-	-	-	N/A
	113.01	103.74	164.72	60.98	58.8%
People					
Individuals	1.25	1.48	1.48	-	-
Institutions	0.22	-	-	-	N/A
Collaborations	5.51	10.00	10.00	-	-
	6.98	11.48	11.48	-	-
Organizational Excellence	0.67	2.05	2.05	-	-
Total, OCI	$123.40	$127.12	$182.42	$55.30	43.5%

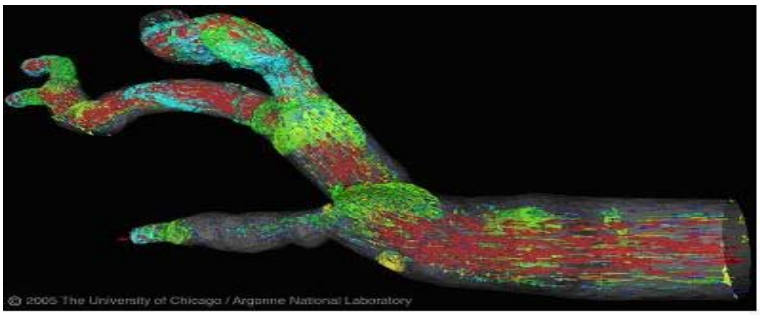
Totals may not add due to rounding.

Recent Research Highlights

► **Forecasting Severe Storms:** Using OCI-supported TeraGrid resources at the Pittsburgh Supercomputer Center, researchers have accurately predicted thunderstorm activity 24 hours ahead of time—the highest resolution storm forecasts ever made. Such improvements will help affected regions better prepare for extreme weather events such as hurricanes, floods, winter storms and tornados. Those preparations, in turn, will help the U.S. reduce an economic toll that averages some $13 billion per year, and a human toll that averages nearly 1,000 deaths per year. This work was jointly supported by NSF and NOAA**.**

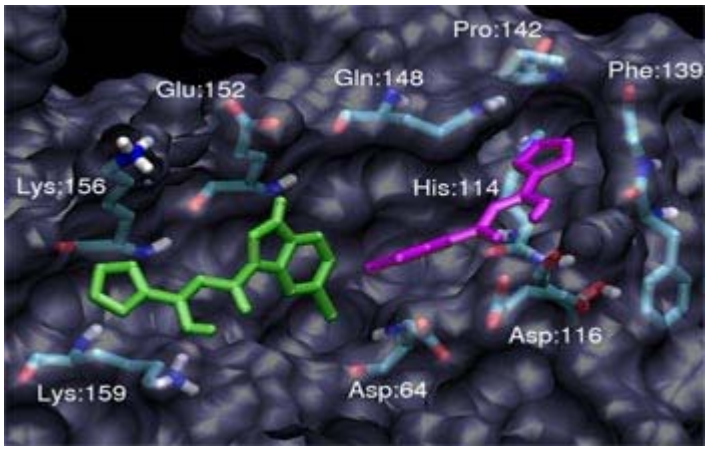


► **Human Blood Flow Study Uses the Combined Power of Multiple TeraGrid Sites:** In a development that could improve the effectiveness of medical diagnoses and surgical interventions, a team of researchers at Brown University has harnessed the computing and visualization resources at five OCI-funded TeraGrid sites to create a three-dimensional simulation of blood flow patterns in the human body. Their high-resolution model includes the 55 largest arteries in the body as well as 27 of the branch points where arteries divide.



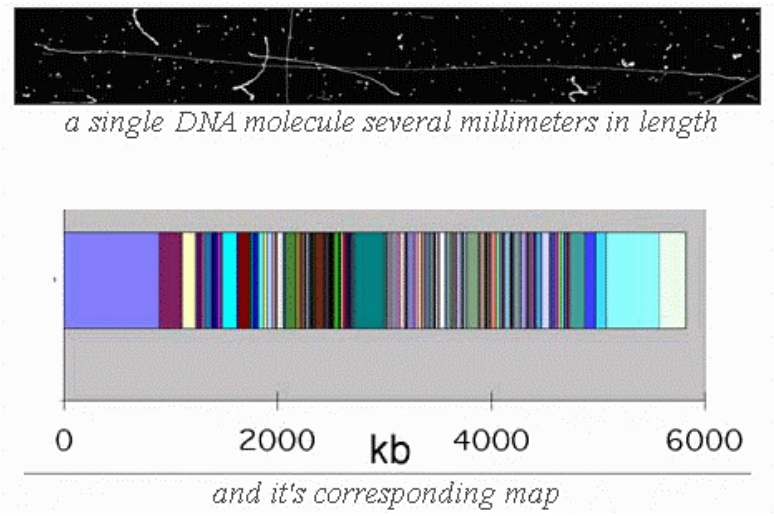
First ever simulation of the human arterial tree on NSF's Teragrid

► **Simulations of HIV Provide Fundamental Tools for Drug Discovery:** Using the San Diego Supercomputer Center's DataStar machine, a key component of the OCI-supported TeraGrid, researchers at the University of California at San Diego are developing sophisticated models of enzyme molecules essential to the functioning of the HIV virus. These simulations, in turn, are being used by Merck and Company to design and develop drugs targeting one particular HIV enzyme, integrase, which catalyzes a critical step in the HIV life cycle and enables cellular replication.

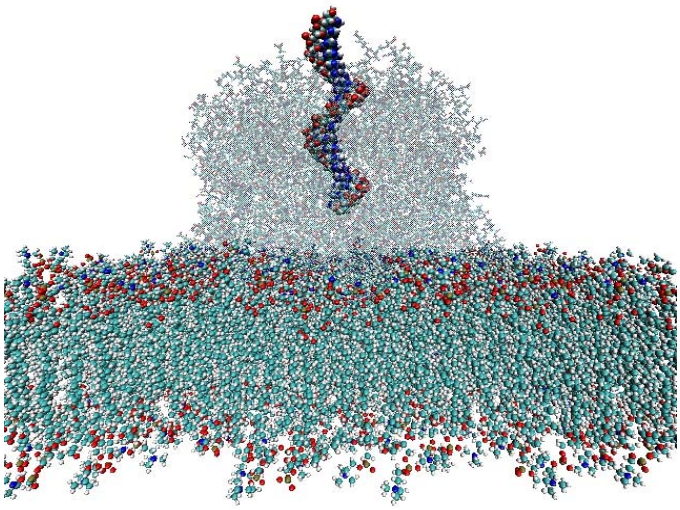


This graphic shows two potential inhibitors for the enzyme HIV-1 integrase.

► **Keeping Condor Flight Worthy:** NSF-funded computer scientists at the University of Wisconsin are continuing to develop and support "Condor": high-throughput computing software that allows scientists around the country and throughout the world to perform large-scale computations by harnessing the power of available computers, regardless of their physical location. In one dramatic example, researchers have recently used Condor to complete the first comprehensive search for structural variation within the human genome. Such variations were originally thought to occur only within cancers or other highly aberrant cell types, but this study demonstrates their existence in normal cells as well. These findings are significant not only because such alterations are linked with common diseases, but because they are also thought to be evolutionary launch pads for speciation.

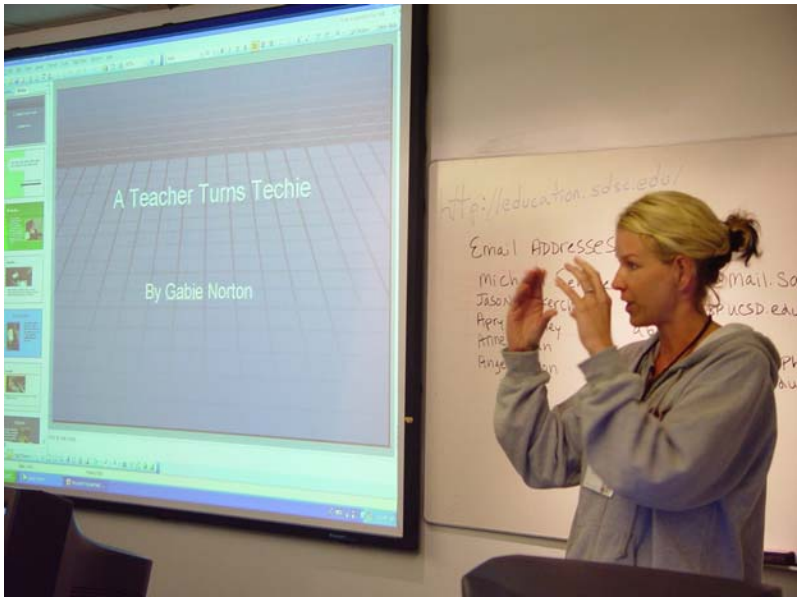


► **SPICE: Simulated Pore Interactive Computing Environment:** Researchers have recently linked systems at three US-based TeraGrid sites and two UK sites to run a computer model called SPICE, which simulates the migration of a DNA molecule through the nano-sized pore of a channel protein. This process, known as "translocation," occurs with both messenger-RNA and DNA. So a detailed knowledge of how it works is critical to many problems, from genetic information transfer to the design of high-throughput DNA screening. The SPICE simulation became tractable only with grid-enabled computational resources, which made possible to farm-out around 100 large-scale, non-equilibrium simulations across the transatlantic interconnected grid.



Translocation: Simulation of the migration of a DNA molecule through nano-size pore of a protein

► **Creating Cyber-savvy Teachers:** Between February 2005 to December 2005, the San Diego Supercomputer Center's (SDSC) TeacherTECH program reached 540 K-12 educators through monthly and summer workshops in science, technology, engineering and math. The participants represented all of San Diego County, from urban to rural, from the northern tip all the way to the border with Mexico. The sessions included TeacherTECH Workshops in both Technology Tools and Advanced Technology Tools, as well as TeacherTECH Series in both science and math. Many of the science series presentations are archived on SDSC's TeacherTECH site (http://education.sdsc.edu/teacherte ch) for viewing by teachers across the nation. Ten thousand people have visited the new TeacherTECH website since its inception in May 2005. The site includes standards-based curriculum submitted by workshop participants, science lectures, scientific visualizations, notes, resources and much more.



Other Performance Indicators

The table below shows the number of people benefiting from OCI funding.

Number of People Funded by OCI Projects

	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate
Senior Researchers	314	315	350
Other Professionals	554	600	650
Postdoctorates	21	40	50
Graduate Students	162	170	200
Undergraduate Students	29	40	50
Total Number of People	1,080	1,165	1,300

However OCI investments directly impact a much larger number of researchers and educators within the U.S. and around the world who use OCI-supported cyberinfrastructure facilities, resources and tools. For example, OCI-funded cyberinfrastructure enables the work of an estimated 150,000 senior researchers, graduate students, undergraduate students and K-12 teachers annually.

The OCI funding profile is provided below.

OCI Funding Profile

	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate
Statistics for Competitive Awards:			
Number	75	75	75
Funding Rate	65%	65%	65%
Statistics for Research Grants:			
Number of Research Grants	28	21	24
Funding Rate	41%	11%	12%
Median Annualized Award Size	$207,902	$365,408	$370,000
Average Annualized Award Size	$339,956	$404,209	$410,000
Average Award Duration, in years	2.3	2.6	2.7