

**DIRECTORATE FOR COMPUTER AND INFORMATION
SCIENCE AND ENGINEERING (CISE)**

**\$728,420,000
+\$109,590,000 / 17.7%**

CISE Funding
(Dollars in Millions)

	FY 2010	Enacted/ Annualized	FY 2012 Request	Change Over	
	Omnibus Actual	FY 2011 CR		FY 2010 Enacted Amount	Percent
Computing and Communication Foundations (CCF)	\$170.40	\$170.35	\$210.13	\$39.78	23.4%
Computer and Network Systems (CNS)	204.33	\$204.42	\$235.20	30.78	15.1%
Information and Intelligent Systems (IIS)	163.21	\$163.32	\$197.35	34.03	20.8%
Information Technology Research (ITR)	80.78	\$80.74	\$85.74	5.00	6.2%
Total, CISE	\$618.71	\$618.83	\$728.42	\$109.59	17.7%

Totals may not add due to rounding.

About CISE

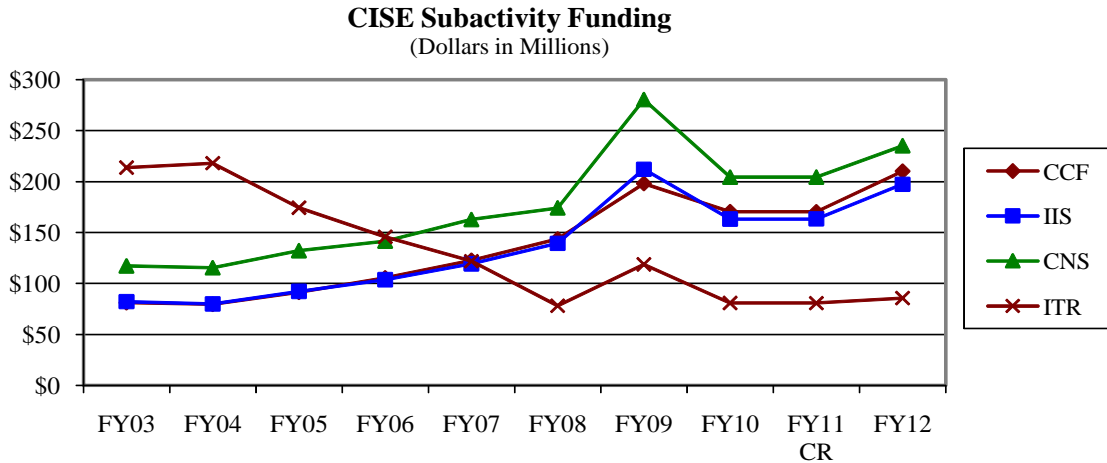
CISE’s mission is to promote the progress of computer and information science and engineering research and education; to promote understanding of the principles and uses of advanced computer, communications, and information systems in service to society; and to contribute to universal, transparent, and 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.

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, including advanced scientific research, healthcare, energy and sustainability science, national and homeland security, 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.

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.

NSF provides approximately 82 percent of the total federal support for basic research at academic institutions in computer science. Since 1995, networking and IT industries have accounted for 25 percent of the Nation’s economic growth, although they represent only three percent of the gross domestic product.¹

¹ *Leadership Under Challenge: IT R&D in a Competitive World*, President’s Council of Advisors on Science and Technology (PCAST) 2007, page 9.



FY 2012 Summary by Division

- CCF's FY 2012 Request is focused on enhancing support for core programs and, as part of the NSF-wide Science, Engineering and Education for Sustainability (SEES) and clean energy investments, funding foundational research in energy-intelligent computing, the development of new theory, algorithms, and design principles to optimize energy-computational performance in computing and communications systems, and the scalability and sustainability of smart energy production software and hardware. CCF will also support the NSF-wide Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21) investment through research on new functional capabilities in support of the entire software lifecycle and the development of new sustainable software elements. CCF will support research in advanced manufacturing through investments in the National Nanotechnology Initiative Signature Initiative: Nanoelectronics for 2020 and Beyond (NEB). CCF will focus on research leading to innovations on novel computational paradigms that will take computation and information processing beyond Moore's Law.
- CNS's FY 2012 Request reflects its commitment to support the NSF-wide SEES investment through research to explore the use of information technology in smart sensing systems that promise to save energy and reduce greenhouse gas emissions as well as the systems trade-offs among computation, communication, and performance. CNS will support research on the networking and computing systems dimensions of clean energy through investments in the NSF-wide SEES Sustainable Energy Pathways (SEP) and Sustainability Research Networks (SRN) activities. CNS will also support the NSF-wide CIF21 investment through research in new experimental architectures and approaches to leading-edge computational infrastructure (e.g., clouds, clusters, data centers) as well as new approaches to networking and distributed computing that allow for seamless access to distributed computational resources. In partnership with the Directorate for Engineering (ENG), CNS will support the research in advanced manufacturing through increased support for forward-looking research on cyber-physical systems. CNS will continue to support the Trustworthy Computing program, which includes support for the Comprehensive National Cybersecurity Initiative (CNCI), with a focus on new computing and networking security and privacy architectures. CISE supports CNCI in collaboration with the Office of Cyberinfrastructure (OCI) and the Directorate for Social, Behavioral and Economic Sciences (SBE). CNS will partner with the Directorates for Mathematical and Physical Science (MPS), Engineering and SBE to support the Enhancing Access to Radio Spectrum (EARS) program's goal of sponsoring research that can enable more users to share a fixed amount of radio spectrum.

- IIS’s FY 2012 Request will provide support for the NSF-wide SEES investment through research to optimize energy usage through intelligent decision-making for compute- and data-intensive systems. IIS will support research on the information processing dimensions of clean energy through additional investments in the NSF-wide SEES Sustainable Energy Pathways (SEP) activity. In addition, 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 and knowledge extraction and visualization. IIS will lead CISE's investment in Smart Health and Wellbeing research partnering with ENG and SBE, as well as CISE's other divisions. IIS will spearhead the multi-agency National Robotics Initiative by investing in the basic science and engineering of robotics, with accompanying industrial transfer, productization, distribution, and support.
- ITR’s FY2012 Request will support the cross-directorate investment in public-private partnerships that promise to enhance IT innovation. Leveraging recent partnerships with a variety of private sector organizations, CISE will create an academic-industry research incubator that encourages and supports transformative research at the computing frontier. ITR will continue support for the Expeditions in Computing program. In planning and implementing Expeditions, researchers are encouraged to come together within or across departments or institutions to identify compelling, transformative research agendas that promise disruptive innovations in computing and information for many years to come. In collaboration with ENG and MPS, ITR will support research on advanced manufacturing through increased investments in innovative partnerships and collaborations between universities and industries, in part through the Industry/University Cooperative Research Center (I/UCRC) program. This program establishes centers that partner industry with university research efforts. ITR provides flexibility for emerging high-priority areas of potentially transformative research.

Major Investments

CISE Major Investments

(Dollars in Millions)

Area of Investment	FY 2010	FY 2010	FY 2012 Request	Change Over	
	Omnibus Actual	Enacted/ Annualized FY 2011 CR		FY 2010 Enacted Amount	Percent
CAREER	\$41.56	\$50.96	\$57.91	\$6.95	13.6%
SEES Portfolio	15.00	17.00	46.36	29.36	172.7%
Comprehensive National Cybersecurity Initiative (CNCI)	40.00	40.00	37.00	-3.00	-7.5%
SEBML (includes NNI: Nanoelectronics for 2020 and Beyond)	15.00	15.00	20.00	5.00	33.3%
National Robotics Initiative	-	-	17.50	17.50	N/A
Smart Health and Wellbeing	15.00	15.00	17.00	2.00	13.3%
CIF21	-	-	16.00	16.00	N/A
Science and Technology Centers	7.32	7.32	9.00	1.68	23.0%
EARS	-	-	7.00	7.00	N/A

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

Proposed activities in CISE for FY 2012 were guided by its strategic priorities: supporting the NSF wide investments in SEES and CIF21; Innovating for Society, which includes activities in robotics (such as the multi-agency National Robotics Initiative), Smart Health and Wellbeing, and Enhancing Access to the

Radio Spectrum (EARS); and enhancing core disciplinary research, including support for CAREER awards. Additional investments include support for science and technology centers, the National Nanotechnology Initiative Signature Initiative: Nanoelectronics for 2020 and Beyond, and the Comprehensive National Cybersecurity Initiative (CNCI). CISE is also focusing on support for clean energy, via our participation in SEES; and advanced manufacturing, through activities in Cyber-Physical Systems, the National Nanotechnology Initiative, and the Industry/University Cooperative Research program.

- CAREER: CISE supports the CAREER program, an Administration priority. Contributing to the development of current and future generations of computing faculty is a priority and is reflected in the strong CISE commitment to the CAREER program.
- Science, Engineering and Education for Sustainability (SEES): In FY 2012, CISE will support the NSF-wide SEES investment and enrich the SEES portfolio with a program aimed at the challenges created as well as addressed by information and communications technologies. This effort will support research activities developing algorithmic foundations and new software and hardware for energy-efficient, energy-aware, and sustainable computing and communications.
- Through the SEES portfolio, CISE will support research on clean energy through investments in the NSF-wide SEES Sustainable Energy Pathways (SEP) and Sustainability Research Networks (SRN) activities.
- Comprehensive National Cybersecurity Initiative (CNCI): In FY 2012, CISE is focused on the development of a Science of Cybersecurity as well as three game-changing research themes – Moving Target Defense, Tailored Trustworthy Spaces, and Cyber Economic Incentives. In partnership with OCI, CISE will also actively work to transition the best of this new research into a secure research infrastructure. The Science of Cybersecurity will develop the underlying fundamental principles that allow for the adoption of a more scientific approach to building, maintaining, and using trustworthy systems. Moving Target Defense research aspires to elude attackers through diverse, shifting, and increasingly complex cyber techniques and mechanisms. The Tailored Trustworthy Spaces theme supports research into varying trustworthy space policies and services that are context specific with the aim to create flexible, distributed trust environments. The Cyber Economic Incentives theme, which both CISE and SBE support, focuses on research at the interstices of economic and computer sciences to achieve secure practices through the development of market forces that incentivize good behavior.
- Science and Engineering Beyond Moore’s Law (SEBML): In partnership with other federal agencies, MPS, ENG and the Directorate for Biological Sciences (BIO), CISE will support research in advanced manufacturing, in part through investments in the National Nanotechnology Initiative Signature Initiative: Nanoelectronics for 2020 and Beyond. CISE will support research leading to departures from traditional architectural practices of computing, including reconfigurable, evolvable, adaptive hardware architectures and the use of heterogeneous systems that can dynamically change via software mechanisms and architectures capable of combating error prone devices at the nano-scale.
- The National Robotics Initiative (NRI) is a new inter-agency initiative that engages four U.S. agencies (NSF, NASA, NIH and USDA) in a concerted program to provide U.S. leadership in science and engineering research and education aimed at the development of next generation robotics, conceived as robots that work beside, or cooperatively, with people in areas such as manufacturing, space and undersea exploration, healthcare and rehabilitation, military and homeland surveillance and security, education and training, and safe driving. In partnership with ENG, CISE will focus on fundamental research in robotics science and engineering. This 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.

- Smart Health and Wellbeing: Partnering with ENG and SBE, CISE will support Smart Health and Wellbeing in FY 2012. CISE will pursue improvements in safe, effective, efficient, equitable, and patient-centered health and wellness technology and services through innovations in computer and information science and engineering that recognize the technical feasibility of diagnosis, treatment, and care based on an individual's genetic makeup and lifestyle and acknowledge the changing demographics of an increasingly aging population. This program supports the vision laid out in the recent National Research Council report, "Computational Technology for Effective Health Care," (W. Stead and H. Lin, editors) and responds to two reports from the President's Council of Advisors on Science and Technology (PCAST) issued in FY 2011: "Report to the President, Realizing the Full Potential of Health Information Technology to Improve Healthcare for Americans: The Path Forward", and "Report to the President and Congress, Designing A Digital Future: Federally Funded Research and Development in Network and Information Technology" that advises a "national long-term multi-agency research initiative on Networking and Information Technology (NIT) that goes well beyond the current national program to adopt electronic health records."
- CIF21: In FY2012, CISE support for the new NSF-wide CIF21 investment will focus on two particular areas: new computational infrastructure and data-enabled science.
 - New computational infrastructure: CISE investments in software will catalyze and nurture the multidisciplinary processes required to support the entire software lifecycle, and result in the development of sustainable community software elements at all levels of the software stack.
 - Data-enabled science: CISE investments will lead to advances in data analytics or e-science tools and techniques – such as data mining, machine learning, and data visualization.
- Science and Technology Centers: Support for the Science and Technology Center for Embedded Networked Sensing sunsets as planned in FY 2011. In FY 2012, CISE will continue to fund the Team for Research in Ubiquitous Secure Technology (TRUST) at the University of California at Berkeley. Starting in FY 2011, CISE is supporting an STC for the Science of Information at Purdue University.
- Enhancing Access to the Radio Spectrum (EARS): In partnership with MPS, ENG, and SBE, CISE will initiate support for the basic research that underpins EARS in FY 2012. The recent NSF workshop report, *Enhancing Access to the Radio Spectrum*, outlines the need for research on new and innovative ways to use the spectrum more efficiently. CISE will focus on the development of new wireless testbeds to support experiments on increasing the efficiency with which the spectrum is used. Additional information on EARS is available in the Selected Cross-Cutting Programs section of the NSF-wide Investments chapter.

Summary and Funding Profile

CISE supports investment in core and interdisciplinary research and education as well as research infrastructure, such as centers and facilities.

In FY 2012, the number of research grant proposals is expected to increase by approximately 1,630 compared to FY 2010 Enacted. CISE expects to award approximately 1,590 research grants in FY 2012. Average annualized award size and duration will be held level with the FY 2010 Enacted.

CISE Funding Profile

	FY 2010 Actual Estimate	FY 2010 Enacted/ Annualized FY 2011 CR Estimate	FY 2012 Estimate
Statistics for Competitive Awards:			
Number of Proposals	6,486	5,900	7,630
Number of New Awards	1,586	1,450	1,840
Regular Appropriation	1,567	1,450	1,840
ARRA	19	-	-
Funding Rate	24%	25%	24%
Statistics for Research Grants:			
Number of Research Grant Proposals	6,140	5,600	7,230
Number of Research Grants	1,350	1,220	1,590
Regular Appropriation	1,349	1,220	1,590
ARRA	1	-	-
Funding Rate	22%	22%	22%
Median Annualized Award Size	\$150,000	\$140,000	\$140,000
Average Annualized Award Size	\$199,356	\$180,000	\$180,000
Average Award Duration, in years	2.9	3.0	3.0

CISE Funding for Centers Programs and Facilities

CISE Funding for Centers Programs

(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted	
				Amount	Percent
Centers Programs	\$9.82	\$9.82	\$11.50	\$1.68	17.1%
<i>STC: Center for Embedded Networked Sensing (CCF)</i>	3.32	3.32	-	-3.32	-100.0%
<i>STC: Team for Research in Ubiquitous Secure Technology (CCF)</i>	4.00	4.00	4.00	-	-
<i>STC: Science of Information (CCF)</i>	-	-	5.00	5.00	N/A
<i>SLC: Pittsburgh Science of Learning (ITR)</i>	2.50	2.50	2.50	-	-

No FY 2010 obligations for centers were made with funds provided by the ARRA, so that column is not included here.

Detailed information on individual centers can be found in the NSF-Wide Investments chapter.

Centers Programs

- Funding for the Center for Embedded Networked Sensing (CENS) at the University of California at Los Angeles will end as planned in FY 2011, after ten years of support.
- In FY 2012, CISE will provide the eighth year of funding 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.
- Starting in FY 2011, CISE is supporting the Center for the Science of Information at Purdue University. This center will develop a unifying set of principles to guide the extraction, manipulation, and exchange of information, integrating elements of space, time, structure, semantics and context. The center will bring together researchers from diverse fields (physics, life science, chemistry, computer science, economics, etc.) to develop models and methods to apply to these diverse applications.
- CISE will continue support for the Pittsburgh Science of Learning Center (SLC) for Robust Learning. The Pittsburgh SLC will leverage 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 2010	FY 2010	FY 2012	Change Over	
	Omnibus	Enacted/ Annualized		FY 2010	FY 2010
	Actual	FY 2011 CR	Request	Amount	Percent
Facilities	\$0.60	\$0.60	\$0.60	-	-
<i>National Nanotechnology</i>					
<i>Infrastructure Network (CCF)</i>	0.60	0.60	0.60	-	-

No FY 2010 obligations for facilities were made with funds provided by the ARRA, so that column is not included here.

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

Facilities

- CISE will continue support in FY 2012 for the National Nanotechnology Infrastructure Network.

Program Evaluation and Performance Improvement

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

During FY 2009, CISE held three Committees of Visitors (COV) reviews, which together examined and assessed the quality of the entire CISE portfolio. 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 for CISE as a whole.

In FY 2012, CISE COV reviews will take place for all CISE divisions. All CISE divisions are responding to and implementing recommendations from recent COVs.

Evaluation is a vital part of CISE's STEM education programs such as Computing Education for the 21st Century (CE21) which is a partnership with EHR and OCI. Each CE21 award will provide a rigorous research and/or evaluation plan designed to guide project progress and measure its impact; the plan will also include a description of the instruments/metrics that will be used. The overall CISE education portfolio will be assessed with an appropriately rigorous evaluation process.

Number of People Involved in CISE Activities

	FY 2010 Actual Estimate	FY 2010 ARRA Estimate	FY 2010 Enacted/ Annualized FY 2011 CR Estimate	FY 2012 Estimate
Senior Researchers	5,553	295	5,700	6,540
Other Professionals	578	30	550	680
Postdoctorates	336	7	350	400
Graduate Students	4,556	27	6,200	5,360
Undergraduate Students	1,823	25	2,350	2,150
Total Number of People	12,846	384	15,150	15,130

**DIVISION OF COMPUTING AND COMMUNICATION
FOUNDATIONS (CCF)**

\$210,130,000
+\$39,780,000 / 23.4%

CCF Funding

(Dollars in Millions)

	FY 2010	FY 2010	FY 2012	Change Over	
	Omnibus	Enacted/ Annualized		FY 2010	FY 2010
	Actual	FY 2011 CR	Request	Amount	Percent
CCF Funding	\$170.40	\$170.35	\$210.13	\$39.78	23.4%
Research	165.40	167.05	207.13	40.08	24.0%
<i>CAREER</i>	<i>13.09</i>	<i>17.50</i>	<i>19.89</i>	<i>2.39</i>	<i>13.7%</i>
<i>Centers Funding (total)</i>	<i>7.32</i>	<i>7.32</i>	<i>9.00</i>	<i>1.68</i>	<i>23.0%</i>
<i>STC: Center for Embedded Networked Sensing</i>	<i>3.32</i>	<i>3.32</i>	<i>-</i>	<i>-3.32</i>	<i>-100.0%</i>
<i>STC: Team for Research in Ubiquitous Secure Technology</i>	<i>4.00</i>	<i>4.00</i>	<i>4.00</i>	<i>-</i>	<i>-</i>
<i>STC: Science of Information</i>	<i>-</i>	<i>-</i>	<i>5.00</i>	<i>5.00</i>	<i>N/A</i>
Education	4.40	2.70	2.40	-0.30	-11.1%
Infrastructure	0.60	0.60	0.60	-	-
<i>National Nanotechnology Infrastructure Network</i>	<i>0.60</i>	<i>0.60</i>	<i>0.60</i>	<i>-</i>	<i>-</i>

CCF supports research and education activities that explore the foundations and limits of computing and communication; advance algorithmic foundations and knowledge applicable to areas both within and outside computer science; and advance the science and engineering of computer hardware and software.

CCF research investments support explorations of algorithmic thinking accompanied by rigorous analysis as well as the theoretical understanding of the intrinsic difficulty of computational problems. CCF invests in transformative research that addresses the theoretical underpinnings and enabling technologies for information acquisition, transmission, and processing in communication and information networks. Investments also advance the design, verification, evaluation, and utilization of computing hardware and software to meet the future computational needs of our society. CCF invests in research that explores the impact of emerging technologies, including nanotechnology, biotechnology, and quantum physics, to create new models of computation and programmable computing substrates.

In general, 60 percent of the CCF portfolio is available each year for new research grants, with 40 percent used primarily to fund continuing grants made in prior years.

FY 2012 Summary

Research

- Support the NSF-wide SEES portfolio, including clean energy investments, by funding foundational research in energy-intelligent computing, the development of new theory, algorithms, and design principles to optimize energy-computational performance in computing and communication systems, and the scalability and sustainability of smart energy production software and hardware.
- Support the NSF-wide CIF21 investment through research on new functional capabilities in support of the entire software lifecycle and the development of new sustainable software elements.

- Continue support of Science and Engineering Beyond Moore's Law (SEBML) through research to advance computation and information processing beyond the physical and conceptual limitations of current technologies.
- Support research on advanced manufacturing, including investments in:
 - The National Nanotechnology Initiative Signature Initiative: Nanoelectronics for 2020 and Beyond (NEB). Focus on research leading to departures from traditional architectural practices of computing, including reconfigurable, evolvable, adaptive hardware architectures and the use of heterogeneous systems that can dynamically change via software mechanisms and architectures capable of combating error prone devices at the nano scale.
 - Cyber-Physical Systems (CPS). Focus on new computational abstractions to represent and manage data and algorithms leading to a better understanding of complex system and the interaction between computational and physical processes.
- Continue supporting interdisciplinary research, in partnership with SBE, through the Interface between Computer Science, Economics, and Social Science (ICES) program. This includes algorithmic game theory, automated mechanism design, computational tractability of basic economic problems, and the role of information, trust, and reputation in markets.
- Continue investment in CAREER awards (+\$2.39 million to a total of \$19.89 million).
- Continue support of the Science and Technology Center: Team for Research in Ubiquitous Secure Technology (TRUST) at the University of California at Berkeley at a level of \$4.0 million.
- Support the Center for the Science of Information at Purdue University, starting in FY 2011 at a level of \$5.0 million. This center will develop a unifying set of principles to guide the extraction, manipulation, and exchange of information integrating elements of space, time, structure, semantics and context.
- As with all three CISE disciplinary divisions, CCF will participate in CISE cross-cutting research, education, and infrastructure programs, including Trustworthy Computing, and Smart Health and Wellbeing.

Education

- Provide support for the Computing Education for the 21st Century (CE21) program.
- Along with CNS and IIS, continue support for research experiences for undergraduates, graduates, and teachers through programs such as REU sites and supplements, and RET.

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) **\$235,200,000**
+\$30,780,000 / 15.1%

CNS Funding
(Dollars in Millions)

	FY 2010		FY 2012 Request	Change Over	
	FY 2010 Omnibus Actual	Enacted/ Annualized FY 2011 CR		FY 2010 Enacted	Percent
	CNS Funding	\$204.33		\$204.42	\$235.20
Research	144.97	141.68	180.86	39.18	27.7%
<i>CAREER</i>	<i>10.64</i>	<i>15.00</i>	<i>17.04</i>	<i>2.04</i>	<i>13.6%</i>
Education	31.85	32.74	24.34	-8.40	-25.7%
Infrastructure	27.51	30.00	30.00	-	-
<i>Research Resources</i>	<i>27.51</i>	<i>30.00</i>	<i>30.00</i>	<i>-</i>	<i>-</i>

CNS supports research and education activities that advance our understanding of the fundamental properties of computer systems and networks and their complexity; 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 trustworthy computing, 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. Through the Computing Research Infrastructure (CRI) program, CNS supports the 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 supports the Computing Education for the 21st Century (CE21) program that seeks to increase computational competencies for *all* students, regardless of gender, race, ethnicity, disability status, or socioeconomic status, and regardless, too, of eventual career choices.

In general, about 50 percent of the CNS portfolio is available for new research grants. The remaining 50 percent is used primarily to fund continuing grants made in previous years.

FY 2012 Summary

Research

- In partnership with MPS and ENG, support the new Enhancing Access to Radio Spectrum (EARS) program's goal of sponsoring research that can enable more users to share a fixed amount of radio spectrum (+\$7.0 million to a total of \$7.0 million).
- Continue support for the Trustworthy Computing program, which, in collaboration with OCI and SBE includes support for the CNCI targeted research areas of Science of Cybersecurity, Moving Target Defense, Tailored Trustworthy Spaces, and Cyber Economic Incentives.

- Support the NSF-wide SEES investment through research in smart sensing systems that promise to save energy and reduce greenhouse gas emissions as well as system trade-offs among computation, communication, and performance. Support research on the networking and computing systems dimensions of clean energy through investments in the SEES SEP and SRN activities.
- Support the NSF-wide CIF21 investment through research in new experimental architectures and approaches to leading-edge computational infrastructure (e.g., clouds, clusters, data centers) as well as new approaches to networking and distributed computing that allow for seamless access to distributed computational resources.
- In partnership with ENG, support research in advanced manufacturing through increased investments in forward-looking research on cyber-physical systems motivated by grand challenge applications ranging from advanced manufacturing and transportation to healthcare and the environment.
- Continue investments in CAREER awards (+\$2.04 million to a total of \$17.04 million).
- As with all three CISE disciplinary divisions, CNS will participate in CISE cross-cutting research and infrastructure programs, including Smart Health and Wellbeing.

Education

- CNS will provide leadership for the cross-cutting CE21 program. This program will increase the number and diversity of K-14 students and teachers who develop and practice computational competencies in a variety of contexts, and increase the number and diversity 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, continue support for research experiences for undergraduates, graduates and teachers through programs like REU sites and supplements, IGERT and RET.
- Continue support for the ADVANCE program (+\$90,000 to a total of \$3.04 million) to increase the participation and advancement of women in academic science and engineering careers.

Infrastructure:

- Continue to support the development of world-class computing research infrastructure through the cross-cutting CRI program at a level of \$30.0 million in FY 2012.

DIVISION OF INFORMATION AND INTELLIGENT SYSTEMS (IIS)

\$197,350,000
+\$34,030,000 / 20.8%

IIS Funding
(Dollars in Millions)

	FY 2010		FY 2012 Request	Change Over	
	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR		FY 2010 Enacted	Percent
IIS Funding	\$163.21	\$163.32	\$197.35	\$34.03	20.8%
Research	157.99	159.92	194.15	34.23	21.4%
<i>CAREER</i>	<i>17.69</i>	<i>18.46</i>	<i>20.98</i>	<i>2.52</i>	<i>13.7%</i>
Education	5.22	3.40	3.20	-0.20	-5.9%

IIS supports research and education that: develops new knowledge to support people in the design and use of information technology; enhances the capabilities of people and machines to create, discover, and reason by advancing the ability to represent, collect, store, organize, visualize, and communicate data and information; 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 individual 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, 55 percent of IIS funding is available for new research grants. The remaining 45 percent is used primarily to fund continuing grants made in previous years.

FY 2012 Summary

Research

- In partnership with other federal agencies and ENG, IIS will lead the multi-agency National Robotics Initiative. IIS will focus on fundamental research in robotics science and engineering. This 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.
- IIS will spearhead CISE's participation in Smart Health and Well-being research, partnering with ENG and SBE, as well as CISE's other divisions. IIS will pursue improvements in safe, effective, efficient, equitable, and patient-centered health and wellness technology and services through innovations in computer and information science and engineering. These innovations will investigate the technical feasibility of diagnosis, treatment, and care based on an individual's genetic makeup and lifestyle and acknowledge the changing demographics of an increasingly aging population.

- Support the NSF-wide SEES investment through research to optimize energy usage through intelligent decision-making for compute- and data-intensive systems. Support research on the information processing dimensions of clean energy through additional investments in SEP.
- Support the NSF-wide CIF21 investment through research in data analytics and e-science, including new approaches to data mining, machine learning and knowledge extraction and visualization.
- Continued funding for the NSF investment for the Cyberlearning Transforming Education (CTE) program through support for research on new modalities of learning. This program is conducted jointly with EHR and OCI.
- Continue investment in CAREER awards (+\$2.52 million to a total of \$20.98 million).
- As with all three CISE disciplinary divisions, IIS will participate in CISE cross-cutting research, education, and infrastructure programs including Trustworthy Computing.

Education

- Actively participate in the CE21 program.
- With CCF and CNS, continue support for research experiences for undergraduates, graduates, and teachers through programs such as REU sites and supplements, and RET.

DIVISION OF INFORMATION TECHNOLOGY RESEARCH (ITR) **\$85,740,000**
+\$5,000,000/ 6.2%

ITR Funding

(Dollars in Millions)

	FY 2010		FY 2012 Request	Change Over	
	FY 2010 Omnibus Actual	Enacted/ Annualized FY 2011 CR		FY 2010 Enacted Amount	Enacted Percent
	ITR Funding	\$80.78		\$80.74	\$85.74
Research	79.62	80.74	85.74	5.00	6.2%
<i>CAREER</i>	0.14	-	-	-	N/A
<i>SLC: Pittsburgh Science of Learning Center for Robust Learning</i>	2.50	2.50	2.50	-	-
Education	1.16	-	-	-	N/A

The ITR subactivity 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, often multidisciplinary projects.

In general, 70 percent of the ITR portfolio is available for new research grants. The remaining 30 percent is used primarily to fund continuing grants made in previous years.

FY 2012 Summary

Research

- Support the cross-directorate investment in public-private partnerships that promise to enhance IT innovation. Leveraging recent partnerships with a variety of private sector organizations that provided the academic computing community with access to research resources (including strategic large-scale data sets and powerful cloud computing platforms), CISE will create an academic-industry research incubator that encourages and supports transformative research at the computing frontier.
- Continue support for the Expeditions in Computing program. In planning and implementing Expeditions, researchers are encouraged to come together within or across departments or institutions to identify compelling, transformative research agendas that promise disruptive innovations in computing and information for many years to come. Funded at levels up to \$10 million per award, Expeditions projects represent some of the largest single investments currently made by CISE.
- Support for research on Networked Society, partnering with SBE. This research will help to quantify, understand, and purposely design the fabric of 21st century networked society.
- In collaboration with ENG, support research on advanced manufacturing through increased investments in innovative partnerships and collaborations between universities and industries, in part through the Industry/University Cooperative Research (I/UCRC) program, which will establish centers that partner industry with university research efforts.
- Provide flexibility for support of emerging high-priority areas of potentially transformative research.
- Continue support to the Pittsburgh Science of Learning Center (SLC) for Robust Learning at a level of \$2.50 million.

