DIRECTORATE FOR COMPUTER AND INFORMATION SCIENCE AND ENGINEERING (CISE)

$709,720,000
+$56,130,000 / 8.6%

CISE Funding
(Dollars in Millions)

|	FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	Change Over FY 2012 Estimate	
				Amount	Percent
Computing and Communication Foundations (CCF)	$175.93	$179.13	$195.00	$15.87	8.9%
Computer and Network Systems (CNS)	210.26	212.50	233.50	21.00	9.9%
Information and Intelligent Systems (IIS)	169.14	176.50	193.00	16.50	9.3%
Information Technology Research (ITR)	80.73	85.46	88.22	2.76	3.2%
Total, CISE	**$636.06**	**$653.59**	**$709.72**	**$56.13**	**8.6%**

Totals may not add due to rounding.

About CISE

CISE's mission is to promote the progress of computer and information science and engineering research and education; to promote understanding of the principles and uses of advanced computer, communications, and information systems in service to society; and to contribute to universal, transparent, and affordable participation in an information-based society. CISE supports ambitious long-term research and research infrastructure projects within and across the many sub-fields of computing, contributes to the education and training of computing professionals and, more broadly, informs the preparation of a U.S. workforce with computing competencies essential to success in an increasingly competitive global market. CISE's FY 2013 Request is shaped by investments in NSF's three strategic goals in addition to investments in its core research, education, and infrastructure programs.

CISE continues to play a leadership role in the multi-agency Subcommittee on Networking and Information Technology Research and Development (NITRD), which is co-chaired by the CISE Assistant Director. All research, education, and research infrastructure projects supported by CISE enrich the agency's NITRD portfolio. As noted by the President's Council of Advisors on Science and Technology (PCAST) in their review of the NITRD program in December 2010, advances in Networking and Information Technology (NIT) are key drivers of U.S. economic competitiveness. Essentially all practical applications of Information Technology (IT) are based on ideas and concepts that emerged from investments in basic computing research. These fundamental ideas and concepts have enabled innovative products and applications that now permeate all areas of modern life. IT forms a sizeable portion of the economy, and it drives discovery and innovation in many other areas, e.g., advanced scientific research, advanced manufacturing, education and workforce development, health and wellness technologies, sustainability and energy science, transportation, national and homeland security research, and public and private organizational effectiveness and efficiency. Innovation in IT will remain an essential and vital force in productivity gains and economic growth in both the manufacturing and service sectors for many years to come, positioning NSF and CISE as central and essential actors in improving the Nation's economic outlook and advancing a highly trained, technologically astute workforce.

NSF provides approximately 79 percent of the total federal support for basic research at academic institutions in computer science.

CISE Subactivity Funding
(Dollars in Millions)
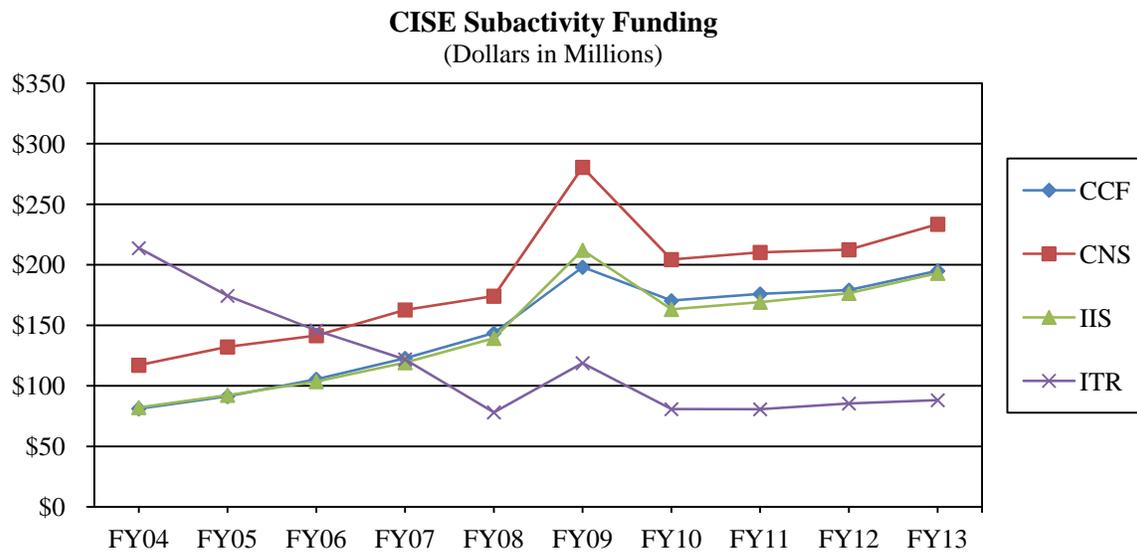
FY 2009 funding reflects both the FY 2009 omnibus appropriation and funding provided through the American Recovery and Reinvestment Act of 2009 (P.L. 111-5).

FY 2013 Summary by Division

- CCF's FY 2013 Request is focused on enhancing support for its core programs and on support for NSF-wide investment areas. CCF will support the NSF-wide Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21) investment through foundational research advancing the science of big data including algorithms and software tools for managing massive amounts of heterogeneous and complex data; new functional capabilities in support of highly parallel computing; and multi-core and multi-machine data management systems. CCF will support Enhancing Access to the Radio Spectrum (EARS) research through investments in reliable wireless transmission; theoretical performance limits of spectrum sharing; and technical and economic models for flexible spectrum access, real-time auctions, and on-demand spectrum services. CCF, as part of the NSF-wide Science, Engineering, and Education for Sustainability (SEES) portfolio, will invest in the computational methods and models necessary to attain a sustainable future. CCF will support research on the foundations of Secure and Trustworthy Cyberspace (SaTC), including new theories, models, methods, architectures, and tools towards achieving security-aware computing, self-healing hardware, and self-protecting software. As part of the National Nanotechnology Signature Initiatives, CCF will focus on research in nanotechnology design automation and computer architectures.

- CNS's FY 2013 Request is focused on enhancing support for its core programs and on support for NSF-wide investment areas. CNS will lead the SaTC program in partnership with EHR, ENG, MPS, OCI, and SBE. SaTC aims to build a cybersecure society and provide a strong competitive edge in the Nation's ability to produce high-quality digital systems and a well-trained cybersecurity workforce. These efforts will maintain CISE's national leadership in developing the scientific foundations of cybersecurity as part of the Comprehensive National Cybersecurity Initiative (CNCI). In partnership with ENG, MPS, OCI, BIO, and other CISE divisions, CNS will support research in Cyber-enabled Materials, Manufacturing, and Smart Systems (CEMMSS) through increased support for research on cyber-physical systems, advanced manufacturing, and critical infrastructure. CNS will partner with ENG, MPS, and SBE to support EARS research in new wireless communications and spectrum sharing architectures and services. CNS will also support the NSF-wide CIF21

investment through research on pervasive computing combining distributed sensing with data analytics and distributed response, and research on large-scale data management systems. In support of the NSF-wide SEES investment, CNS will support research in large-scale smart sensing and control systems that promise to increase resource sustainability. CNS will continue its investment in Computing Education for the 21st Century (CE21) with a goal to increase the pool of K-14 students with the computational competencies needed to successfully pursue degrees in computing and computationally-intensive fields. CNS will continue its support of the Global Environment for Network Innovations (GENI) activity by investing in transformational networking research infrastructure, and experimentation not possible elsewhere; phasing in full-time technical support for the increasing demand from experimenters; and expanding GENI to a national research testbed by research-enabling and integrating more partners at U.S. academic campuses, regional and backbone networks, and cities across the Nation.

- IIS's FY 2013 Request is focused on enhancing support for its core programs and on support for NSF-wide investment areas. IIS will participate in CEMMSS through leadership of the interagency National Robotics Initiative (NRI). The NRI aims to accelerate the development and use of co-robots, i.e., robotic systems and devices that work cooperatively with, or alongside, people, increasing their performance, productivity, and safety. IIS will participate in the NSF-wide CIF21 investment through research in data analytics and e-science, including new approaches to data mining, machine learning, knowledge extraction, visualization, predictive modeling, and automated discovery. IIS will continue to lead NSF's investment in Smart Health and Wellbeing research, partnering with ENG and SBE as well as CISE's other divisions. NSF seeks to address fundamental technical and scientific issues that would support much needed transformation of healthcare, from reactive and hospital-centered to preventive, proactive, evidence-based, and person-centered, as well as focus on wellbeing rather than disease. IIS, jointly with EHR and SBE, will participate in Expeditions in Education (E^2) through support of the Cyberlearning Transforming Education (CTE) program. CTE aims to integrate advances in technology with advances in what is known about how people learn by focusing on personalized learning experiences, access to learning resources anytime and anywhere, and providing new ways of assessing capabilities.

- ITR's FY 2013 Request will provide support for emerging high-priority areas of potentially transformative research. ITR will continue to invest in ongoing awards in the Expeditions in Computing program, which encourages researchers to come together to identify the compelling ideas that promise transformations in computing and information sciences for years to come. Through I-Corps, a cross-directorate investment in public-private partnerships, ITR will develop and nurture a national innovation ecosystem that builds on foundational research and guides the output of scientific discoveries to the development of technologies, products, and processes that benefit society. In collaboration with ENG, ITR will support investments in innovative partnerships and collaborations between universities and industries, in part through the Industry/University Cooperative Research Center (I/UCRC) program. ITR will invest in a Virtual Institute (VI) as part of the Science Across Virtual Institutes (SAVI) activity, providing increased opportunities for international collaborations, especially for early career researchers. ITR also provides support for the development of novel mid-scale infrastructure and testbeds. Through US Ignite, ITR will leverage previous investments in GENI by expanding and research-enabling partners at U.S. academic campuses, regional and backbone networks, and cities; advancing networking and systems research through experiments conducted on wireline and wireless testbeds at scale; and jumpstarting public sector gigabit application development, deployment, and evaluation with the promise of long-term scientific, social, and economic benefit.

Major Investments

CISE Major Investments

(Dollars in Millions)

Area of Investment	FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	Change Over FY 2012 Estimate	
				Amount	Percent
Advanced Manufacturing	$15.72	$27.80	$37.88	$10.08	36.3%
CAREER	46.75	48.27	50.60	2.33	4.8%
CEMMSS	-	50.00	91.00	41.00	82.0%
CIF21	-	12.00	16.00	4.00	33.3%
Clean Energy Technology	15.75	18.00	21.50	3.50	19.4%
CNCI	40.00	51.00	44.50	-6.50	-12.7%
E^2	-	-	4.00	4.00	N/A
EARS	-	7.00	24.00	17.00	242.9%
I-Corps	0.20	2.50	6.00	3.50	140.0%
INSPIRE	-	-	4.00	4.00	N/A
NRI	-	12.50	17.50	5.00	40.0%
SEES	2.25	8.00	11.50	3.50	43.8%
SaTC	-	55.00	69.00	14.00	25.5%

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

All CISE divisions will participate intellectually in the Major Investments noted above.

- Advanced Manufacturing: In FY 2013 CISE will invest in research that integrates ubiquitous sensors, computational tools, and highly connected cyber-physical systems in smart processing and advanced manufacturing systems, resulting in higher quality products with greater efficiency and sustainability produced by the factories of the future. CISE will also invest in basic research to advance robotics technology in order to enable new functionalities and provide the next-generation of products and services in various industries including advanced manufacturing. CISE will also support research aimed at the development of next generation robotics, conceived as co-robots that work alongside, or cooperatively, with people in manufacturing environments, increasing their productivity, performance, and safety. As part of this research activity, CISE will also synergize investments across multiple research communities and programs in order to transform static manufacturing systems, processes, and edifices into adaptive, pervasive "smart" systems with embedded computational intelligence that can sense, adapt, and react.

- CAREER: This program invests in the integration of research and education of early-career researchers and contributes to the development of future generations of computer and information scientists and engineers. CISE estimates that it will make approximately 100 CAREER awards in FY 2013.

- Cyber-Enabled Materials, Manufacturing, and Smart Systems (CEMMSS): In FY 2013, the Cyber-Physical Systems (CPS) program, funded jointly with ENG, will be expanded by investments from MPS, SBE, and BIO to accelerate advances in 21st century smart engineered systems. CEMMSS aims to establish a scientific basis for engineered systems interdependent with the physical world and

social systems; synthesize multi-disciplinary knowledge to model and simulate systems in their full complexity and dynamics; and develop a smart systems technology framework. CEMMSS includes CISE investments in the National Robotics Initiative (NRI), an important multi-agency activity.

- Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21): In FY 2013, CISE will support investments to advance big data science and engineering research through core scientific and technological means of managing, analyzing, visualizing, and extracting useful information from large, diverse, distributed, and heterogeneous data sets so as to: accelerate the progress of scientific discovery and innovation; lead to new fields of inquiry that would not otherwise be possible; encourage the development of new data analytic tools and algorithms; facilitate scalable, accessible, and sustainable data infrastructure; and promote economic growth and improved quality of life. CISE will also target new computational infrastructure through investments in: (i) new functional capabilities in support of highly parallel computing; and (ii) large-scale data management systems – multi-core and multi-machine systems – with computational models and new programming paradigms for distributed approaches, such as cloud and cluster computing.

- Clean Energy Technology: In FY 2013, CISE will support foundational research in energy-intelligent computing, the development of new theory, algorithms, and design principles to effectively tackle energy versus computation and communication tradeoffs, and the scalability and sustainability of smart energy production software and hardware. CISE research on clean energy is partially supported via investments in SEES.

- Comprehensive National Cybersecurity Initiative (CNCI): In FY 2013, CISE will focus on the development of the science of cybersecurity, as well as four game-changing research themes – designed-in security, moving target defense, tailored trustworthy spaces, and cyber economic incentives. In partnership with OCI, CISE will actively work to transition mature discoveries into a secure research infrastructure. In partnership with SBE, CISE will also invest in research at the interstices of economic and computer sciences to achieve secure practices through the development of market forces that incentivize good behavior in cyberspace.

- Expeditions in Education (E^2): In FY 2013, CISE will invest in the Cyberlearning Transforming Education program, supported jointly with EHR and SBE, in order to integrate advances in technology with advances in the ways people learn; more effectively use technology for promoting learning; design new technologies for integration in learning environments; and evaluate their use.

- EARS: In FY 2013, CISE will continue support for research in wireless communication, spectrum sharing, and mobile computing, as well as the development of wireless and spectrum testbeds. Collaborations with ENG, MPS, and SBE in EARS will strengthen U.S. leadership in the global wireless technology marketplace.

- I-Corps: In FY 2013, CISE will develop and nurture a national innovation ecosystem that builds upon fundamental research to guide the output of scientific discoveries closer to the development of technologies, products, and processes that benefit society. The CISE activities funded through I-Corps will identify NSF-funded researchers who will receive additional support – in the form of mentoring and funding – to accelerate innovations that can attract subsequent third-party funding.

- INSPIRE: In FY 2013, CISE will catalyze interdisciplinary research by seamlessly integrating a suite of new activities with existing efforts to foster and support transformative research. In FY 2013, CISE will invest in several mid-scale awards to surface and build a new pool of potential innovators and transformative interdisciplinary researchers.

- National Robotics Initiative (NRI): The NRI is a national multi-agency research program including the National Institutes of Health (NIH), National Aeronautics and Space Administration (NASA), and Department of Agriculture (USDA) that aims to accelerate the development and use of co-robots. In FY 2013, CISE and ENG will support fundamental robotics science and engineering; will partner with EHR to fund robotics education; and will partner with SBE to enhance understanding of human interaction with co-robots. NRI is a primary component of the smart systems research investments in CEMMSS.

- SEES: In FY 2013, CISE will create a research community engaged in cyber-enabled sustainability to advance research in: large-scale, intelligent, data management and analysis; widespread, heterogeneous sensing and control; and optimization, modeling, and simulation of large, complex problems, including energy, computation and communication trade-offs.

- Secure and Trustworthy Cyberspace (SaTC): SaTC aligns NSF cybersecurity investments (including investments from OCI, SBE, MPS, and ENG) with the President's national cybersecurity strategy, *Trustworthy Cyberspace: Strategic Plan for the Federal Cybersecurity Research and Development Program*. SaTC aims to support scientific foundations, induce change, maximize research impact, and accelerate the transition to practice. This investment also includes support for the Comprehensive National Cybersecurity Initiative (CNCI). CISE will collaborate with EHR to support rigorous evaluation of cybersecure workforce development to enable a growing pipeline of researchers and educators, and to develop a citizenry that understands the security and privacy of the digital systems on which society depends.

CISE Funding for Centers Programs and Facilities

CISE Funding for Centers Programs
(Dollars in Millions)

	FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	Change Over FY 2012 Estimate Amount	Percent
Centers Programs Total	**$14.16**	**$11.50**	**$10.47**	**-$1.03**	**-9.0%**
STC: Center for Embedded Networked Sensing (CCF)	2.66	-	-	-	N/A
STC: Team for Research in Ubiquitous Secure Technology (CCF)	4.00	4.00	3.32	-0.68	-17.0%
STC: Science of Information (CCF)	5.00	5.00	5.00	-	-
SLC: Pittsburgh Science of Learning Center for Robust Learning (ITR)	2.50	2.50	2.15	-0.35	-14.0%

Totals may not add due to rounding.

For detailed information on individual centers, please see the NSF-Wide Investments chapter.

- In FY 2013, CISE will provide the ninth year of funding, at a decreased level as the project ramps down as planned, for the Team for Research in Ubiquitous Secure Technology (TRUST) at the University of California at Berkeley. TRUST is focused on the development of cybersecurity science and technology that will radically transform the ability of organizations to design, build, and operate trustworthy information systems for the Nation's critical infrastructure by addressing the technical, operational, legal, policy, and economic issues affecting security, privacy, and data protection, as well as the challenges of developing, deploying, and using trustworthy systems.

- In FY 2013, CISE will provide the third year of funding for the Center for the Science of Information

at Purdue University. The center's goal is to develop a new science of information that incorporates common features associated with data/information, such as space, time, structure, semantics, and context that are not addressed by earlier mathematical theories, e.g., data obfuscation and hiding techniques that enhance robustness and the principles of redundancy and fault tolerance found in natural systems.

- In FY 2013, CISE continues to support the Pittsburgh Science of Learning Center (SLC) for Robust Learning at a reduced level as the project begins to ramp down. The Pittsburgh SLC leverages cognitive theory and cognitive modeling to identify the instructional conditions that cause robust student learning in order to enhance scientific understanding of robust learning in educational settings and create a research facility to support field-based experimentation, data collection, and data mining.

CISE Funding for Facilities

(Dollars in Millions)

	FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	Change Over FY 2012 Estimate Amount	Percent
Facilities (Total)	**$0.60**	**$0.60**	**$0.60**	**-**	**-**
National Nanotechnology Infrastructure Network (CCF)	0.60	0.60	0.60	-	-

Totals may not add due to rounding.

For detailed information on individual facilities, please see the Facilities chapter.

Summary and Funding Profile

CISE supports investments in core and interdisciplinary research and education as well as in computing research infrastructure.

In FY 2013, the number of research grant proposals is expected to increase by approximately 7.3 percent compared to FY 2012. CISE expects to award approximately 1,320 research grants in FY 2013. Average annualized award size and duration are expected to rise slightly from FY 2011 to FY 2013.

CISE Funding Profile

	FY 2011 Actual Estimate	FY 2012 Estimate	FY 2013 Estimate
Statistics for Competitive Awards:			
Number of Proposals	5,996	6,500	7,000
Number of New Awards	1,378	1,420	1,540
Funding Rate	23%	22%	22%
Statistics for Research Grants:			
Number of Research Grant Proposals	5,720	6,200	6,650
Number of Research Grants	1,173	1,210	1,320
Funding Rate	21%	20%	20%
Median Annualized Award Size	$149,998	$150,000	$150,000
Average Annualized Award Size	$182,863	$180,000	$190,000
Average Award Duration, in years	2.9	3.0	3.0

Program Monitoring and Assessment

The Performance 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.

Committees of Visitors (COV):
In FY 2012, CISE plans to hold a Committee of Visitors (COV) review, which will examine and assess the quality of the entire CISE portfolio. For the first time, data-driven portfolio analysis will be conducted to more effectively enable recommendations for future portfolio management and priority-setting. Other performance indicators, such as funding rates, award size and duration, and numbers of people supported on research and education grants, are reported in each division's annual report and factored into an annual performance assessment conducted by CISE senior management.

STEM Evaluation:
Evaluation is a vital part of CISE's STEM education programs, including Computing Education for the 21st Century (CE21), which is a partnership with EHR and OCI. Each CE21 project will provide a rigorous research and/or evaluation plan designed to guide project progress and measure its impact. The plan will include a description of the instruments/metrics that will be used. A set of common core metrics has been developed and is now being collected across the set of projects. A contract for external evaluation of the overall CISE education portfolio is currently being competed. Results will be available twelve months from execution of the contract.

As part of the CTE program, in FY 2012, jointly with EHR, a Cyberlearning Resource Center (CRC) will be funded as a cooperative agreement to support Cyberlearning programmatic efforts. The CRC is expected to carry out evaluation of the Cyberlearning program. While each project will have its own individual evaluation plan, the Resource Center is tasked with developing a plan to collect data across projects and to address overall impact, success in meeting Cyberlearning goals, and practices for moving results from research to practice. Proposals must also include evaluation of the impacts of the CRC by an external evaluator.

Reports:
To better assess the long-term economic impact of CISE investments, CISE funded the National Academy of Sciences (NAS) Computer Science and Telecommunications Board (CSTB) to study the IT innovation ecosystem. The report, *Assessing the Impacts of Changes in the Information Technology R&D Ecosystem,* published in 2009, includes a depiction of the creation of almost twenty billion dollar IT industries since 1965 (i.e., figures popularly referred to as the "tire tracks diagrams"). To update this study, CISE recently asked CSTB to identify new IT industries; develop a brief report that highlights the updated figures; and summarize results-to-date of IT research, including the nature and successes of U.S. research partnerships among government, industry, and universities, and the economic payoffs of these research investments. The update is expected in FY 2012.

Number of People Involved in CISE Activities

	FY 2011 Actual Estimate	FY 2012 Estimate	FY 2013 Estimate
Senior Researchers	6,812	7,020	7,620
Other Professionals	605	620	670
Postdoctorates	371	380	410
Graduate Students	4,882	5,030	5,460
Undergraduate Students	1,818	1,880	2,040
Total Number of People	**14,488**	**14,930**	**16,200**

DIVISION OF COMPUTING AND COMMUNICATION FOUNDATIONS (CCF)

$195,000,000
+$15,870,000 / 8.9%

CCF Funding

(Dollars in Millions)

	FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	Change Over FY 2012 Estimate Amount	Percent
Total, CCF	**$175.93**	**$179.13**	**$195.00**	**$15.87**	**8.9%**
Research	**167.50**	**171.03**	**187.40**	**16.37**	**9.6%**
CAREER	*14.75*	*15.37*	*16.11*	*0.74*	*4.8%*
Centers Funding (total)	*11.66*	*9.00*	*8.32*	*-0.68*	*-7.6%*
STC: Center for Embedded Networked Sensing	*2.66*	*-*	*-*	*-*	*N/A*
STC: Team for Research in Ubiquitous Secure Technology	*4.00*	*4.00*	*3.32*	*-0.68*	*-17.0%*
STC: Science of Information	*5.00*	*5.00*	*5.00*	*-*	*-*
Education	**7.83**	**7.50**	**7.00**	**-0.50**	**-6.7%**
Infrastructure	**0.60**	**0.60**	**0.60**	**-**	**-**
Nat'l Nanotechnology Infrastructure Network	*0.60*	*0.60*	*0.60*	*-*	*-*

Totals may not add due to rounding.

CCF supports research and education activities that explore the foundations and limits of computation, communication, and information; advance algorithmic knowledge for research areas both within and outside computer science; and advance software, hardware, and computer system design. CCF's research investments support advances in the design and analysis of algorithms, computational complexity, theoretical and experimental studies of algorithms and their resource requirements, and research on formal models of computation, including models for parallel, distributed, and heterogeneous multi-core machines. CCF invests in research that addresses the theoretical underpinnings and enabling technologies for information acquisition, transmission, and processing in communication and information networks, such as sensor networks, wireless and multimedia networks, biological networks, and networks of quantum devices. CCF investments advance the design, verification, evaluation, and utilization of computing hardware and software through new theories and high-leverage tools that focus on performance, correctness, usability, dependability, reliability, and scalability. CCF also invests in research that explores the impact of emerging technologies on computation and communication, including nanotechnology, biotechnology, and quantum systems.

In general, 72 percent of the CCF portfolio is available for new research grants. The remaining 28 percent is used primarily to fund continuing grants made in prior years.

FY 2013 Summary

All funding decreases/increases represent change over the FY 2012 Estimate.

Research
- CCF continues support for early-career researchers through increased investments in the CAREER program.
- CCF will support the NSF-wide CIF21 portfolio (+$2.0 million to a total of $6.0 million) through foundational research advancing the science of big data including algorithms and software tools for

managing massive amounts of heterogeneous and complex data; models and theories for massive data sets; streaming, sub-linear, space-limited, and probabilistic algorithms; algorithmic methods to corroborate, validate, and verify data; and algorithms and tools to enable new discoveries and extraction of knowledge from massive data sets. Also as part of the CIF21 portfolio, CCF will focus on highly parallel computing focused on fully exploiting the parallelism in existing hardware. Research will seek a paradigm shift in the way we think, teach, and develop parallel languages and algorithms; support computational models that reduce low-level details of specific parallel hardware; and support reasoning about correctness and parallel performance.

- CCF will support the NSF-wide EARS program (+$8.0 million to a total of +$8.0 million) through research in wireless communication with a focus on reliable transmission in the presence of channel impairments; the theoretical performance limits for communication systems under spectrum sharing; and managing spectrum sharing based on the principles of cognitive networking, game-theoretic and economic models, and computationally efficient algorithms.

- CCF will support the NSF-wide SaTC program (+$3.0 million to a total of $14.50 million) through research on the foundations of secure and trustworthy computing, including theories, models, cryptography, algorithms, architectures, languages, and tools, which will enhance the CNCI portfolio.

- CCF will support the NSF-wide SEES portfolio (+$1.50 million to a total of $5.0 million) through research on cyber-enabled sustainability with an emphasis on the role of information sciences and engineering in sustainability. CCF will support research that will develop the theory and design principles to effectively tackle energy versus computation and communication tradeoffs; address large-scale sustainability challenges based on modeling, simulation, and optimization strategies; and develop the software and hardware that support smart management of energy production, energy harvesting, and smart distribution and consumption networks.

- As part of the National Nanotechnology Initiative (NNI) (+$1.17 million to a total of $5.0 million) CCF will support research on emerging technologies in design automation and computer architectures, with a focus on nanotechnology and on a cross layer approach for achieving reliable hardware design. This funding also contributes to the CEMMSS portfolio.

- CCF will participate in the NSF-wide CEMMSS portfolio through NRI (+$1.0 million to a total of $3.0 million) and CPS (+$2.0 million to a total of $6.0 million). In the area of Smart Systems, research will focus on formal and semi-formal methods for the specification, development, and verification of software, hardware, and embedded systems for various industries, including advanced manufacturing.

- CCF will support INSPIRE (+$1.0 million to a total of $1.0 million).

- CCF will continue to support the STC Team for Research in Ubiquitous Secure Technology (TRUST) at the University of California at Berkeley (-$680,000 to a total of $3.32 million). Support is at a reduced level as this center ramps down as planned. CCF will also continue support for the Center for the Science of Information (CSoI) at Purdue University at the FY 2012 Estimate ($5.0 million).

- CCF will participate in the CISE cross-cutting Smart Health and Wellbeing program ($3.0 million, unchanged from the FY 2012 Estimate).

Education
- CCF will provide support for Computing Education for the 21st Century (CE21) ($4.0 million, unchanged from the FY 2012 Estimate) in partnership with the other CISE divisions. (See the CNS section for additional details.)

- Along with CNS and IIS, CCF will continue support for Research Experiences for Undergraduates (REU) sites and supplements ($3.0 million, level with the FY 2012 Estimate).

Infrastructure
- CCF co-funds the National Nanotechnology Infrastructure Network, supported primarily by ENG, at a level of $600,000.

DIVISION OF COMPUTER AND NETWORK SYSTEMS (CNS)

$233,500,000
+$21,000,000 / 9.9%

CNS Funding
(Dollars in Millions)

	FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	Change Over FY 2012 Estimate Amount	Percent
Total, CNS	**$210.26**	**$212.50**	**$233.50**	**$21.00**	**9.9%**
Research	**156.60**	**166.60**	**187.30**	**20.70**	**12.4%**
CAREER	*13.42*	*15.15*	*15.88*	*0.73*	*4.8%*
Education	**28.52**	**15.90**	**16.20**	**0.30**	**1.9%**
Infrastructure	**25.14**	**30.00**	**30.00**	-	-
Research Resources	*25.14*	*30.00*	*30.00*	-	-

Totals may not add due to rounding.

CNS supports research and education activities that advance understanding of the fundamental properties of computer systems and networks; explore new ways to address the limitations of existing computer and networked systems to make better use of these technologies; and develop better paradigms, abstractions, and tools for designing, analyzing, and building next generation computer and networked systems that are robust, secure, and trustworthy. CNS investments in computer systems research focus on: distributed, mobile, and embedded systems; sensing and control systems; dynamically configured, multiple-component systems; and parallel systems. CNS investments in fundamental network research create new insights into the dynamics of complex networks and explore new architectures for future-generation networks and services. CNS provides scientific leadership in cybersecurity, supporting research and education activities that will ensure that society's increasingly ubiquitous and distributed computing and communication systems deliver the quality of service they are designed to achieve, without disruption, while enabling and preserving privacy, security, and trust. CNS also plays a leadership role in coordinating CISE investments in research infrastructure resources and in the development of the computing workforce of the future.

In general, about 56 percent of the CNS portfolio is available for new research grants. The remaining 44 percent is used primarily to fund continuing grants made in previous years.

FY 2013 Summary

All funding decreases/increases represent change over the FY 2012 Estimate.

Research
- CNS continues support for early-career researchers through increased investments in the CAREER program.
- In partnership with EHR, ENG, MPS, OCI, SBE, and the other CISE divisions, CNS will lead the SaTC program (+$8.0 million to a total of $44.0 million), which aligns with the President's national cybersecurity strategy, *Trustworthy Cyberspace: Strategic Plan for the Federal Cybersecurity Research and Development Program.* SaTC will invest in game-changing research topics in support of CNCI, develop scientific foundations, maximize research impact, and accelerate transition to practice, in addition to addressing education and workforce issues. CNS plans to fund large-scale collaborations requiring multi-disciplinary teams to focus on grand challenge research problems in cybersecurity.

- CNS will expand support for research in wireless communication, spectrum sharing, and mobile computing and the development of wireless testbeds. CNS will collaborate with ENG, MPS, and SBE in EARS (+$7.0 million to a total of $10.0 million), including research in quantifying the value of spectrum, advancing spectrum sensing techniques, exploring machine learning and game theory for dynamic spectrum management, understanding incentive mechanisms, and developing mid-scale experimental infrastructure to test theoretical innovations, wireless devices, protocols, and algorithms.
- In partnership with ENG, MPS, and the other CISE divisions, CNS will expand on the strong portfolio that has been developed under the CPS program (+$6.0 million to a total of $24.0 million) as part of CEMMSS. CNS will support the foundational interdisciplinary research and education necessary to transform static systems, processes, and edifices into adaptive, pervasive "smart systems," as well as to further understanding of the fundamentals arising from grand challenge applications, ranging from advanced manufacturing and transportation to critical infrastructure, such as Smart Grid, medical devices, and disaster response. As part of the CEMMSS portfolio, CNS will also invest in NRI (+$1.50 million to a total of $5.0 million).
- CNS will participate in the CIF21 investment ($3.0 million, equal to the FY 2012 Estimate) through research in pervasive computing, combining distributed sensing with data analytics and distributed response. CNS will support work on large-scale data management systems, including programming support for multi-core, multi-machine, cloud, data-intensive, and highly concurrent systems.
- CNS will support the NSF-wide SEES investment (+$1.0 million to a total of $3.50 million) through research in large-scale intelligent data management and analysis; widespread, heterogeneous sensing and control; new methods for addressing power, thermal, and sustainability issues in the design and operation of computing systems at all scales; and disaster avoidance through advanced sensing.
- CNS will support INSPIRE (+$1.0 million to a total of $1.0 million).
- CNS will participate in CISE cross-cutting research and infrastructure programs, including Smart Health and Wellbeing ($3.0 million, equal to the FY 2012 Estimate) and CTE ($2.0 million, equal to the FY 2012 Estimate).

Education
- CNS will provide leadership for the cross-cutting CE21 program that seeks to increase computational competencies for all students (+$4.0 million to a total of $8.0 million). The goal of CE21 is to increase the pool of K-14 students and teachers who develop and practice computational competencies in a variety of contexts, and increase the pool of early postsecondary students who are engaged and have the background in computing necessary to successfully pursue degrees in computing-related and computationally-intensive fields of study.
- With CCF and IIS, CNS will continue support for REU sites and supplements ($3.50 million, equal to the FY 2012 Estimate).
- CNS continues support for the ADVANCE program at the FY 2012 Estimate level of $2.95 million to increase the participation and advancement of women in academic science and engineering careers.
- CNS will support IGERT (-$3.20 million to a total of $1.0 million).

Infrastructure
- Through the Computing Research Infrastructure program ($18.0 million, equal to the FY 2012 Estimate), CNS supports acquisition, enhancement, and operation of state-of-the-art infrastructures and facilities that enable high-quality computing research and education in a diverse range of institutions and projects.
- CNS will support development of world-class, mid-scale computing research infrastructure through GENI ($12.0 million, equal to the FY 2012 Estimate) by investing in 1) transformational research and infrastructure experimentation not possible elsewhere; and 2) a wireline and wireless suite of interconnected testbeds, integrating campuses, cities, research backbones, and regional optical networks.

DIVISION OF INFORMATION AND INTELLIGENT SYSTEMS (IIS)

$193,000,000
+$16,500,000 / 9.3%

IIS Funding

(Dollars in Millions)

	FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	Change Over FY 2012 Estimate	
				Amount	Percent
Total, IIS	**$169.14**	**$176.50**	**$193.00**	**$16.50**	**9.3%**
Research	**159.97**	**168.50**	**185.50**	**17.00**	**10.1%**
CAREER	*16.63*	*17.75*	*18.61*	*0.86*	*4.8%*
Education	**9.17**	**8.00**	**7.50**	***-0.50***	***-6.3%***

Totals may not add due to rounding.

IIS supports research and education that develops and applies information technology to enhance the capabilities of people and machines to create, discover, and reason by advancing their ability to represent, collect, store, organize, visualize, and communicate data and information; develops new knowledge to support people in the design and use of information technology; and advances knowledge about how computational systems can perform tasks autonomously, robustly, and flexibly.

IIS research investments support the exploration of novel theories and innovative technologies that advance our understanding of the complex and increasingly coupled relationships between people and computing. Investments in information integration and informatics focus on the processes and technologies involved in creating, managing, visualizing, and understanding diverse digital content as it relates to individuals, groups, organizations, and societies, and as it is hosted on engineered systems ranging from personal devices to globally-distributed systems. IIS also invests in research on artificial intelligence, computer vision, human language research, robotics, machine learning, computational neuroscience, cognitive science, and related areas leading to the computational understanding and modeling of intelligence in complex, realistic contexts.

In general, 67 percent of IIS funding is available for new research grants. The remaining 33 percent is used primarily to fund continuing grants made in previous years.

FY 2013 Summary

All funding decreases/increases represent change over the FY 2012 Estimate.

Research

- IIS continues support for early-career researchers through increased investments in the CAREER program.
- In partnership with other federal agencies (NIH, NASA and USDA), ENG, and the other CISE divisions, IIS will lead the multi-agency National Robotics Initiative (NRI) (+$2.50 million to a total of $9.50 million). IIS will focus on fundamental research in robotics science and engineering. NRI science and technology are underpinnings of the NSF-wide CEMMSS investment, which includes advanced sensing, control, and power sources; dynamical system mechanics; optimization, design, and decision algorithms; problem-solving architectures; hybrid architectures that integrate or combine methods (deductive, case-based, symbolic, etc.); safe and soft structures and mechanisms with reactive surfaces and elastic actuators; computational models of human cognition; integration of artificial intelligence, computer vision, and assistive robotics. Application domains include robots as

co-workers in advanced manufacturing environments, aides supporting emergency responders in the field, and service robots assisting the elderly and infirm to live independently.

- As part of the CEMMSS investment, IIS will support the CPS program (+$2.0 million to a total of $5.0 million). IIS will support basic research in smart systems with embedded computational intelligence that can sense, adapt, and react and that will enable new functionalities and provide the next-generation of products and services in various industries, including advanced manufacturing, that will vastly exceed those of today in terms of adaptability, functionality, reliability, safety, usability, and recyclability

- IIS will support the NSF-wide CIF21 investment (+$2.0 million to a total of $7.0 million) through research on data analytics across massive and diverse datasets. Core research includes cloud-database architectures, trusted and secure data, data mining methods, and data- and information-fusion techniques. The scientific scope of CIF21 will advance machine learning, predictive modeling, automated discovery of phenomena and causality in data, and the development of new technologies for twenty-first century data-enabled collaborative science ("eScience") and other areas of broad societal benefit, such as national and homeland security, smart transportation, healthcare, education, and energy.

- IIS will spearhead CISE's participation in Smart Health and Wellbeing research ($9.0 million, equal to the FY 2012 Estimate), partnering with ENG, SBE, and the other CISE divisions. IIS will pursue improvements in safe, effective, efficient, equitable, and patient-centered health and wellness technologies and services through innovations in computer and information science and engineering. Smart Health and Wellbeing acknowledges the changing demographics of an increasingly aging population with advances enabling assistive cyber-physical engineered systems that are embedded or distributed in the local physical environment.

- IIS will support the EARS program (+$2.0 million to a total of $2.0 million) through innovative wireless applications in areas of societal and economic benefit.

- IIS will support the NSF-wide SaTC program (+$3.0 million to a total of $10.50 million) through research in secure and privacy-protecting mechanisms for data aggregated across multiple sources, and user interfaces facilitating and visualizing complex levels of user-controllable access to personal information, which will enhance the CNCI portfolio.

- IIS will support the NSF-wide SEES investment (+$1.0 million to a total of $3.0 million) through research to optimize energy usage through intelligent decision-making for compute- and data-intensive systems. Research will focus on the information processing dimensions of energy utilization.

- The IIS division will lead the Cyberlearning Transforming Education (CTE) program jointly with EHR and SBE (+$4.0 million to a total of $12.0 million). CTE focuses on technological advances that allow more personalized learning experiences, allow access to learning resources anytime and anywhere, and provide new ways of assessing capabilities and new metrics for measuring progress. In FY 2012, a Cyberlearning Resource Center will be funded as a cooperative agreement to support Cyberlearning programmatic efforts and to carry out evaluation of the Cyberlearning program. CISE research in CTE is partially supported via investments in E^2.

- IIS will support INSPIRE (+$2.0 million to a total of $2.0 million).

Education
- IIS will participate in the Computing Education for the 21st Century (CE21) program ($4.0 million, equal to the FY 2012 Estimate) in partnership with the other CISE divisions.
- With CCF and CNS, IIS continues support for REU sites and supplements ($3.50 million, level with the FY 2012 Estimate).

DIVISION OF INFORMATION TECHNOLOGY RESEARCH (ITR) $88,220,000
+$2,760,000 / 3.2%

ITR Funding
(Dollars in Millions)

	FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	Change Over FY 2012 Estimate	
				Amount	Percent
Total, ITR	**$80.73**	**$85.46**	**$88.22**	**$2.76**	**3.2%**
Research	**74.42**	**81.46**	**77.22**	**-4.24**	**-5.2%**
CAREER	*1.95*	*-*	*-*	*-*	*N/A*
SLC: Pittsburgh Science of Learning Center for Robust Learning	*2.50*	*2.50*	*2.15*	*-0.35*	*-14.0%*
Education	**0.48**	**-**	**-**	**-**	**N/A**
Infrastructure	**5.83**	**4.00**	**11.00**	**7.00**	**175.0%**
Research Resources	*5.83*	*4.00*	*11.00*	*7.00*	*175.0%*

Totals may not add due to rounding.

ITR provides support for transformative explorations in computer and information science and engineering research and related education activities, emphasizing the funding of high-risk, multi-investigator, and multidisciplinary projects.

In general, about 56 percent of the ITR portfolio is available for new research grants. The remaining 44 percent is used primarily to fund continuing grants made in previous years.

FY 2013 Summary

All funding decreases/increases represent change over the FY 2012 Estimate.

Research
- ITR will continue its investments in ongoing awards in the Expeditions in Computing program ($12.0 million, equal to the FY 2012 Estimate). This program identifies projects with transformative research agendas that promise to accelerate discovery at the frontiers of computing and communication. It will also continue to encourage researchers to come together within or across departments or institutions to identify the compelling ideas that promise transformations in computing and information sciences for many years to come.
- Through I-Corps (+$3.50 million to a total of $6.0 million), ITR will develop and nurture a national innovation ecosystem, by mentoring and providing funding support, which builds upon fundamental research to guide the output of scientific discoveries closer to the development of technologies, products, and processes that benefit society. I-Corps will identify NSF-funded researchers who will receive support to accelerate innovation that can attract subsequent third-party funding.
- ITR will invest in a Virtual Institute (VI), as part of the Science Across Virtual Institutes (SAVI) activity ($2.0 million, equal to the FY 2012 Estimate). VIs provide opportunities to explore international collaborations in areas of mutual interest, giving U.S. researchers and students access to complementary skill sets and broader environments in which to carry out their research. Early career researchers will be encouraged to participate in international workshops and seminars. Through this investment, ITR will foster globally-engaged researchers and educators in computing and information sciences and support a diverse portfolio of international activities.

- In collaboration with ENG, CISE will continue to support innovative partnerships and collaborations between universities and industries, in part through the Industry/University Cooperative Research Centers (I/UCRC) program, which will continue to establish centers that partner industry with university research efforts. I/UCRC is funded at $7.0 million in FY 2013, level with the FY 2012 Estimate.
- ITR will continue to provide support for emerging high-priority areas of potentially transformative research through various award mechanisms, such as RAPIDs and EAGERS, and through co-funding of awards with other NSF directorates, to pursue important emerging areas in a timely manner.
- ITR will continue to support the EARS program at the FY 2012 Estimate level ($4.0 million) through integration and deployment of wireless and spectrum testbeds.
- CISE will continue its support of the Pittsburgh Science of Learning Center (SLC) for Robust Learning (-$350,000 to a total of $2.15 million). Support is at a reduced level in FY 2013 as the project begins to ramp down.
- Leveraging previous investments in GENI, ITR will invest in US Ignite, a research effort to ultimately promote U.S. leadership in developing applications and services for ultra-fast broadband and software-defined networks. As part of US Ignite, ITR will invest in foundational research and experimentation on wired, wireless, cloud computing, security, and distributed systems as well as public sector gigabit application development, initiated in FY 2013 at $3.0 million.

Infrastructure
- As part of US Ignite, ITR will expand the current CISE mid-scale infrastructure investment in GENI to a national-scale by research-enabling and integrating additional partners at U.S. academic campuses, regional and research backbone networks, commercial equipment and cities across the Nation to create a unique at-scale network infrastructure available for research and experimentation not possible elsewhere, initiated in FY 2013 at $7.0 million.