OFFICE OF CYBERINFRASTRUCTURE (OCI) $236,020,000
+$21,740,000 / 10.1%

OCI Funding
(Dollars in Millions)

	FY 2010 Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Change Over FY 2010 Enacted Percent
Research	**$45.51**	**$53.13**	**$79.36**	**$26.23**	**49.4%**
Software	22.71	12.50	30.00	17.50	140.0%
Data	3.70	12.27	26.00	13.73	111.9%
Other Disciplinary and Interdisciplinary Research	19.10	28.36	23.36	-5.00	-17.6%
Education	**8.81**	**10.77**	**8.60**	**-2.17**	**-20.1%**
Infrastructure	**160.40**	**150.38**	**148.06**	**-2.32**	**-1.5%**
High Performance Computing (HPC)	128.10	$113.00	$94.00	-19.00	-16.8%
Other Networking and Computational Programs	32.30	$37.38	$54.06	16.68	44.6%
Total, OCI	**$214.72**	**$214.28**	**$236.02**	**$21.74**	**10.1%**

Totals may not add due to rounding.

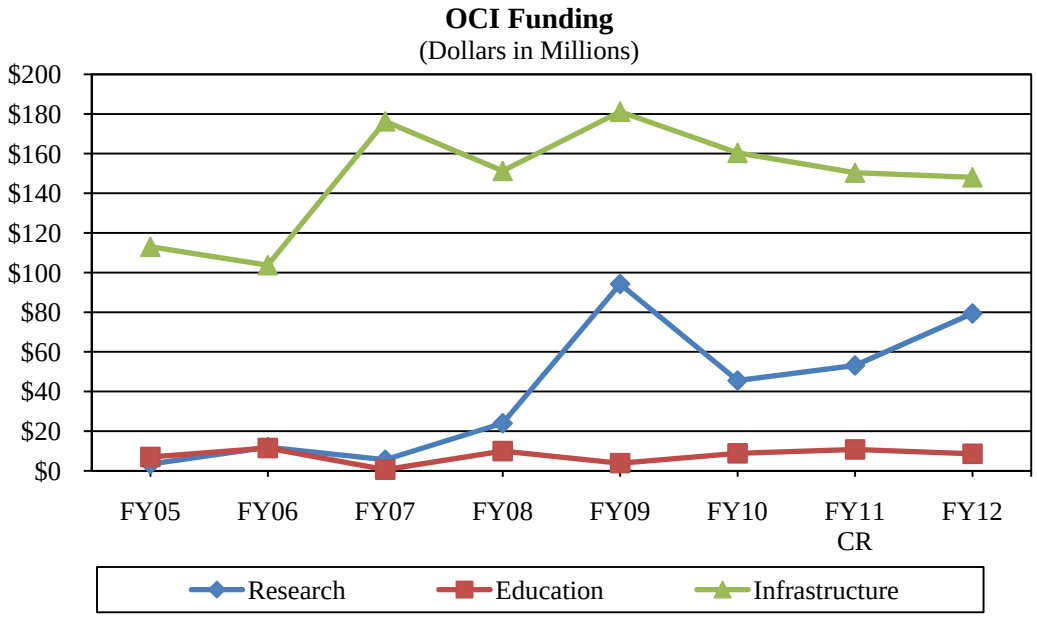
About OCI

OCI supports research, development, acquisition, and operation of advanced shared and connecting cyberinfrastructure (CI) that enables otherwise unrealizable advances in 21st century science and engineering research and education. Every discipline of science and engineering is undergoing a revolution, transformed by the widespread use and deployment of cyberinfrastructure. Data volumes, computing power, software, and network capacities are all on exponential growth paths, and research collaborations are expanding dramatically. Data are everywhere: produced by all scientific and education endeavors, and generated by surveys, mobile and embedded systems, sensors, observing systems, scientific instruments, publications, experiments, simulations, evaluations, and analyses. Scientists and citizens alike communicate by sharing data, software, papers, and visualizations.

OCI supports the development and use of advanced CI to address frontier science problems through the growing discipline of computational science and engineering, as well as the computational scientists who develop and use it. OCI capitalizes on a broad range of fundamental scientific and engineering research and education to create and expand the next generation of CI. CI is used to convert data to knowledge, thereby understanding complexity through simulation and prediction, and creating more systematic knowledge about the social and technical issues of large-scale, multidisciplinary, collaborative communities, known as virtual organizations. CI is needed to address the complex problems and grand challenges facing science and society. It does this by ensuring broad and useful access to scientific instruments, facilities, and data. CI also enables end-users to access remote resources at-speed to support transformative research.

OCI's FY 2012 Request is influenced by three key priorities: (1) ongoing support for the High Performance Computing (HPC) portfolio; (2) expanding support for core research and development in

software, data, and networking; and (3) providing support and funding for the two NSF-wide investment portfolios: Science, Engineering, and Education for Sustainability (SEES) and Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21). In addition, OCI is making a focused effort to provide healthy funding and support for education and broadening participation efforts to develop the next generation of cyberinfrastructure professionals.



All funding increases/decreases represent change over the FY 2010 Enacted level.

Research

There is a growing need for increased software and data capabilities. Consequently, OCI has reprioritized funding towards research based on feedback from the other offices and directorates within NSF, as well as recommendations from the NSF Advisory Committee for Cyberinfrastructure (ACCI).

- Software funding increases by $17.50 million to a total of $30.0 million in FY 2012. This increase will support a focus on sustainability and extensibility of software, tools, algorithms, and efforts that ensure robustness and security while also providing opportunities for upgrades and new capabilities.
  - This includes a $2.50 million increase for CIF21 New Computational Infrastructure, and a $14.0 million increase for Software Institutes. There is also a $1.0 million increase for CI Reuse, which supports sustainable software.
- Data support increases by $13.73 million to a total of $26.0 million for data-enabled science, including long-term data support and infrastructure, a data life-cycle program focus (access, curation, mining, security, management), data tools, data interoperability, data repositories, and a multi-disciplinary focus on data services, data science, and data-intensive science.
  - This includes a $10.0 million increase for CIF21 Data Enabled Science and a $3.73 million increase for the DataNet and data interoperability networks programs.
- Other disciplinary and interdisciplinary research funding decreases by $5.0 million to a total of $23.36 million. This includes:
  - An increase of $2.0 million for CIF21 Community Research Networks activities and programs linking organizations, people, buildings, computers, and vehicles. It will also support the development of collaboration tools, virtual organizations, shared tools (e.g., visualization, crowd-

sourcing), and cybersecurity tools research to create a secure environment that facilitates and supports transformative research.

- A decrease of $4.0 million for CDI since the objectives of CDI have been included in the broader objectives of CIF21.

Education

- Support for education decreases by $2.17 million to a total of $8.60 million. Funding decreases slightly for educational activities overall. However, support for students will also be provided through research awards that are part of the CIF21 portfolio.
  - GRF funding is eliminated (-$1.0 million) as the Research and Related Activities (R&RA) contribution to the program will be funded centrally through Integrative Activities (IA).
  - It also reflects small decreases in support for CI-TEAM (-$1.0 million to a total of $4.0 million), IGERT (-$400,000 to a total of $1.0 million) and CI-TRaCS (-$170,000 to a total of $2.0 million).
  - OCI support of $500,000 for EHR's TUES program ends.
  - Support for REU Sites increases by $400,000 to a total of $1.0 million.
  - OCI will provide $500,000 of support for the CISE-led Computing Education for the 21st Century program.

Infrastructure

Reflecting the growing need for software and data capabilities, OCI has shifted funding away from infrastructure to fund research. This is based on the feedback from the other offices and directorates within NSF, as well as recommendations from the ACCI.

- Support for High Performance Computing decreases by $19.0 million to a total of $94.0 million.
  - The Blue Waters (Track One) program is reduced by $58.0 million as this program will be transitioning from acquisition to operations and maintenance.
  - Funding for Track 2D awards is reduced by $10.0 million as the funding for the program ramps down as planned.
  - Innovative HPC funding increases by $20.0 million to a total of $30.0 million. This increase will fund operations and maintenance for the Innovative HPC acquisition that is scheduled to occur in FY 2011.
  - Funding for eXtreme Digital is increased by $29.0 million to meet outstanding commitments as the program ramps up.
- Support for other networking and computational programs increases by $16.68 million to $54.06 million.
  - An increase of $17.0 million for the Comprehensive National Cybersecurity Initiative (CNCI) (+$16.0 million to a total of $16.0 million) and other cybersecurity efforts (+$1.0 million to a total of $5.0 million) including early deployment and testing of game-changing cybersecurity prototypes, and experimental approaches and development of cybersecurity in advanced compute environments and leading-edge IT services.
  - An increase of $2.50 million will support activities and programs for the development of CIF21 New Computational Infrastructure including new computational resources (HPC, Clouds, Data Centers), sustainable software, new architectures and algorithms, and end-to-end access to resources.
  - An increase of $6.0 million for CIF21 Access and Connections to Cyberinfrastructure Facilities to support activities and programs in high-speed connections to emerging national data- and compute-intensive facilities, such as NEON, OOI, NEES, iPlant, and other major MREFC projects, and supporting the use of networks of remote instruments (e.g., Arctic Observing Network and Polenet) and access to large databases by remote users are essential and require research and development for user-control and interactive remote steering.

- A decrease of $3.40 million for seed grants in networking and computation, as these efforts will be integrated into the FY 2012 CIF21 New Computational Infrastructure and Access and Connections to Cyberinfrastructure Facilities program areas.
- And a decrease of $5.42 million to broadband, as these efforts will be integrated into CIF21 Access and Connections to Cyberinfrastructure Facilities.

Major Investments

OCI Major Investments

(Dollars in Millions)

Area of Investment	FY 2010 Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Change Over FY 2010 Enacted Percent
High Performance Computing	$128.10	$113.00	$94.00	-$19.00	-16.8%
CIF21	-	-	23.00	23.00	N/A
CNCI	-	-	16.00	16.00	N/A
SEES Portfolio	2.60	5.50	5.00	-0.50	-9.1%
CAREER	3.77	3.71	4.21	0.50	13.5%

Major investments may have funding overlap, and thus should not be summed.

- OCI continues to invest in high performance computing (HPC). However, efforts will transition from acquisition to operations and maintenance for Track 1, while Track 2 funding is eliminated as these resources transition into the TeraGrid. Consistent with recent recommendations from the President's Council of Advisor's on Science and Technology, OCI's overall HPC investments will shift to the innovative HPC and extreme Digital programs.

- Support for the new NSF-wide CIF21 investment will focus on the Data Enabled Science component of CIF21. Data Enabled Science funding will be used to facilitate the collection, analysis, and retention of data critical to OCI-related research domains. CIF21 also includes support for Community Research Networks, which link organizations, people, buildings, computers, and vehicles to form the effective and efficient distributed, coordinated, interdisciplinary collaborations that are increasingly central to science and engineering. CIF21 also includes New Computational Infrastructure, which encompasses HPC, clouds, clusters, data centers and focused special-purpose resources. It incorporates sustained software at all levels, all protected and embedded in a rich and robust cybersecure environment. Lastly, CIF21 includes Access and Connections to Cyberinfrastructure facilities, which will create improved access and connections to facilities and scientific instruments and resources that will enable computational communities built around emerging national data- and compute-intensive facilities, such as the National Ecological Observatory Network (NEON), Ocean Observatories Initiative (OOI), EarthScope, Network for Earthquake Engineering Simulation (NEES), and iPlant.

- OCI will support the NSF-wide Comprehensive National Cybersecurity Initiative (CNCI), which includes early deployment and testing of game-changing cybersecurity prototypes, and experimental approaches and development of cybersecurity in advanced compute environments and leading-edge IT services.

- OCI will support the NSF-wide SEES investment by funding CI activities that support research efforts in energy, environment, and society.

- OCI supports the CAREER program, an Administration priority. OCI's CAREER awards support young investigators who exemplify the role of teacher-scholars through outstanding research, excellent education, and the integration of education and research within the context of the mission of their organizations.

Summary and Funding Profile

OCI supports investment in core research and education as well as research infrastructure such as high performance computing resources, software, data, and networking infrastructure. In FY 2012 the number of research grant proposals is expected to increase by 190 compared to FY 2010 Enacted. OCI expects to award approximately 120 research grants in FY 2012. Average annualized award size and duration will be slightly above FY 2010 Enacted.

OCI Funding Profile

	FY 2010 Actual Estimate	FY 2010 Enacted/ Annualized FY 2011 CR Estimate	FY 2012 Estimate
Statistics for Competitive Awards:			
Number of Proposals	826	510	700
Number of New Awards	169	103	125
Regular Appropriation	156	103	125
ARRA	13	-	-
Funding Rate	20%	20%	18%
Statistics for Research Grants:			
Number of Research Grant Proposals	739	490	680
Number of Research Grants	112	97	120
Regular Appropriation	112	97	120
Funding Rate	15%	20%	18%
Median Annualized Award Size	$204,617	$225,000	$230,000
Average Annualized Award Size	$318,813	$395,550	$400,000
Average Award Duration, in years	2.7	2.4	2.5

Program Evaluation and Performance Improvement

The Performance Information chapter provides details regarding the periodic reviews of programs and portfolios of programs by external Committees of Visitors and directorate Advisory Committees. Please see this chapter for additional information.

The most recent OCI Committee of Visitors met in FY 2008. The COV focused on two performance dimensions in the context of OCI's four focus areas of High Performance Computing, Data, Virtual

Organizations, and Learning and Workforce Development: 1) assessments of the quality and integrity of program operations and program-level technical and managerial matters pertaining to proposal decisions; and 2) comments on how the outputs and outcomes generated by awardees have contributed to the attainment of NSF's mission and strategic outcome goals. The COV made a number of recommendations that OCI has since addressed.

OCI will be holding its next COV meeting in April 2011. This COV will focus on the same two performance dimensions described above in the context of OCI's six focus areas: Software, Data and Visualization, Networking, Virtual Organizations, Learning and Workforce Development, and High Performance Computing.

The Office of Cyberinfrastructure is working with NSF's Advisory Committee for Cyberinfrastructure (ACCI) to gather input from the researchers and educators who use computing and the technologists who develop high-performance computing on future requirements and opportunities for the national CI. The NSF-wide ACCI has established six task forces and has asked them to address long-term cyberinfrastructure issues and provide recommendations for the future. The task forces are:

- Campus Bridging;
- Data;
- Grand Challenge Communities;
- High Performance Computing;
- Software and Tools; and
- Learning and Work Force Development.

These task forces are composed of a set of distinguished members from the external science and engineering community, with NSF program officers from the research directorates and offices acting as liaisons. The task forces reported their findings and recommendations at the December 2010 ACCI meeting and are in the process of completing their final reports by third quarter of FY 2011.

Number of People Involved in OCI Activities

	FY 2010 Actual Estimate	FY 2010 ARRA Estimate	FY 2010 Enacted/ Annualized FY 2011 CR Estimate	FY 2012 Estimate
Senior Researchers	778	91	455	775
Other Professionals	319	21	205	320
Postdoctorates	98	-	50	100
Graduate Students	340	-	200	340
Undergraduate Students	158	-	75	155
Total Number of People	**1,693**	**112**	**985**	**1,690**

Office of Cyberinfrastructure High Performance Computing Portfolio

OCI High Performance Computing Funding

(Dollars in Millions)

	Prior Years[1]	FY 2010 Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request
TeraGrid[2]	$133.91	$6.70	-	-
Track 1	98.38	90.50	90.00	32.00
Track 2	144.22	15.40	10.00	-
Innovative HPC Program	-	11.90	10.00	30.00
Teragrid - Phase III (XD)	20.22	3.60	3.00	32.00
Total	**$396.73**	**$128.10**	**$113.00**	**$94.00**

Totals may not add due to rounding.

[1] Prior Years includes $17.0 million of ARRA funding in FY 2009.

[2] Transition from TeraGrid to eXtreme Digital (XD) in FY 2010 - refer to section on XD for more information.

Track 1 – Blue Waters

Description

The National Center for Supercomputing Applications (NCSA) at the University of Illinois at Urbana-Champaign will provide the capability for researchers to tackle much larger and more complex research challenges than previously possible, across a wide spectrum of domains. NCSA will acquire, deploy, and operate a petascale sustainable, architecturally coherent, innovative, leadership-class, high-performance computational resource, to be known as Blue Waters, for the science and engineering research community. This investment complements the Department of Energy (DoE) Office of Science program on compute hardware, which focuses on peak petascale performance, while Blue Waters will provide sustained petascale performance. Also, while the DoE microprocessors are commodity processors, the microprocessors in Blue Waters were altered to address the specific needs of the HPC community. This system will be sited at University of Illinois at Urbana-Champaign (UIUC) where it will be operated by NCSA and its partners in the Great Lakes Consortium for Petascale Computing (GLC).

The Blue Waters project also includes education and outreach programs that will target pre-college, undergraduate, graduate, and post-graduate levels. A Virtual School of Computational Science and Engineering has been established to create courses that focus on petascale computing and petascale-enabled science and engineering. The Virtual School is exploring new instructional technologies and creating courses, curricula, and certificate programs tailored to science and engineering students. It has also sponsored workshops, conferences, summer schools, and seminars.

The project includes an annual series of workshops targeted at the developers of simulation packages and aspiring application developers. In addition, the project includes two industrial partnership activities: the Industry Partners in Petascale Engagement (IPIPE) program will provide industrial partners with a first look at the technological and scientific developments that flow from the petascale program. The Independent Software Vendor Application Scalability Forum will promote collaborations among consortium members, independent software vendors, and the industrial end-user community.

The broader impacts of this award include: provisioning of unique infrastructure for research and

education; extensive efforts accelerating education and training in the use of high-performance computation in science; training in petascale computing techniques; promoting an exchange of information between academia and industry about the applications of petascale computing; and broadening participation in computational science through NCSA's Girls Engaged in Mathematics and Science (GEMS) program. GEMS is designed to encourage middle-school girls to consider mathematics-oriented and science-oriented careers.

Science and engineering research and education activities enabled by Blue Waters

This award permits investigators across the country to conduct innovative research demanding petascale capabilities. Allocations have been requested for research on: complex biological behavior in fluctuating environments, the electronic properties of strongly correlated systems, the properties of hydrogen and hydrogen-helium mixtures in astrophysically relevant conditions, the electronic and magnetic structures of transition metal compounds, the molecular dynamics responsible for the properties of liquid water, and the propagation of seismic energy through a detailed structural model of Southern California together with the predicting of ground motion and the modeling of the response of buildings and other structures. Other allocations address testing hypotheses about the role of cloud processes and ocean mesoscale eddy mixing in the dynamics of climate and improving climate models, the formation of the first galaxies, turbulent stellar hydrodynamics, binary black hole and neutron star systems as sources of gamma ray bursts, and other intense radiation phenomena, contagion, and particle physics.

Management and Oversight

NSF Structure: The project is managed and overseen by OCI program staff and a grants officer from the Division of Grants and Agreements (DGA). These NSF staff members receive strategic advice from NSF's CIF21 working group, which includes representatives from the various directorates and offices and is currently jointly led by OCI and the Directorate for Mathematical and Physical Sciences (MPS). Advice from the Office of General Counsel (OGC) is sought as necessary.

The contract between UIUC and IBM, the principal sub-awardee, includes milestones at which IBM's progress is assessed through a series of deliverables, including software packages and demonstrations, tests of preliminary hardware, simulators, technical specifications, and programmer guides.

External Structure: During the development and acquisition phase of this project, UIUC oversees work by a number of sub-awardees, conducts software development, and assists competitively selected research groups to prepare to use the Blue Waters system. The primary sub-awardee, IBM, is responsible for implementation of the hardware, system software, and main program development tools. Other sub-awardees will work on performance modeling, the evaluation of an astrophysical modeling framework, the engagement of applications groups, scalable performance tools, undergraduate training, and broadening the participation of underrepresented groups in high-performance computing. Following system testing and acceptance in mid-2012, the Blue Waters project will enter a five-year operations phase. A proposal from UIUC for operations is anticipated in FY 2012. The project team is advised by a Petascale Executive Advisory Committee composed of senior personnel with technical and management expertise in high-performance scientific computing, the management of acquisition contracts for leading-edge computing systems, and the operation of large computing centers.

Risks: Any activity of this nature, and at this scale, comes with a certain element of risk. The extensive review process, conducted prior to award, reviews and analyzes the risks as presented in the proposal and identifies any additional risk that should be considered. The Track 1 award required that risks be identified, analyzed, and a mitigation plan created and followed. One of the activities of the periodic NSF external reviews, by a panel of experts, is to revisit and assess the risk situation and make recommendations as deemed necessary. Risks that are no longer applicable are retired. New risks may

be added, or degree of risk promoted or demoted as necessary, all of which is documented in a risk register. Discussion of risks is part of the weekly discussions between UIUC and NSF. Periodic closed session updates to the NSB identify any major changes in risk assessment.

Reviews: The project was selected through a competitive review in 2007. An external panel of experts, selected by NSF, reviews the progress of the project including project management, risk management, hardware and software development, and the provision of advanced user support to research groups receiving provisional resource allocations on the Blue Waters system. One of the important roles of this external review panel is to analyze the awardee's assessments of the deliverables from its sub-awardees, together with the awardee's and sub-awardees' plans for remedial action when necessary, and to provide NSF with advice on whether these assessments and plans are reasonable. At the time of writing, these external reviews had been conducted in February 2008, April 2008, October 2008, April 2009, July 2009, December 2009, April 2010, and September 2010, with further reviews planned for February 2011 and at four to six month intervals thereafter until project completion. In addition, NSF conducts site visits. The most recent review, held in September 2010, focused on project deliverables, project risks and risk management. In addition, current milestone deliverables were reviewed for acceptance. Specific topics included IBM deliverables, IBM schedule, IBM technical plans for hardware and system software, early testing results, I/O and storage plans, and science and engineering team support. The review panel provided feedback and recommendations on all items, concurring with proposed revisions to project schedule and overall project plans.

Current Status: In late FY 2010 UIUC was notified by IBM that FY 2011 sub-award milestones would be delayed. UIUC submitted a request to NSF to extend the project end date by approximately nine months. The external review panel recommended approval of the extension in December 2010 and NSF approved the change to schedule in January 2011. Acquisition is expected to be completed in FY 2012. Mitigation includes installation of a large partial system for early science users in FY 2011. The project is currently within budget and the project scope remains unchanged.

Track 2

The Track 1 system is targeted to provide sustained petascale performance, while the Track 2 systems provide, at most, petascale peak performance. The Track 1 system is expected to support on the order of a dozen projects, each capable of producing break-through results as a direct result of having access to such a facility. Each Track 2 system is capable of supporting hundreds of researchers (over the course of a year) doing leading-edge science and engineering. In previous years, funding was provided for Track 2A and 2B awards that have transitioned into production TeraGrid resources. The Track 2C competition did not result in an award. The three Track 2D awards are in the initial phases and will transition to production resources in 2011 and 2012. Operations and maintenance funding for the Track 2Da and Track 2Dc awards was provided in FY 2010 as they will begin to support early TeraGrid science users in FY 2011 Track 2Db installed an initial system in FY 2010 and operations and maintenance will be provided in FY 2011.

There is a direct relationship between the Track 2 awards and the TeraGrid activity. Track 2A and 2B provide the acquisition process for new systems that will become part of TeraGrid. Track 2 awards are made to an institution following an extensive external review process. Track 2A and B proposals submitted consisted of two parts: a) an acquisition component and associated funding, and b) an operations and maintenance component and associated funding. Track 2D proposals did not separate these components due to the experimental nature of the systems. When an award is made, the funding goes to the institution which issues sub-awards to vendors as necessary. Once the system has passed the acceptance process, any vendors receive final payment for the system. Once the system has been fully

tested, it becomes a TeraGrid/eXtreme Digital (XD) resource and the institution becomes a TeraGrid/XD resource provider and has access to the operations and maintenance funding component of the award. Immediately below is information that is common to the Track 2D program and hence is applicable to all Track 2D awards. Any differences or project-specific information are discussed in that award's section.

Science and engineering research and education activities enabled by Track 2D

- The complete spectrum of scientific research is supported, including: climate and weather modeling, cosmology and astrophysics, geosciences, physics, chemistry, biology and medicine, earthquake engineering, and mechanical engineering.

- TeraGrid is required to provide evidence of outreach activities that include various education and training opportunities being made available. These are evaluated as part of the annual review process.

- In addition, part of the Track 2D acquisition review process includes an assessment of education and outreach activities being considered.

Management and Oversight for Track 2D

NSF Structure:

- NSF oversight is provided by OCI program officers who provide direct oversight during both the acquisition and operations phase and the system integration into the TeraGrid and the follow-on eXtreme Digital (XD) activity.

- Formal reporting consists of quarterly and annual reports. These are reviewed by the program officer. There are also bi-weekly teleconferences with NSF program officers.

Risks: Any activity of this nature, and at this scale, comes with a certain element of risk. The review process, conducted prior to award, reviews and analyzes the risks as presented in the proposal and identifies any additional risk that should be considered. The Track 2D award process requires that risks be identified, analyzed, and a mitigation plan created and followed. One of the activities of the periodic NSF external reviews, by a panel of experts, is to revisit and assess the risk situation and make recommendations as deemed necessary. Risks that are no longer applicable are retired. New risks may be added, or degree of risk promoted or demoted as necessary, all of which is documented in a risk register.

Reviews:

- Annual reviews are performed as part of the TeraGrid annual review.

- Semi-annual reviews are performed as part of the acquisition phase. The reviews are arranged by the NSF program officer. The reviewers' backgrounds include scientific research, project management, and large scale systems acquisitions and operations, and include familiarity with projects funded by NSF as well as other federal agencies. To the extent possible, continuity through the series of reviews is provided by using the same set of reviewers.

External Structure:

- Each Track 2D award will be managed under a cooperative agreement. Each Track 2D awardee will be responsible for the satisfactory completion of milestones in order for the spending authorization to be raised. Progress will be determined by the review process and the NSF program officer.

- Each project has a detailed management plan in place. Each cooperative agreement includes the management structure, milestones, spending authorization levels, and review schedule.

Current Status:

- The Track 2D cooperative agreement awards were made in FY 2009 and are proceeding appropriately with early TeraGrid science users beginning to test the Track2Da and Track2Dc systems. The Track2Db system was delayed to late FY 2010 to take advantage of a newer, improved technology, which has since been implemented.

Track 2Da - Gordon Data Intensive Computing at San Diego Supercomputer Center (SDSC)

Description

- The University of California at San Diego (UCSD) will provide a ground-breaking new computing facility, Gordon, which will be made available to the research community together with advanced user support for researchers with data intensive problems that may not parallelize well or will require access to very large amounts of memory.

- The distinguishing features are the integration of solid state disks (SSDs) and very large shared memory. This system will be optimized to support research with very large data-sets or very large input-output requirements. It will provide a step-up in capability for data-intensive applications that scale poorly on current large-scale architectures, providing a resource that will enable transformative research in many research domains.

- The system will become part of the NSF TeraGrid and the follow-on eXtreme Digital cyberinfrastructure in FY 2011.

Track 2Db – Keeneland Experimental High Performance Computing at Georgia Institute of Technology

Description

- The Georgia Tech Research Corporation (GTRC) will provide a new experimental high performance computing facility with unconventional architectures, Keeneland, to scientific and engineering researchers so they can evaluate the merit of these architectures.

- The distinguishing feature of Keeneland is the inclusion of General-Purpose computation on Graphics Processing Units (GPGPU) processors as general purpose compute accelerators in a sufficiently large system to address computational problems that are challenging to more conventional supercomputing architectures. Productivity is of particular interest in using Open Computing Language (OpenCL) as a mechanism to program the GPGPUs.

- Applications will require additional development and testing to be appropriately prepared to effectively use this new type of architecture.

- An initial system has been installed, has passed acceptance testing and is in use for software development and applications testing. This allows researchers lead time in order to prepare their applications for the full scale system to be installed two years later.

- The system will become part of the NSF eXtreme Digital cyberinfrastructure in FY 2012.

Track 2Dc - FutureGrid Experimental High Performance Grid Testbed at Indiana University (IU)

Description

- The project team, led by Indiana University, will provide a significant new experimental computing grid and cloud test-bed, named FutureGrid, to the research community, together with user support for third-party researchers conducting experiments on FutureGrid. This will enable them to tackle complex research challenges in computer science related to the use and security of grids and clouds.
- The test-bed includes a geographically distributed set of heterogeneous computing systems, a data management system that will hold both metadata and a growing library of software images, and a dedicated network allowing isolatable, secure experiments.

- The test-bed will support virtual machine-based environments as well as native operating systems for experiments aimed at minimizing overhead and maximizing performance.

- The project partners will integrate existing open-source software packages to create an easy-to-use software environment that supports the instantiation, execution, and recording of grid and cloud computing experiments.

- The FutureGrid project team has been directed to prepare a written interaction plan and to present this to NSF after the award for XD has been made. The plan should include the mechanism by which XD may leverage FutureGrid.

Innovative HPC Program

Description

Using lessons learned during the execution of the HPC Track 2 program and informed by the NSF ACCI's High Performance Computing task force, the HPC Track 2 program has been renamed in 2011 with incremental changes in the FY 2011 solicitation. This program provides production ready HPC systems and services as well as opportunities for investigating innovative high-risk/high-payoff approaches to providing the necessary computational resources required by the science and engineering community. The newly named program is aligned with the eXtreme Digital activity, TeraGrid Phase III (XD). XD serves as the consistent foundation for the services and resources within the Innovative HPC Program. XD contributes to achieving the NSF Vision for Cyberinfrastructure for 21st Century Science and Engineering.

Beginning in FY 2011, based on feedback from the scientific and engineering community, a more sustained approach to core HPC services will be initiated. This will allow a longer time horizon for funding of HPC providers in recognition of the value and time required for building and retaining staff skilled in interdisciplinary computational science. Thus, an eight to ten year horizon is envisioned for a core HPC provider, with at least two awards plus accompanying O&M awards over the same time period for each provider. At least one acquisition award of up to $30.0 million is planned in FY 2011.

Science and Engineering Activities Enabled by Innovative HPC

- Innovative HPC will enable world leading transformative advances in science and engineering research, in the integration of research and education, and in broadening participation in science and engineering by underrepresented groups, by providing researchers and educators with usable access to computational resources, beyond those typically available on most campuses, together with the interfaces, consulting support, and training necessary to facilitate their use.

- Through the unifying XD framework and services, Innovative HPC will enable researchers to

manipulate extremely large amounts of digital information from simulation, sensors, and experiments, and add needed capabilities in remote visualization, an increasingly important analysis tool for modern science and engineering.

- Outreach and training critical to reducing the barriers to the use of HPC systems by the research and education community will be provided. Innovative HPC will incorporate new computational technologies and new approaches to software and data management, together with the expertise to enable researchers and students to complement theory and experiment with an equal emphasis in computation.

Management and Oversight

NSF Structure: OCI program officers provide direct oversight during both the acquisition and operations phase. Formal reporting consists of quarterly and annual reports, which are reviewed by the program officer. There are also bi-weekly teleconferences with NSF program officers.

Risks: Any activity of this nature, and at this scale, comes with a certain element of risk. The review process, conducted prior to award, reviews and analyzes the risks as presented in the proposal and identifies any additional risk that should be considered. The experimental awards, by nature, will encompass high-risk, high-reward scenarios. The award process requires that risks be identified, analyzed, and a mitigation plan created and followed. One of the activities of the periodic NSF external reviews, conducted by a panel of experts, is to revisit and assess the risk situation and make recommendations as deemed necessary. Risks that are no longer applicable are retired. New risks may be added, or degree of risk promoted or demoted as necessary, all of which is documented in a risk register.

Reviews:
Annual reviews will be performed as part of the XD review. Semi-annual reviews will be performed as part of the acquisition phase. The reviews are arranged by the NSF program officer. The reviewers' backgrounds include scientific research, project management, and large scale systems acquisitions and operations, and include familiarity with projects funded by NSF as well as other federal agencies. To the extent possible, continuity through the series of reviews will be provided by using the same set of reviewers.

External Structure:
Each Innovative HPC award will be managed under a cooperative agreement. Each awardee will be responsible for the satisfactory completion of milestones in order for the spending authorization to be raised. Progress will be determined by the review process and the NSF program officer. Each cooperative agreement will include the management structure, milestones, spending authorization levels, and review schedule.

Current Status: The solicitation was released in December 2010 with proposals due in March 2011. One award is expected in late FY 2011.

TeraGrid Phase III: eXtreme Digital (XD)

Description:
- The TeraGrid (TG), predecessor to XD, is an advanced, nationally distributed, open cyberinfrastructure comprised of supercomputing, storage, analysis, and visualization systems, data

services, and science gateways, connected by high-bandwidth networks, integrated by coordinated policies and operations, and supported by computing and technology experts.

- It enables and supports leading-edge scientific discovery and promotes science and technology education.
- XD takes a significant step forward by encouraging innovation in the design and implementation of an effective, efficient, increasingly virtualized approach to the provision of high-end digital services – extreme digital services – while ensuring that the infrastructure continues to deliver high-quality access for the many researchers and educators that use it in their work.

Science and engineering research and education activities enabled by XD

- XD will enable transformative advances in science and engineering research, in the integration of research and education, and in broadening participation in science and engineering by under-represented groups, by providing researchers and educators with usable access to extreme-scale digital resources beyond those typically available on most campuses, together with the interfaces, consulting support, and training necessary to facilitate their use.

- XD will provide high-performance computing services, enable researchers to manipulate extremely large amounts of digital information from simulations, sensors, and experiments, and add needed capabilities in remote visualization, an increasingly important analysis tool for modern science and engineering.

- Outreach and training critical to reducing the barriers to the use of advanced digital systems by the research and education community will be provided. XD will incorporate new ideas and technologies to enable researchers and students to move transparently between local and national resources, substantially lowering the barriers to effective use of cyberinfrastructure and promoting enhanced productivity.

Management and Oversight

NSF Structure:

- XD will consist of several inter-related parts: a High-Performance Remote Visualization Service (HPRVS), a Coordination and Management Service (CMS), a Technology Audit and Insertion Service (TAIS), an Advanced User Support Service (AUSS), and a Training, Education and Outreach Service (TEOS).

- These elements are designed and implemented in a way that is consistent with sound system engineering principles, clearly tied to the user requirements of the science and engineering research community using a flexible methodology that permits the architecture to evolve in response to changing user needs and presents the individual user with a common user environment regardless of where the resources or user are located.

- The HPRVS was reviewed in FY 2009 and two awards were made, one to the University of Texas ($7.0 million) and one to the University of Tennessee ($10.0 million).

- The TAIS component of XD was reviewed in FY 2010 and two awards were made; one to the University of Buffalo for the Technical Audit Service and one to the University of Illinois for the Technical Insertion Service. These two awards will facilitate the TeraGrid to XD transition.

- The final phase of XD, involving the other three services, is scheduled to come online in FY 2011. The total anticipated funding for XD in FY 2012 is $32.0 million.

- Similar to TG, XD will be managed by OCI, informed by the ACCI and its task forces, with ongoing strategic guidance from the NSF cross-directorate CIF21 working group. An external Science Advisory Board, similar to the TG Science Advisory Board, will provide ongoing community input to the XD project.

- OCI will hold weekly teleconferences with XD senior personnel.

External Structure:

- The final configuration of XD will consist of seven sites, each containing a range of high performance computing platforms, large disk storage devices, computational platforms specifically tailored for remote visualization, high-bandwidth networks, a broad set of user services and an education, outreach, and training component designed to fulfill the needs of current users of high-performance computing as well as to broaden participation to new communities and under-represented groups in science and engineering.

Current Status:

- Phase I – Two planning grants, one to UCSD ($1.60 million) and one to UIUC ($1.62 million), were made in FY 2009 to obtain community input and engagement in order to develop the ideas and expanded horizons that will be required to deploy the advanced infrastructure required for XD. The planning grants were reviewed in February 2010, and the two teams submitted their full proposals in July 2010.

- Phase II – The full proposals were reviewed by an external panel of experts in the fourth quarter of FY 2010 and a recommendation will be made in the second quarter of FY 2011. NSF expects to make an award in FY 2011.

- NSF expects to have all components of XD in production between FY 2011 and FY 2013.