Advanced Scientific Computing Research
Funding Profile by Subprogram and Activity

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR*	FY 2014 Request
Mathematical, Computational, and Computer Sciences Research			
Applied Mathematics	45,547	—	49,500
Computer Science	46,131	—	54,580
Computational Partnerships	45,961	—	46,918
Next Generation Networking for Science	13,929	—	15,931
SBIR/STTR	0	—	5,518
Total, Mathematical, Computational, and Computer Sciences Research	151,568	—	172,447
High Performance Computing and Network Facilities			
High Performance Production Computing	57,800	—	65,605
Leadership Computing Facilities	156,000	—	147,000
Research and Evaluation Prototypes	26,922	—	38,552
High Performance Network Facilities and Testbeds	36,014	—	32,608
SBIR/STTR	0	—	9,381
Total, High Performance Computing and Network Facilities	276,736	—	293,146
Total, Advanced Scientific Computing Research[a]	428,304	443,566	465,593

*FY 2013 amounts shown reflect the P.L. 112-175 continuing resolution level annualized to a full year. These amounts are shown only at the "congressional control" level and above; below that level a dash (—) is shown.

[a] SBIR/STTR funding:
- FY 2012 Appropriation: SBIR $11,073,000 and STTR $1,491,000 (transferred out of ASCR in FY 2012 Current column)
- FY 2014 Request: SBIR $13,037,000 and STTR $1,862,000

Public Law Authorizations

Public Law 95-91, "Department of Energy Organization Act", 1977
Public Law 102-468, "Energy Policy Act of 1992"
Public Law 109-58, "Energy Policy Act of 2005"
Public Law 110-69, "America COMPETES Act of 2007"
Public Law 111-358, "America COMPETES Reauthorization Act of 2010"

Overview

The Advanced Scientific Computing Research (ASCR) program's mission is to advance applied mathematics and computer science; deliver, in partnership with disciplinary science, the most advanced computational scientific applications; advance computing and networking capabilities; and develop, in partnership with the research community, including U.S. industry, future generations of computing hardware and tools for science. In this way, ASCR supports the science goal of the Department of Energy (DOE) 2012 Strategic Plan to maintain a vibrant U.S. effort in science and engineering as a cornerstone of our economic prosperity and underpins the targeted outcome to "develop and deploy high-performance computing hardware and software systems through exascale platforms."

Over the past two decades, in both theory and experiment, computing has become a ubiquitous tool for science and engineering that allows researchers to delve deeper, think bigger, and explore regimes previously out of reach. ASCR and its predecessor organizations, in partnership with the National Nuclear Security Administration's Advanced Simulation and Computing (ASC) program, has led this computing revolution for the past decade, building on a foundation of over 50 years of research and collaboration. This partnership has delivered the scientific promise of high performance computers for national security, science, and engineering and has driven the world leadership of U.S. vendors in high performance computing. Together, ASCR and ASC led the transition to parallel computing with interconnected commercial processors in the 1990s. In 2009, ASCR delivered the first petascale systems for open science that helped increase our understanding of diseases such as Parkinson's and Alzheimer's and disasters such as earthquakes and hurricanes along with enabling improvements in the energy efficiency of aircraft and long-haul trucks. In addition, ASCR-supported software, such as the Message Passing Interface (MPI) built into all massively parallel software, has enabled the worldwide parallel computing industry—from dual core laptops to supercomputers. ASCR-developed software, protocols, advanced storage technologies, data tools and math libraries are used throughout industry and academia. ASCR's Scientific Discovery through Advanced Computing (SciDAC) program improved the performance of DOE applications up to 10,000 percent and have enabled dozens of applications to run at the petascale enabling researchers to increase the efficiency of combustion engines, understand the physical mechanisms of stress-corrosion cracking, reduce uncertainties in global climate models such as those due to the transport of ice sheets, predict the behavior of fusion plasmas, explain the progression of supernovae, predict structure and decay of novel isotopes, and calculate the subatomic interactions that determine nuclear structure.

Growth in the use of computing, the demand for both capability and capacity computing and the impact on science and engineering continues to challenge and inspire the ASCR program. ASCR's FY 2014 budget positions the Department to address scientific challenges that require 1,000 fold increases in computing capability and scientific data. The transition to the next generation of high performance computing is fundamentally different than the transition to parallel computing because the electric power required to move data now dwarfs the power necessary for calculations, and because the increases in parallelism are now multilayered—both on the chips and between them. ASCR's research investments seek to ensure DOE applications continue to efficiently harness the potential of commercial hardware while controlling power bills at DOE computing facilities, which based on current technologies, are projected to rise dramatically in order to achieve performance increases.

Since the power and parallelism challenges span the computing industry, ASCR's research investments will impact computing at all scales from the largest scientific computers to home laptops.

The strategy to accomplish this, like the strategy that has underpinned the Department's leadership during the past half century, has two thrusts: developing and maintaining world-class computing and network facilities for science; and research in applied mathematics, computer science and advanced networking. ASCR leverages partnerships to bring the first two thrusts together to transform science.

Through both the Research and Evaluation Prototype activity and the facility upgrade projects, ASCR has a history of successfully partnering with the research community, including industry to improve the programmability of the next generation of computers while readying applications to run on those computers from the first day of operations. The current upgrade of the Argonne Leadership Computing Facility to a 10 petaflop system is the direct result of a five year partnership between Argonne and Lawrence Livermore national laboratories and industry, funded through the Research and Evaluation Prototype activity. In addition, Argonne has been working with computer science researchers and 15 "early science applications" that best represent DOE applications, take advantage of the novel features of the system, and identify any remaining issues before the machine is transitioned to operations. This technique has been successfully used at all of the ASCR facilities to identify hardware and software issues in the early stages of deployment. In addition, the planned National Energy Research Scientific Computing (NERSC-7) upgrade will triple NERSC's capacity and will be the first installation of a High Productivity Computing System developed through the Research and Evaluation Prototype partnership with DARPA. The Oak Ridge Leadership Computing Facility has worked extensively with hardware and software vendors to develop the tools, system software, and user interfaces necessary to enable DOE applications to effectively use hybrid technologies such as those incorporated into the upgrade currently underway at the facility.

The U.S. is not alone in recognizing the growing importance of high performance computing and its potential economic impact. The potential from broad adoption of more advanced computing for our society, our economy, and the Department's missions is tremendous and has been well documented through numerous reports from DOE, DARPA, the National Academies, the Council on Competitiveness, and other workshops, studies, and reports[a]. Today, the United States is the clear leader in high-performance computing (HPC), with 90% of HPC platforms employing U.S.-developed technologies and most of the work performed on supercomputers using software developed by U.S. researchers. Seeing HPC as a key to economic competitiveness, China, the European Union, India, and Japan, have significantly increased their investments in HPC hardware, software, and applications. A new Japanese machine is one of the most powerful computers in the world; it was built using processors from a Japanese vendor and has a specially designed interconnection network developed in Japan. The Chinese, who didn't have a noticeable presence in HPC ten years ago, have also developed one of the world's fastest computers using processors from U.S. vendors with a Chinese interconnection network. There is a real possibility that within ten years a Chinese company, with significant investments from the Chinese government, will produce the world's most powerful supercomputer using processors designed and manufactured in China. In November 2012, DOE, using U.S.-developed components, dominated the list of the Top 500 supercomputers[b] with ASCR's Titan machine at the Oak Ridge Leadership Computing Facility topping the list at 27 petaflops. The FY 2014 budget seeks to build on that accomplishment with open science upgrades and application support that delivers on the promise of leadership computing today while also making strategic research investments for the future.

[a] www.science.energy.gov/ascr/programdocuments
[b] www.top500.org

Basic and Applied R&D Coordination

Coordination across disciplines and programs is an ASCR cornerstone. Partnerships within SC are mature and continue to advance the use of high performance computing and scientific networks for science. A growing area of collaboration will be in the area of data-intensive science. ASCR continues to have a strong partnership with the National Nuclear Security Administration that is essential to achieving the Department's goals for exascale computing. In April 2011, ASCR and the NNSA strengthened this partnership by signing a memorandum of understanding for collaboration and coordination of exascale research within the Department. Key areas of mutual interest between ASCR and the DOE technology programs, particularly the Office of Electricity Delivery and Energy Reliability and the Office of Nuclear Energy, continue to be applied mathematics for the optimization of complex systems, control theory, and risk assessment. Through the National Information Technology Research and Development (NITRD) Subcommittee of the National Science and Technology Council's Committee on Technology, the interagency networking and information technology R&D coordination effort, ASCR also coordinates with similar programs across the Federal Government.

Program Accomplishments and Milestones

DOE Computers Dominate November 2012 Top500 list. DOE's Oak Ridge National Laboratory (ORNL), Lawrence Livermore National Laboratory (LLNL), and Argonne National Laboratory (ANL) put DOE back on the top of the world's most powerful supercomputers as measured by the November 2012 Top500 list, with ORNL's Titan ranking first at 27 petaflops, LLNL's Sequoia is second at 20 petaflops, and ANL's Mira is fourth at 10 petaflops. Two of these machines are the result of a long-standing research and development partnership among ANL, LLNL, and industry.

Small Business Uses OLCF to Rapidly Move from Simulations to New Turbo Compressor. A small, Seattle-based energy R&D firm is developing a novel gas compressor system based on shock wave technology used in supersonic flight applications. This technology has important promise for the turbo machinery industry of engines and compressors. With support from OLCF, the company has dramatically increased its ability to use high performance simulation to solve complex engineering problems. Simulations at the OLCF guide the testing of prototypes to optimize aerodynamic performance improvements. Such a process requires a system like Jaguar, with hundreds of thousands of processors, along with sophisticated mathematical algorithms to analyze and predict this optimal solution. According to the firm, use of the OLCF has cut the projected time from concept to a commercial product by at least two years and the cost by over $2 million.

NERSC Enables A New Approach to Water Desalination. The availability of fresh water is dwindling in many parts of the world, a problem that is expected to grow with populations. One promising source of potable water is seawater, but so far desalination technology has been too expensive for widespread use. Using NERSC supercomputers, researchers from the Massachusetts Institute of Technology have come up with a new approach for desalinating sea water using graphene, one-atom-thick sheets of carbon. Reverse osmosis, a common method of desalination, uses membranes to filter the salt from the water. Graphene is 99.9% thinner than reverse osmosis membranes. Using NERSC, the researchers were able to simulate the properties of the material down to the atomic level, producing a graphene sheet perforated with precisely sized holes. The new graphene system will operate at a much lower pressure and could purify water at far lower costs.

Co-design Center Challenges Conventional Wisdom. The Center for Exascale Simulation of Advanced Nuclear Reactors, or CESAR, has performed some preliminary studies to understand the various uncertainties in a reactor simulation. Conventional wisdom suggests that in considering the uncertainties, the numerical approximations are not a factor and the uncertainties in the physical data (such as nuclear reaction cross-sections) used in these simulations are major contributors. However, CESAR's studies, incorporating advanced uncertainty quantification techniques, have suggested otherwise. These preliminary studies have paved the way for more detailed studies that will improve how we characterize and quantify uncertainties in nuclear reactors simulations.

New Technique Compresses Scientific Data up to 50%, Lowers Memory Footprint and Saves Energy. ASCR supported researchers at ORNL have developed ISOBAR, a compression technique for hard-to-compress scientific datasets. ISOBAR exhibits both read and write performance gains proportional to the degree of data reduction, up to 46% on scientific datasets, in addition to reducing the total amount of data that is being stored and accessed. By operating on a lower memory footprint in parallel, this method offers high throughput, reduced data movement, and data reduction that collectively translate to a 50% reduction in energy consumption.

ESnet-5, A New 100 Gigabit per second Nationwide Platform for Science Discovery, Wins Awards. Currently ESnet carries up to 10 petabytes of data every month. Traffic over ESnet has increased an average of 10 times every 4 years, propelled by the rising tide of data produced by supercomputers, global collaborations that can involve thousands of researchers, and specialized facilities like the Large Hadron Collider and digital sky surveys. After three years of planning and deployment, ESnet-5—ESnet's fifth generation network—launched in November 2012 and became the world's fastest science network and the first continental 100 Gbps network. This provided an immediate tenfold increase in bandwidth to DOE research sites at the same cost. ESnet has also created a national-scale network testbed, available to researchers and industry for experiments with new network technologies, protocols, and applications at 100 Gbps. *FierceGovernment* chose the ESnet5 Deployment Team as a recipient of the annual Fierce 15 award, in recognition of "federal employees and teams who have done particularly innovative things." Information Week named ESnet as one of the "top 15 innovators in government IT for 2012" stating that "Advanced research can't exist on high-performance computing alone. It needs big bandwidth, too."

Milestone	**Date**
Initiate at least four new teams to conduct fundamental computer science research and at least three new applied mathematics research awards that address issues of fault tolerance or energy management for massive scale heterogeneous systems. (Applied Mathematics and Computer Science)	4th Qtr, FY 2013
Independent review of co-design center progress in influencing industry designs and preparing applications for next generation hardware. (Computational Partnerships)	4th Qtr, FY 2013

Program Planning and Management

ASCR planning, program evaluation, and priority setting strongly benefit from input and review by outside experts. ASCR peer review and oversight processes are designed to regularly assess the quality, relevance, and performance of the ASCR portfolio, and are consistent with the President's management agenda[a].

The Advanced Scientific Computing Advisory Committee (ASCAC) provides input to ASCR in response to charges from the Office of Science. For example, ASCAC organizes regular Committees of Visitors (COVs) and other subcommittees to review ASCR research management, identify opportunities and challenges in specific areas of research, review the impact of ASCR scientific user facilities, and track progress toward the long-term goals of the program. In 2012, ASCAC delivered a report on the opportunities and challenges associated with exascale computing, a review of the data policies of ASCR relevant communities, a COV report on the Next Generation Networking for Science elements of the ASCR program, a report on the management and impact of the Computational Science Graduate Fellowship, and a COV on the Computer Science activity. Currently, ASCAC is responding to charges to identify the critical areas where exascale and data-intensive science intersect, with attention to opportunities for high pay-off research; to provide input for Office of Science prioritization of planned scientific user facilities; and to conduct a COV for the Applied Mathematics activity. The first two reports are due in spring 2013 and the COV will report later in 2013.

The Department's mission applications require the ASCR portfolio to be continuously assessed and shifted to support critical new research efforts. FY 2014 will require significant shifts across the research portfolio to emphasize the rapid development of new tools and methods to allow DOE applications to continue to make effective use of commercial HPC.

Critical tools for managing ASCR scientific user facilities include tailored project management principles, annual operational reviews, and regular requirements gathering workshops. For example, ESnet and NERSC conduct requirements workshops with at least two SC program offices every year in order to accurately characterize their near-, medium-, and long-term network and computing requirements. The ASCR facilities are also required to understand the challenges of evolving hardware vis-à-vis their users and to ensure that users are ready to meet those challenges and continue to mission-relevant science. This means scientific support staff at the facilities work with scientists and their applications to get them ready to run effectively on the new architectures.

Other planning and management tools include community-driven workshops, NITRD participation, and studies by outside groups such as the National Research Council and the U.S. Council on Competitiveness.

Program Goals and Funding

Office of Science performance expectations (and therefore funding requests) are focused on four areas:

- *Research*: Enable high performance computational science and engineering to increase our understanding of and enable predictive control of phenomena in the physical and biological sciences.
- *Facility Operations*: Maximize the performance, usability, and capacity of the SC scientific computing user facilities and connect Office of Science researchers, labs, and facilities via an ultra-reliable, high performance scientific network.
- *Future Facilities*: Build future and upgrade existing facilities and capabilities to get the best value from investments and advance continued U.S. leadership in computational science and engineering.
- *Scientific Workforce*: Continue to support graduate students and Post-Docs on research projects to ensure a sustained pipeline of highly skilled, computationally savvy, and diverse science, technology, engineering, and mathematics (STEM) workers.

[a] http://www.whitehouse.gov/sites/default/files/omb/memoranda/2012/m-12-14.pdf

Goal Areas by Subprogram

	Research	Facility Operations	Future Facilities	Workforce
Mathematical, Computational, and Computer Sciences Research	100%	0%	0%	0%
High Performance Computing and Network Facilities	10%	85%	5%	0%
Total, Advanced Scientific Computing Research	43%	53%	4%	0%

Performance Measures

Performance Goal (Measure)	**ASCR Facility Operations**—Average achieved operation time of ASCR user facilities as a percentage of total scheduled annual operation time		
Fiscal Year	**2012**	**2013**[a]	**2014**
Target	≥ 90%	≥ 90%	≥ 90%
Result	Met		
Endpoint Target	Many of the research projects that are undertaken at the Office of Science's scientific user facilities take a great deal of time, money, and effort to prepare and regularly have a very short window of opportunity to run. If the facility is not operating as expected the experiment could be ruined or critically setback. In addition, taxpayers have invested millions or even hundreds of millions of dollars in these facilities. The greater the period of reliable operations, the greater the return on the taxpayers' investment.		

Performance Goal (Measure)	**ASCR Research**—Discovery of new applied mathematics and computer science tools and methods that enable DOE applications to deliver scientific and engineering insights with a significantly higher degree of fidelity and predictive power		
Fiscal Year	**2012**	**2013**[a]	**2014**
Target	Develop exascale plan coordinated with the NNSA and socialized with the community and policy makers	Accept and put into service 10 petaflop upgrades at Argonne and Oak Ridge Leadership Computing Facilities	Initiate at least four new teams to conduct fundamental computer science research and at least three new applied mathematics research awards that address issues of fault tolerance or energy management for next-generation computing systems
Result	Not Met		
Endpoint Target	Develop and deploy high-performance computing hardware and software systems through exascale platforms		

[a] 2013 targets reflect DOE's FY 2013 Budget Request to Congress. FY 2013 target updates can be found in the upcoming FY 2012–2014 Annual Performance Plan and Report.

Explanation of Funding and Program Changes

The FY 2014 budget includes increases and priority shifts to deliver world-class computing and network facilities for science and to support research in applied mathematics, computer science, and advanced networking for computing in a new era of hardware parallelism. ASCR will also support partnerships to bring the first two thrusts together.

In FY 2014, ASCR will continue its long history as a leader in research and tools underpinning advances in storing, sending, sharing, analyzing, visualizing, and validating big data. Data-intensive science faces many of the same hardware challenges as computing-intensive science. In the past, the workflow for computational science and experiments at other SC scientific user facilities was represented by large-scale data collection or simulation followed by off-line data analyses and visualizations. However, data being produced by experiments and simulations today are rapidly outstripping our current ability to explore and understand them. Increasingly, simulations require that some analyses and visualizations be performed while data is still resident in memory, so-called in-situ analysis and visualization. Because of ASCR's close partnerships with other Office of Science programs, which steward research and facilities currently facing the immense challenges of big data, it is uniquely positioned to focus on the intersection between data-intensive science and next-generation computing research.

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
Mathematical, Computational, and Computer Sciences Research	151,568	172,447	+20,879
Research will focus on the linked challenges of emerging computing hardware (such as energy management and fault tolerance) and on data-intensive science. There are increases for core research efforts in Applied Mathematics, Computer Science, and Next Generation Networking for Science for this purpose. The cornerstones of ASCR's data-intensive science investments within Computational Partnerships will continue to be our Scalable Data Management Analysis and Visualization (SDAV) Institute and data-intensive co-design center. The goal of these efforts is to develop new and improved tools to broadly help scientists manage and analyze massive data with SDAV focused on the near term and co-design focused on emerging hardware.			
High Performance Computing and Network Facilities	276,736	293,146	+16,410
Increased funding supports operations, lease payments, and user support for ASCR facilities. ESnet expands production use of the 100 Gbps optical ring. Research and Evaluation Prototypes will expand investments in critical technologies for exascale and will begin planning system integration efforts. The focus of these efforts is to improve the energy efficiency and usability of next generation systems for the Department's science and engineering applications.			
Total, Advanced Scientific Computing Research	428,304	465,593	+37,289

Mathematical, Computational, and Computer Sciences Research
Funding Profile by Activity

	(dollars in thousands)		
	FY 2012 Current	FY 2013 Annualized CR	FY 2014 Request
Applied Mathematics	45,547	—	49,500
Computer Science	46,131	—	54,580
Computational Partnerships	45,961	—	46,918
Next Generation Networking for Science	13,929	—	15,931
SBIR/STTR	0	—	5,518
Total, Mathematical, Computational, and Computer Sciences Research[a]	151,568	—	172,447

[a] SBIR/STTR funding:

- FY 2012 Appropriation: SBIR $4,019,000 and STTR $541,000 (transferred out of ASCR in FY 2012 Current column)
- FY 2014 Request: SBIR $4,828,000 and STTR $690,000

Overview

The Mathematical, Computational, and Computer Sciences Research subprogram supports research activities aimed at effectively utilizing the Department's forefront computational and networking capabilities to advance DOE missions and extending these capabilities to forge the future of high performance computing and networking. Computational science is increasingly central to progress at the frontiers of science and to our most challenging engineering problems. Accordingly, the subprogram must be positioned to address scientifically challenging questions, to deliver:

- new mathematics required to more accurately model systems involving processes taking place across broad time and length scales;
- software, tools, and middleware to efficiently and effectively harness the potential of today's high performance computing systems and advanced networks for DOE science and engineering applications;
- operating systems, data management, analyses, representation model development, user interfaces, and other tools required to make effective use of future-generation supercomputers and the data sets from current and future scientific user facilities;
- computer science and algorithm innovations that increase the energy efficiency of future-generation supercomputers; and
- networking and collaboration tools to make scientific resources readily available to scientists, in university, national laboratory, and industrial settings.

Explanation of Funding Changes

The challenges of high performance computing systems during a period of significant hardware changes, the demands of DOE's science and engineering applications, data-intensive research, and next generation scientific user facilities require us to look ahead and make coordinated investments across the ASCR research portfolio. The research program will need to rapidly develop methods, software, and tools that enable DOE to effectively use commercial products for HPC systems. This requires a renewed focus on energy management, data movement, resiliency to work through individual chip failures, and methods and tools to improve HPC usability up to the exascale and exabytes.

(dollars in thousands)

	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
Applied Mathematics	45,547	49,500	+3,953
Increased research efforts will focus on the most critical challenges from emerging hardware for DOE mission applications with increased emphasis on energy management, data movement, and resiliency.			
Computer Science	46,131	54,580	+8,449
Increased research efforts will focus on tools and software that make emerging high performance computing hardware more usable for DOE mission applications with emphasis on improving the fault tolerance, data management, and energy utilization of applications.			
Computational Partnerships	45,961	46,918	+957
The cornerstones of ASCR's data-intensive science investments within Computational Partnerships will continue to be our Scalable Data Management Analysis and Visualization (SDAV) Institute and data-intensive co-design center. The goal of these efforts is to develop new and improved tools to broadly help scientists manage and analyze massive data with SDAV focused on the near term and co-design focused on emerging hardware.			
Next Generation Networking for Science	13,929	15,931	+2,002
Research will focus on the challenges of moving, sharing, and validating massive quantities of data from DOE scientific user facilities and large scale collaborations via high speed optical networks. This includes the challenges in building, operating, and maintaining the network infrastructure over which these data pass.			
SBIR/STTR	0	5,518	+5,518
In FY 2012, $4,019,000 and $541,000 were transferred to the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs, respectively. SBIR/STTR funding is set at 2.95% of non-capital funding in FY 2012, 3.05% in FY 2013 and 3.2% in FY 2014.			
Total, Mathematical, Computational, and Computer Sciences Research	151,568	172,447	+20,879

Applied Mathematics

Overview

The Applied Mathematics activity supports the research and development of applied mathematical models, methods, and algorithms for understanding complex natural and engineered systems related to DOE's mission. These mathematical models, methods, and algorithms are the fundamental building blocks for describing physical and biological systems computationally. Applied Mathematics research underpins all of DOE's modeling and simulation efforts.

This activity supports the development of:

- numerical methods related to problems such as fluid flow, magneto-hydrodynamics, wave propagation, and other natural or physical processes;
- computational meshing tools for developing ways in which physical domains can be efficiently partitioned into smaller, possibly geometrically complex, regions as part of a larger-scale simulation;
- advanced linear algebra libraries for fast and efficient numerical solutions of linear algebraic equations that often arise when simulating physical processes;
- optimization of mathematical methods for minimizing energy or cost, finding the most efficient solutions to engineering problems, or discovering physical properties and biological configurations;
- multiscale mathematics and multiphysics computations for connecting the very large with the very small, the very long with the very short, and multiple physical models in a single simulation;
- uncertainty quantification methodology and techniques to improve our overall understanding of complex scientific and engineering problems and allow us to make quantitative predictions about the behavior of these systems;
- efficient new mathematical models, algorithms, libraries, and tools for next generation computers that blur the boundary between applied mathematics and computer science;
- mathematics for the analysis of extremely large datasets for identifying key features, determining relationships between the key features, and extracting scientific insights from large, complex data sets; and
- mathematical optimization and risk assessment in complex systems such as cyber security or the electric grid that address anomalies in existing engineered systems, modeling of large-scale systems, and understanding dynamics and emergent behavior in these systems.

Funding and Activity Schedule

Fiscal Year	Activity	Funding (dollars in thousands)
FY 2012	Initiated new long-range, multi-institutional investments for high-risk applied mathematics research focused on achieving an integrated view of the mathematical methods required to solve difficult challenges in key application areas. The Computational Science Graduate Fellowship program is funded at $6,000,000 within this activity.	45,547
FY 2013	The FY 2013 request proposed $49,500,000 to continue support of new and redirected research efforts to develop algorithms and methods that address the challenges of data-intensive science. There are two broad categories in which DOE's missions lead to unique data-centric computing needs: advanced computing to simulate complex physical and engineering systems and DOE's advanced experimental resources.	—

Fiscal Year	Activity	Funding (dollars in thousands)
	In the FY 2013 Request, the Computational Science Graduate Fellowship (CSGF) program is funded at $6,000,000.	
FY 2014	Due to technology limitations, the next generation of high performance computers will be fundamentally different from today's systems. Although transistor sizes are continuing to decrease, power issues have eliminated meaningful increases in clock rates resulting in rapid increases in parallelism on the chip—from dual core to 24 cores in one upgrade cycle. This trend is further complicated by the addition of specialized accelerator chips. Significant innovation in applied mathematics is needed to realize the potential of these next generation machines. The Applied Mathematics portfolio will shift toward investments aimed at addressing these critical research challenges, as well as associated challenges in complex systems and data intensive science. Energy management, data movement, and resiliency research will be emphasized. The Administration is proposing a comprehensive reorganization of science, technology, engineering, and mathematics (STEM) education programs to increase the impact of Federal investments in four areas: K–12 instruction, undergraduate education, graduate fellowships, and education activities that typically take place outside the classroom. As part of this strategy, the DOE Computational Science Graduate Fellowship will be redirected for inclusion in a consolidated graduate fellowship program at the National Science Foundation. DOE will work with NSF to provide input into the development and implementation of the reformed NSF fellowship program which will reach more students and address national workforce needs.	49,500

Computer Science

Overview

The Computer Science activity supports research to utilize computing at extreme scales and to understand extreme scale data from both simulations and experiments. Industry reports indicate that because of power constraints, data movement, rather than computational operations, will be the limiting factor for future systems. Memory per core is expected to decline sharply due to power requirements and the performance growth of storage systems will continue to lag behind the computational capability of the systems. Multi-level storage architectures that span multiple types of hardware are anticipated and require the activity to support research that develops new approaches to run-time data management and analysis.

A fundamental challenge for researchers supported by this activity is enabling science applications to harness computer systems with increasing scale and increasing complexity that take advantage of technology advances such as multicore chips and specialized accelerator processors. This will require developing system software (operating systems, file systems, compilers, and performance tools) with more dynamic behavior than historically developed to deal with time-varying power and resilience requirements. Substantial innovation is needed to provide essential system software functionality in a timeframe consistent with the anticipated availability of hardware.

This activity supports the development of several areas:

- operating and file systems for extreme scale computers with many thousands of multi-core processors and complicated interconnection networks;
- performance and productivity tools for extreme scale systems that enable users to diagnose and monitor the performance of software and scientific application codes to enable users to improve performance and energy utilization and to get scientific results faster;
- programming models that enable today's computations and discover new models that scale to hundreds of thousands of processors to simplify application code development for petascale computing;
- approaches to simulate and understand the impact of advanced computer architectures on scientific applications critical to the Department; and
- data management and visualization tools to transform extreme scale data into scientific insight through investments in visualization tools that scale to multi-petabyte datasets and innovative approaches to indexing and querying data.

Funding and Activity Schedule

Fiscal Year	Activity	Funding (dollars in thousands)
FY 2012	In FY 2012, activity focused on the challenges of emerging extreme scale architectures containing as many as a billion cores and hybrid processors (such as mixed central processing unit/graphical accelerator nodes). Research efforts continued in advanced architectures and related technologies for exascale computing including the associated software with significant investments in simulators for future systems.	46,131

Fiscal Year	Activity	Funding (dollars in thousands)
FY 2013	The FY 2013 request proposed $54,580,000 to continue support of new research efforts to address the challenges of data-intensive science with a focus on full data lifecycle management and analysis for the massive data from DOE scientific user facilities. These efforts look at the full spectrum of the computer science data challenges from hardware to user interfaces and tools. This builds on decades of DOE leadership in this area of computer science and will be informed by recent ASCR workshops and reports including the requirements gathering workshops of NERSC and ESnet and the exascale series of workshops that identified many data challenges across DOE communities and those associated with the complexity of emerging hardware.	—
FY 2014	Significant innovation in computer science is needed to realize the potential of next generation high performance computing systems and other scientific user facilities. There will be continued emphasis on data-intensive science challenges with particular attention to the intersection with exascale computing challenges and the unique needs of DOE scientific user facilities including data management. There will also be expanded efforts in tools, user interfaces, the high performance computing software stack, and visualization and analytics. These efforts are essential to ensure DOE mission applications are able to use commercially available hardware.	54,580

Computational Partnerships

Overview

The Computational Partnerships activity supports the Scientific Discovery through Advanced Computing (SciDAC) program to dramatically accelerate progress in scientific computing that delivers breakthrough scientific results through partnerships among applied mathematicians, computer scientists, and scientists from other disciplines. Efforts apply results from applied mathematics and computer science core research to scientific applications sponsored by other SC programs. These partnerships enable scientists to conduct complex scientific and engineering computations on leadership-class and high-end computing systems at a level of fidelity needed to simulate real-world conditions. SciDAC applications pursue computational solutions to challenging problems in climate science, fusion research, high energy physics, nuclear physics, astrophysics, material science, chemistry, and particle accelerators.

Over the past decade, SciDAC has influenced and shaped the development of a distinct approach to science and engineering research through high performance computation. Today the SciDAC program is recognized as the leader in accelerating the use of high-performance computing to advance the state of knowledge in science applications.

SciDAC focuses on the very high end of high performance computational science and engineering and faces two distinct challenges: to broaden the community and thus the impact of high performance computing, particularly to address the Department's missions, and to ensure that further progress at the forefront is enhanced rather than curtailed by the emergence of hybrid, multi-core architectures. A decade of effort has enabled this program to simultaneously meet both of these important challenges. SciDAC has also shown U.S. industry new ways to use computing to improve competitiveness.

Looking to the challenges of the future, the SciDAC portfolio was recompeted and streamlined in FY 2011 and FY 2012 to support strategic investments in petascale scientific discovery (Institutes and Science Applications) and Co-Design Centers focused on advancing applications that need exascale computing systems while informing the designs of the emerging hardware.

Funding and Activity Schedule

Fiscal Year	Activity	Funding (dollars in thousands)
FY 2012	In partnership with other Office of Science programs, ASCR recompeted Science Applications with a focus on the highest priorities of the partner programs and on development of community codes with sustained multi-petaflop performance. The selected applications work with the ASCR-led SciDAC Institutes to enhance capabilities and ready codes for the 10 petaflop leadership computing systems available in FY 2013. These efforts support areas such as nuclear physics, high energy physics, astrophysics, fusion energy, earth system models to understand and quantify the impact of energy production and use on the environment, advanced materials, chemistry, and accelerator design to make more effective use of existing facilities and inform plans for future facilities. In addition, ASCR established a SciDAC Institute for Scientific Data Management, Analysis and Visualization to provide a single point of contact for scientists participating in Science Applications to leverage ASCR expertise to more efficiently and effectively manage, analyze, visualize, and understand their scientific data. The materials, combustion, and nuclear engineering Co-Design Centers are continued.	45,961

Fiscal Year	Activity	Funding (dollars in thousands)
FY 2013	The FY 2013 request proposed $56,776,000 to support new research efforts engaging partners across the Office of Science to address the data-intensive science challenges at the science application level. ASCR supports an additional Co-Design Center with a focus on the challenges to data-intensive science from emerging hardware. This effort engages SC scientific user facilities at the forefront of the data challenge that are also dependent on leveraging commercially available hardware. The dedicated SciDAC Institute for Scientific Data Management, Analysis, and Visualization continues to be supported as well as the other projects selected in FY 2011 and FY 2012.	—
FY 2014	The SciDAC institutes continue to play a key role in assisting DOE mission critical applications to effectively utilize the ASCR production and leadership computing facilities. The strategic partnerships with the other Office of Science programs will continue to address their specific needs as they move toward larger data sets and more complex computing systems. Computational partnerships will also focus on the current set of co-design centers that partner DOE mission applications with forefront researchers and computing vendors. These efforts, including the data-intensive co-design center proposed in FY 2013, will inform core research efforts in applied mathematics and computer science as well as the computing resources for the next generation of scientific user facilities.	46,918

Next Generation Networking for Science

Overview

To facilitate scientific collaborations, ASCR has played a leading role in driving development of the high-bandwidth networks connecting researchers to facilities, data, and each other. The invisible glue that binds today's networks—passing trillions of bits across the world—has roots in ASCR-supported research. For example, ASCR-supported researchers helped establish critical protocols on which the internet is based. Next Generation Networking for Science research makes possible international collaborations such as the Large Hadron Collider and underpins virtual meeting and other commercial collaboration tools. These research efforts build upon results from Computer Science and Applied Mathematics to develop integrated software tools and advanced network services to utilize new capabilities in ESnet to advance DOE missions. These efforts broaden opportunities for other government agencies, U.S. industry, and the American people.

Funding and Activity Schedule

Fiscal Year	Activity	Funding (dollars in thousands)
FY 2012	In FY 2012, research in this activity continued to make critical investments, including new protocols that allow hosts to rapidly and efficiently adapt to network conditions to maximize the available bandwidth, new routing algorithms that can improve the performance of routers and switches, a rich suite of secure collaboration tools and services, and advanced simulation environments that duplicate real networks to ensure that science communities achieve their goals.	13,929
FY 2013	The FY 2013 request proposed $16,194,000 to support new research efforts to address the data-intensive science challenges facing scientific communities using unique DOE facilities and engaging in large-scale collaborations. Currently these user communities generate and share multi-petabyte datasets that pass through ESnet and are stored and shared within program-sponsored grids. These datasets will continue to grow, surpassing exabyte scales in the next few years. This presents many challenges in moving, sharing, analyzing, and validating such massive quantities of data. It also presents new challenges in building, operating, and maintaining the network infrastructure over which data passes. This activity focuses on developing new middleware and networking tools for moving, sharing, and verifying such massive datasets and on innovative analysis tools and services.	—
FY 2014	With the production deployment of 100 gigabits per second (Gbps) technologies, research will continue to focus on developing networking software, middleware, and hardware that delivers 99.999% reliability while allowing the successful products of prior research to transition into operation. These investments are increasingly important as ESnet expands production use of very high-throughput and optical technologies.	15,931

High Performance Computing and Network Facilities
Funding Profile by Activity

	(dollars in thousands)		
	FY 2012 Current	FY 2013 Annualized CR	FY 2014 Request
High Performance Production Computing	57,800	—	65,605
Leadership Computing Facilities	156,000	—	147,000
Research and Evaluation Prototypes	26,922	—	38,552
High Performance Network Facilities and Testbeds	36,014	—	32,608
SBIR/STTR	0	—	9,381
Total, High Performance Computing and Network Facilities[a]	276,736	—	293,146

[a] SBIR/STTR funding:
- FY 2012 Appropriation: SBIR $7,054,000 and STTR $950,000 (transferred out of ASCR in FY 2012 Current column)
- FY 2014 Request: SBIR $8,208,000 and STTR $1,173,000

Overview

The High Performance Computing and Network Facilities subprogram delivers forefront computational and networking capabilities to scientists nationwide. These include high performance production computing at the National Energy Research Scientific Computing Center (NERSC) facility at LBNL and Leadership Computing Facilities (LCFs) at ORNL and ANL. These computers and the other SC research facilities generate many petabytes of data each year. Moving data to the researchers who need them requires advanced scientific networks and related technologies provided through High Performance Network Facilities and Testbeds, which includes the Energy Science network (ESnet). The Research and Evaluation Prototypes activity invests in research and development that will play a critical role in delivering world-leading capabilities and achieving the Department's exascale computing goals.

Computing resources are allocated through competitive processes. Up to 60% of the processor time on the LCFs is allocated through the Innovative and Novel Computational Impact on Theory and Experiment (INCITE) program, which is open to all researchers and results in awards to 20–30 large projects per year. The high performance production computing facilities at NERSC are predominately allocated to researchers supported by SC programs. Remaining processor time on the LCFs and NERSC is allocated through the ASCR Leadership Computing Challenge (ALCC). ALCC is open year-round to scientists from the research community in the national labs, academia, and industry for projects with an emphasis on high-risk, high-payoff research in areas directly related to the DOE's energy mission, for national emergencies, or for broadening the community of researchers capable of using leadership computing resources.

Allocations on ASCR facilities provide critical resources for the scientific community following the peer reviewed, public access model used by other SC scientific user facilities. In addition, ASCR facilities provide a crucial testbed for U.S. industry to deploy the most advanced hardware and have it tested by the leading scientists across the country in universities, national laboratories, and industry.

Explanation of Funding Changes

Research and Evaluations Prototypes will increase investments in critical technologies for exascale and will begin planning for system integration research, development, and engineering. Continued upgrades to ESnet are supported to be ready for the massive increase in data from next generation scientific user facilities and large-scale collaborations.

	(dollars in thousands)		
	FY 2012 Current	FY 2014 Request	FY 2014 Request vs. FY 2012 Current
High Performance Production Computing	57,800	65,605	+7,805
Increase supports operations, lease payments, and user support for NERSC including preparations for NERSC-7, which will more than double the capacity of NERSC but also increases the power requirement of NERSC.			
Leadership Computing Facilities	156,000	147,000	-9,000
Supports operations, lease payments, and user support for the 27 petaflop system at the OLCF and 10 petaflop machine at the ALCF. Infrastructure investments are decreased pending identification of specific technology requirements for future upgrades.			
Research and Evaluation Prototypes	26,922	38,552	+11,630
The current Research and Evaluation Prototypes investments in critical technologies will be increased. Planning will begin for system integration research, development, and engineering in partnership with the NNSA. Increase also supports non-recurring engineering investments, in partnership with the NNSA, for near-term technology customization for the ASCR facilities.			
High Performance Network Facilities and Testbeds	36,014	32,608	-3,406
ESnet completes installation and expands production use of 100 Gbps optical ring.			
SBIR/STTR	0	9,381	+9,381
In FY 2012, $7,054,000 and $950,000 were transferred to the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs, respectively. SBIR/STTR funding is set at 2.95% of non-capital funding in FY 2012, 3.05% in FY 2013, and 3.2% in FY 2014.			
Total, High Performance Computing and Network Facilities	276,736	293,146	+16,410

High Performance Production Computing

Overview

This activity supports the National Energy Research Scientific Computing Center (NERSC) facility located at LBNL. NERSC delivers high-end production computing services for the SC research community. Annually, approximately 5,000 computational scientists in about 500 projects use NERSC to perform basic scientific research across a wide range of disciplines including astrophysics, chemistry, climate modeling, materials, high energy and nuclear physics, and biology. NERSC enables teams to perform modeling, simulation, and data analysis on some of the most capable computational and storage systems in the world to address some of the biggest scientific challenges within the SC mission. NERSC users come from nearly every state in the U.S., with about 65% based in universities, 25% in DOE laboratories, and 10% in other government laboratories and industry. NERSC's large and diverse user base requires an agile support staff to aid users entering the high performance computing arena for the first time as well as those preparing codes to run on the largest machines available at NERSC and other SC computing facilities.

NERSC is a vital resource for the SC research community and it is consistently oversubscribed, with requests exceeding capacity by a factor of 3–10. This gap between demand and capability exists despite upgrades to the primary computing systems approximately every 3 years. NERSC regularly gathers requirements from SC programs through a robust process that informs NERSC upgrade plans. These requirements activities are also vital to planning for SciDAC and other ASCR efforts to prioritize research directions and inform the community of new computing trends, especially as the computing industry moves toward heterogeneous, multi-core computing.

Funding and Activity Schedule

Fiscal Year	Activity	Funding (dollars in thousands)
FY 2012	Supported operation of the NERSC high-end capability systems (NERSC-5 and NERSC-6), lease payments, user support, and preparation for future system upgrades.	57,800
FY 2013	The FY 2013 request proposed $65,605,000 to support staff, maintenance, operations, and lease payments for the NERSC high-end capability systems and an upgrade to NERSC-7, while NERSC-6 remains in production. The NERSC-7 upgrade will be installed in the current NERSC facility; however, this machine takes power and space at this facility to its maximum. NERSC has selected a new site adjacent to the laboratory with a projected move in date in 2015. As part of the NERSC-7 upgrade, FY 2013 funding supports site preparations at current facility for NERSC-7 and for the planned relocation to the new site.	—
FY 2014	Supports operation of the NERSC high-end capability systems (NERSC-7) including increased power costs, lease payments, and user support. Also supports, as part of the NERSC-7 upgrade project, continued site preparations for the new NERSC facility on the LBNL campus.	65,605

Leadership Computing Facilities

Overview

The Leadership Computing Facilities (LCFs) enable open scientific applications, including industry applications, to harness the potential of leadership computing to advance science and engineering. The era of petaflop science opened significant opportunities to dramatically advance research as simulations more realistically capture complex behavior in natural and engineered systems. The success of this effort is built on the gains made in Research and Evaluation Prototypes and ASCR research efforts. LCF staff operates and maintains forefront computing resources. One LCF strength is the staff support provided to INCITE projects, ASCR Leadership Computing Challenge projects, scaling tests, early science applications, and tool and library developers. Support staff experience is critical to the success of industry partnerships to address the challenges of next-generation computing.

The Oak Ridge Leadership Computing Facility (OLCF) 27 petaflop system is the most powerful computer in the world for scientific research, according to the November 2012 Top 500 list. Through INCITE allocations, several applications, including combustion studies in diesel jet flame stabilization, simulations of neutron transport in fast reactor cores, and groundwater flow in porous media, are running at the multi-petaflop scale. OLCF staff is sharing its expertise with industry to broaden the benefits for the Nation. For example, OLCF worked with industry to significantly reduce the need for costly physical prototyping and wind tunnel testing to advance the integration of a next generation aircraft rotor and to increase fuel efficiency in 18 wheelers.

The Argonne Leadership Computing Facility (ALCF) provides a 10 petaflop machine with relatively low-electrical power requirements. The Blue Gene/Q was developed through a joint research project with support from the NNSA, industry, and ASCR's Research and Evaluation Prototypes activity. The ALCF and OLCF systems are architecturally distinct and this diversity of resources benefits the Nation's HPC user community. ALCF supports many applications, including molecular dynamics and materials, for which it is better suited than OLCF or NERSC. Through INCITE, ALCF also transfers its expertise to industry, for example, helping to study the complex interactions of billions of atoms to determine how tiny submicroscopic structures impact the characteristics of the ingredients in soaps, detergents, lotions, and shampoos, as well as in fire retardants and foams used in national security applications.

Funding and Activity Schedule

Fiscal Year	Activity	Funding (dollars in thousands)
FY 2012	In FY 2012, this activity supported staff, operations, and lease payments. OLCF completed sited preparations and phase 1 of their upgrade to a 27 petaflop system by replacing the processor boards and interconnects, while continuing to support users and managing INCITE allocations. At ALCF, installation and operation of a new test and development system in early FY 2012 provided early science access to the new architecture, with installation of the full 10 petaflop upgrade completed by the end of FY 2012. The upgrade is expected to be accepted in FY 2013. In addition, the ALCF supported users and manage INCITE allocation of the existing ALCF machine.	156,000

Fiscal Year	Activity	Funding (dollars in thousands)
FY 2013	The FY 2013 request proposed $145,000,000 to support staff, operations, and lease payments. OLCF continues completion of phase 2 of the upgrade with the addition of graphical processing units (GPUs) to a portion of the computer cabinets taking it to 20 petaflops and will provide access to early science applications. Overall funding is reduced in FY 2013 due to reduced funding for infrastructure upgrades. ALCF supports full operation and INCITE allocations of their 10 petaflop leadership computing system with associated increased lease and power payments.	—
FY 2014	Supports operation and allocation, through INCITE and ALCC, of the upgraded 20 petaflop OLCF and 10 petaflop ALCF. This includes lease payments, power, and user support. Although the Department approved CD-0, mission need statement, for the next LCF upgrades in December 2012, specific technology requirements for those upgrades are evolving and funding for planning is reduced.	147,000

(dollars in thousands)

	FY 2012 Current	FY 2013 Annualized CR	FY 2014 Request
Leadership Computing Facility at ANL	62,000	—	60,000
Leadership Computing Facility at ORNL	94,000	—	87,000
Total, Leadership Computing Facilities	156,000	—	147,000

Research and Evaluation Prototypes

Overview

The Research and Evaluation Prototypes activity addresses the challenges of next generation computing systems. These activities are coupled to the co-design centers and the ASCR facilities to strengthen feedback loops in the portfolio. By actively partnering with the research community, including industry, on the development of technologies that enables next-generation machines, ASCR can ensure that the commercially available architectures serve the needs of the scientific community. Coupling this activity to the co-design centers ensures that application and software researchers can gain a better understanding of future systems to get a head start in developing software and models to take advantage of the new capabilities. Research and Evaluation Prototypes prepares researchers to effectively utilize the next generation of scientific computers and seeks to reduce risk for future major procurements.

DOE has been at the forefront of leadership computing for science and national security applications for decades. ASCR continues to invest in leadership class systems at Argonne and Oak Ridge, which play a key role in the health of the U.S. high performance computing industry. However, the next generation of computing hardware is expected to present new challenges for science and engineering applications—most notably from power demands that will restrict memory usage, effectively managing communication between billions of chips and accelerators, and from chip failures and silent errors. This activity supports research and development partnerships with vendors to influence and accelerate critical technologies for exascale, system integration research, development and engineering efforts that are coupled to application development to ensure Department applications are ready to make effective use of commercial offerings.

In addition, this activity partners with the NNSA to support research investments in non-recurring engineering, for near-term technology customization for the ASCR facilities.

Funding and Activity Schedule

Fiscal Year	Activity	Funding (dollars in thousands)
FY 2012	ASCR partnered with the NNSA and worked with the research community, including industry, to deliver high bandwidth, power efficient memory, processor, and storage technology for future computer systems. This activity supported basic research and development to optimize the performance and energy capabilities of emerging hybrid memory technology. These investments are critical because the current commercial roadmaps indicated that memory power requirements dominated the power budgets for computers targeted at scientific and engineering applications. The goal of these efforts was to deliver low-energy, high performance memory with the 10–100 fold improvement over current commercial offerings that is required for DOE applications. This approach eased the path to broad commercial adoption in this decade—from individual laptops to servers—leading to energy efficiency gains across the information technology sector.	26,922

Fiscal Year	Activity	Funding (dollars in thousands)
	In addition, this activity supported partnerships with the NNSA and the research community, including industry, to advance the Department's goals for exascale computing. Significant technical challenges must be faced in meeting the needs of the computational science and engineering community over the next decade, among these are power, performance, concurrency, cost, and resiliency. The system goals are aggressive, and thus tradeoffs will be necessary—for example, reducing memory bandwidth can reduce power consumption but slows performance.	
FY 2013	The FY 2013 request proposed 22,500,000 to continue research started in FY 2012 with the NNSA and the research community, including industry, to develop critical technologies and low level software architectures that enable the creation of high performance scientific applications for these computers, as well as the smaller scale commercial versions that will be ubiquitous in the scientific infrastructure. The current portfolio of projects is augmented with a second round of competitively selected research partnerships that reduce risk and fill gaps from the first round of awards.	—
FY 2014	Critical technology research partnerships will continue with increased support for efforts deemed most likely to deliver reductions in power requirements or increased usability for DOE applications. This includes processor R&D to accelerate low power features in next generation processors including low power memory interfaces and the development of low power, high bandwidth memory. In addition, planning will begin for system integration research, development, and engineering, in partnership with the NNSA. This builds on the strengths of the national laboratories and will be critical to delivering systems built from commercially available processors that meet the needs of DOE applications. The increase also supports research investments in non-recurring engineering, in partnership with the NNSA, for near-term technology customization for the ASCR facilities.	38,552

High Performance Network Facilities and Testbeds

Overview

The Energy Sciences Network (ESnet) provides the national network and networking infrastructure connecting DOE science facilities and SC laboratories with other institutions connected to peer academic or commercial networks. This network allows scientific users to effectively and efficiently access, distribute, and analyze the massive amounts of data produced by these science facilities.

The costs for ESnet are dominated by operations, including maintaining the fiber optic backbone and refreshing switches and routers on the schedule needed to ensure the 99.999% reliability required for large-scale scientific data transmission. Additional funds are used to support the continued growth in science data traffic and for testing and evaluation of new technologies and services that will be required to keep pace with the data volume from new DOE facilities and unique DOE scientific instruments.

Funding and Activity Schedule

Fiscal Year	Activity	Funding (dollars in thousands)
FY 2012	ESnet operated the network infrastructure to support critical DOE science applications and unique SC facilities. Building on 2011 procurements, ESnet began to transition the 100 Gbps prototype network to production service replacing the 10 Gbps production link to the first segment of the ESnet backbone. In addition, 100 Gbps production network was extended to additional SC laboratories by upgrading and connecting the Bay area metropolitan ring.	36,014
FY 2013	The FY 2013 request proposed $32,000,000 for ESnet to continue to operate the network infrastructure that supports critical DOE science applications and SC facilities. ESnet continues to extend deployment of 100 Gbps capacity to additional SC laboratories by upgrading additional segments of the backbone network and Metropolitan Area Networks to 100 Gbps speeds.	—
FY 2014	ESnet will operate the network infrastructure to support critical DOE science applications and SC facilities. ESnet extends deployment of 100 Gbps production network by connecting remaining SC laboratories at 100 Gbps speeds.	32,608

Supporting Information

Capital Operating Expenses

Capital Operating Expenses Summary

(dollars in thousands

	FY 2012 Current	FY 2013 Annualized CR	FY 2014 Request
Capital equipment over $500,000	15,300	—	0

Other Supporting Information

Funding Summary

	(dollars in thousands		
	FY 2012 Current	FY 2013 Annualized CR	FY 2014 Request
Research	178,490	—	205,481
Scientific user facility operations	249,814	—	245,213
Other	0	—	14,899
Total, Advanced Scientific Computing Research	428,304	443,566	465,593

Scientific User Facility Operations

	(dollars in thousands		
	FY 2012 Current	FY 2013 Annualized CR	FY 2014 Request
NERSC	57,800	—	65,605
OLCF	94,000	—	87,000
ALCF	62,000	—	60,000
ESnet	36,014	—	32,608
Total, Scientific User Facility Operations	249,814	—	245,213

Facilities Users and Hours

	(dollars in thousands)		
	FY 2012 Current	FY 2013 Annualized CR	FY 2014 Request
NERSC			
Achieved operating hours	8,500	—	N/A
Planned operating hours	8,585	—	8,585
Optimal hours	8,585	—	8,585
Percent of optimal hours	99%	—	100%
Unscheduled downtime percentage	1%	—	1%
Number of users	4,659	—	5,500

	(dollars in thousands)		
	FY 2012 Current	FY 2013 Annualized CR	FY 2014 Request
ESnet			
Achieved operating hours	8,760	—	N/A
Planned operating hours	8,760	—	8,760
Optimal hours	8,760	—	8,760
Percent of optimal hours	100%	—	100%
Unscheduled downtime percentage	0%	—	0.001%
Number of users[a]	N/A	—	N/A
OLCF			
Achieved operating hours	6,889	—	N/A
Planned operating hours	7,008	—	7,008
Optimal hours	7,008	—	7,008
Percent of optimal hours	98.3%	—	100%
Unscheduled downtime percentage	1.7%	—	1%
Number of users	1,161	—	1,300
ALCF			
Achieved operating hours	6,917	—	N/A
Planned operating hours	7,008	—	7,008
Optimal hours	7,008	—	7,008
Percent of optimal hours	98.7%	—	100%
Unscheduled downtime percentage	1.3%	—	1%
Number of users	828	—	1,000
Total			
Achieved operating hours	31,066	—	N/A
Planned operating hours	31,361	—	31,361
Optimal hours	31,361	—	31,361
Percent of optimal hours (funding weighted)	98.8%	—	100%
Unscheduled downtime percentage	1.2%	—	1%
Number of users	6, 648	—	7,800

[a] ESnet is a high performance scientific network connecting DOE facilities to researchers around the world; user statistics are not collected.

Scientific Employment

	FY 2012 Actual	FY 2013 Estimate	FY 2014 Estimate
Number of university grants	210	—	218
Average size	$247,000	—	$265,000
Number of laboratory projects	175	—	178
Number of graduate students (FTEs)	563	—	564
Number of permanent Ph.D.'s (FTEs)	770	—	789
Other scientific employment (FTEs)	270	—	275