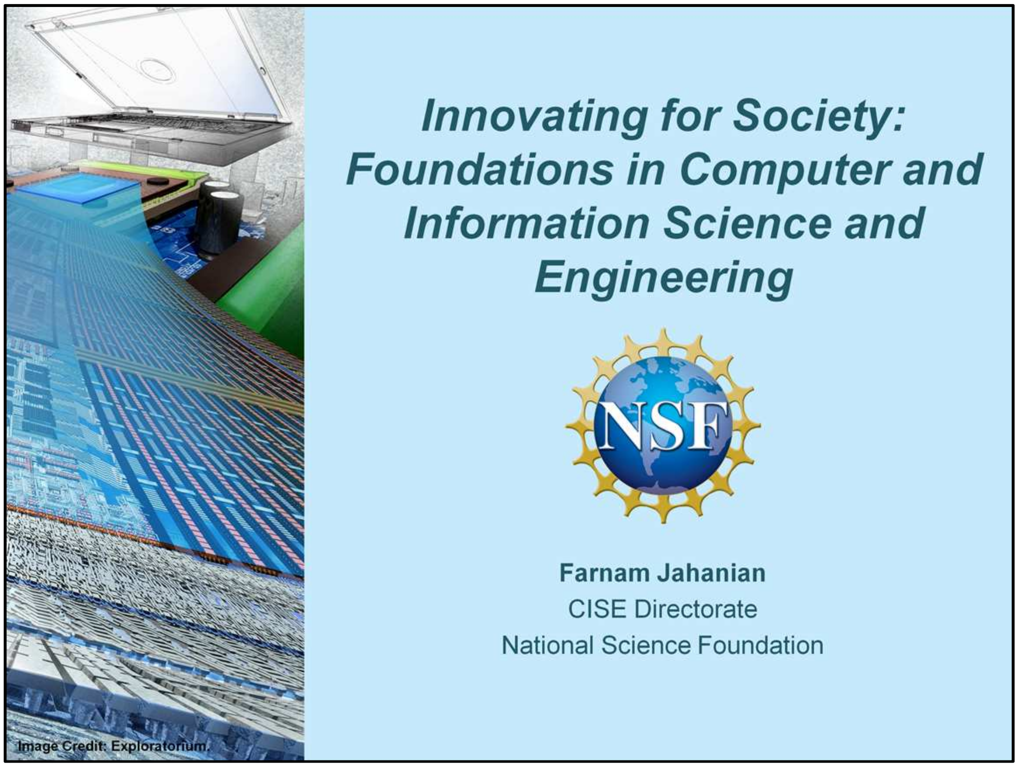


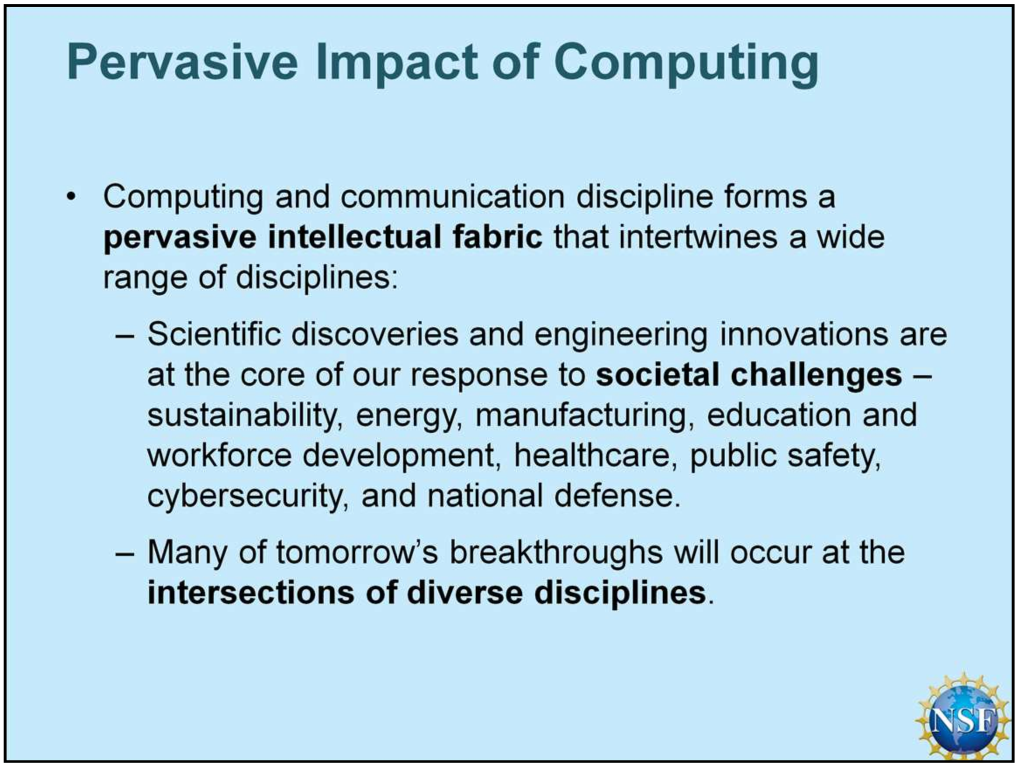
Thank you very much for that kind introduction, X.

I welcome the opportunity to spend next few mins sharing with you my thoughts on the extraordinary opportunities for the science and engineering community, in the areas of computing, communication and broadly speaking information technology.

We all recognize that … a breathtaking pace of advances has brought NIT into the forefront of science, medicine, commerce, transportation, arts and entertainment in ways that were barely imagined twenty five years ago. These advances have transformed the way **we live, work, learn, play, and communicate.**

TODAY … Networking and Information Technology (NIT) is at the center of an ongoing **societal transformation**:

- It underpins our **economic prosperity and national security**.
- In an increasingly global market, it is a driver of US Competitiveness and has played a pivotal role in our economic growth through innovation and idea-driven "creative" industries.
- It accelerate the pace of scientific discovery and technological innovation in nearly all other fields of scientific and engineering inquiry
- are crucial to achieving our major national and global priorities in energy and transportation, education and life-long learning, healthcare, and national and homeland security



NIT has the potential to form a **pervasive intellectual fabric** that intertwines a wide range of disciplines – recognizing that:

Scientific discovery and technological innovation are at the core of our response to **national and societal challenges** – sustainability, energy, transportation, manufacturing, education and workforce development, healthcare, public safety, cybersecurity, and national defense.

Many of tomorrow's breakthroughs will occur at the **intersections of diverse disciplines.**

Comment on:

Widespread deployment of low-power sensors

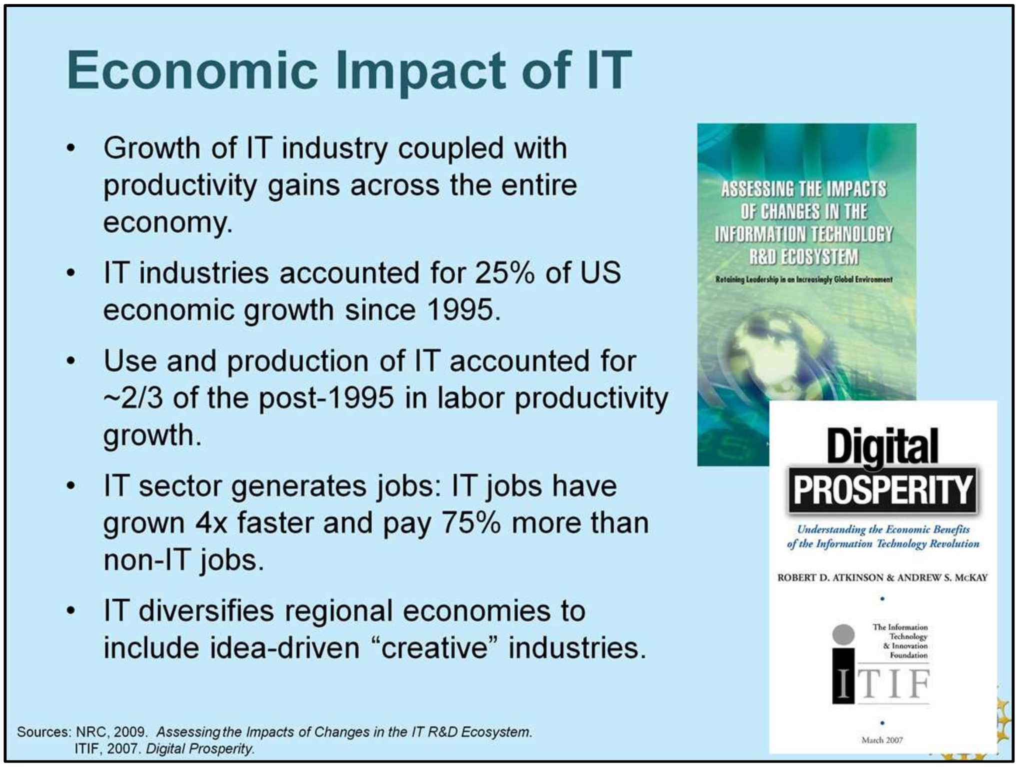
The **explosive growth in size, diversity and complexity of scientific and social data**,

wireless connectivity at broadband speeds for billions of endpoints – which are both people and environmental sensors –

seamless access to computational resources and applications in the "cloud"

Computation and data-enabled techniques enable automatic extraction of new knowledge about the physical, biological or the cyber world

What's possible? New insights into science, spot business trends, prevent diseases, manage our previous natural resources, mitigate natural or man-made disasters.



Consider for a moment the enormous economic impact of information technology over the last 25 years:

- The enormous economic impact is not only from the **growth of IT industry** itself, but to a greater extent from IT-enabled **productivity gains** from across the entire economy.
- Since 1995, Networking & IT industries accounted for **25%** of US economic growth.
- The use and production of IT accounted for **roughly 2/3** of the post-1995 step-up in labor productivity growth.
- The IT sector is a **job generator**. IT jobs have grown 4x faster than non-IT jobs (between 1999-2008), and on average pay 75% more.
- Over the last decade, IT has played a pivotal role in the **diversification** of regional economies to include **innovation and idea-driven "creative"** industries. Consider the role of modeling and simulation computation tools, coupled with data-enabled techniques in advanced manufacturing.

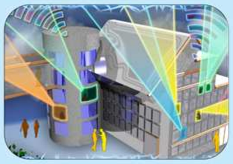
The economic impact of our discipline has been truly phenomenal. Several national academies' studies[1] on the role of federal investments in basic IT R&D, including the 2009 report on "Assessing the Impact of Changes in the IT R&D Ecosystems" highlight this issue.

The enormous economic impact of IT derives not only from the growth of the NIT industry itself, but to an even greater extent from IT-enabled productivity gains across the entire economy.

BULLETS: Billion $ industries, 25% of US economic growth due to IT, and roughly 2/3 of the post-1995 step-up in labor productivity growth.

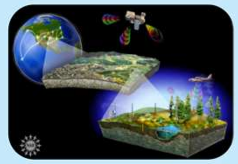
The enormous economic impact of IT derives not only from the growth of the NIT industry itself, but to an even greater extent from IT-enabled productivity gains across the entire economy. While the fruits of IT advances are most evident in the rise of the modern technology sector – now-familiar corporate names such as Apple, Facebook, Google, Intel, Microsoft, and others – the impact in other areas of the economy has been equally dramatic. Companies as diverse as FedEx and Walmart, although they provide services that existed long before the current technology boom, have used advances in NIT to revolutionize their industries, boosting operational efficiency and economic output to an unprecedented extent.

Information Technology and National Priorities



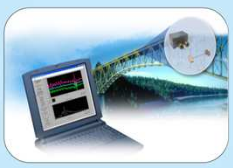
Broadband & Universal Connectivity

Emergency Response & Disaster Resiliency



Environment & Sustainability

Health & Wellbeing

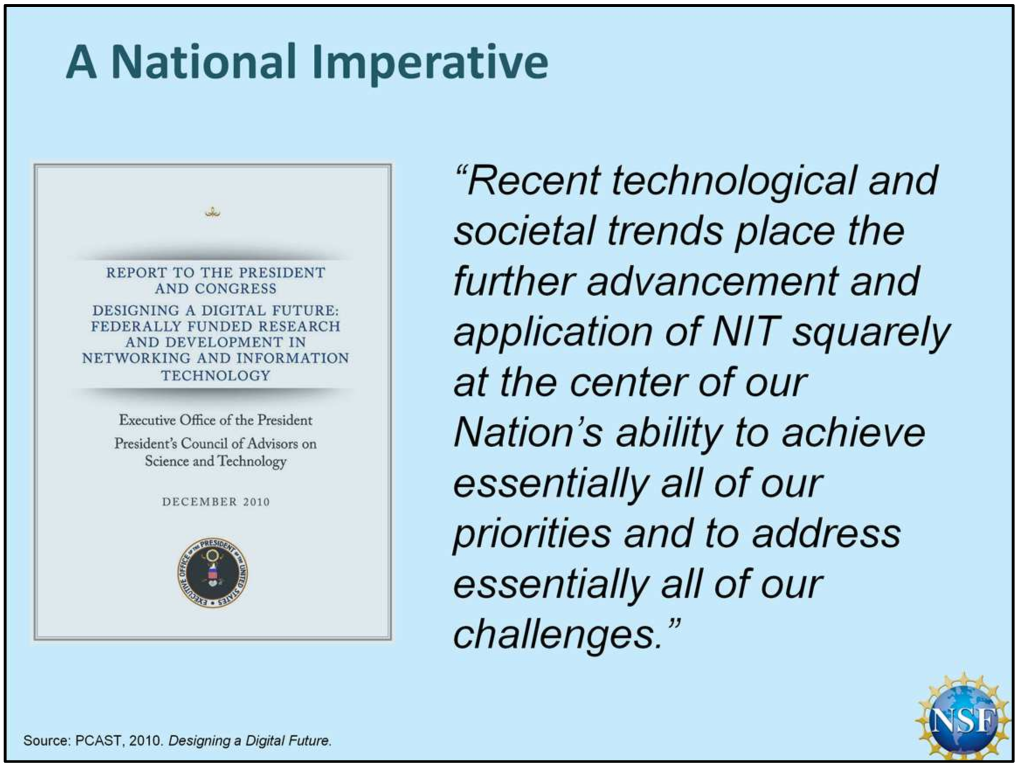


Manufacturing, Robotics, & Smart Systems

Secure Cyberspace

Transportation & Energy

Education and Workforce Development



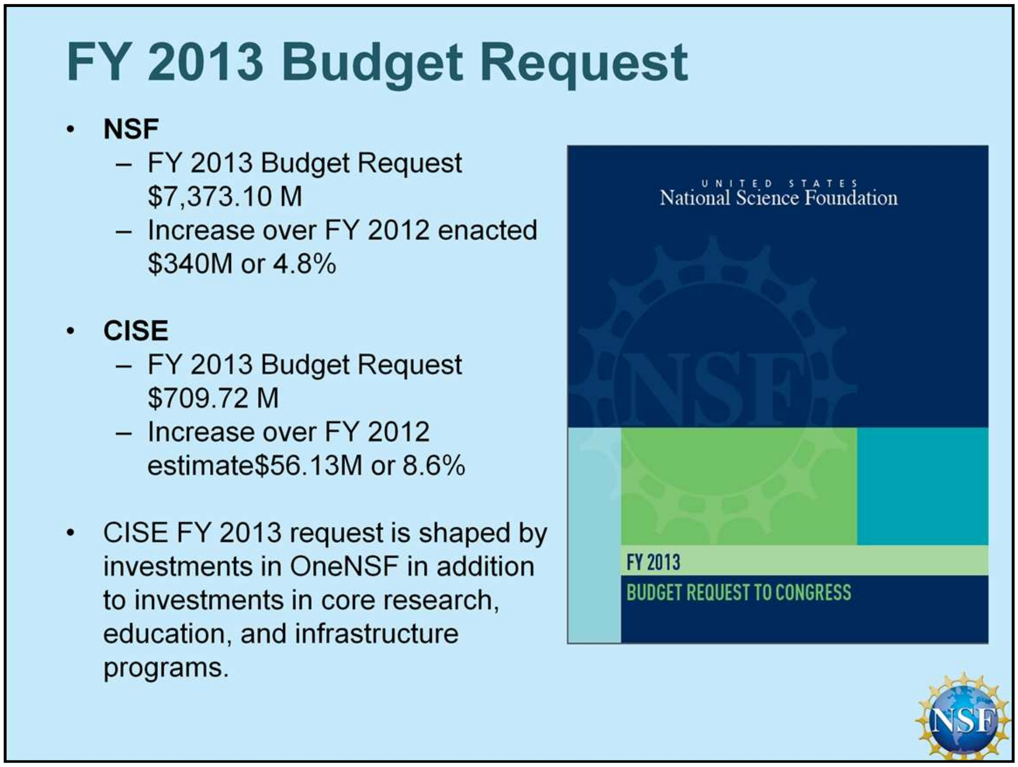
The latest report by The President's Council of Advisors on Science and Technology (PCAST) on the NITRD program, in fact, offers a compelling a case for Networking and Information Technology as a NATIONAL IMPERATIVE.

This report, which was released released in December of 2010, was developed by a WG led by David Shaw and Ed Lazowska, with significant input from the community.

It brings to focus the benefits that have been achieved through the Nation's 20-year coordinated investments in Networking and Information Technology Research and Development.

The President's Council of Advisors on Science and Technology (PCAST) conducts periodic congressionally-mandated review of the Federal Networking and Information Technology Research and Development (NITRD) Program.

Previous PCAST and PITAC reports have positioned NIT principally as central to discovery in science and engineering. This report places NIT as *additionally* central to fields such as health, energy, transportation, and education. It also focuses heavily on the exceptional role of NIT as an engine of economic growth.



The President is requesting a total of $7.373 billion dollars for NSF in FY 2013. That's an increase of $340 million, or 4.8 percent above the FY 2012 enacted level.

The request also includes an increase of $56M, or 8.6% above the FY2012 estimated level, for the Computer and Information Science and Engineering Directorate.

Quote Subra: "**In today's changing economic landscape, science and technology are the new frontiers of American prosperity. The nation's well being and global competitiveness depend, more than ever before, on the steady stream of new ideas and the highly skilled science, technology, engineering and mathematical talent that the National Science Foundation supports, and particularly the young researchers that NSF so skillfully nurtures."**

There is overwhelming consensus worldwide that scientific discovery and technological innovation, driven by a creative and skilled science and engineering workforce, are the new engines of economic growth.

CISE FY 2013 request is shaped by investments in OneNSF in addition to investments in core research, education, and infrastructure programs.

CISE Mission

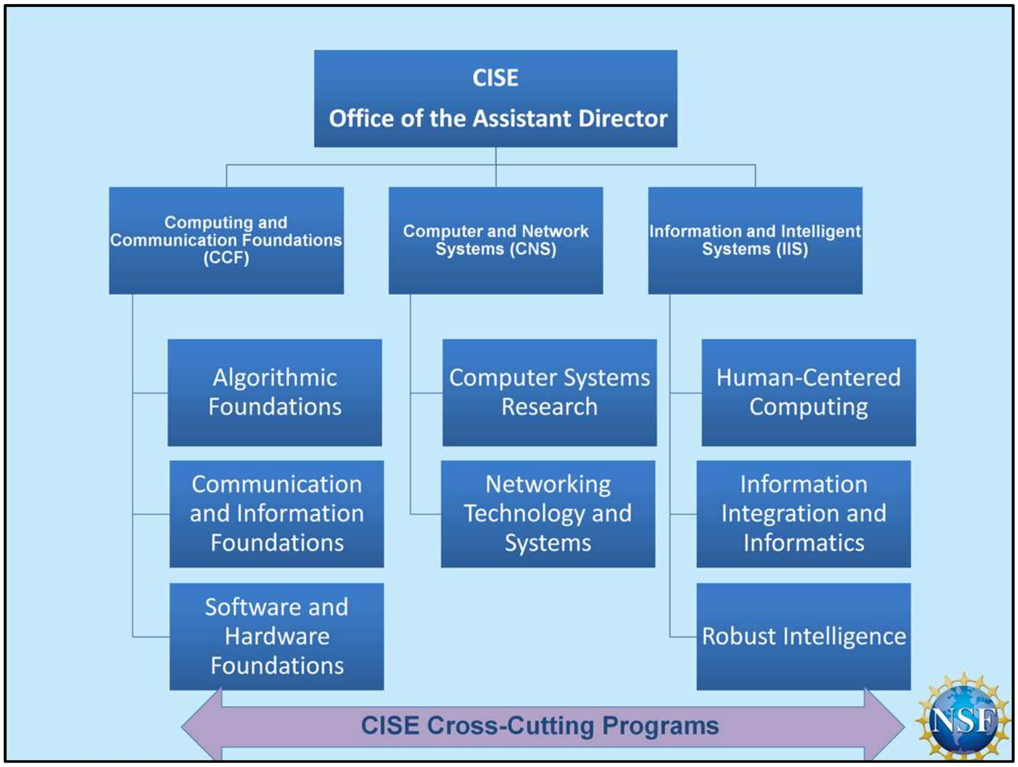
Exploring the frontiers of computing

- Promote progress of computer and information science and engineering research and education.
- Promote understanding of the principles and uses of advanced computer, communications, and information systems in service to society.
- Contribute to universal, transparent, and affordable participation in an information-based society.

These frontiers have interfaces with all the sciences, engineering, education, and humanities and a strong emphasis on innovation for society.

CISE’s mission is to uphold the nation's leadership in computer and information science and engineering through its support for fundamental and transformative advances that are a key driver of economic competitiveness and crucial to achieving national priorities.

contribute to the development of a computing and information technology workforce with skills essential to success in the increasingly competitive, global market.



The budget request includes substantial increases for core programs in frontier research and for education and human resources.

CISE continues to cast a wide net and let the best ideas surface, rather than pursuing a prescriptive research agenda. It engages the research community in developing new fundamental ideas, which are then evaluated by the best researchers through the merit review process. This process, which supports the vast majority of unclassified computing research in the United States, has led to innovative and transformative scientific results with enormous economic impact and societal benefits.

Snapshot of FY 2011 Activities

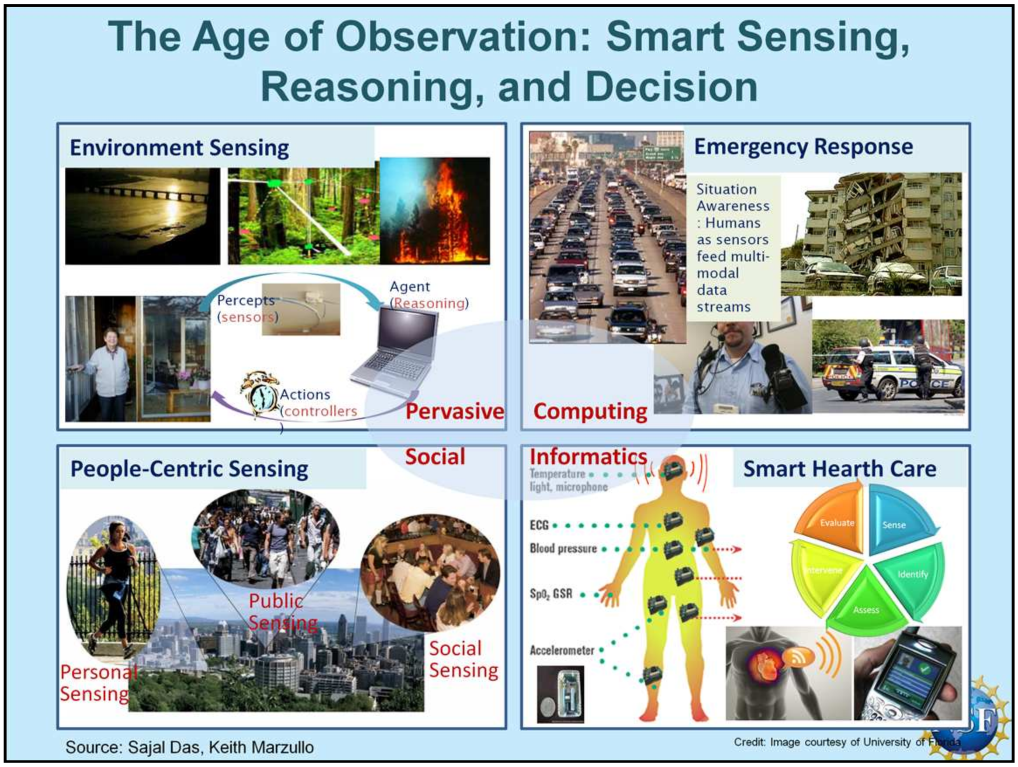
	CISE
Research Budget ($M)	$635M
Number of Proposals	5,998
Number of Awards	1,378
Success Rate	~20%
Average Award Size	$164K
Number of Panels Held	247
Number of People Supported	14,488

	CISE
Senior Researchers	6,812
Other Professionals	605
Postdoctoral Associates	371
Graduate Students	4,882
Undergraduate Students	1,818

As Dr. Subra mentioned, OneNSF is a comprehensive vision of how NSF works together on cross-foundational activities **to respond to new challenges in a global science and engineering environment that is changing rapidly. It aims to leverage financial and human resources for maximum impact, and it encourages leadership by promoting innovative practices and programs to advance scientific knowledge and STEM education.**

The OneNSF operational philosophy was put into practice in shaping CISE's strategic budget priorities for FY13.

The CISE's budget presents a well-targeted portfolio of innovative investments that align closely with the Administration's priorities. It provides increased support for fundamental research in CISE addressing the Administration's government-wide priorities in critical areas including advanced manufacturing, sustainability, cybersecurity, and education and workforce development.



The melding of the cyber world with the physical world, a trend that will continue to accelerate in the coming decades as a breathtaking pace of advances has brought computing and communication into all facets of our society, and allows us to record and observe a wide set of phenomena.

In our community, this is being ushered in by widespread deployment of low-power sensors ranging

-- from tiny specialized communicating processors ("smart dust") and

-- specialized sensors (in body sensors, structural sensors, power sensors) to

-- mobile phone-based sensors (geolocation, vibration, etc).

Enabling applications including:

-- sensing environmental information (air quality, beech erosion),

-- physical structural information (health of bridges and buildings, power consumption of buildings and campuses)

-- Emergency response during man-made or natural disasters

-- social data and health information.

Of course, we can often do more than just monitor and observe:

we can combine disparate sources of data to create a deeper form of reasoning, and we can make decisions, i.e. control or react

Instrument, observe, analyze and respond.

Cyber-Enabled Materials, Manufacturing, and Smart Systems (CEMMSS)

Accelerating advances in 21st century smart engineered systems

OneNSF investment: $257.42M, CISE: $91.0M

- Creating smart systems that sense, respond, and adapt to the environment.
- In partnership with BIO, ENG, MPS, and OCI, CISE aims to:
  - Establish scientific basis for engineered systems interdependent with physical world and social systems;
  - Synthesize multi-disciplinary knowledge to model and simulate systems in full complexity and dynamics; and
  - Develop a smart systems technology framework.
- CISE focus in CEMMSS includes Advanced Manufacturing, Cyber-Physical Systems (CPS), and National Robotics Initiative (NRI).

NSF's Cyber-enabled Materials, Manufacturing, and Smart Systems (CEMMSS) is a path-breaking effort to develop "smart" systems that can sense, respond and adapt to changes in the environment. The program brings together researchers and educators from the areas of advanced manufacturing, materials science, cyber-physical systems and robotics to build an integrated community of interest and stimulate new directions in research.

Cyber-Physical Systems (CPS)

Deeply integrating computation, communication, and control into physical systems

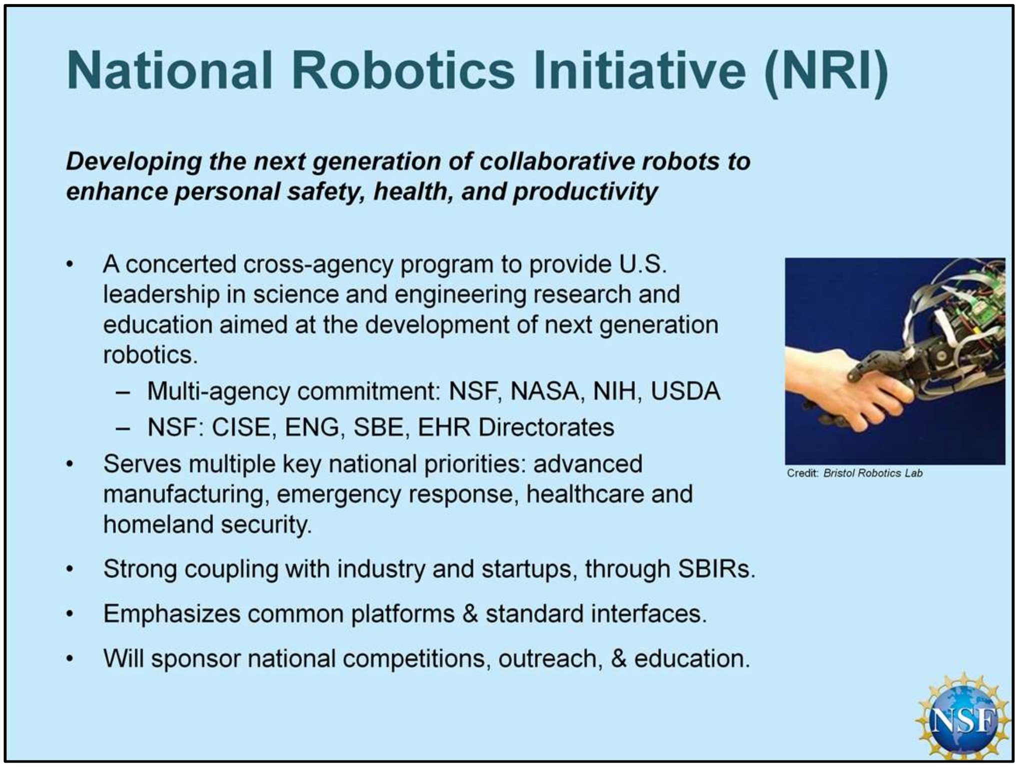
- Aims to develop the core system science needed to engineer complex “smart” cyber-physical systems.
- Serves multiple key national priorities: transportation, energy, healthcare, and critical infrastructure.
- Cross-Directorate : CISE & ENG
- Also cooperates with other government agencies to support cyber-physical systems research that is relevant to their missions.

Transportation
- Faster and safer aircraft
- Improved use of airspace
- Safer, more efficient cars

Energy and Industrial Automation
- Homes and offices that are more energy efficient and cheaper to operate
- Distributed micro-generation for the grid

Healthcare and Biomedical
- Increased use of effective in-home care
- More capable devices for diagnosis
- New internal and external prosthetics

Critical Infrastructure
- More reliable power grid
- Highways that allow denser traffic with increased safety



To assess the opportunities and challenges for a national robotics initiative, over 140 robotics experts from industry, laboratories, and universities from across the country joined forces to produce a definitive report entitled: *A Roadmap for US Robotics- From Internet to Robotics, May 21, 2009* (http://www.us-robotics.us/reports/CCC Report.pdf).

The primary purposes of this initiative are to provide leadership in research fundamental to the development of the next generation of robotics, particularly co-robotics, to advance the capability and usability of such systems and artifacts, and to encourage existing and new communities to focus on innovative applications areas. Co-robots establish a symbiotic relationship with their persons,

We have seen a dramatic increase in size, complexity and diversity of cyber attacks across the Internet over the last decade.

Words such as worms, viruses, identity theft, denial-of-service attacks, botnets, spyware, phishing attacks are now part of our lexicon.

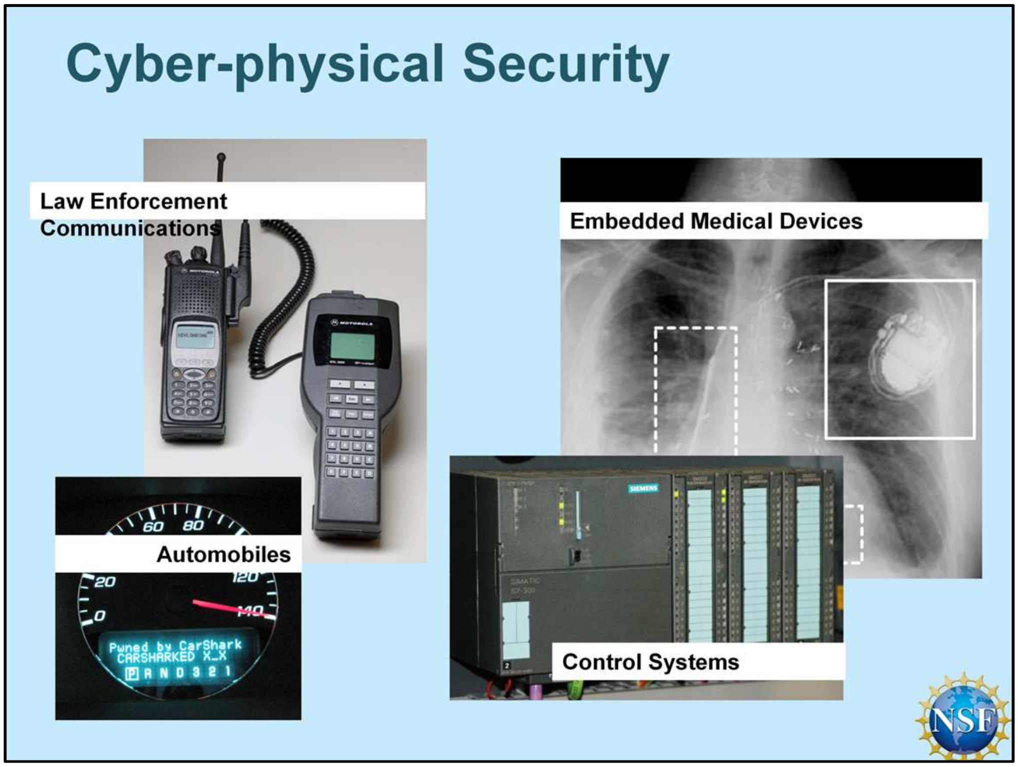
As the world moves online … as we become more reliant on information technology and as we become more digitally connected, the impact of cyber attacks can be seen in every aspects of our lives.

Cyber Security Challenge

- **Attacks and defenses co-evolve**: a system that was secure yesterday might no longer be secure tomorrow.
- The technology base of our systems is frequently updated to improve functionality, availability, and/or performance. **New systems introduce new vulnerabilities** that need new defenses.
- The **environments** in which our computing systems are deployed and the functionality they provide are **dynamic**, e.g. cloud computing, mobile platforms.
- As **automation pervades new platforms**, vulnerabilities will be found in critical infrastructure, automotive systems, medical devices.
- The **sophistication** of attackers is increasing as well as their sheer **number** and the **specificity** of their targets.
- Cyber security is a **multi-dimensional** problem requiring expertise from CS, mathematics, economics, behavioral and social sciences.

- *The Nation's critical infrastructure, and, more generally, the Internet, play a vital role in tightly integrating the economic, political, and social fabric of society. These interdependencies leave the Nation vulnerable to a wide range of threats that challenge the security, reliability, availability, and overall trustworthiness of all information technology resources. Overcoming this present vulnerability is a major challenge as well as a significant opportunity. It calls for long-term investments in a spectrum of scientific and technical areas in computer science, mathematics, economics, social sciences, and education.*

- Achieving system trustworthiness is not purely a technology problem: social engineering, usable mechanisms, incentives.



Each sector that becomes cyber-enabled becomes vulnerable to attack. Healthcare, education, and finance are already at risk, and physical infrastructure – manufacturing, energy production, and transportation – will be next. This trend toward increasingly cyber-physical systems, the integration of computation, communication, and control into physical systems, will continue to offer new challenges.

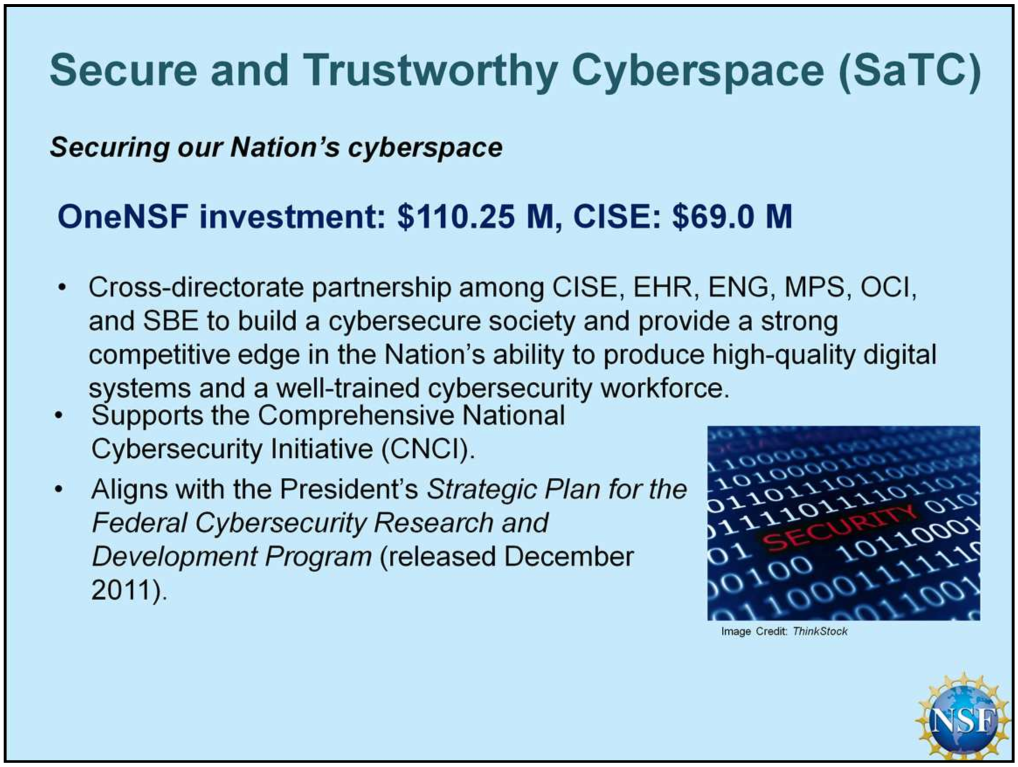
Consider, for example, the recent STUXNET worm. Discovered in July 2010, this worm targeted SCADA systems that were configured to monitor and control a kind of centrifuge used in Iranian nuclear fuel processing facilities.

1. "We monitored sensitive transmissions about operations by agents in every Federal law enforcement agency in the Department of Justice and the Department of Homeland Security," wrote the researchers, who were led by computer science professor Matt Blaze and plan to reveal their findings Wednesday in a paper at the Usenix Security Symposium in San Francisco.http://www.usenix.org/events/sec11/tech/full_papers/Clark.pdf

2. A team of computer security researchers planned to report Wednesday that it had been able to gain wireless access to a combination heart defibrillator and pacemaker. They were able to reprogram it to shut down and to deliver jolts of electricity that could potentially have been fatal if the device had been in a person. In this case, the researchers were hacking into a device in a laboratory. The researchers said they had also been able to glean personal patient data by eavesdropping on signals from the tiny wireless radio that Medtronic, the device's maker, had embedded in the implant as a way to let doctors monitor and adjust it without surgery. http://www.secure-medicine.org/icd-study/icd-study.pdf

3. Researchers at the University of Washington and the University of California, San Diego, have taken a close look at the computer systems used to run today's cars and discovered new ways to hack into them, sometimes with frightening results. In a paper set to be presented at a security conference in Oakland, California, next week, the researchers say that by connecting to a standard diagnostic computer port included in late-model cars, they were able to do some nasty things, such as turning off the brakes, changing the speedometer reading, blasting hot air or music on the radio, and locking passengers in the car. http://www.autosec.org/pubs/cars-oakland2010.pdf

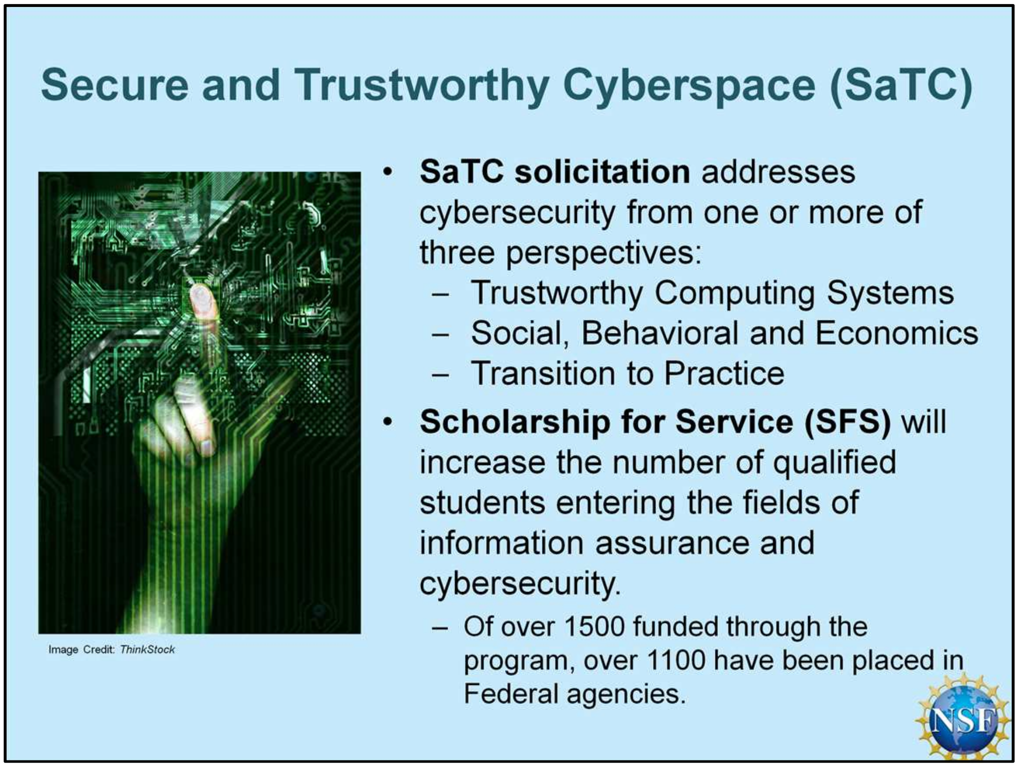
4. Stuxnet is a computer worm discovered in June 2010. It targets Siemens industrial software and equipment running Microsoft Windows. While it is not the first time that hackers have targeted industrial systems, it is the first discovered malware that spies on and subverts industrial systems,[3] and the first to include a programmable logic controller (PLC) rootkit. http://en.wikipedia.org/wiki/Stuxnet



Secure and Trustworthy Cyberspace (SaTC) is a broad research and education program designed to protect the Nation's critical information technology infrastructure, including the Internet, from a wide range of threats that challenge its security and reliability.

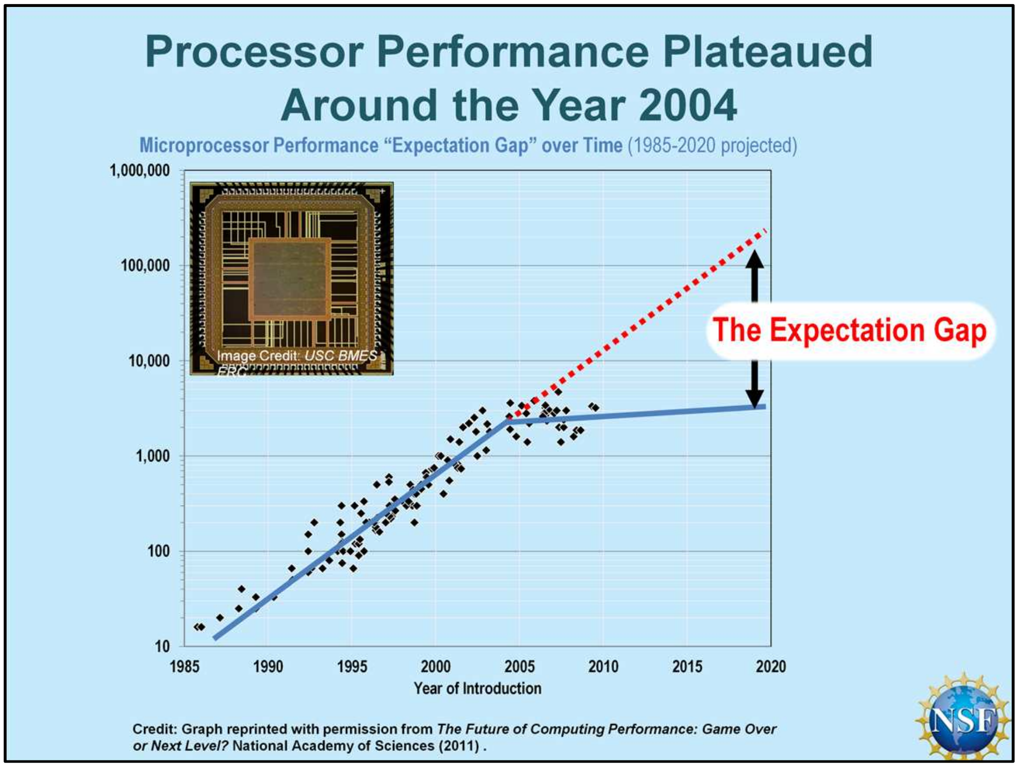
As President Obama has pointed out, the "cyber threat is one of the most serious economic and national security challenges we face as a nation" The cybersecurity vulnerabilities in our government and critical infrastructure are a risk to national security, public safety, and economic prosperity.

Securing our nation's cyberspace requires long-term investments across statistical, mathematical, economic, human, computational, and computer sciences and ultimately in the transition of new concepts and technologies into practice.



The Foundation's **Secure and Trustworthy Cyberspace (SaTC)** investment aims to provide the scientific basis for designing, building, and operating a cyberinfrastructure that can resist attacks and be tailored to meet a wide range of technical and policy requirements. The effort also encourages state-of-the-art research in the design of incentives that either reduce the likelihood of cyber attacks or the negative effects arising from them. This innovative research will improve the resilience of operating systems, software, hardware, and critical infrastructure while preserving privacy, promoting usability, and ensuring trustworthiness through foundational research and prototype deployments.

The Federal Cyber Service: Scholarship for Service (SFS) program will increase the number of qualified students entering the fields of information assurance and cybersecurity. The program will improve the capacity of the U.S. higher education enterprise to produce professionals with cybersecurity expertise. This program provides funding to colleges and universities for scholarships and capacity building in the information assurance and computer security fields.



Single-Processor performance has plateaued

Decades of exponential growth (Moore's law) stalled around 2004 due to the fact (clock speed frequency has not kept up) because of the physical limitation of heat-density in CMOS devices

The Single-Processor Performance Plateau is Problematic because:

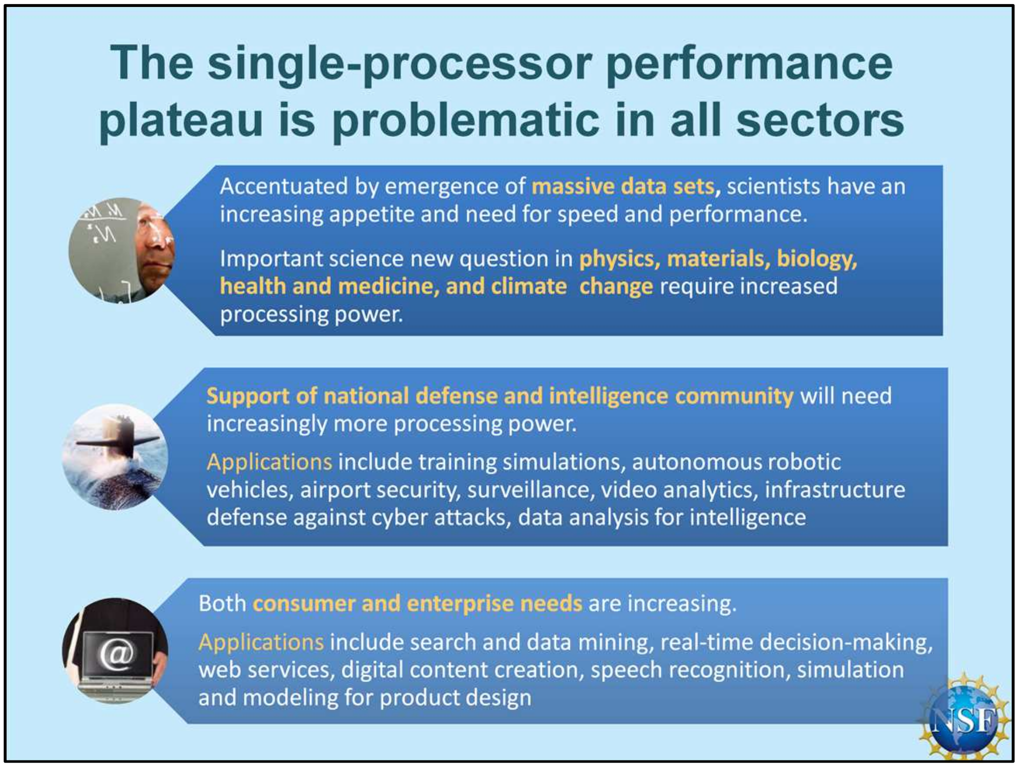
Scientists and users have an enormous appetite for speed and performance

– accentuated by emergence of massive data sets

Important science problems need increased processing power
– physics, materials, biology, climate, etc.

Support of national defense will always demand more processing power than our adversaries

Consumer and enterprise application needs



The Single-Processor Performance Plateau is Problematic because:

Scientists and users have an enormous appetite for speed and performance

– accentuated by emergence of massive data sets

-- not just do old things faster but the ability to answer new questions (*e.g.*, in physics, materials, biology, climate).

Important science problems need increased processing power

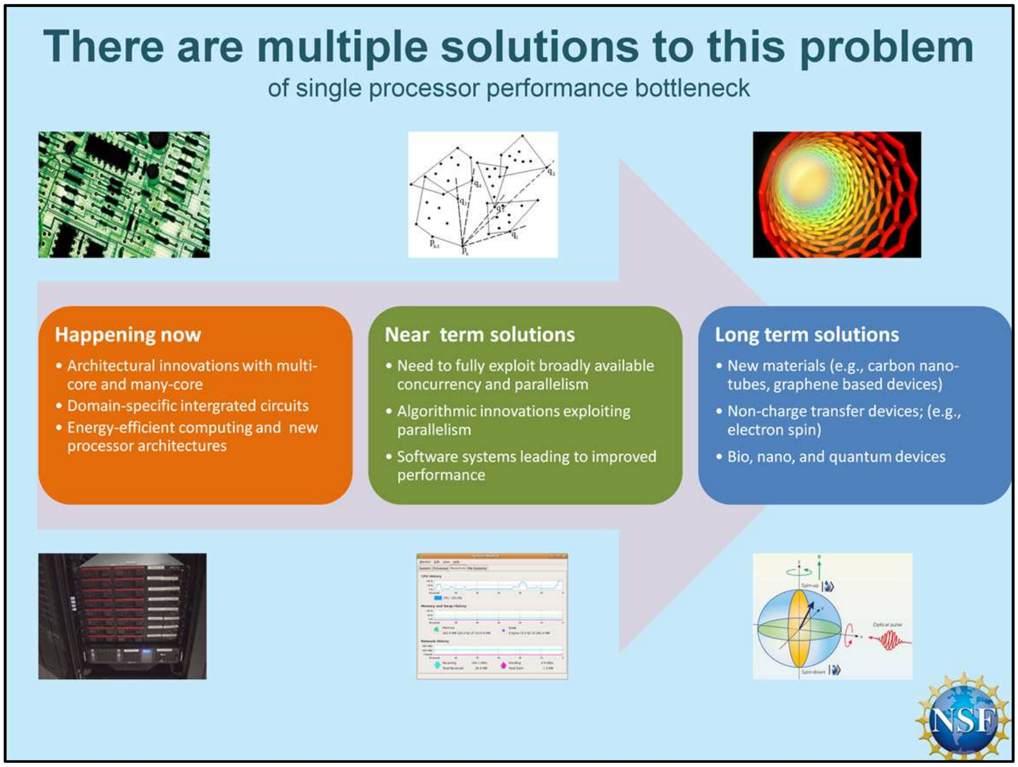
– physics, chemistry, materials, biology, climate-change, etc.

Support of national defense and data analysis for intelligence community will always demand more processing power.

-- e.g. training simulations, autonomous robotic vehicles, airport security, surveillance, video analytics, infrastructure defense against cyber attacks, military and warfighting technology, simulation of nuclear weapons, data analysis for intelligence

Consumer needs and enterprise applications: ubiquity of digital data and growth in the population of users who are not tech savvy.

-- e.g. search and data mining, computationally-enhanced (real-time) decision-making, web services, digital content creation, speech recognition, product design



Research supported by CISE goes beyond improvements to processor performance -

One way around performance scaling dilemma is to construct chip multi-processors (CMPs), or multi-core microprocessors. The idea is to use less aggressive processor-core design to reduce energy (heat) dissipation per instruction and at the same time, using multiple processor cores (CPUs) to scale the overall chip performance.

Another approach is application-specific integrated circuits --- e.g. specialized peta-scale (10^15 FLOPS) supercomputers (at LBNL) for climate modeling.

Architectural innovations and development of new algorithms and software will enable concurrency and parallelism, allowing for immediate improved systems performance.

We also make investments which will lead to improved performance in the future. For example, new materials development, non-charge transfer devices, and quantum devices serve as alternative ways to improve computing performance.

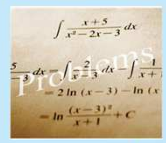
BUT there is no known alternative to parallel systems for sustaining growth in computing performance.

Device Physics:
Very recently, IBM has developed a 12 Atom magnetic storage bit– likely the smallest device they can make before quantum properties take over. Also, physicists at University of New South Wales have built a 4 atom wire.

Circuit board from microsoft clip art **MP900289054_**

Computing Research Agenda Centered on Parallelism and Concurrency

- **Computational models** to enable new ways of "thinking parallel"
- **Programming languages** to enable effective expression of parallelism at every scale
- **Algorithms** to better exploit parallelism and concurrency
- **Software systems** capable of handling both small and extreme-scale data systems and data analytics
- **Software Architectures** to enable resilient computation at scale
- **Parallel architectures** to achieve energy- and power-efficiency, resilient and secure systems, possibly customized for applications
- **Techniques to map legacy applications onto parallel architectures**
- **Rethinking the canonical computing "stack"** applications, programming language, compiler, run time systems, OS, architecture



Parallelism has gone mainstream … not about supercomputers anymore …different ecosystem from desktops, to clusters, to data centers and supercomputers

Successful software abstractions are needed to enable programmers to express

The parallelism that is inherent in a program

The dependences between operations

Structure a program to enhance locality

All without being bogged down in low-level architectural details

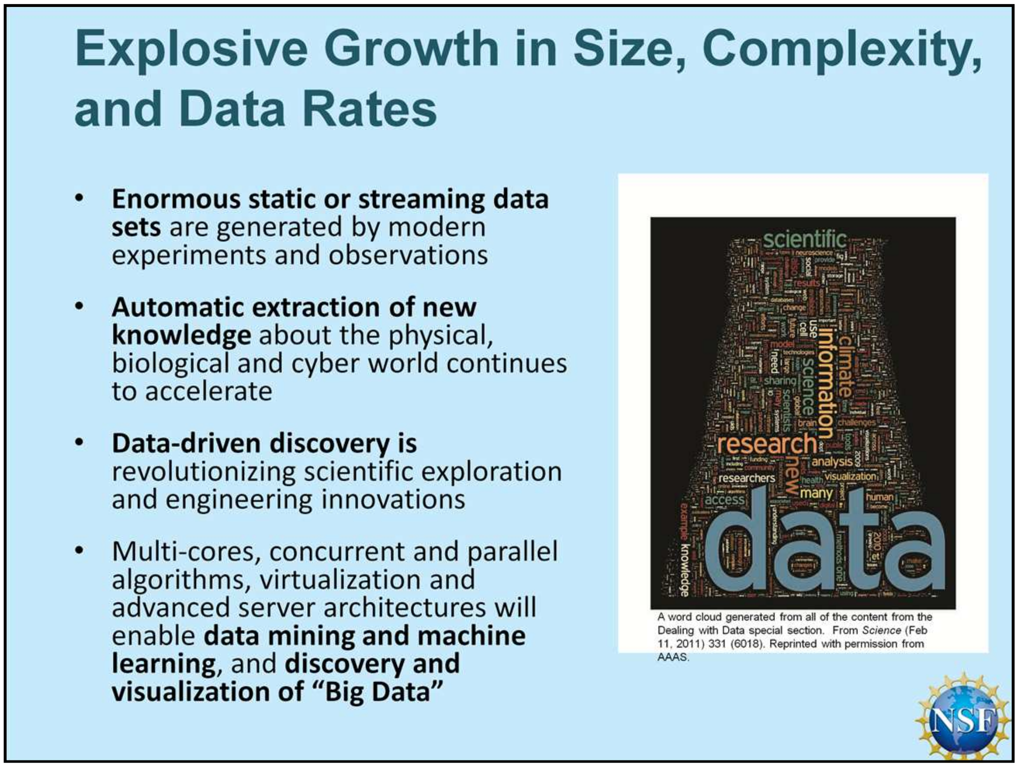
----

The future stack must enable the optimization of the **five key challenges** to scalable and efficient performance:

Independent threads
Communication
Locality
Synchronization, and
Load-balancing.

Some trends in hardware architecture:

Multiple processors sharing a memory, e.g. multicore/multiprocessors
Multiple computers interconnected via a high-speed comm network.
Single processor containing multiple execution units, e.g. DSPs, VLIW processors
Array of specialized processors, e.g. GPGPU.



1) We are in a period where it's been called the "Era of Observation" or the "Era of Data and Information."

Actually, the truth is that we're drowning in the DATA TSUNAMI

2) We have seen an Explosive Growth in Size, Complexity and Data Rates generated by generated by modern experimental and observational methods.

3) Today, science gathers data at an ever-increasing rate across all scales and complexities of natural phenomena. We need to store, integrate, and extract meaning and information from all of these raw numbers and data points.

The explosive growth of scientific and social data:

4) Creates enormous opportunities in harnessing large-scale data, turning it into information and extracting knowledge from it.

In other words, storage and accessing data is just the beginning. We need to go from Data → Predictive Models → Decision Analysis

5) Enabled by data mining and machine learning, discovery and visualization techniques, the shift toward indirect, automatic extraction of new knowledge about the physical and biological world, and social and behavioral trends continues to accelerate.

Time permitting --- for CS community

6) What's possible: New insights into science, spot business trends, prevent diseases, manage our previous resources such water better, …

This is all enabled by cheap storage, huge data centers, easier access and programmability, and advances in hardware architectures and data management tools.

Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21)

Accelerating the progress of scientific discovery and innovation

OneNSF investment: $106.08 M, CISE: $16.0 M

- **Advanced Computational Infrastructure (ACI)** investments:
  - Foundational research to fully exploit parallelism and concurrency through innovations in computational models and languages, mathematics and statistics, algorithms, compilers, operating and run-time systems, and software and analytic tools.
  - Distributed systems at scale – multi-core and multi-machine systems – with computational models and new programming paradigms for distributed approaches, such as cloud and cluster computing.

Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21) provides a framework for integrating cyberinfrastructure in research at all scales, and across every discipline. These powerful tools will increase the productivity of research and promote new ways for discovery.

CISE's investments in CiF21 is focused in two broad areas:
-- ACI
-- foundational research for managing, analyzing, visualizing, and extracting useful information from large, diverse, distributed, and heterogeneous data sets.

Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21)

Accelerating the progress of scientific discovery and innovation

- Advance **big data** science and engineering through support of foundational research for managing, analyzing, visualizing, and extracting useful information from large, diverse, distributed, and heterogeneous data sets.

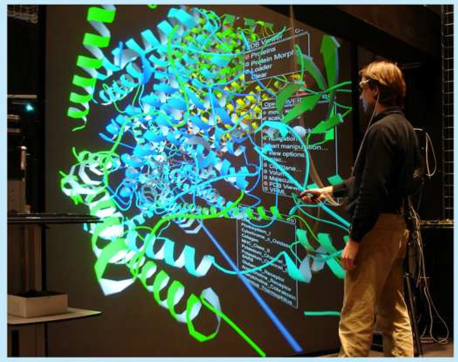
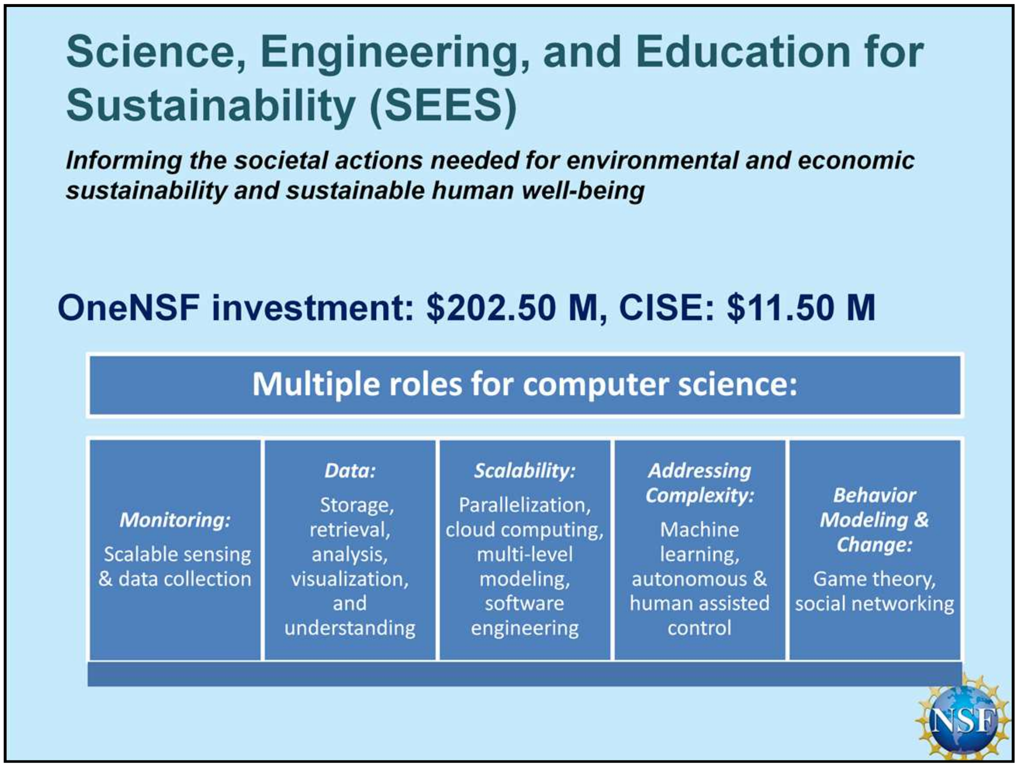
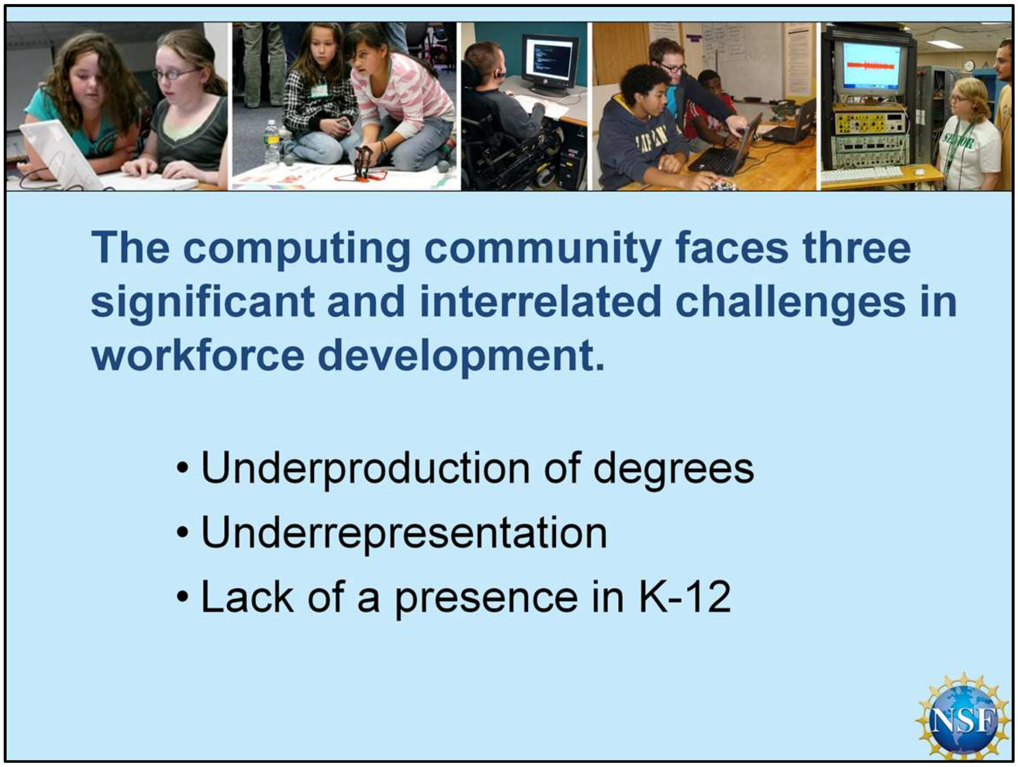


Image Credit: *Jurgen Schulze, Calit2, UC-San Diego*

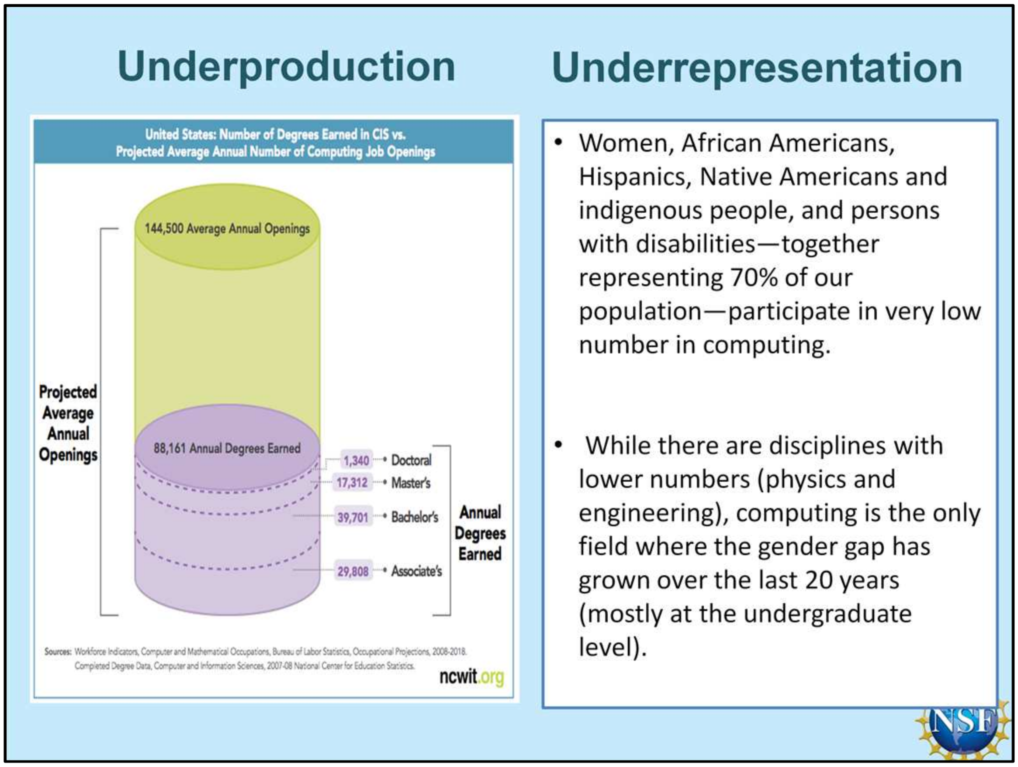
Of all the challenges we face as a nation and as a planet, none is as pressing as the three-pronged challenge of climate change, sustainable development and the need to foster new and cleaner sources of energy.



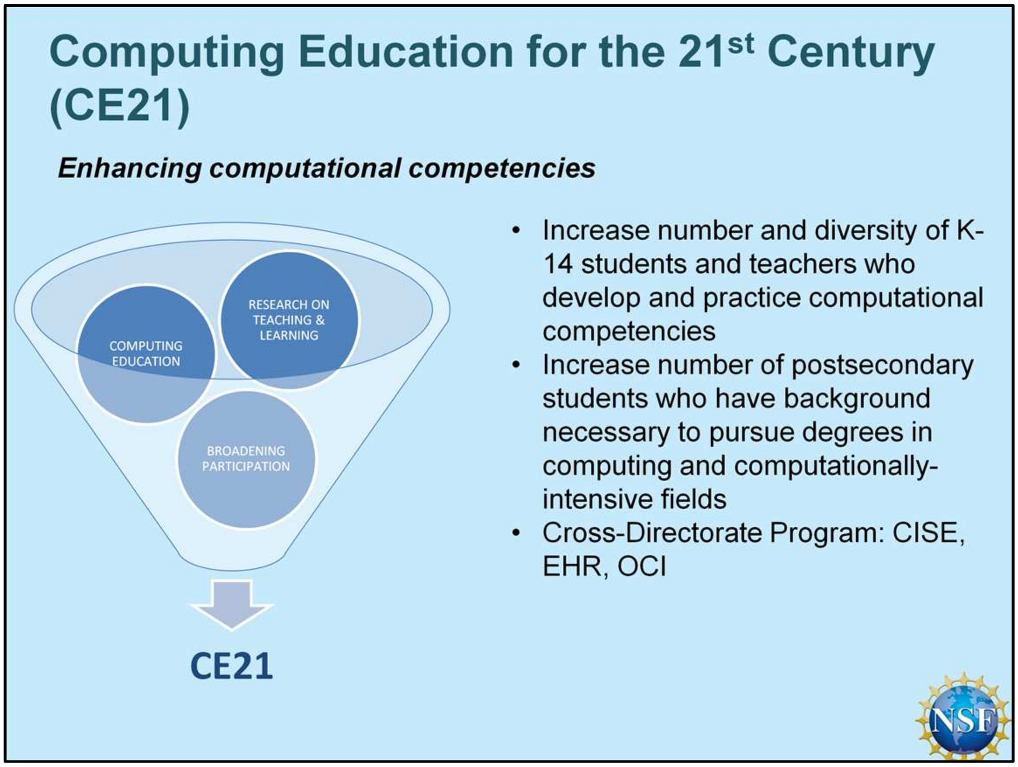
Science, Engineering and Education for Sustainability (SEES) is NSF's flagship portfolio to address pressing issues of clean energy and sustainability.



The computing community faces three significant and interrelated challenges in workforce development that go beyond those faced in the other STEM disciplines: underproduction of degrees, underrepresentation, and lack of a presence in K-12.



Education and Workforce Development – heading and this goes later



Basic educational research on the learning and teaching of computing (EHR style research)

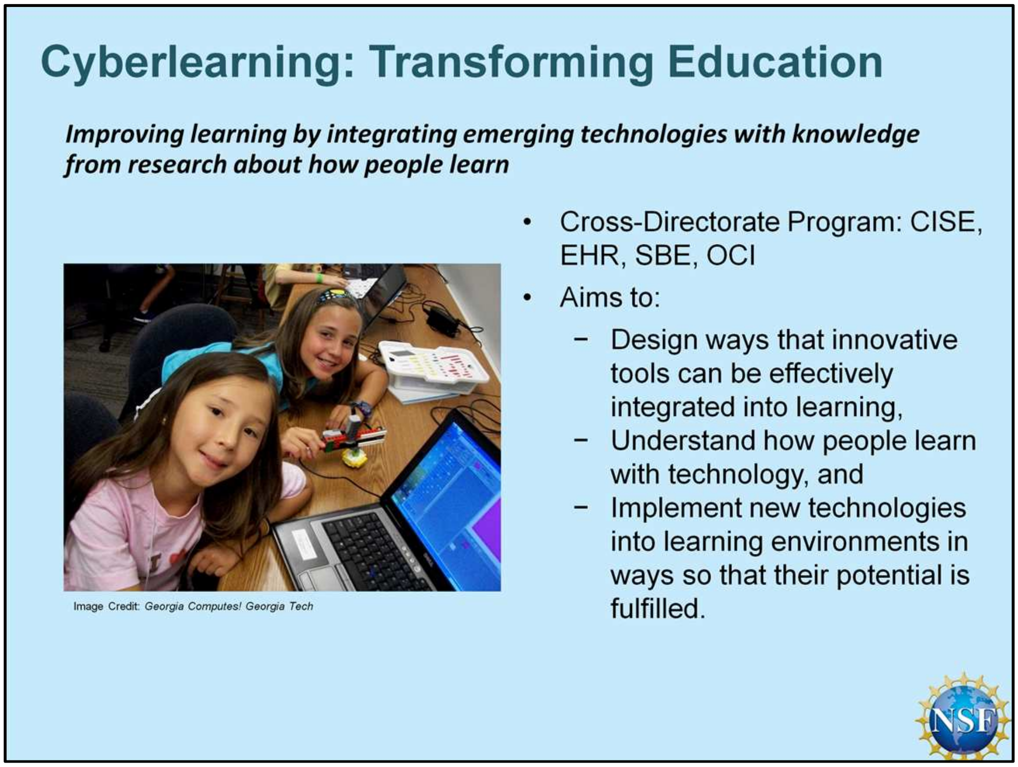
Computing education (creation and assessment of content, curriculum, materials, etc.)

Broadening participation (development and evaluation of engagement, recruitment, and retention activities for underrepresented groups)

Note the centrality of BP to this solicitation. The argument for including it as an integral part of the solicitation is that (1) it will not serve us well as a field if we continue to develop curriculum, materials, and pedagogy that appeals to only 30% of our population – so education efforts must be informed by BP, and (2) it is not enough to engage students from the underrepresented groups, we must also increase their capacity and move them along the continuum to degrees and careers – so BP efforts must be informed by what we're learning about best practices in education.

CE21 was intended to have a strong BP component. All proposals had BP as a third review criteria.

Note as well that we see the CS 10K Project to some extent as a diversity/equity effort: high resources schools do have academic computer science curriculum but most low resourced schools do not (if they have "CS" courses at all, they teach keyboarding and how to use office products).



Script from WH announcement:

"As technology advances at rapid speed, realizing the potential of new learning technologies depends on more than inventing exciting tools and resources. Success also depends on designing ways that innovative tools can be effectively integrated into learning, on understanding their impact on learning, and on supporting teachers with the resources to use them well."

"The goal of this joint program between CISE, EHR, SBE, and OCI, is to improve learning by integrating emerging technologies with knowledge from research about how people learn."

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.

Supports NSF strategic plan: enhances our nation’s economic competitiveness by “reaching out to a range of communities that play complementary roles in the innovation process and are essential to ensuring the impact of NSF Investments.”[1]

Increases networking opportunities: aims to help create a national network of scientists, engineers, innovators, business leaders and entrepreneurs, building on existing NSF grantee events.

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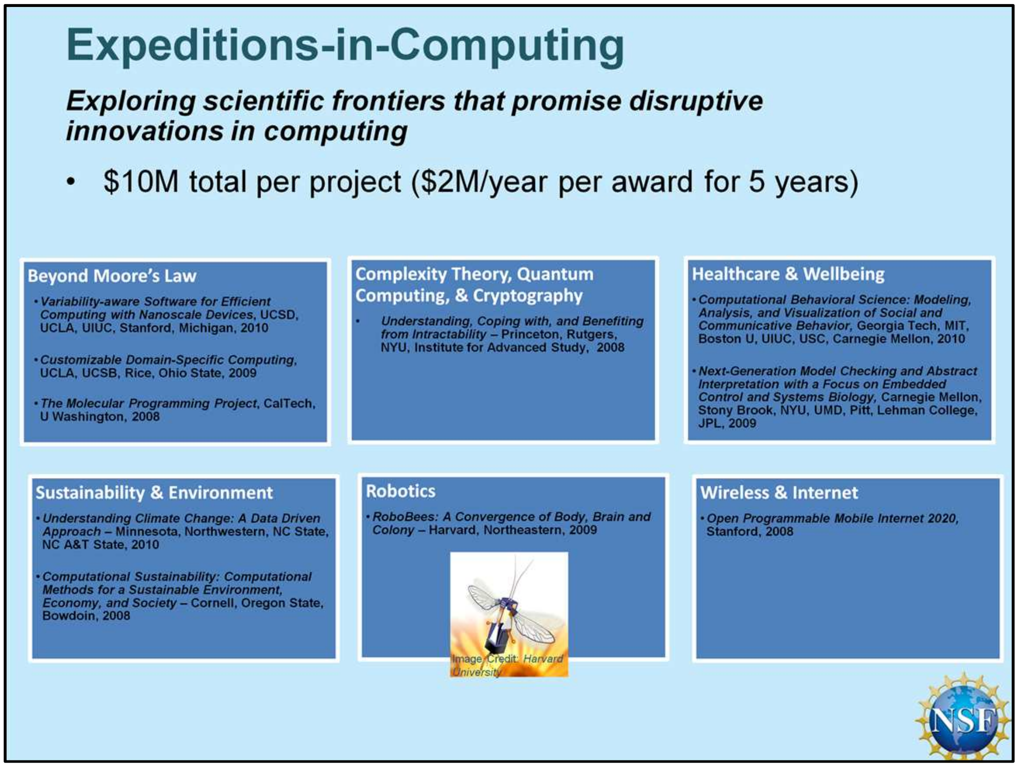
[1] *“Empowering the Nation through Discovery and Innovation,” NSF Strategic Plan, April 2011 .*

CISE Cross-Cutting Programs

Image Credit: Harvard University

- Expeditions in Computing
- Computing Education for the 21st Century (CE21)
- Smart Health and Wellbeing
- Enhancing Access to the Radio Spectrum (EARS)
- Mid-scale Research Infrastructure
- Faculty Early Career Development (CAREER)



4 years into it … we've made 10 awards – many of which are having great impact on advancing not only the frontiers for computing, but for science as a whole. Cite example – Understanding Climate Change or RoboBees

Wrap Up

Advances in computing and information technology promise to reshape our world with more responsive, secure, and efficient systems:

- transform the way we live
- drive economic prosperity
- underpin national security
- enhance societal well-being

Static infrastructures, such as buildings and bridges, are transformed into *smart* spaces that adapt to consumption, growth, and/or changing environmental needs or can continuously monitor and identify risk, moderate the impact of failures, and avoid disasters through the use of networked instrumentation and software control.

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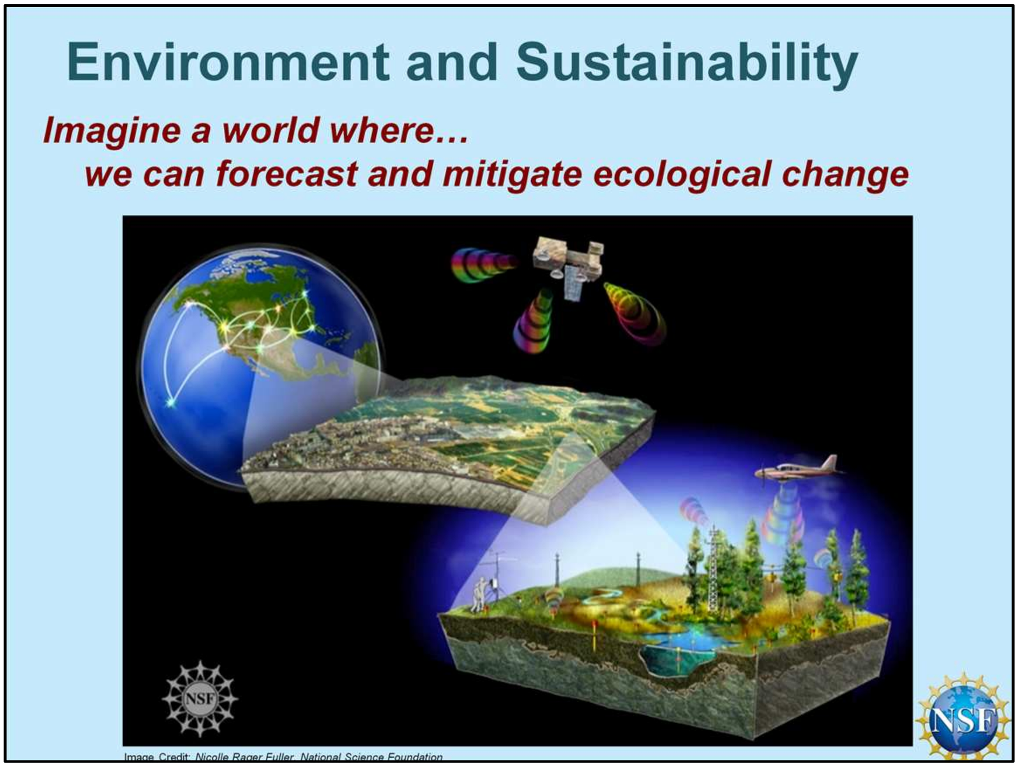
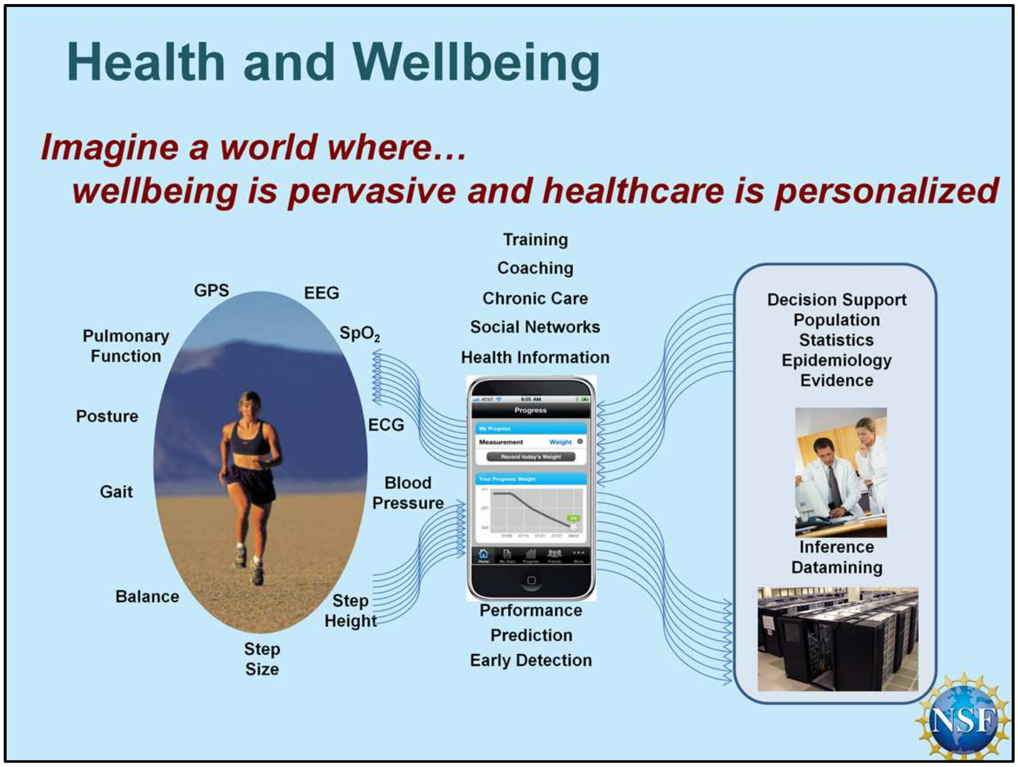
Civil engineers can continuously monitor and identify at risk man-made structures like bridges, moderate the impact of failures, and avoid disasters.

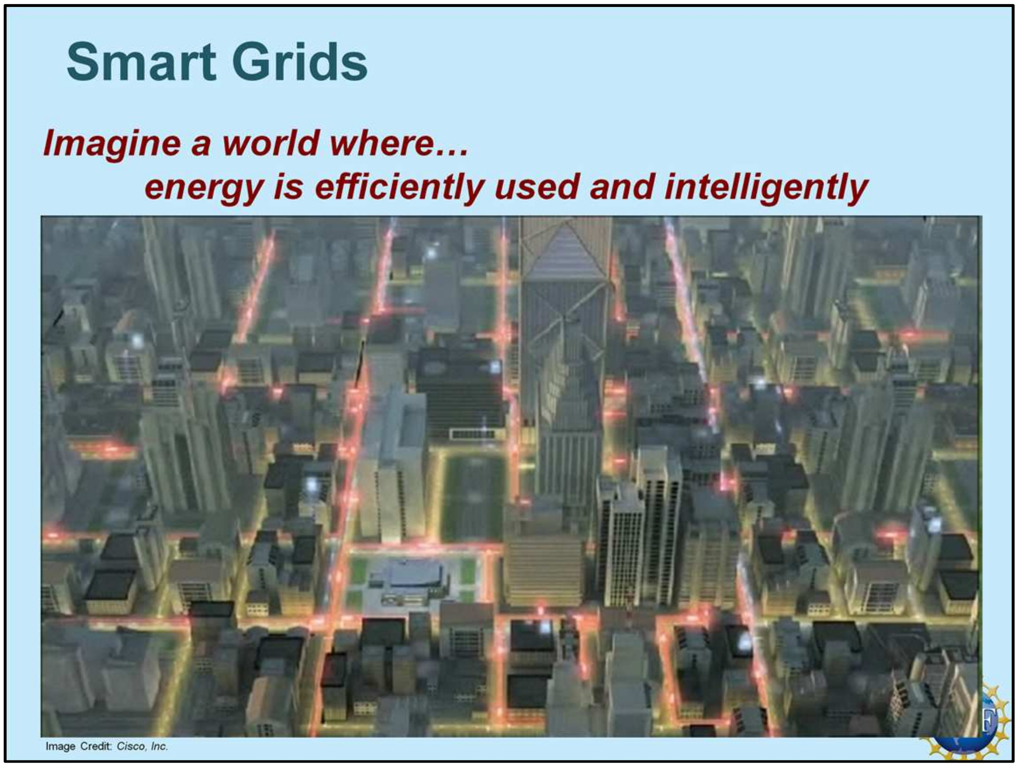


By developing rich ecological and environmental monitoring systems, we can create accurate models that support forecasting and management of increasingly stressed resources.

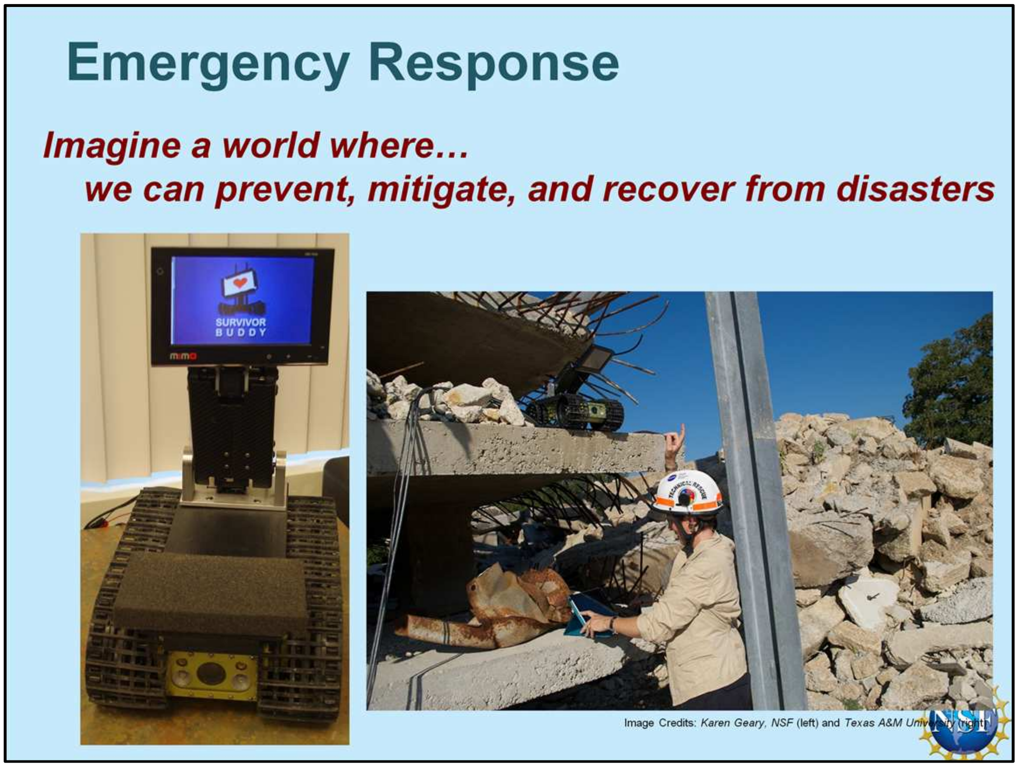


We can improve quality of life through personalized healthcare and assistive technologies, enabled in part by robust, usable, and trustworthy wearable mobile devices integrated with instrumented environments.

We can create a healthcare system that helps people prevent and manage chronic and acute diseases in their own every day context; robots extend independent living for seniors; and devices worn or embedded in the home can report adverse health events.



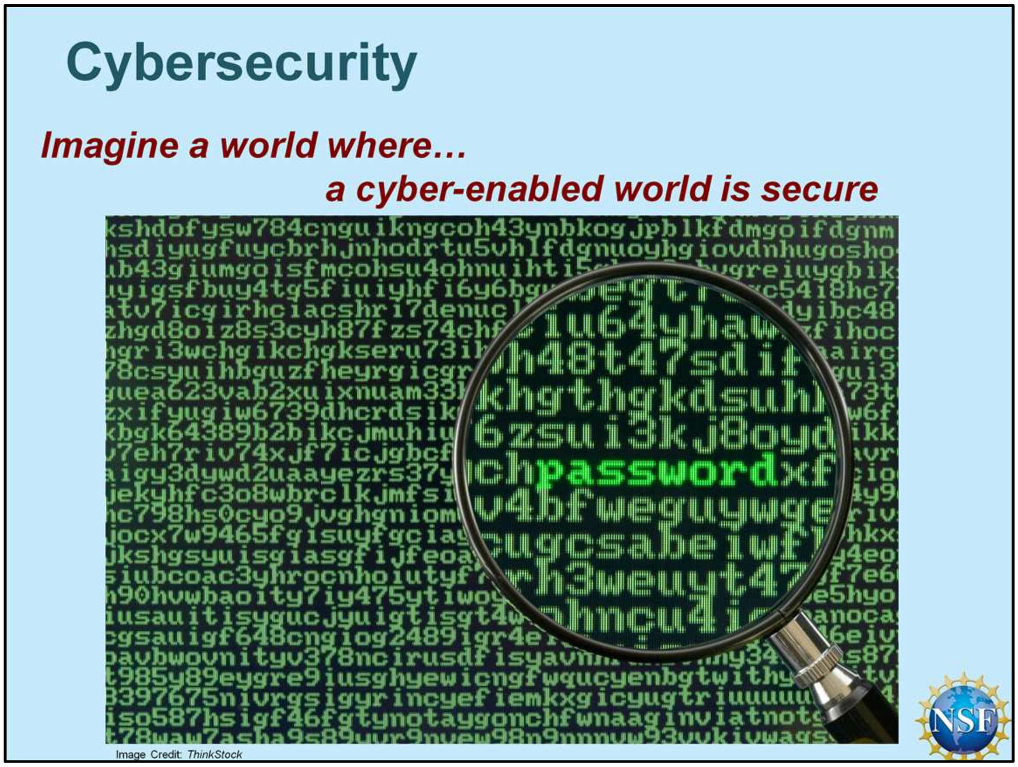
We can efficiently manage energy through the deployment of intelligent sensor networks and distributed control and decision capabilities. These smart grids will improve resource utilization, reduce congestion, and enable real-time response and real-time pricing.



During the time of a natural disaster or a national emergency, ***unmanned*** search, rescue, and recovery is a reality through the use of autonomous, highly coordinated, and remotely operated robots in shared physical spaces – the promise of distributed, low-power sensing combined with communications and control.

Your car will be able to drive you safely and securely to your destination, where traffic fatalities are uncommon rather than daily events.

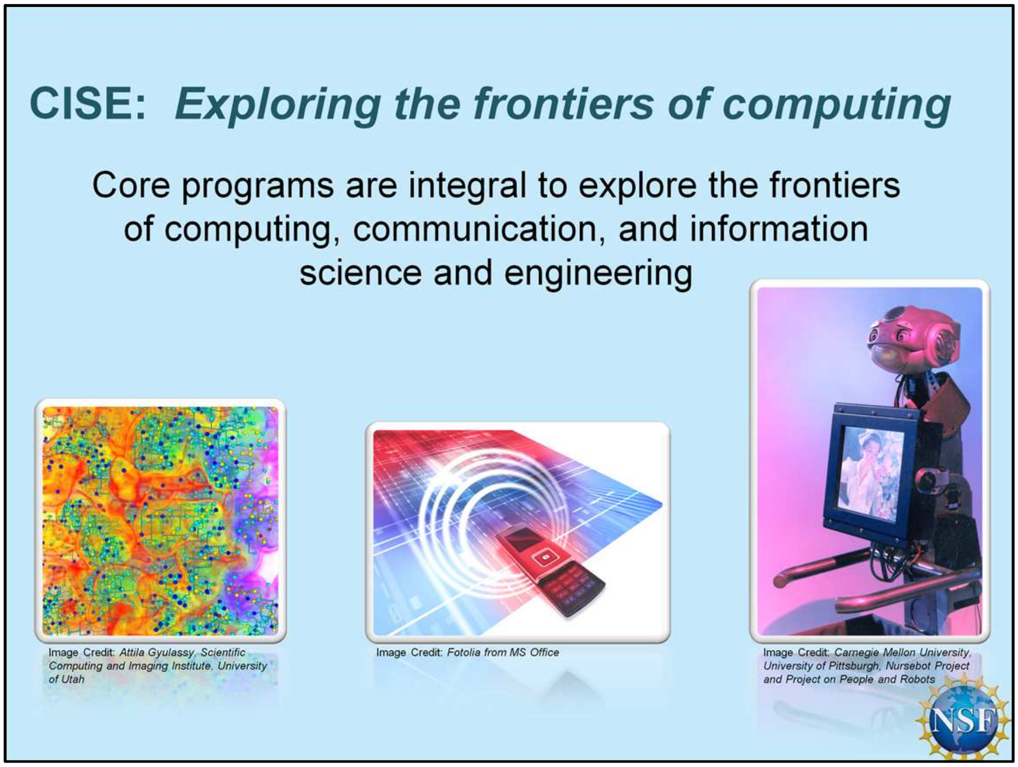
Your home and car both consume energy from – and provide energy to – the electricity grid, and where advanced controls can provide substantial energy savings that can decouple the economic benefits of transportation from regional and global environmental impacts.



Computing and communications are safe, secure, and private enabling defense of our Nation, assured use of our critical infrastructure and commerce, and enhanced individual liberty.

CISE's mission is to uphold the nation's leadership in computer and information science and engineering through its support for fundamental and transformative advances that are a key driver of economic competitiveness and crucial to achieving national priorities.

contribute to the development of a computing and information technology workforce with skills essential to success in the increasingly competitive, global market.



NSF investments in research and education have returned exceptional dividends to the Nation. To keep those benefits flowing, we need to constantly replenish the wellspring of *new ideas* and train *new talent*.

Subra: “**The Foundation plays a vital role in ensuring that America remains at the epicenter of the ongoing revolution in research and innovation that is driving twenty-first century economies. More than ever, the future prosperity and well being of Americans depend on sustained investments in our science and technology.“**

Thanks!