COMPUTER AND INFORMATION SCIENCE AND ENGINEERING

$633,000,000
+$59,260,000 / 10.3%

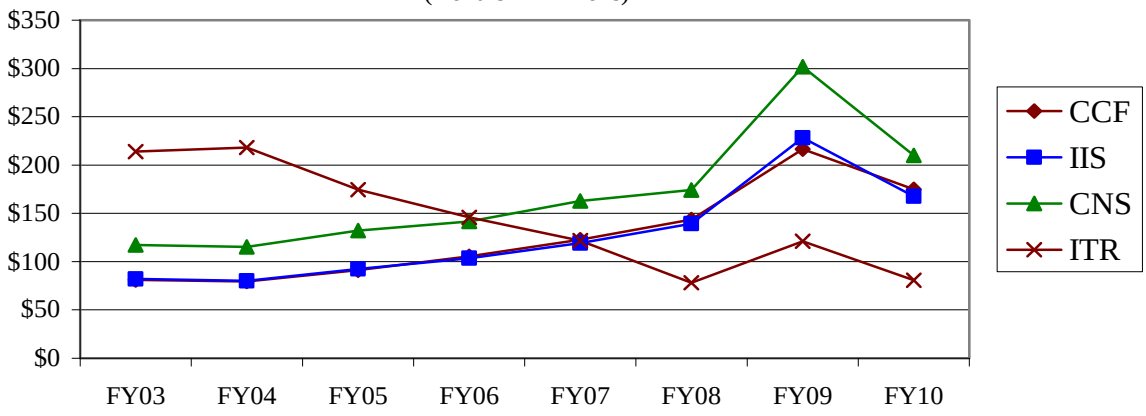
Computer and Information Science and Engineering Funding
(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY 2009 Plan Amount	Change Over FY 2009 Plan Percent
Computing and Communication Foundations (CCF)	$143.63	$156.93	$41.50	$174.83	$17.90	11.4%
Computer and Network Systems (CNS)	174.16	188.31	92.57	209.87	21.56	11.4%
Information and Intelligent Systems (IIS)	139.33	150.26	60.50	167.56	17.30	11.5%
Information Technology Research (ITR)	78.14	78.24	40.43	80.74	2.50	3.2%
Total, CISE	**$535.26**	**$573.74**	**$235.00**	**$633.00**	**$59.26**	**10.3%**
Major Components:						
Research and Education Grants	499.75	539.74	203.00	592.50	52.76	9.8%
Centers Programs	8.00	8.00	-	10.50	2.50	31.3%
Computing Research Resources	27.51	26.00	32.00	30.00	4.00	15.4%

Totals may not add due to rounding.

CISE's mission is to enable the U.S. to uphold a position of world leadership in computer and information science and engineering; 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 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-supported fundamental research outcomes in computing and information technology inform the development and deployment of cyberinfrastructure supported by the agency in service to all fields of science and engineering.

CISE Subactivity Funding
(Dollars in Millions)



CISE in Context

NSF is the principal source of federal funding for university-based basic research in computer science, providing the vast majority – 84 percent – of total federal support in this area. In recent years, basic research investments in computing have provided unsurpassed value-added to the U.S. economy. Since 1995, networking and information technology industries have accounted for 25 percent of the Nation's economic growth, although they represent only three percent of the gross domestic product.[1]

Essentially all practical applications of IT are based on ideas and concepts that emerged from basic research investments. These fundamental ideas and concepts have enabled innovative product and application developments that now permeate all areas of modern life. IT not only forms a sizeable portion of the economy in its own right, but drives discovery and innovation in many other areas, including advanced scientific research, healthcare, national and homeland security, organizational effectiveness, and governmental 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.

The CISE Directorate 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 projects supported by CISE investments, including all research, education, and cyberinfrastructure (computing research infrastructure), enrich the agency's NITRD portfolio. In FY 2010 CISE will continue to explore the computing frontier, stimulating research advances in new foundations and systems – all enabling applications yet to be imagined. CISE will continue to strengthen the intellectual foundations of computing, supporting research in algorithms and theoretical computer science, computer architecture, cryptography, information theory, network and communication theory, parallel computing, programming languages, semantics and logics, software engineering, and in emerging models and substrates of computation; As computing systems provide richer functionalities and faster performance, as they become more ubiquitous and pervasive, and as user expectations of and demands on them increase, CISE investments in the fundamental research essential to systems design for properties such as privacy, security, reliability, and usability become increasingly important. As we seek to better understand human intelligence and to use computing to enhance our quality of life, CISE will also continue to invest in artificial intelligence, computer vision, graphics, machine learning, natural language processing, robotics, speech, search, information retrieval, and technologies for collaboration. CISE contributions to the National Nanotechnology Initiative will permit exploratory and interdisciplinary work on novel quantum and bio-inspired device and systems technologies, as well as related programming models, languages and tools that promise to form the basis of the revolutionary new computing systems of the future.

NSF is the principal source of federal support for strengthening science, technology, engineering and mathematics (STEM) education across all levels and is uniquely positioned to lead the Nation in STEM education due to its focus on STEM education research. Two programs in particular, CISE Pathways to Revitalized Undergraduate Computing Education (CPATH) and Broadening Participation in Computing (BPC), aim to increase American competitiveness in the global economy and support NSF's underlying strategy of integration of research and education.

The FY 2010 Request for CISE includes $8.0 million to leverage activities across the directorate aimed at

[1] *Leadership under Challenge: IT R&D in a Competitive World*, President's Council of Advisors in Science and Technology (PCAST) 2007.

increasing support for transformative research. Examples of potential foci for these investments include CISE's Expeditions in Computing program, which supports large multi-disciplinary awards targeted to compelling, transformative research agendas that promise disruptive innovations in computing and information for many years to come.

Directorate-wide Changes and Priorities

Computing Fundamentals (+$13.05 million, to a total of $458.37 million)..

CISE will increase investment in disciplinary and emerging areas of computer and information science and engineering in research programs that emphasize transformative work and cross-cutting areas. These areas include: the exploration of revolutionary computational models, languages, and tools, and hardware and software architectures that will serve as the primary catalysts for future innovations in information technology; transformative research on trustworthy software and networked systems that simultaneously explore the technological challenges as well as the equally important organizational, sociological, economic, legal, and psychological factors impeding progress in securing cyberspace; and exploration of human-centered computing and information and intelligent systems that promise value to a diverse range of individuals and to society at large. CISE will increasingly focus on programs and projects that identify plausible but high-risk opportunities with potential to result in significant, enduring impact in societal applications.

As part of CISE's $123.50 million investment in cybersecurity research and education, the directorate will devote $40.0 million to research in usability; theoretical foundations; and privacy to support the Comprehensive National Cybersecurity Initiative.

Cyber-enabled Discovery and Innovation (CDI) (+$16.37 million, to a total of $50.0 million).

The CDI program, NSF-wide and begun in FY 2008, recognizes that "computational thinking," i.e., computational methods, concepts, models, algorithms, and tools, will transform how all science and engineering will be conducted in the 21st Century. It will be the computational abstractions, as much as the high-speed computers and high-bandwidth networks that will enable scientists and engineers to make new discoveries – by changing the very questions they ask. Research in Cyber-Physical Systems (CPS) is a major component of CDI. Cyber-physical systems (e.g., autonomous cars, intelligent energy-efficient buildings, embedded medical devices, assistive technology for the aged, quality-of-life robots) are already penetrating every sector of our daily lives: transportation (e.g., automotive, aerospace), infrastructure (e.g., bridges, buildings), and healthcare (e.g., pacemakers, MRI technology), to name a few. Research in data-intensive computing also is an important component of CDI. To transform an abundance of digital data into new knowledge, CISE researchers will: explore new fundamental mathematical and computational abstractions to represent and manage data; participate in multidisciplinary projects that explore data mining, data federation, and extraction strategies in demanding science and engineering applications; and develop the underpinnings essential to the development of sophisticated data visualization and delivery tools. CISE will also invest in an emerging data-intensive computing paradigm ("cloud computing") where systems are designed, programmed, and operated on massively large server clusters.

Science and Engineering Beyond Moore's Law (SEBML) (+$11.0 million, to a total of $15.0 million).

In SEBML, CISE researchers will explore radically new systems based on revolutionary technologies such as organic molecules, carbon nanotubes, optical switches, and superconductors, among others. New programming models will also be explored, along with the languages and compilers that support them. To optimize computing power, new algorithms that exploit highly parallel hardware and architecture characteristics in contemporary silicon-based technologies, such as multi-cores and

communication and memory latencies, will also be examined.

Climate Research (CR) (+$10.0 million, to a total of $10.0 million).

CISE will play an important role in CR. Research in fundamental new algorithms, data structures, and software capabilities will enable development of computational models of our planet so that climate prediction can be done on a regional and decadal scale. Research in smart sensor and smart sensor networking technologies will enable state-of-the-art observatories in the sky, ocean, ice, land, and in living systems, including humans. Research in advanced machine learning, data mining, visualization, and other information-extraction techniques will enable real-time processing of multiple and disparate data streams and intelligent decision-making.

Program Evaluation and Performance Improvement

The Performance Information chapter describes the Foundation's performance evaluation framework, which is built upon the four strategic outcome goals in NSF's Strategic Plan: *Discovery*, *Learning*, *Research Infrastructure*, and *Stewardship*. Performance evaluation is conducted at all levels within the Foundation, using both qualitative and quantitative measures – including an agency-wide annual review of research and education outcomes by an external expert committee and periodic reviews of programs and portfolios of programs by external Committees of Visitors and directorate Advisory Committees. During FY 2009, CISE will hold three Committees of Visitors, one for each division other than ITR. Other performance indicators, such as funding rates, award size and duration, and numbers of people supported on research and education grants, are also factored into the performance assessment process.

Number of People Involved in CISE Activities

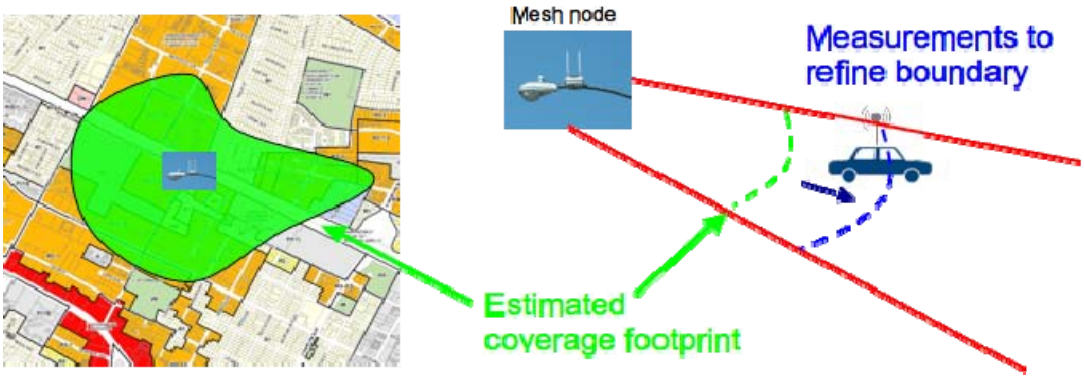
	FY 2008 Estimate	FY 2009 Estimate	FY 2009 ARRA Estimate	FY 2010 Estimate
Senior Researchers	6,462	6,915	2,840	7,605
Other Professionals	522	560	230	615
Postdoctorates	274	290	220	320
Graduate Students	5,594	5,985	2,450	6,585
Undergraduate Students	1,752	1,875	770	2,065
Total Number of People	14,604	15,625	6,510	17,190

CISE Funding Profile

	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate
Statistics for Competitive Awards:			
Number of Proposals	5,566	6,500	6,100
Number of New Awards	1,352	1,950	1,580
Regular Appropriation	1,352	1,420	1,580
ARRA	-	530	-
Funding Rate	24%	30%	26%
Statistics for Research Grants:			
Number of Research Grant Proposals	5,182	6,050	5,700
Number of Research Grants	1,046	1,500	1,220
Regular Appropriation	1,046	1,100	1,220
ARRA	-	400	-
Funding Rate	20%	25%	21%
Median Annualized Award Size	116,667	120,000	120,000
Average Annualized Award Size	164,212	170,000	170,000
Average Award Duration, in years	3.1	3.5	3.0

Recent Research Highlights

► **Broadband Wireless Networks:** Wireless access networks have the potential to expand broadband access throughout the United States. NSF-funded researchers have not only developed a set of design blueprints to guide the deployment of low-cost, broadband wireless access networks, but they also demonstrated the value of their designs in a wireless network deployed in an under-resourced neighborhood in Houston, Texas. Research innovations include new algorithms used to decide where to install wireless access points to minimize network dead zones and to determine where to install cables or fiber to ensure sufficient broadband connectivity is available throughout the network. The research team also developed an algorithm to detect dead spots following network deployment, without needing to take measurements at every place in the network. These research innovations provide network operators with a valuable toolkit, allowing them to build high performance broadband networks at lower cost.



An illustration of the technique for determining the coverage footprint of a mesh access point using coverage estimation (left) and a small number of measurements for refinement (right). This technique won the prestigious ACM MobiCom 2008 Best Paper Award. *Credit: City of Mountain View, CA and Joshua Robinson, Rice University.*

► **New Technology Helps Data Centers Conserve Energy:** The nation's rapidly growing information-based economy relies on power-hungry computing facilities called data centers. When computer programs run, computer systems consume electricity and generate heat, which needs to be removed from the data center room by the cooling installation. In a typical data center, jobs are submitted, executed, and finished at different times, thus creating various usage patterns, or layouts, of the center. Researchers at Arizona State University report they have devised a model of heat recirculation and an algorithm that uses the model to find the most energy-efficient task schedules. Simulations of the technology predict up to 30 percent energy savings in a moderately busy data center. This research enables the data center to monitor itself and self-adjust its behavior automatically to increase efficiency and avoid critical situations of overheating.

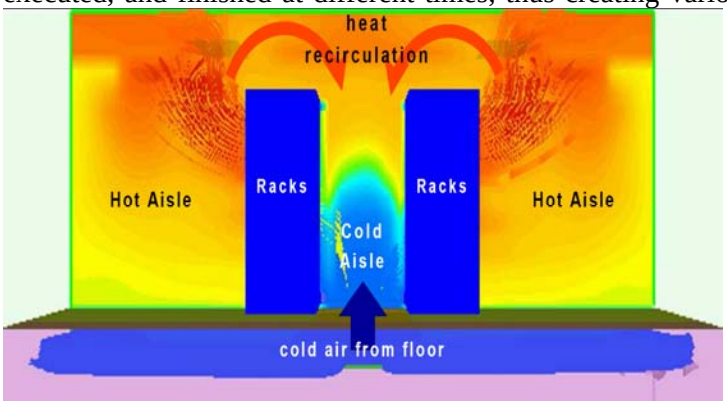


Figure shows the heat recirculation effect in a typical data center using a cold aisle – hot aisle configuration. *Credit: Image generated in the Arizona State University Impact lab using the Flovent Computation Fluid Dynamics (CFD) software.*

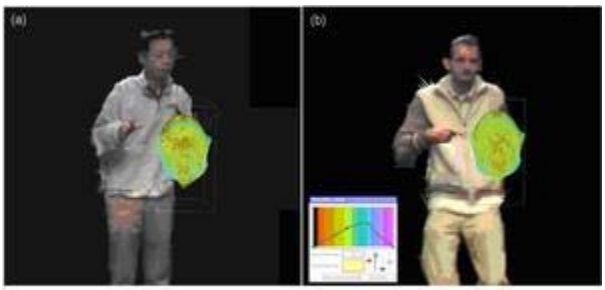
► **Error Correction in Digital Information Reaches Best Case Scenario:** Today, reliable, correct transmission and storage of digital information is of paramount importance. Despite the errors inherent in all communication channels and storage media, reliability can be achieved through the application of error-correcting codes, which were first conceived by Claude Shannon about 60 years ago. Recent advances made by NSF-funded scientists have led to error-correcting codes with the best possible trade-off between error-correction capability and efficiency. This new discovery yields an improvement by a factor of two over conventional error-correction algorithms currently used in most computing devices today. It remains to be seen whether we will all be using these new codes whenever we play a CD or access a computer hard disk in the years to come. But it is clear that these researchers have achieved an elusive milestone that has been sought ever since the birth of this field 60 years ago.

Error-correcting codes are all around us. *Credits (left to right): http://commons.wikimedia.org/wiki/File:Storhaugen_p%C3%A5_Fitjar.JPG, NASA, http://commons.wikimedia.org/wiki/File:Harddisk-head.jpg.*

► **Human-Robots Provide Post-Stroke Rehabilitation:** In the United States, about 730,000 people are victims of strokes each year, often resulting in some form of permanent disability. Yet rehabilitation is a scarce health-care service. To provide more patients with extended care, researchers at the University of Southern California have developed an integrated system composed of humanoid robots, software, and sensors. Together, they provide affordable monitoring, motivating, and coaching of rehabilitation exercises for people recovering from strokes. Low-cost, wearable sensors enable the robot to understand what the patient is doing and to decide what appropriate coaching and encouragement should be given. The robot uses a learning algorithm that enables it to adjust its personality and coaching style to match that of the patient's, resulting in rehabilitation exercise improvements. This project has the potential to create more affordable means of extended supervised rehabilitation, increasing the health and quality of life for many stroke survivors.

Wearable wristwatch-sized sensor used for robot-assisted stroke rehabilitation. *Credit: Dr. Eric Wade.*

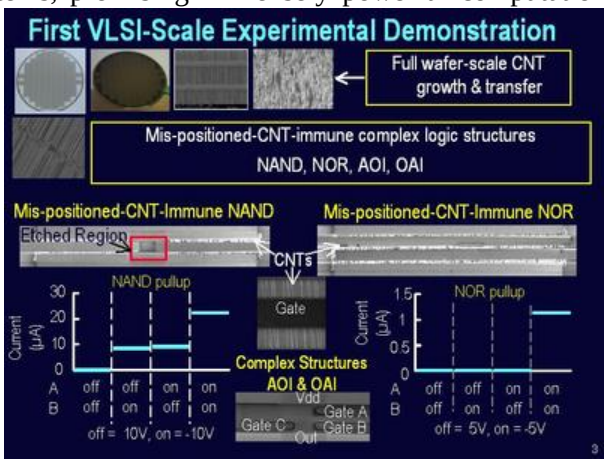
► **Improving Human Social Interaction in Multi-Site 3D Tele-Immersive Environments:** Many remote collaboration technologies failed because they have been unable to reproduce the richness of human social interaction. Typically, non-colocated users, for example those participating in videoconferencing, are unable to see the eye gaze or gestures of other participants, decreasing social cues and potential for appropriate social interaction. NSF-funded researchers have developed a teleimmersive system that fully immerses users in a common virtual space where normal social interactions can take place. To explore whether full human interaction is possible, a number of teleimmersive applications have been developed, including 3D



Two remote users rendered in the teleimmersive virtual environment with MRI data of human brain. The two screenshots show user A's and user B's perspective of the meeting. *Credit: Diana Kaljian.*

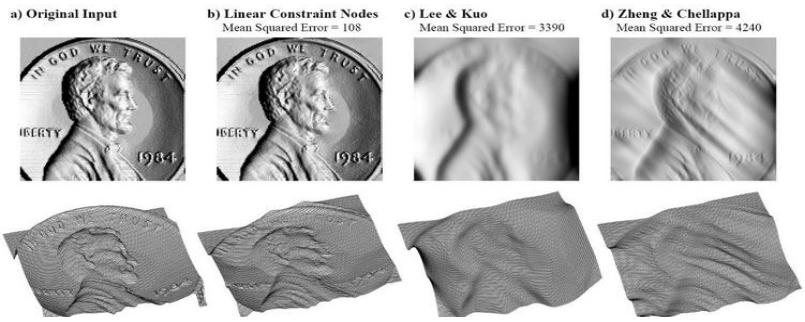
video conferencing, collaborative work on 3D MRI data sets , remote training in military scenarios, and remote teaching of dance performance. The researchers found that in contrast to existing 2-D videoconferencing or text-based collaboration technologies, teleimmersion humanizes remote communication. Progress is being made toward creating a low-cost, portable version of this system for use in the home or office.

► **Computing with Carbon Nanotubes:** Carbon nanotubes are strong candidates to replace silicon-based electronic building blocks in computing systems, promising immensely powerful computational capabilities in systems the size of pinheads. Unfortunately however, the precise fabrication of carbon nanotube devices and circuits has eluded scientists and engineers for many years, due to the difficulty of adequately controlling the positioning and material characteristics of carbon nanotubes at very large integration scales. Using mathematical principles, NSF-funded computer scientists recently devised a new algorithm that allowed them to design carbon nanotube circuits that are immune to such fabrication imperfections, resulting in the first experimental demonstration of carbon nanotube circuits in complex digital logic structures. The impact of these advances is significant, as it brings us closer to harvesting the great promise of nanotechnology.



VLSI Demonstration of Carbon Nanotube Circuits. *Credit: S.Mitra, Stanford University.*

► **Improving Computer Vision:** Inferring three-dimensional structures of objects based on their two-dimensional images is a central problem in biological and computer vision. Solving this problem is important for a large variety of civilian and military applications, particularly for automatic vehicle and robot navigation, scene understanding, and object tracking and manipulation. Computer scientists at Carnegie Mellon are investigating how neurons in the primate visual cortex encode prior knowledge about the natural environment and how neurons cooperate – as a group – to quickly resolve current ambiguities using that information. The researchers developed algorithms based on efficient belief propagation that have already yielded state-of-the-art results in 3-D shape inference, and which are generally useful for solving a large class of complex probabilistic inference problems. Solving real and difficult vision problems provides them with insights to guide their physiological studies of the visual cortex. This project represents a fruitful synergy between computational and neuroscience research.



State-of-the-art results on inferring 3D surface information from a single image of a U.S. penny provided by our efficient belief propagation algorithms. (a) The input image to the system (top row) and the underlying 3D ground-truth of the penny (second row). (b) The result from our algorithm, showing the image reconstructed (top) based on the inferred 3D map (bottom) are much more superior than current state-of-the-art results (c) and (d). *Credit: Tai Sing Lee, Carnegie Mellon University.*

COMPUTING AND COMMUNICATION FOUNDATIONS $174,830,000
+$17,900,000 / 11.4%

Computing and Communication Foundations Funding

(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY 2009 Plan Amount	Change Over FY 2009 Plan Percent
Total, CCF	**$143.63**	**$156.93**	**$41.50**	**$174.83**	**$17.90**	**11.4%**
Major Components:						
Research and Education Grants	135.63	148.93	41.50	166.83	17.90	12.0%
Centers	8.00	8.00	-	8.00	-	-
STC for Embedded Networked Sensing	*4.00*	*4.00*	-	*4.00*	-	-
STC for Ubiquitous Secure Technology	*4.00*	*4.00*	-	*4.00*	-	-

Summary of FY 2010 Request

Computing and Communications Foundation Division (CCF) (+$17.90 million, to a total of $174.83 million). CCF supports research and education on: algorithmic foundations to help us understand the fundamental limits of resource-bounded computation and to obtain optimal solutions within those limits; algorithms that are applicable to areas both within and outside computer science; the theoretical underpinnings and current and future enabling technologies for information acquisition, transmission, and processing in communication and information networks; the foundational aspects of hardware and software, i.e., the reasoning, comparing and establishing properties of existing and newly-conceived software and hardware components, systems, and other artifacts, which are essential to advance the capability of computing systems; and the design of new computing devices based on nanotechnology, biotechnology, or quantum physics.
In general, 60 percent of the CCF portfolio is available for new research grants with 40 percent used primarily to fund continuing grants from prior years.

In FY 2010, CCF will continue to support two Science and Technology Centers: the Center for Embedded Networked Sensing (CENS) at the University of California at Los Angeles, which is exploring embedded networked sensing systems, which are large-scale, distributed systems composed of smart sensors and actuators embedded in the physical world; and the Center for Ubiquitous Secure Technology at the University of California at Berkeley (TRUST). TRUST is addressing a parallel and accelerating trend of the past decade - the integration of secure, robust computing and communications capabilities across critical infrastructures, in areas such as telecommunications, finance, energy distribution, and transportation.

CCF will continue to explore concepts, methods, technologies and tools foundational to the computing disciplines in FY 2010, assuring the Nation's leadership in computing for the long-term. CCF will place renewed emphasis on processes and tools for the design, development, and deployment of reliable software and hardware systems. The division will also make new investments in research and education at the interface of computer science and other fields of science and engineering. For example, new investments at the interface between computer science and economics will enable a better understanding of trust and risk in our financial markets, how to design emerging online markets to satisfy global goals, the use of network theory to understand economic systems in the developing world, and numerous other applications. Further, CCF will continue to support the design and analysis of algorithms, optimization

methods, and software to facilitate research advances in the natural sciences, social sciences, and engineering.

In FY 2010, CCF will continue its emphasis on Cyber-enabled Discovery and Innovation (CDI). By applying algorithmic insights broadly across science, engineering, and areas of societal importance, CDI will spark a new revolution in our understanding of the world and in our productivity. As part of CDI, CCF will increase its investments in Cyber-Physical Systems (e.g., autonomous cars, intelligent energy-efficient buildings, embedded medical devices, assistive technology for the aged, quality-of-life robots) by $4.0 million in FY 2010. CCF-enabled advances in Cyber-Physical Systems will establish the scientific foundations and engineering principles to help conceptualize, design, analyze, implement, and certify cyber-physical systems Further, to realize the full potential of data-intensive computing CCF will support innovative research in algorithms, programming languages, programming models, resource management, and system design to fully capitalize on the potential of data-intensive systems to transform application areas from science and engineering to healthcare, environmental monitoring and the humanities.

CCF is increasing support in Science and Engineering Beyond Moore's Law (SEBML) by $11.0 million to a level of $15.0 million in FY 2010. As performance gains forecast by Moore's Law continue to level out, multicore processors that incorporate thousands of cores on a single chip promise a new means by which to realize system performance gains. CCF-supported research will address all the hardware and software challenges associated with exploiting multicore technology, including capitalizing on the energy efficiencies it promises. In addition, CCF will support fundamental research to identify promising, radically new technologies for computing, including, for example, the use of molecules or biomolecules as basic logic elements, the use of nanowires for gates or interconnections, and the exploitation of quantum phenomena to perform parallel computations.

All three CISE disciplinary divisions will play important roles in the NSF-wide program on Climate Research. CCF will provide $3.30 million in FY 2010, supporting research on fundamental new algorithms, data structures, and software capabilities to enable development of computational models of our planet so that climate prediction can be done on regional and decadal scales.

COMPUTER AND NETWORK SYSTEMS

$209,870,000
+$21,560,000 / 11.4%

Computer and Network Systems Funding

(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY 2009 Plan Amount	Change Over FY 2009 Plan Percent
Total, CNS	**$174.16**	**$188.31**	**$92.57**	**$209.87**	**$21.56**	**11.4%**
Major Components:						
Research and Education Grants	146.65	162.31	60.57	179.87	17.56	10.8%
Computing Research Resources	27.51	26.00	32.00	30.00	4.00	15.4%

Summary of FY 2010 Request

Computer and Network Systems Division (CNS) (+$21.56 million, to a total of $209.87 million). 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 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 Broadening Participation in Computing (BPC) program to significantly increase the number and diversity of U.S. citizens and permanent residents receiving post secondary degrees in the computing disciplines, and the CISE Pathways to Revitalized Education in Computing (CPATH) program to identify and define the core computing concepts, methods, technologies and tools to be integrated into promising new undergraduate education models.

In general, 47 percent of the CNS portfolio is available for new grants. The remaining 53 percent is used primarily to fund continuing grants made in previous years.

In FY 2010, CNS will increase its investments in Trustworthy Computing by $10.0 million, emphasizing foundational cybersecurity research, as well as research in areas such as privacy and usability. CNS will also continue its emphasis on Cyber-enabled Discovery and Innovation (CDI), supporting research leading to a better understanding of how complex systems and networks behave at scale and evolve over

time. As part of CDI, CNS will increase investments in Cyber-Physical Systems (CPS) by $2.0 million to enable the development of methods, tools, components, and architectures that promise significant impact in application domains ranging from transportation and automotive to healthcare and the environment.

Along with CCF and IIS, CNS will play an important role in the NSF-wide program on Climate Research. CNS will provide $3.40 million in FY 2010, supporting research on smart sensor and smart sensor networking technologies that will enable state-of-the-art observatories in the sky, ocean, ice, land, and in living systems, including humans.

INFORMATION AND INTELLIGENT SYSTEMS

$167,560,000
+$17,300,000 / 11.5%

Information and Intelligent Systems Funding

(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY 2009 Plan Amount	Change Over FY 2009 Plan Percent
Total, IIS	**$139.33**	**$150.26**	**$60.50**	**$167.56**	**$17.30**	**11.5%**
Major Component:						
Research and Education Grants	139.33	150.26	60.50	167.56	17.30	11.5%

Summary of FY 2010 Request

Information and Intelligent Systems Division (IIS) (+$17.30 million, to a total of $167.56 million). 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 with knowledge 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 the research traditions of 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.

In FY 2010, IIS will increase investments in disciplinary areas, reflecting the continuing and growing importance of topics such as: designing and developing innovative technologies that support the reuse, repurposing, integration, and protection of diverse and heterogeneous sources of digital content; building creative systems that exhibit the broad competencies and robust behaviors exhibited by humans and other biological organisms; and understanding the fundamental capabilities and limitations of people and computers networked together as social and intelligent systems. With an investment of $5.0 million, IIS will spearhead a new multidisciplinary program focused on socially intelligent computing, in collaboration with colleagues in the human sciences. By better characterizing, understanding, and designing for desired behaviors arising from computationally mediated groups of people at all scales, new forms of knowledge creation, new models of computation, new forms of culture, and new types of interaction will result.

IIS will continue its emphasis on Cyber-enabled Discovery and Innovation (CDI) in FY 2010, targeting new data technologies that scale to the quantities, speed, dimensionality, and complexity of data that

challenges innovation in scientific and engineering. To address CDI's thrust on virtual organizations, IIS will support research that enables large-scale collaboration across scientific and engineering domains, with emphasis placed on building and applying more principled understanding of virtual organization design. Virtual organizations will also be explored as primary vehicles for supporting inquiry-based STEM education, with the potential to reach students at all levels and the public at large.

Along with CCF and CNS, IIS will play important roles in the NSF-wide program on Climate Research. IIS will provide $3.30 million in FY 2010, supporting research to develop data technologies and intelligent decision-making techniques that can enable real-time processing of the numerous and highly disparate sources of data that are crucial to understanding climate.

INFORMATION TECHNOLOGY RESEARCH

$80,740,000
+$2,500,000 / 3.2%

Information Technology Research Funding

(Dollars in Millions)

	FY 2008 Actual	FY 2009 Current Plan	FY 2009 ARRA Estimate	FY 2010 Request	Change Over FY 2009 Plan Amount	Change Over FY 2009 Plan Percent
Total, ITR	**$78.14**	**$78.24**	**$40.43**	**$80.74**	**$2.50**	**3.2%**
Major Components:						
Research and Education Grants	78.14	78.24	40.43	78.24	-	-
Science of Learning Centers	-	-	-	2.50	2.50	N/A

Summary of FY 2010 Request

Information Technology Research Division (ITR) ($+2.50 million, to a total of $80.74 million). 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 to make new awards. The remaining 30 percent is used primarily to fund continuing grants made in previous years.

In FY 2009 and FY 2010, funds from the ITR subactivity will be used to target CISE-wide IT research and education priorities.

Continued support will be provided for the Expeditions in Computing program. In planning and implementing *Expeditions*, researchers are encouraged to come together within or across departments or institutions in the identification of compelling, transformative research agendas that promise disruptive innovations in computing and information for many years to come. Funded at levels up to $10 million, *Expeditions* projects represent some of the largest single investments currently made by CISE. Together with the Science and Technology Centers and the Science of Learning Center CISE supports, *Expeditions* form the centerpiece of the directorate's award portfolio.

In FY 2010, ITR will provide support to the Pittsburgh Science of Learning Center (SLC) for Robust Learning.