NATIONAL SCIENCE FOUNDATION

FISCAL YEAR 2015 BUDGET REQUEST

Farnam Jahanian
CISE
March 10, 2014

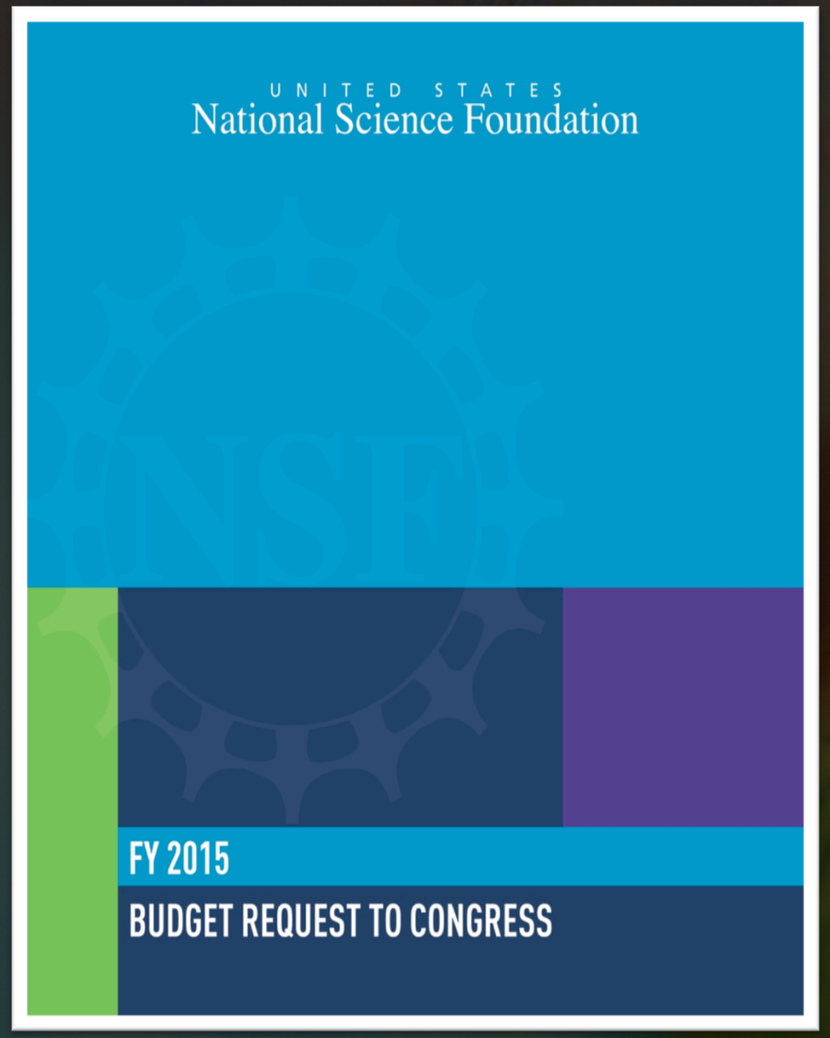
CISE Mission

Exploring the frontiers of computing

- Promote progress of computer and information science and engineering research and education, and advance the development and use of cyberinfrastructure.
- Promote understanding of the principles and uses of advanced computer, communications, and information systems in support of societal priorities.
- Contribute to universal, transparent and affordable participation in a knowledge-based society.

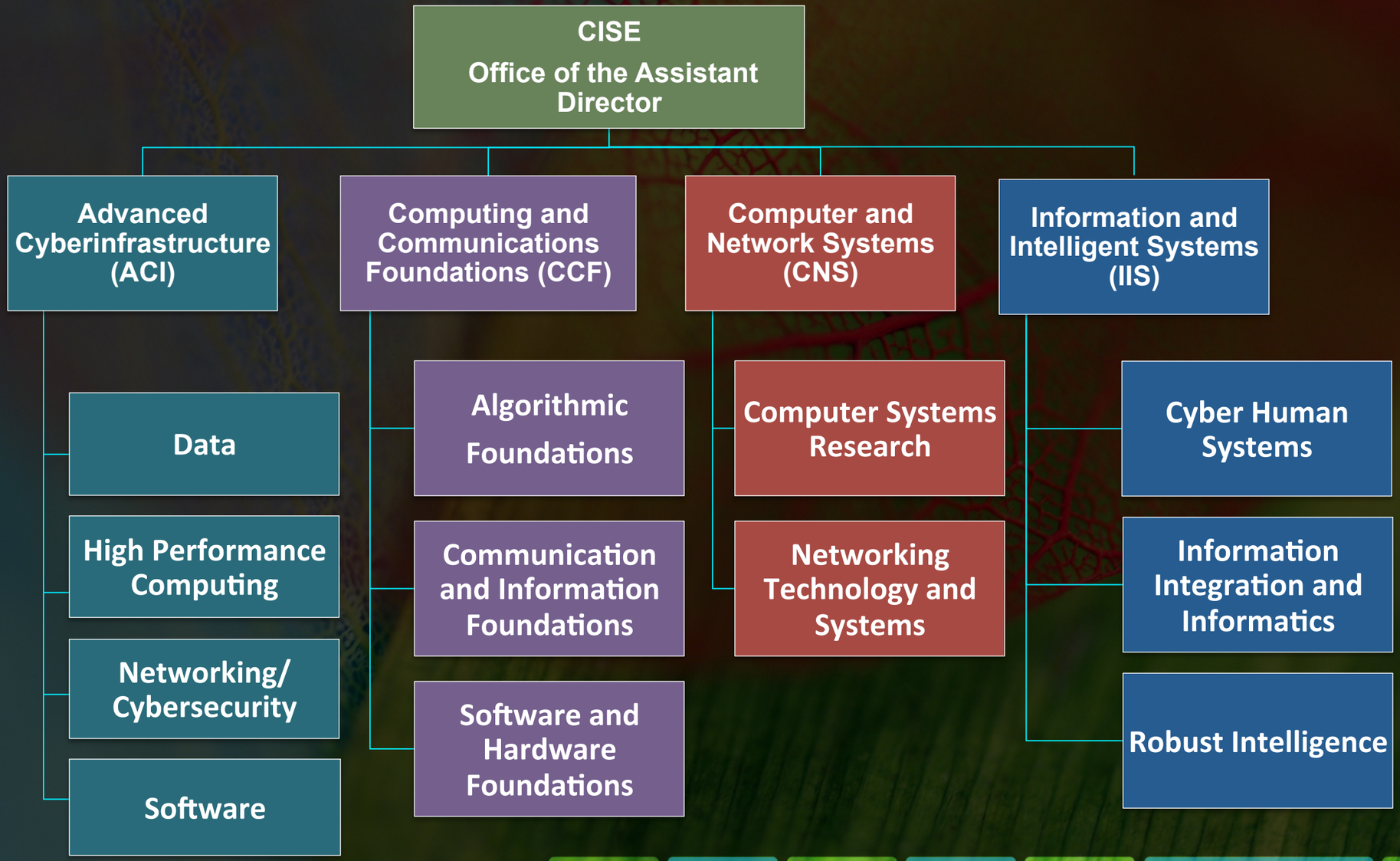
These frontiers have interfaces with all the sciences, engineering, education and humanities and a strong emphasis on innovation for society.

FY 2015 Budget Request



- **NSF**
  - FY 2015 Budget Request: $7255.00 Million
- **CISE**
  - FY 2015 Budget Request: $893.35 Million
  - *CISE FY 2015 request is shaped by investments in core research, education, and infrastructure programs as well as critical investments in NSF cross-foundation priorities and programs.*

CISE Divisions and Core Research Areas



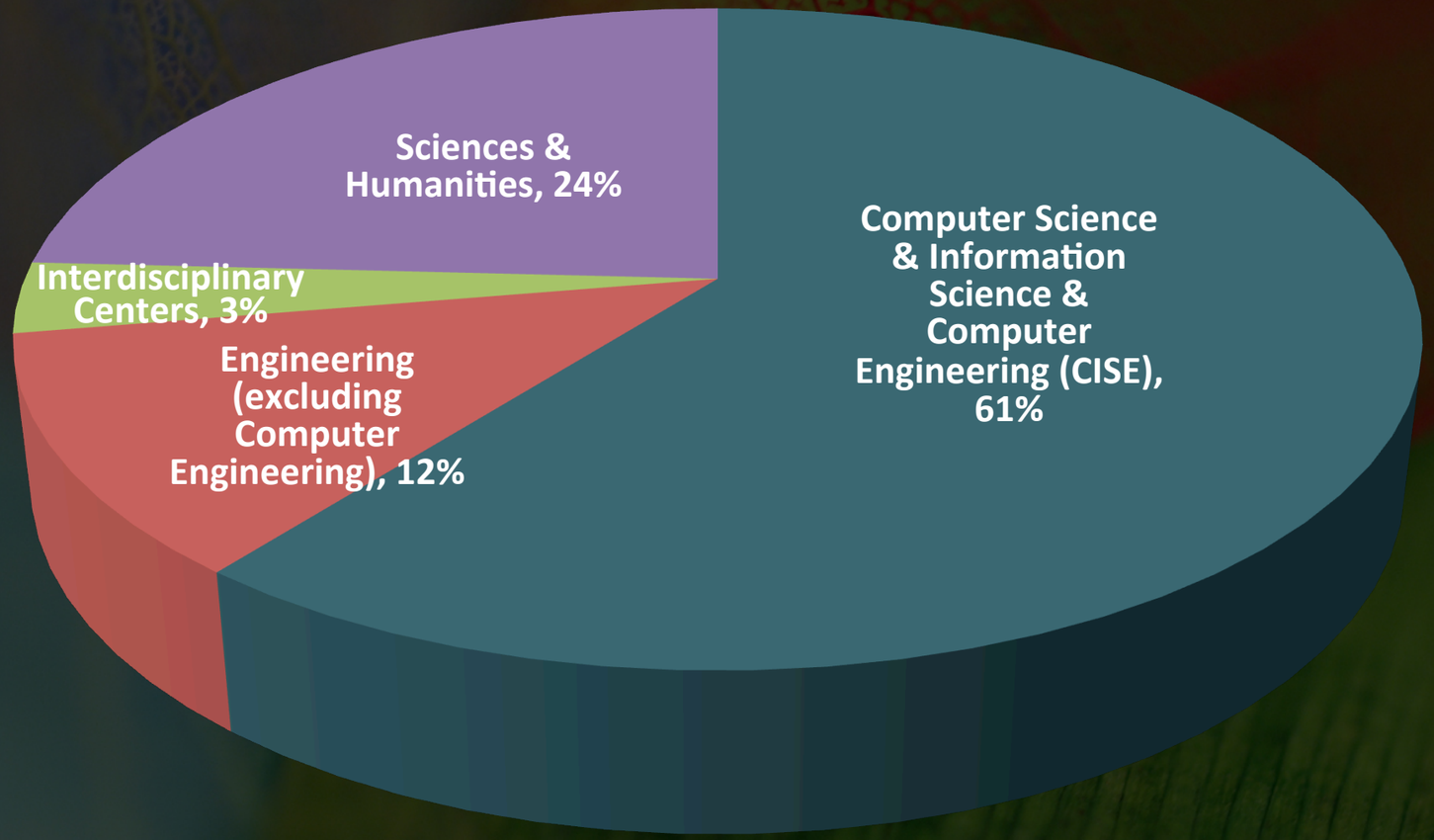
Snapshot of CISE FY 2013 Activities

	CISE
Research Budget	$858M
Number of Proposals	7,821
Number of Awards	1,616
Success Rate	~21%
Average Annualized Award	$204K
Number of Panels Held	344
Number of People Supported	17,227

	CISE
Senior Researchers	6,652
Other Professionals	1,186
Postdoctoral Associates	475
Graduate Students	6,609
Undergraduate Students	2,305

Who is the CISE Community?

PI and Co-PI Departments for FY 2013 Awards Funded by CISE



CISE's Commitment to the Core

CISE continues to cast a wide net and to 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.

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

Accelerating advances in 21st century smart engineered systems

- CISE focus includes:
  - Advanced Manufacturing,
  - Cyber-Physical Systems (CPS),
  - The National Robotics Initiative (NRI),
  - Critical Resilient Interdependent Infrastructure Systems and Processes (CRISP),
  - and their interaction and synthesis.

$81.5M
CISE Investment

CISE, BIO, EHR, ENG, and MPS

Secure and Trustworthy Cyberspace (SaTC)

Securing our Nation's cyberspace

- Aligns with the national *Trustworthy Cyberspace: Strategic Plan for the Federal Cybersecurity Research and Development Program* (released December 2011).
- SaTC cross-directorate program (NSF 13-578): Aims to support fundamental scientific advances and technologies to protect cyberspace.
- Scholarship for Service: Aims to increase the number of cybersecurity professionals in the U.S.
- Focus on Privacy: Dear Colleague Letter for new collaborations between Computer and Social Scientists, including a focus on privacy.

$67.0M
CISE Investment

CISE, EHR, ENG, MPS, and SBE

Secure and Trustworthy Cyberspace (SaTC)

Solicitation NSF 13-578

Image Credit: *ThinkStock*

- Aims to support fundamental scientific advances and technologies to protect cyber-systems from malicious behavior, while preserving privacy and promoting usability.
- Program addresses three research perspectives:
  - Trustworthy Computing Systems,
  - Social, Behavioral and Economic Sciences, and
  - Cybersecurity Education.
- *Transition to Practice* option.
- *Frontier* awards support center-scale activities.

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

Accelerating the progress of scientific discovery and innovation

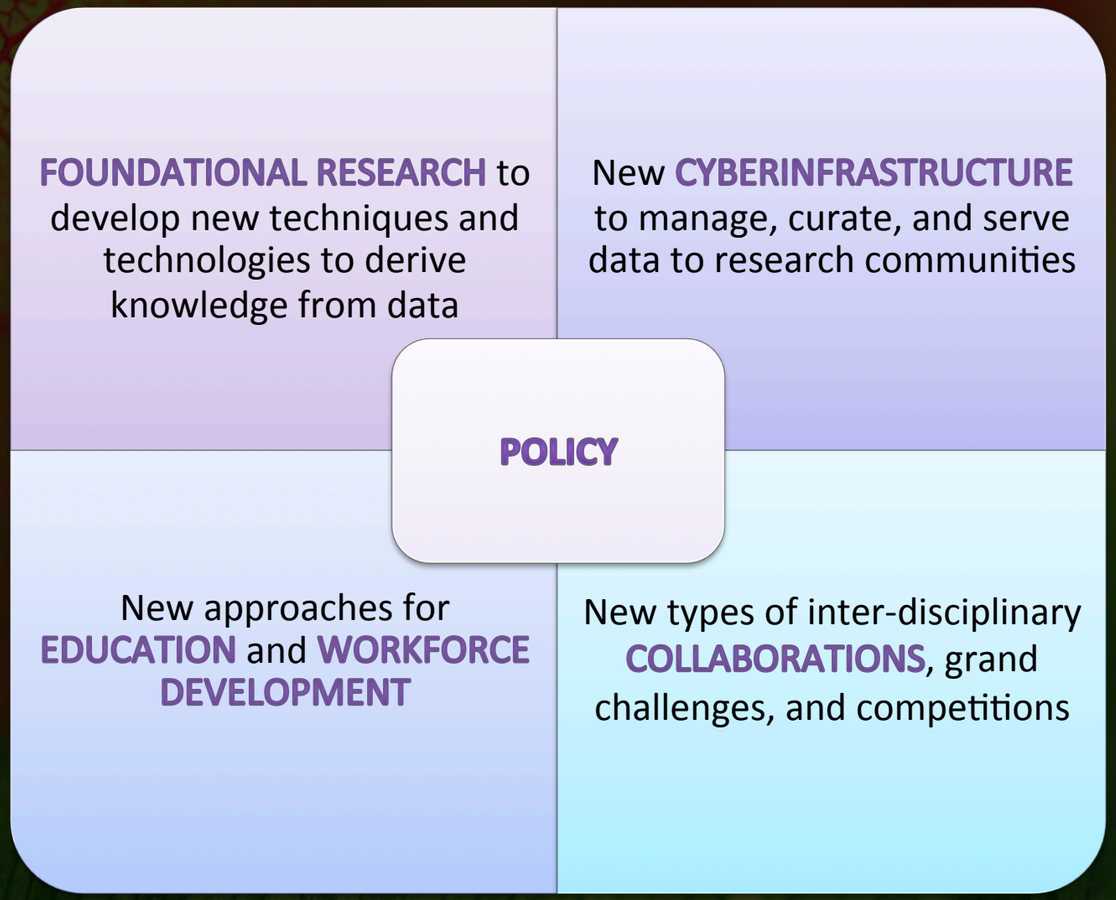
$80.0M
CISE Investment

- CISE focus in CIF21 includes:
  - **BigData** – Developing core scientific and technological means of managing, analyzing, visualizing and extracting useful information from large, diverse, distributed and heterogeneous data sets;
  - **DIBBS** - Building data infrastructure building blocks through pilots and early implementations of robust and shared data-centric cyberinfrastructure for scientific communities;
  - **CDS&E** - Building and developing new computational and data-enabled science and engineering research communities;
  - **SI²** - Advancing new computational infrastructure, and catalyzing new paradigms and practices in the development and use of software that is robust, reliable, usable, and sustainable; and
  - **Community Building Partnerships** - EarthCube, Building Community and Capacity (BCC), and DataWay.

CISE, BIO, EHR, ENG, GEO, IIA, MPS, and SBE

Federal Big Data R&D Initiative

- **Cross-agency "Big Data" Senior Steering Group –** chartered in spring 2011 by OSTP:
  - Co-chaired by NSF and NIH
  - Significant research community input
- **Launched** by OSTP on March 29, 2012
  - **Major Announcements**: NSF, NIH, USGS, DoD, DARPA, DOE
- **Data to Knowledge to Action** event hosted by OSTP November 12, 2013
  - Encouraging **public-private partnerships** across the country



Cognitive Science and Neuroscience

Improve understanding of the brain

- White House BRAIN Initiative launched in April 2013 (NSF, NIH, DARPA).
- Addresses critical challenge of research integration across multiple scales ranging from molecular to behavioral levels with the ultimate goal of understanding the brain.
- Builds on ongoing NSF investments (e.g., Collaborative Research in Computational Neuroscience – CRCNS- in collaboration with NIH, Germany, France, and Israel; Robust Intelligence Core Research).
- Catalyzed conversations among diverse scientific communities to prioritize research areas related to the BRAIN Initiative.

$5.65M
CISE investment

CISE, BIO, ENG, MPS, and SBE

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CISE, BIO, ENG, MPS, and SBE

BRAIN INITIATIVE
BRAIN RESEARCH THROUGH ADVANCING INNOVATIVE NEUROTECHNOLOGIES

- **Multiscale & Multimodal Modeling** to relate dynamic brain activity to behavior
- **Comparative Analyses Across Species** to identify conserved functional circuitry: take advantage of Biodiversity
- **Innovative Technologies** to understand brain function and treat brain disorders
- **Cyber Tools & Standards** for data acquisition, analysis and integration
- **Quantitative & Predictive Theories** of brain function

Cyberlearning and Future Learning Technologies

Improving learning by integrating emerging technologies with knowledge from research about how people learn

- **Solicitation NSF 14-526**
- **Research Thrusts:**
  - **Innovation**
    - Identifying new means of using technology for fostering and assessing learning;
  - **Advancing understanding of how people learn in technology-rich learning environments**
    - Enhancing understanding of how people learn and how to better foster and assess learning; and
  - **Promoting broad use and transferability of genres**
    - Extracting lessons from experiences with these technologies that can inform design and use.

$12.0M
CISE Investment

Image Credit: *Georgia Computes! Georgia Tech*

CISE, EHR, ENG, and SBE

Science, Engineering and Education for Sustainability (SEES)

Advancing interdisciplinary science to help society achieve sustainability

CISE focus:

- **CyberSEES program** to increase understanding of sustainability via new advances in computing and to enable new sustainable approaches to computing.
- **Hazard SEES program** to improve the understanding of hazards, mitigate their effects, and to better prepare for, respond to, and recover from disasters.

$11.0M
CISE Investment

CISE, BIO, ENG, GEO, IIA MPS, and SBE

NSF Research Traineeship (NRT)

Preparing professionals in emerging STEM fields vital to the nation

Priority research theme: Data-enabled science and engineering

- **Purpose:** create and promote new, innovative, effective, and scalable models for STEM graduate student training and prepare scientists and engineers of the future, particularly in emerging STEM fields vital to the nation.
- **Anticipated award amount:** up to $3M over 5 yrs.

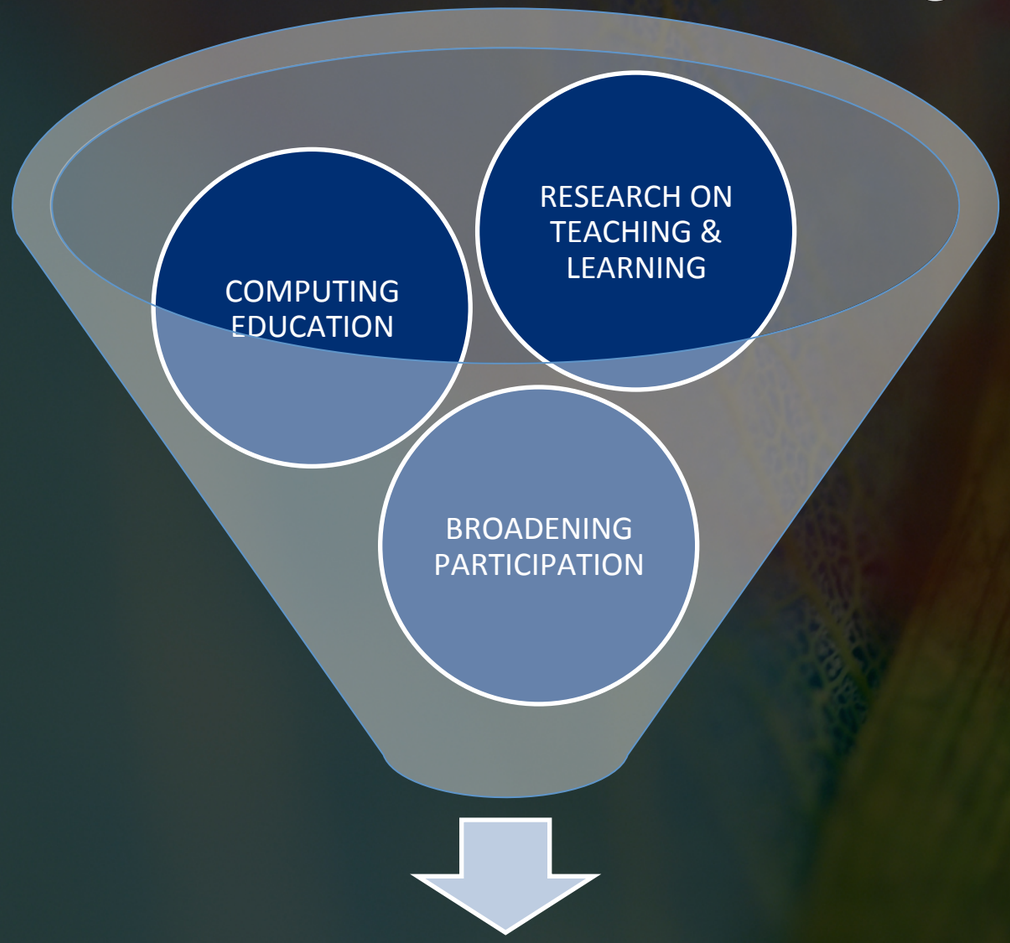
$7.59M
CISE Investment

NSF-wide Initiative

Science and Technology, Engineering, and Mathematics, including Computing (STEM-C) Partnerships

Enhancing computational competencies

$12.0M
CISE Investment



- Joint Activity between CISE and EHR.
- Consolidation of the Computing Education for the 21st Century (CE21) program and Math and Science Partnerships (MSP) program.
- CISE focus:
  - Increase number and diversity of K-14 students and teachers who develop and practice computational competencies,
  - Increase number of postsecondary students who have the background necessary to pursue degrees in computing and computationally-intensive fields, and
  - Transform the computing education pipeline through CS10K.

Innovation Corps (I-Corps)

Accelerating innovations from the laboratory to the market

Ayanna Howard used an I-Corps grant to develop an input device that allows children with disabilities to operate tablet computers.

$10.0M
CISE Investment

CISE will continue to support I-Corps Sites and Nodes to further build, utilize, and sustain a national innovation ecosystem that augments the development of technologies, products, and processes that benefit the Nation.

NSF-wide Initiative

NSF Advanced Computational Infrastructure

- Anticipate and invest in diverse and innovative national scale shared resources, outreach and education complementing campus and other national investments.

- Leverage and invest in collaborative flexible “fabrics” dynamically connecting scientific communities with computational resources and services at all scales (campus, regional, national, international).

Image Credit: *UC San Diego Publications/Erik Jepsen*

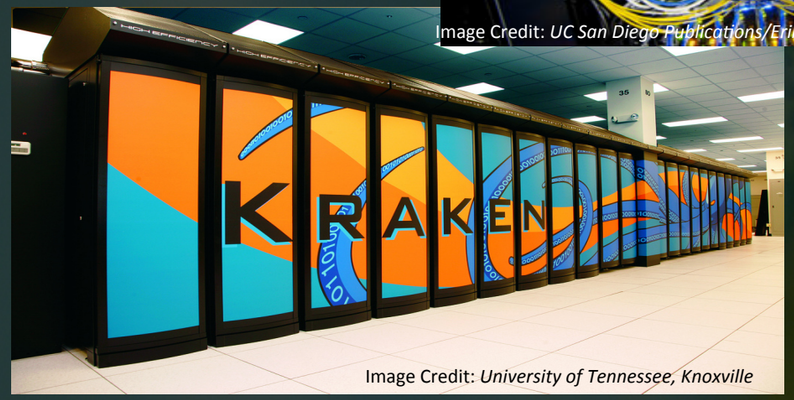


Image Credit: *University of Tennessee, Knoxville*

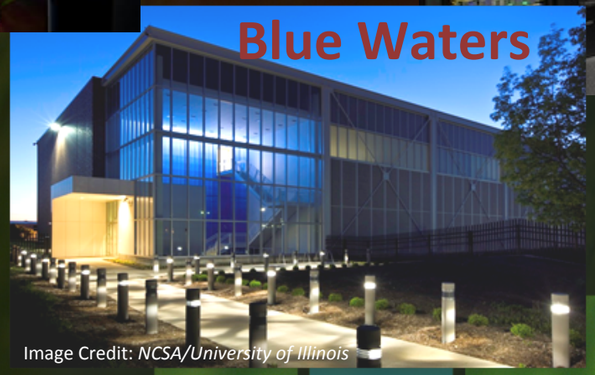


Image Credit: *NCSA/University of Illinois*

Image Credit: *TACC*

XSEDE
Extreme Science and Engineering Discovery Environment

ACI Network Infrastructure Programs

- Campus Cyberinfrastructure –Infrastructure, Innovation and Engineering (CC*IIE)
  - Invests in improvements and re-engineering at the campus level to support a range of data transfers supporting computational science and computer networks and systems research and to achieve higher levels of performance, reliability, and predictability for science applications and distributed research projects.
- International Research Network Connections (IRNC)
  - Continues NSF's ~20 year commitment to directly support international network connectivity dedicated to research and education.
  - Mid-way through 5-year awards supporting multi-gig connectivity to Europe, Asia, Americas, Australia – see www.irnclinks.net for more info.

Mid-scale Research Infrastructure

Global Environment for Network Innovations (GENI)

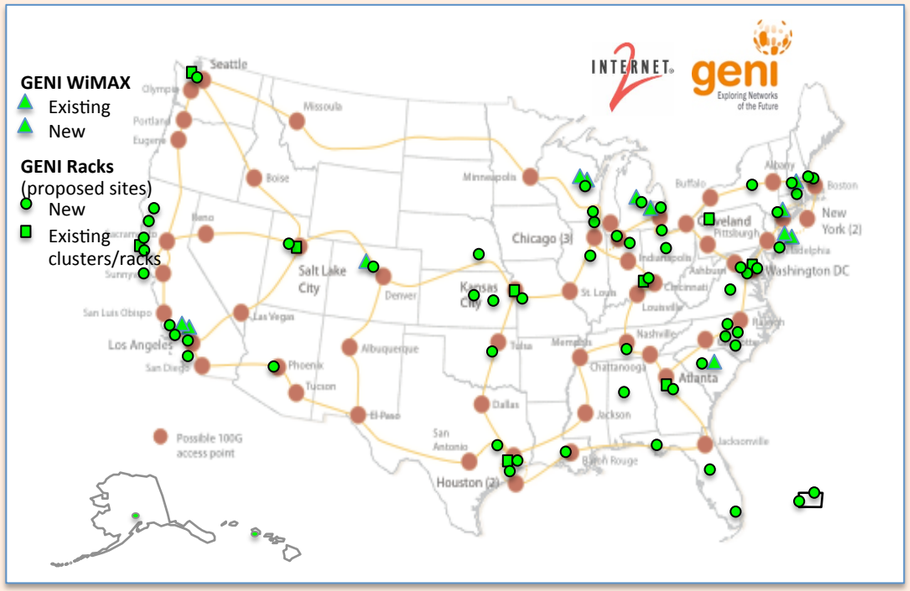
- A virtual laboratory for exploring future internets at-scale, now taking shape in prototype form across the U.S.
- Key GENI concepts:
  - Slices & deep programmability
  - Federation and enabling “at scale” experiments
- 1400 unique users have allocated GENI resources for research and/or education

US Ignite

- Launched June 14, 2012 at the WH
- NSF leadership
  - Leveraging GENI investments
  - Stitching together testbeds and network resources across the country
  - Jumpstarting gigabit public sector application development
- Public Private Partnership
  - Bringing industry and foundations into the effort

FY14-15

- NSF Cloud: virtualization beyond the network to resources located in the “cloud”
- Fund competing prototypes
- Allow for cloud experimentation not possible elsewhere



Advancing networking, distributed systems, cloud computing and cybersecurity research through experimentation at scale

CISE Cross-Cutting Investments

- Exploiting Parallelism and Scalability - $15M
- Smart and Connected Health - $15M
- Expeditions in Computing


Image Credit: *Georgia Computes! Georgia Tech*

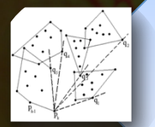

Image Credit: *Harvard University*

Exploiting Parallelism and Scalability (XPS)

Support groundbreaking research that will lead to a new era of parallel computing

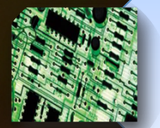
$15.0M
CISE Investment

- Goal is to establish *new* collaborations combining expertise cutting across abstraction, software, hardware layers.
- Invest in foundational research advancing parallel and scalable computing, challenging validity of traditional computer hardware and software stack for heterogeneous parallel systems.
- Focus on new principles and cross-layer approaches that integrate both software and hardware through new programming languages, models, algorithms, compilers, runtime systems, and architectures.



Foundational Principles

- New models guiding parallel algorithm design on diverse platforms
- Optimization for resources (energy, bandwidth, memory hierarchy)

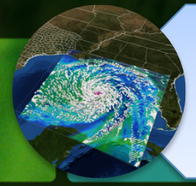


Cross-layer and Cross-cutting Approaches

- Re-thinking/re-designing the hardware and software stack
- Coordination across all layers

Scalable Distributed Architectures

- Highly scalable and parallel architectures for people and things connected everywhere
- Runtime platforms and virtualization tools



Domain-specific Design

- Exploiting domain knowledge to improve programmability and performance

Smart and Connected Health

Transforming healthcare knowledge, delivery, and quality of life through IT

$15.0M
CISE Investment

- Partnership with NIH launched in FY 2013
- Cross-Directorate Program: CISE, ENG, SBE
- Fundamental technical and scientific issues to support the transformation of healthcare from reactive and hospital-centered to preventive, proactive, evidence-based, person-centered and focused on wellbeing rather than disease.
- Must relate to a key health problem and must make a fundamental contribution to ENG, CISE, or SBE domains.

Digital Health Information Infrastructure	Data to Knowledge to Decision	Empowered Individuals	Sensors, Devices, and Robotics
Informatics and Infrastructure	*Reasoning under uncertainty*	*Energized, enabled, educated*	*Sensor-based actuation*

Expeditions in Computing

Exploring scientific frontiers that promise transformative innovations in computing

16 awards made so far (each award is for 5 years, $2M/year)

Beyond Moore's Law

- ***Molecular Programming Architectures, Abstractions, Algorithms and Applications,*** Caltech, Harvard, UC, San Francisco, UW, 2013
- ***Variability-aware Software for Efficient Computing with Nanoscale Devices,*** UCSD, UCLA, UIUC, Stanford, Michigan, 2010
- ***Customizable Domain-Specific Computing,*** UCLA, UCSB, Rice, Ohio State, 2009
- ***The Molecular Programming Project***, CalTech, U Washington, 2008

Sustainability & Environment

- ***Understanding Climate Change: A Data Driven Approach,*** Minnesota, Northwestern, NC State, NC A&T State, 2010
- ***Computational Sustainability: Computational Methods for a Sustainable Environment, Economy, and Society,*** Cornell, Oregon State, Bowdoin, 2008

Wireless & Internet

- ***Open Programmable Mobile Internet 2020,*** Stanford, 2008

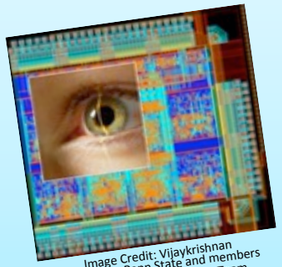


Image Credit: Vijaykrishnan Narayanan, Penn State and members of Visual Cortex on Silicon Team

Healthcare & Wellbeing

- ***Visual Cortex on Silicon***, Penn State, USC, Stanford, York College, UCSD, SCLA, Pitt, MIT, 2013
- ***Socially Assistive Robots***, Yale, USC, MIT, Stanford, Willow Garage, 2011
- ***Computational Behavioral Science: Modeling, Analysis, and Visualization of Social and Communicative Behavior,*** Georgia Tech, MIT, Boston U, UIUC, USC, *Carnegie Mellon, 2010*

Robotics

- ***An Expedition in Computing for Compiling Printable Programmable Machines, MIT, U Penn, Harvard, 2011***
- ***RoboBees: A Convergence of Body, Brain and Colony, Harvard, Northeastern, 2009***

Image Credit: Harvard University

Limits of Computation

- ***Understanding, Coping with, and Benefiting from Intractability,*** Princeton, Rutgers, NYU, Institute for Advanced Study, 2008

Image Credit: UC San Diego Jacobs School of Engineering

Formal Modeling and Verification

- ***Expeditions in Computer Augmented Program Engineering, U Penn, UC Berkeley, UMD, Rice, Cornell, U of Michigan, U of Illinois-UC, UCLA, MIT, 2011***
- ***Next-Generation Model Checking and Abstract Interpretation with a Focus on Embedded Control and Systems Biology, Carnegie Mellon, Stony Brook, NYU, UMD, Pitt, Lehman College, JPL, 2009***

Big Data

- ***Algorithms, Machines, and People, UC Berkeley, UC San Francisco, 2011***
- ***(Understanding Climate Change: A Data Driven Approach,*** Minnesota, Northwestern, NC State, NC A&T State, 2010)

Image Credit: UC San Diego Jacobs School of Engineering

President’s Opportunity, Growth & Security Initiative

$552 million across NSF

CISE's Commitment to Research and Education

- Our investments in **research, education, and infrastructure** have returned exceptional dividends to our Nation.
- A thriving basic research community is the foundation for long-term **discovery** and **innovation**, **economic prosperity**, and **national security**.
- Growing investment in **cyberinfrastructure** is crucial to accelerating the pace of scientific discovery and engineering innovation across all disciplines.
- As a field of inquiry, computer, communication and information science and engineering has a **rich intellectual agenda** – highly creative, highly interactive, with enormous possibilities for changing the world!

Thanks!