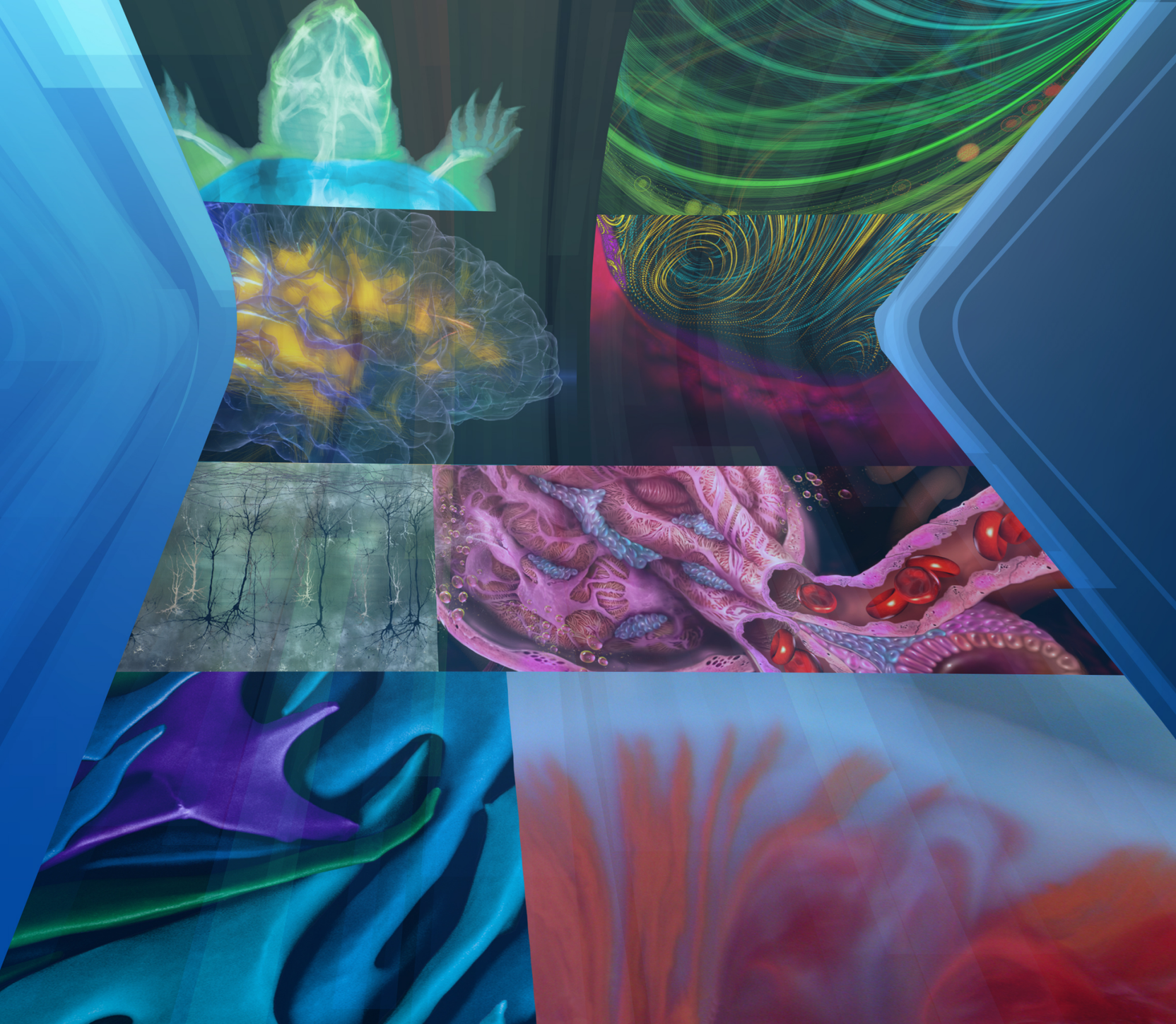


NATIONAL SCIENCE FOUNDATION

FISCAL YEAR 2017 BUDGET REQUEST

DR. JIM KUROSE

ASSISTANT DIRECTOR, CISE

Overview

- Introduction
- FY 2017 Budget Priorities
- Beyond FY 2017

Overview

- Introduction
- FY 2017 Budget Priorities
- Beyond FY 2017

CISE's Economic and Societal Context

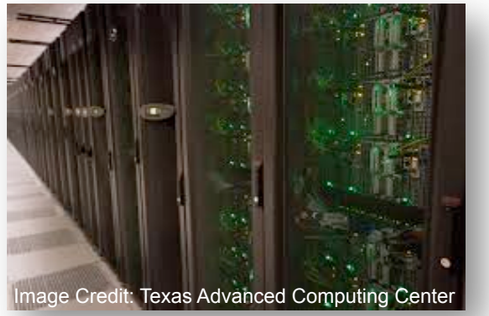
- CISE is at the center of an ongoing societal transformation and will be for decades to come.
- Advances in computing, communications and information technologies and cyberinfrastructure:
  - underpin economic prosperity, national security;
  - drive U.S. competiveness and sustainable economic growth;
  - accelerate the pace of discovery and innovation; and
  - are crucial to achieving national and societal priorities.

CISE Research: Addressing National Priorities

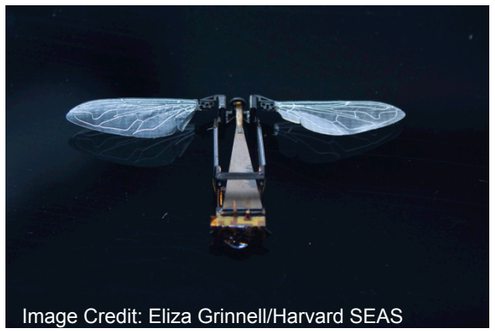
White House Initiatives

Big Data R&D

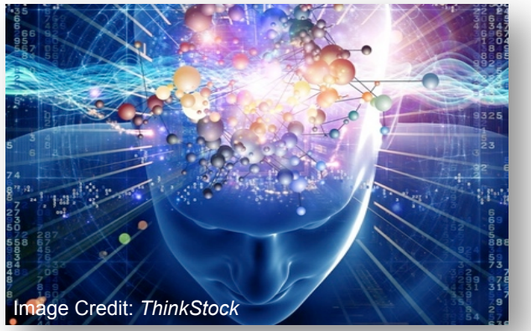
THE WHITE HOUSE
WASHINGTON



National Strategic Computing Initiative



Manufacturing, Robotics, & Smart Systems



Understanding the Brain

Smart Cities

Computer Science Education

Computer Science for All (CS for All)

- Enable *all* students to have access to high-quality CS education in K-12:
  - Accelerates efforts to build knowledge base, capacity for rigorous, engaging CS education
  - Professional development for educators
- Collaboration: NSF, Dept. Ed., industry, non-profits
- CISE, EHR to provide $120 million over five years through existing programs, e.g.:
  - STEM+C Partnerships
  - Innovative Technology Experiences for Students and Teachers (ITEST)

"In the new economy, computer science isn't an optional skill – it's a basic skill…"
– President Obama

President's Weekly Address 1/30/2016

CISE Research: Addressing National Priorities

Continuing Priorities


Image Credit: ThinkStock

Secure and Trustworthy Cyberspace


Image Credit: Wikicommons

Food, Energy, & Water Systems

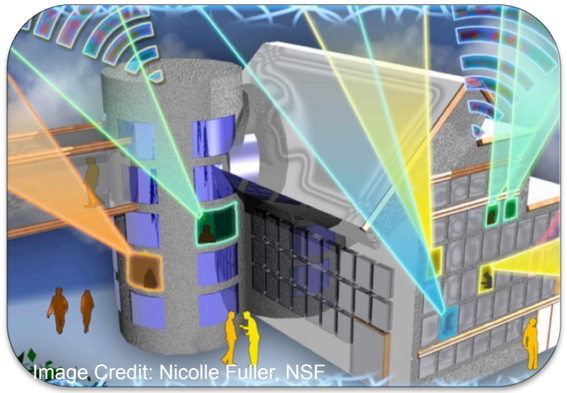


Image Credit: Nicolle Fuller, NSF

Broadband & Universal Connectivity


Image Credit: Texas A&M University

Risk & Resilience

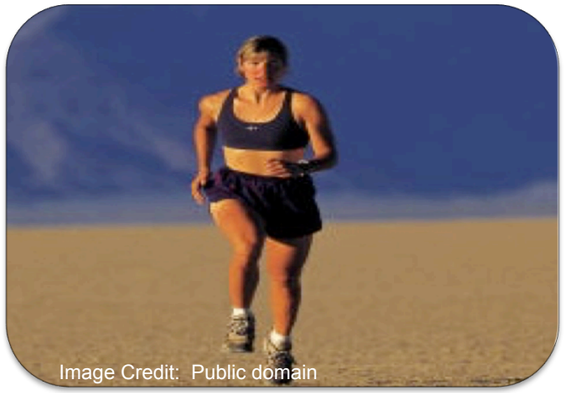


Image Credit: Public domain

Health & Wellbeing

CISE Mission

Exploring the frontiers of computing

- Promote progress of CISE research and education
- Advance the development and use of cyberinfrastructure
- Promote understanding of 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

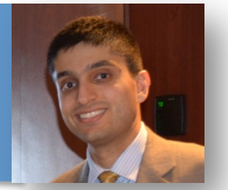
*These frontiers have interfaces with **all** the sciences, engineering, education and humanities and a strong emphasis on innovation for society.*

CISE Organization

CISE Directorate

Jim Kurose, AD

Erwin Gianchandani, Acting DAD



Senior Advisor for Research Cyberinfrastructure
Peter Arzberger

Senior Advisor for Data Science
Chaitan Baru

Advanced Cyberinfrastructure (ACI)
Irene Qualters, DD

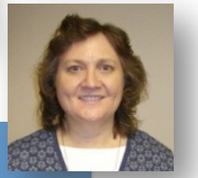
- Data
- High Performance Computing
- Networking/ Cybersecurity
- Software

Computing and Communications Foundations (CCF)
Rao Kosaraju, DD

- Algorithmic Foundations
- Communication and Information Foundations
- Software and Hardware Foundations

Computer and Network Systems (CNS)
Peter Arzberger, Acting DD

- Computer Systems Research
- Networking Technology and Systems
- CS Education and Workforce



Information and Intelligent Systems (IIS)
Lynne Parker, DD

- Cyber Human Systems
- Information Integration and Informatics
- Robust Intelligence

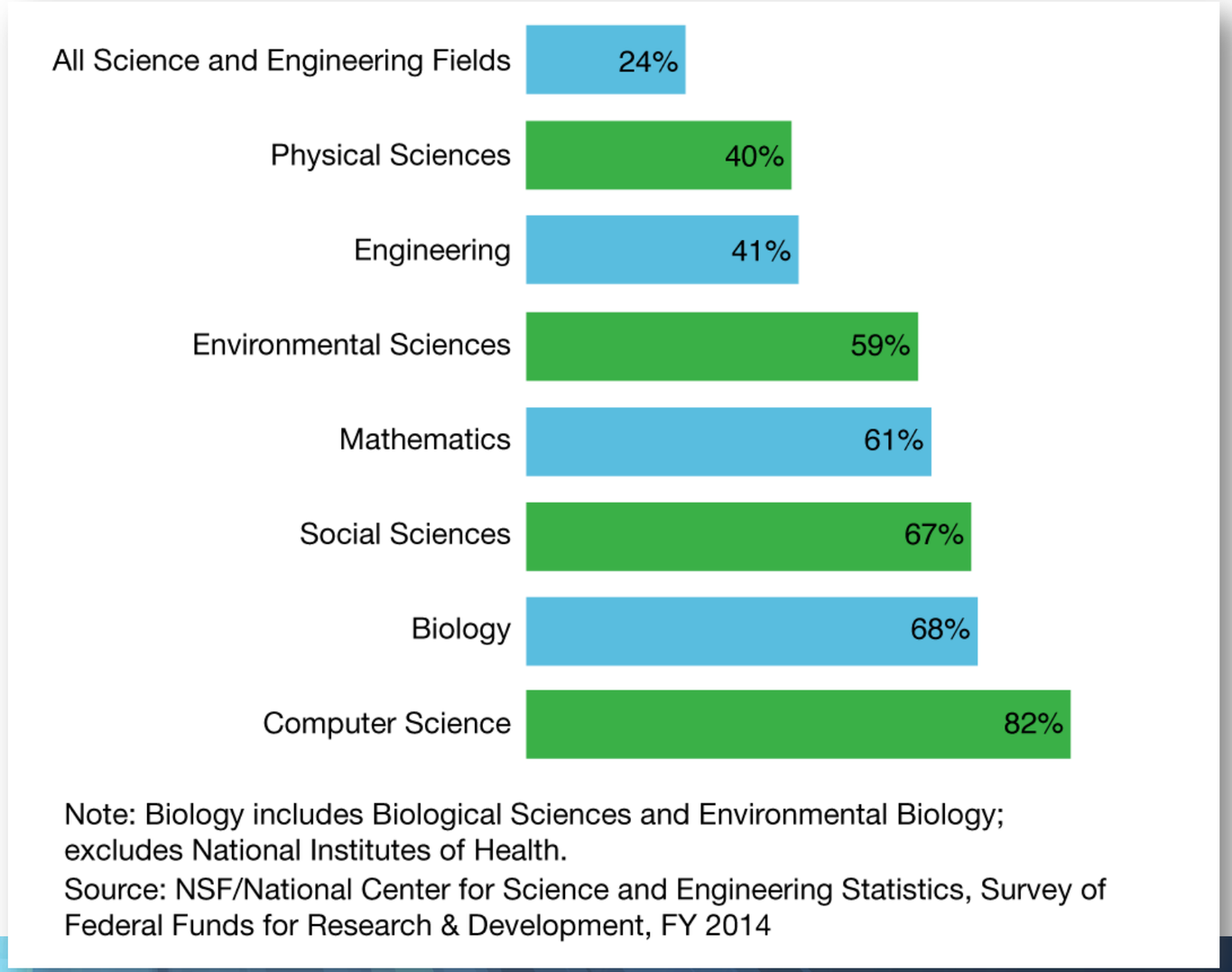
Snapshot of CISE FY 2015 Activities

	CISE
Research Budget	$933M
Number of Proposals	8,038
Number of Awards	1,887
Success Rate	~23%
Average Annualized Award	$187K
Number of Panels Held	342
Number of People Supported	17,868

	CISE
Senior Researchers	7,302
Other Professionals	1,278
Postdoctoral Associates	498
Graduate Students	6,423
Undergraduate Students	2,367

NSF Support of Academic Basic Research

(as a percentage of total federal support)



Note: Biology includes Biological Sciences and Environmental Biology; excludes National Institutes of Health.

Source: NSF/National Center for Science and Engineering Statistics, Survey of Federal Funds for Research & Development, FY 2014

Overview

- Introduction
- FY 2017 Budget Priorities
- Looking Forward

FY 2017 Budget Request

- **NSF**
  - FY 2017 Budget Request: $7,964 Million
  - Increase over FY 2016 Est: $501 Million, +6.7%
- **CISE**
  - FY 2017 Budget Request: $995 Million
  - Comparison to FY 2016 Est: $59 Million, +6.3%
- CISE FY 2017 request is shaped by investments in *core research, education, and infrastructure programs* as well as critical investments *in NSF cross-directorate priorities and programs*.

New Mandatory Funding

- In FY 2017, the Administration is seeking legislation to provide mandatory funding for NSF and other R&D agencies on a one-time basis
- Total FY 2017 NSF Request - $7.964 billion
  - $7.564 billion, discretionary funding
  - $400 million, new one-time mandatory/direct spending authority
- Total FY 2017 CISE Request - $994.80 million
  - $938.43 million, discretionary funding
  - $56.37 million, new one-time mandatory/direct spending authority

CISE FY 2017 Request – Discretionary and New Mandatory Funding

CISE Funding

(Dollars in Millions)

	FY 2016 Estimate	FY 2017 Request Discretionary	FY 2017 Request Mandatory	FY 2017 Request, Total	FY 2017 Request Total Over FY 2016 Estimate	
					Amount	Percent
Advanced Cyberinfrastructure (ACI)	222.30	222.92	13.39	236.31	$14.01	6.3%
Computing and Communication Foundations (CCF)	194.23	194.77	11.70	206.47	$12.24	6.3%
Computer and Network Systems (CNS)	231.10	231.74	13.92	245.66	$14.56	6.3%
Information and Intelligent Systems (IIS)	194.90	195.46	11.74	207.20	$12.30	6.3%
Information Technology Research (ITR)	93.29	93.54	5.62	99.16	$5.87	6.3%
Total, CISE	**$935.82**	**$938.43**	**$56.37**	**$994.80**	**$58.98**	**6.3%**

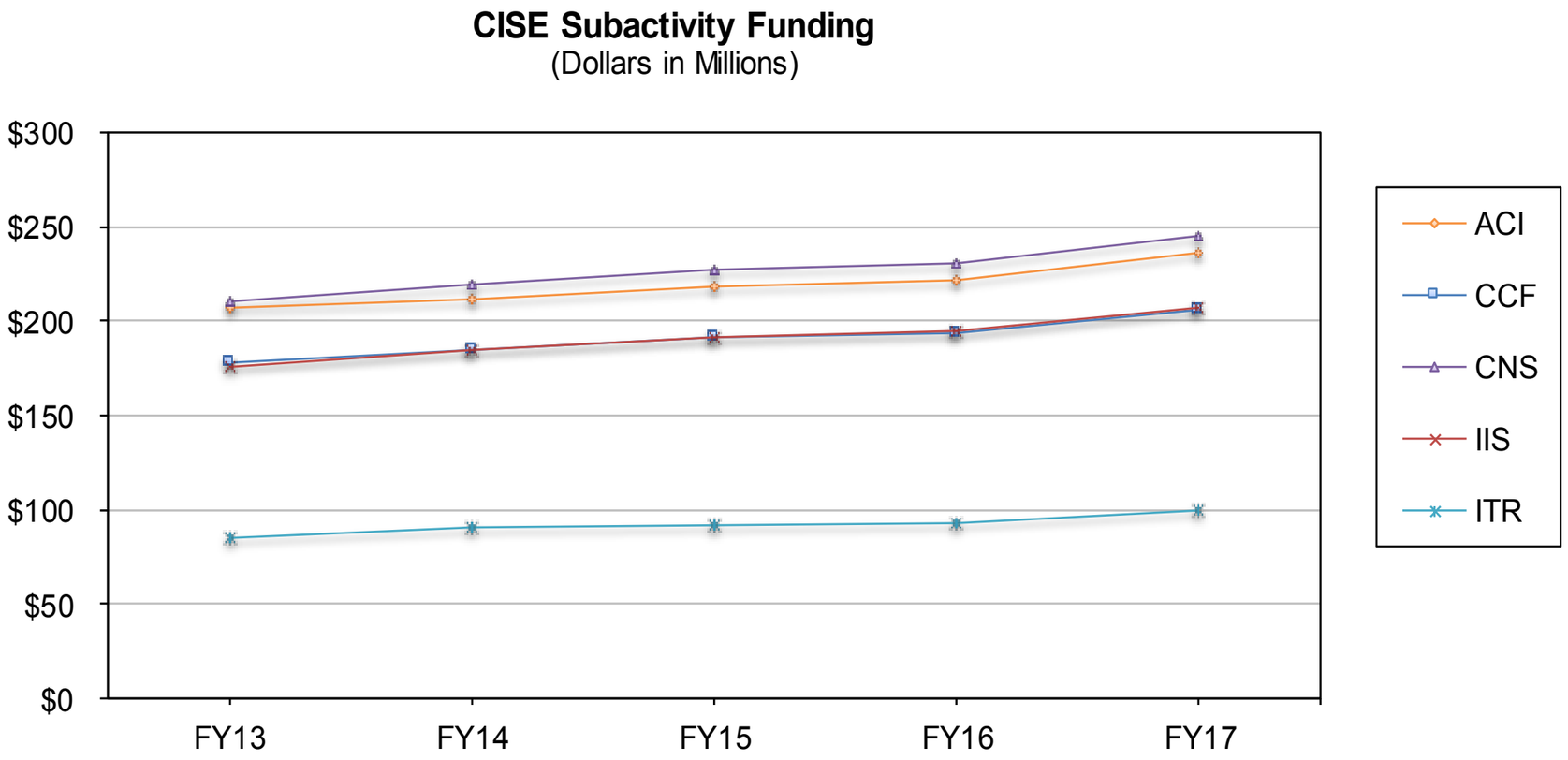
New Mandatory Funding in CISE

Supporting CISE's core activities with special emphasis on early-career investigators

- Improvement in success rate of high-quality research proposals for core, disciplinary programs, including broadening participation
- Emphasis on computational and data-intensive science
- Resources to bridge CISE's core activities, spanning research and research infrastructure, including interdisciplinary activities with other science and engineering disciplines

Growing Division Budgets

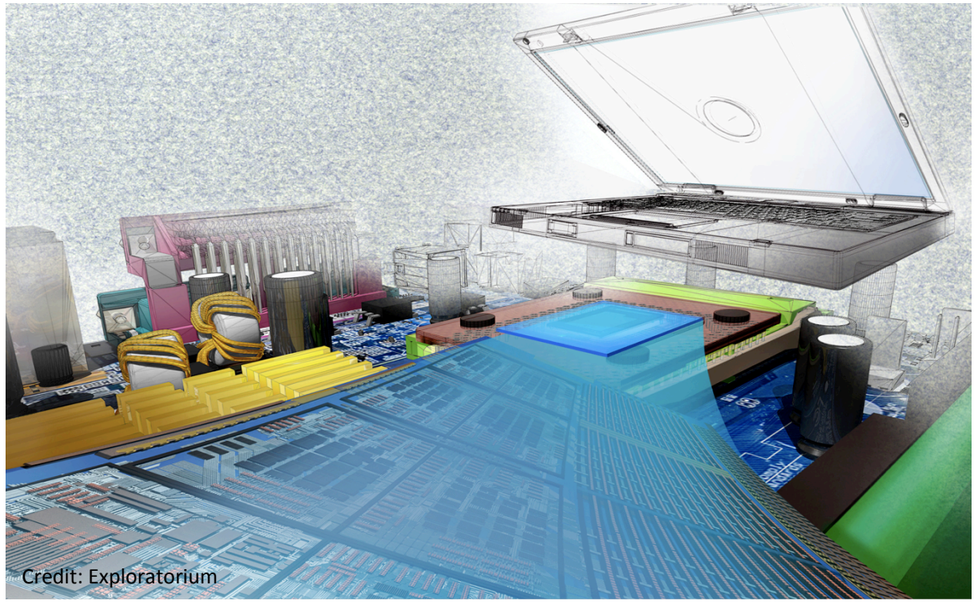
Modest, sustained growth across all CISE divisions



CISE's Commitment to the Core

The heart of what we do

- Casting a broad net
- Letting the best ideas surface
- Engaging research community in developing new fundamental ideas
  - evaluated by research community via merit review process



CISE Investments in NSF Priorities

Area of Investment	FY 2016 Estimate ($M)	FY 2017 Request ($M)
CIF21	$84.21	$50.00
NSCI	---	$19.70
D4SDA	---	$19.60
Smart & Connected Communities	$3.50	$16.50
CEMMSS	$90.98	$92.50
Clean Energy Technology	$22.57	$45.90
INFEWS	$9.00	$6.00
Understanding the Brain	$29.72	$23.58
SaTC	$70.50	$70.50
NSF INCLUDES	$1.87	$1.78

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

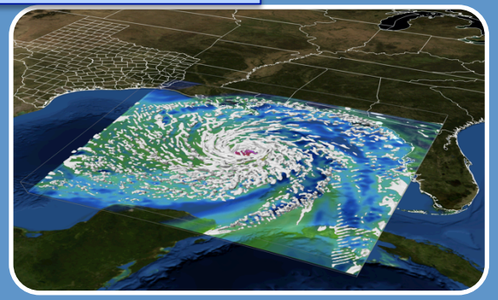
Accelerating the progress of scientific discovery and innovation

CISE Investment: $50.0 M

- Partnership among BIO, CISE, EHR, ENG, GEO, MPS, and SBE
- Sunsets in FY 2017 – activities begin transitioning to National Strategic Computing Initiative (NSCI) and Data for Scientific Discovery and Action (D4SDA)

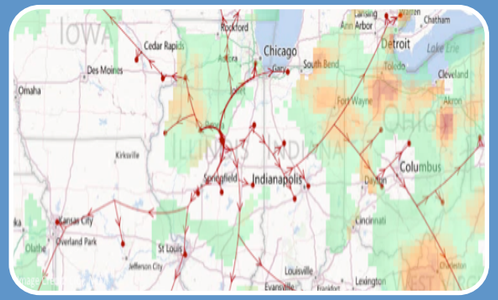
Image Credit: *Chris Coleman, School of Computing, University of Utah*

CIF21

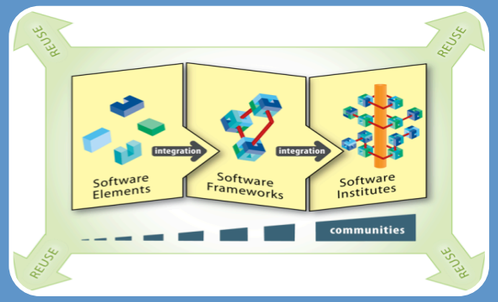


Core Techniques, Technologies and Methodologies for Advancing Foundations and Applications of Big Data Sciences & Engineering (BIGDATA):

Foundational research and innovative applications of broad applicability and key importance to solving big data problems



Data Infrastructure Building Blocks ("DIBBs") and Data Science Pilots:
Developing data infrastructure for multiple scientific disciplines



Software Infrastructure for Sustained Innovation (SI^2):

Transforming innovations in research and education into sustained software resources

Image Credits (from top to bottom): Fuqing Zhang and Yonghui Weng, Pennsylvania State University; Frank Marks, NOAA; Gregory P. Johnson, Romy Schneider, John Cazes, Karl Schulz, Bill Barth, The University of Texas at Austin; and NSF.

National Strategic Computing Initiative (NSCI)

Maximizing benefits of HPC for scientific discovery and economic competitiveness

CISE Investment: $19.70 M

- Partnership among CISE (co-lead), MPS (co-lead), ENG, and GEO
- Executive Order 13702, *Creating a National Strategic Computing Initiative*
- NSF – with CISE/ACI leading – plays a central role in:
  - Scientific discovery advances
  - Broader HPC ecosystem for scientific discovery
  - Workforce development

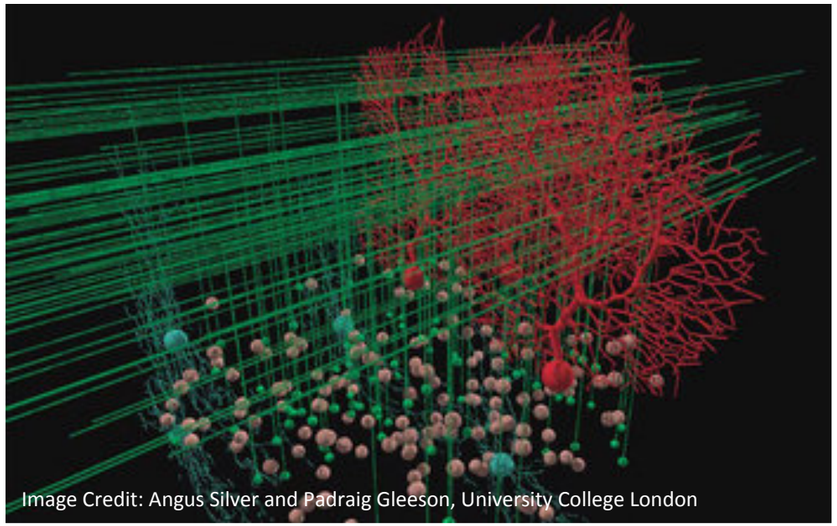


Image Credit: Angus Silver and Padraig Gleeson, University College London

Image Credit: NCSA/University of Illinois

Data for Scientific Discovery and Action (D4SDA)

Enabling 21st century science, engineering, and education to move toward effective use of digital data to advance discovery

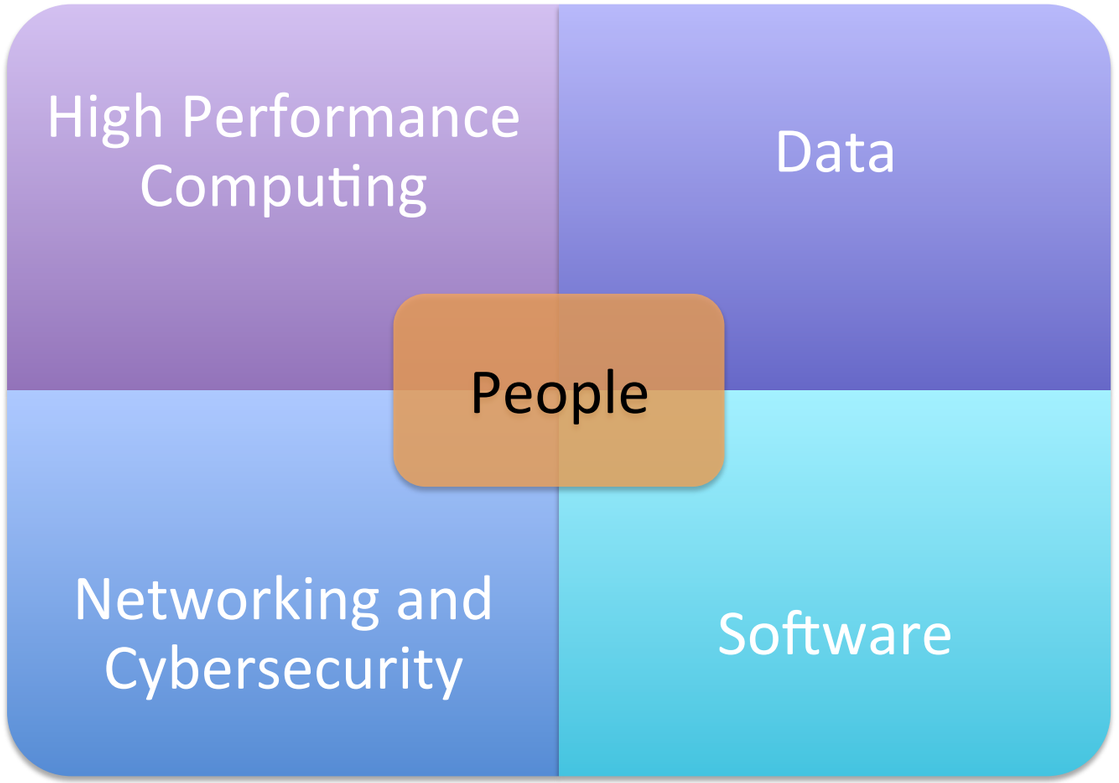
CISE Investment: $19.60 M

- Promote foundational research in critical techniques, technologies
- Provide innovative, reusable data and knowledge infrastructure to support data-intensive science
- Enable/incent science community to address data governance, lifecycle issues
- Educate data-savvy workforce of scientists, engineers, educators

NSF Advanced Cyberinfrastructure

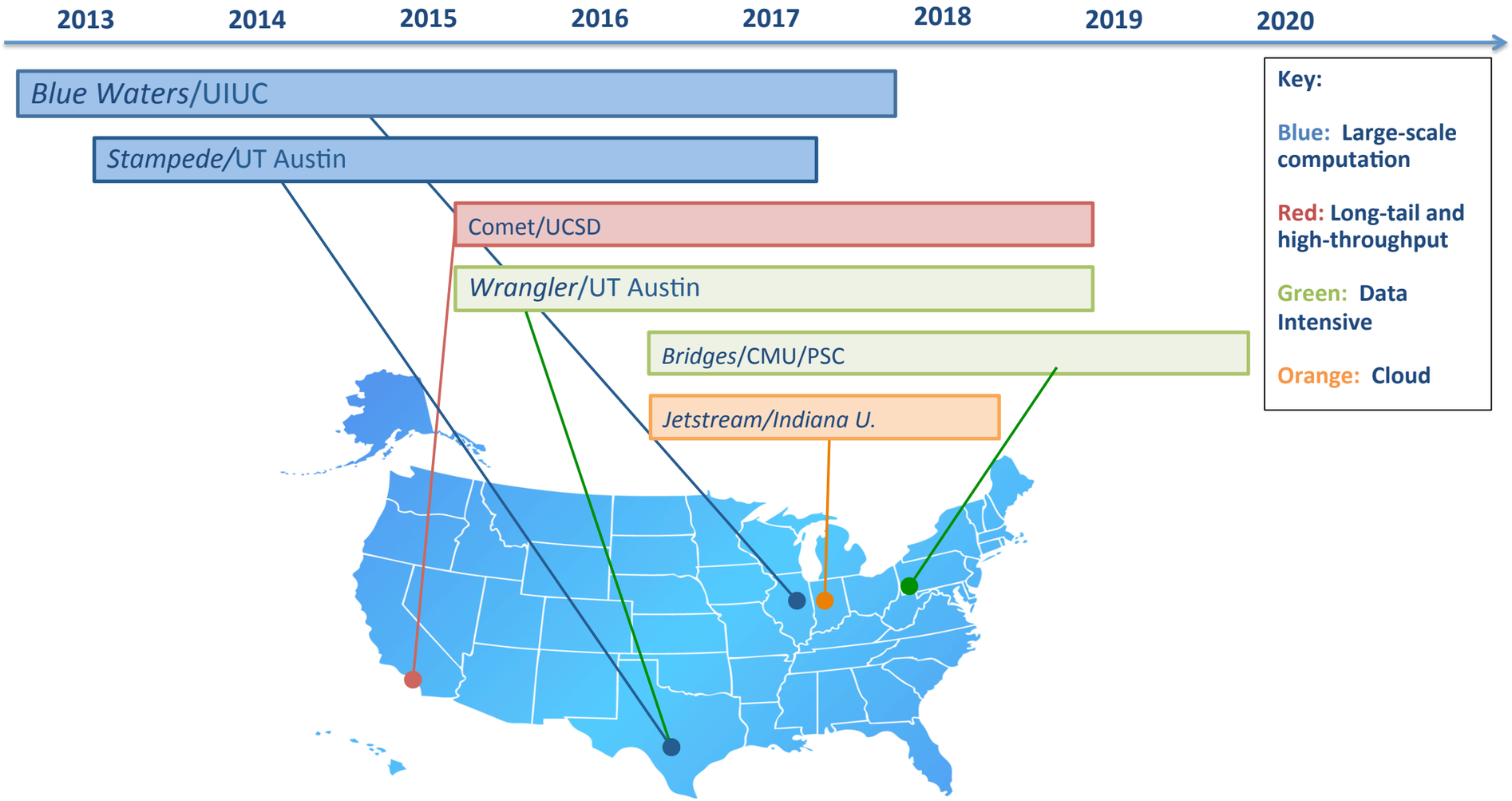
Connecting scientific communities with computational resources and services at all scales

- Advanced cyberinfrastructure accelerates pace of discovery and innovation in **all** areas of inquiry and enables platform on which cross- and inter-disciplinary research thrives
- The deployment and use of cyberinfrastructure across entire spectrum of science, engineering and education expands each year



NSF Advanced Cyberinfrastructure

A diversity of resources in the ecosystem



Smart & Connected Communities (S&CC)

Improving quality of life, health, well-being and learning in communities

CISE Investment: $16.50 M

- Partnership among CISE, EHR, ENG, GEO, SBE
- Network of regional research hubs to advance fundamental research
  - Advanced networking; physical sensors/ devices; large-scale data management, analysis, and decision making
- Builds on previous investments in Urban Science, US Ignite


Image Credit: NSF

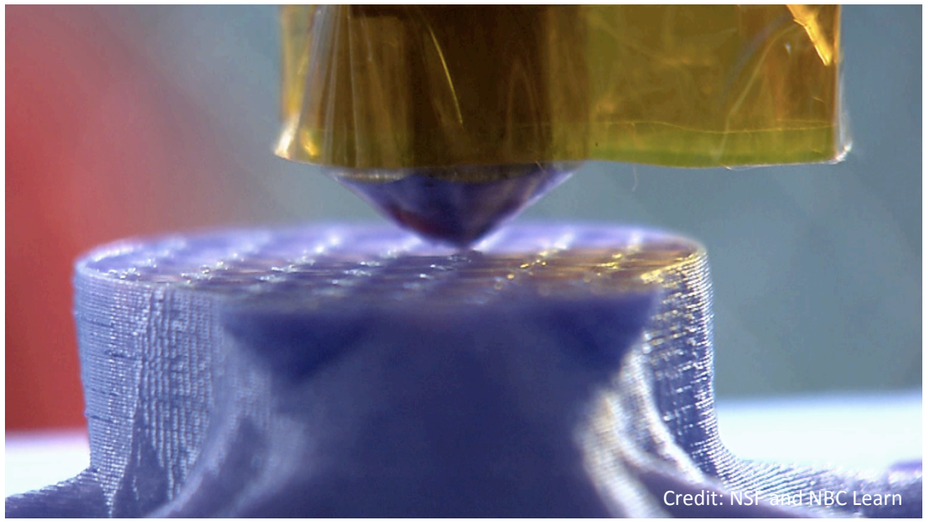

Image Credit: US Ignite

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

Accelerating advances in 21st century smart engineered systems

CISE Investment: $92.50 M

- Partnership among BIO, CISE, ENG, and MPS
- CISE emphasis areas:
  - Advanced Manufacturing
  - Cyber-Physical Systems (CPS)
  - National Robotics Initiative (NRI)
  - Smart & Autonomous Systems (S&AS)



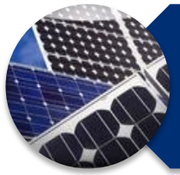
CEMMSS

Cyber-Physical Systems (CPS)

Deeply integrating computation, communication, and control into physical systems

- Partnership between CISE, ENG
- Multi-agency commitments: NSF, DHS, DOT, NASA, NIH, USDA
- Serves multiple key national priorities
- Includes *Transition to Practice* option
- NSF co-chairs NITRD interagency Cyber Physical Systems Senior Steering Group (with NIST)

Transportation



Energy and Industrial Automation

Healthcare and Biomedical

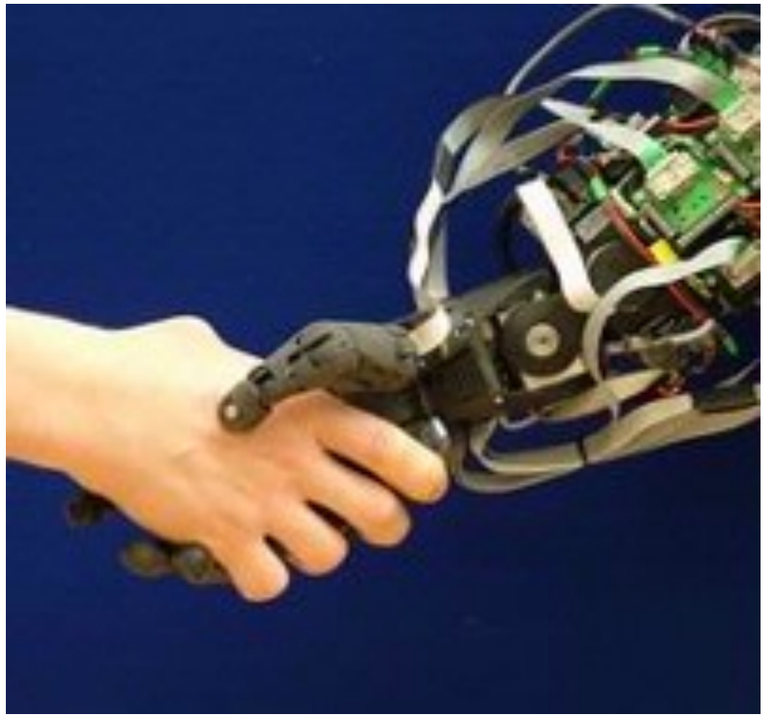
Critical Infrastructure

CEMMSS

National Robotics Initiative (NRI)

Developing the next generation of collaborative robots to enhance personal safety, health, and productivity

- Partnership among CISE, EHR, ENG, SBE
- Multi-agency commitments: NSF, DOD, DOE, NASA, NIH, USDA
- Serves multiple national priorities
- Strong coupling with industry and startups



CEMMSS

Smart & Autonomous Systems (S&AS)

Fundamental research on intelligent physical systems that sense, perceive, and operate in dynamic, uncertain and unanticipated environments

- Research in smart and autonomous systems lies at interstices of NRI and CPS
  - NRI: “co-robots” – robots that work alongside, or cooperatively with, people
  - CPS: deeply integrating computation, communication, control into physical systems, typically with provably correct behavior
- Exceeding today’s capabilities in adaptability, autonomy, functionality, efficiency, reliability, safety, usability, recoverability, recyclability

Image Credit: NSF

Clean Energy Technology

Innovating efficient, renewable, and alternative energy sources for electricity and fuels

CISE Investment: $45.90 million

- Partnership among all NSF directorates
- Includes investment in INFEWS
- CISE emphases (to be supported by core programs):
  - Energy-intelligent computing
  - New theory, algorithms, design principles to investigate energy versus computation and communication tradeoffs
  - Scalability and sustainability of smart energy production software and hardware
  - Innovations in smart grid technologies

Innovations at the Nexus of Food, Energy, and Water Systems (INFEWS)

Securing and protecting food, energy and water resources

CISE Investment: $6.0 M

- Partnership among all NSF directorates
- Cyber-Human-Physical Systems:
  - New resource management algorithms and architectures
  - Real-time coordination and communications
  - Robust observation, sensing, and inference
  - Large-scale data analysis and management, including modeling and simulation
  - Optimization of complex systems
- Advancing computational infrastructure

Understanding the Brain (UtB)

Improving understanding of the brain

CISE Investment: $23.58 M

- Partnership among all NSF directorates
- Includes the BRAIN Initiative
- CISE emphases:
  - Collaborative Research in Computational Neuroscience (CRCNS)
  - Integrative Strategies for Understanding Neural and Cognitive Systems (NCS)
  - MIT STC: *Center for Brains, Minds and Machines*: *The Science and the Technology for Intelligence*
  - Advancing computational infrastructure

BRAIN INITIATIVE
BRAIN RESEARCH THROUGH ADVANCING INNOVATIVE NEUROTECHNOLOGIES

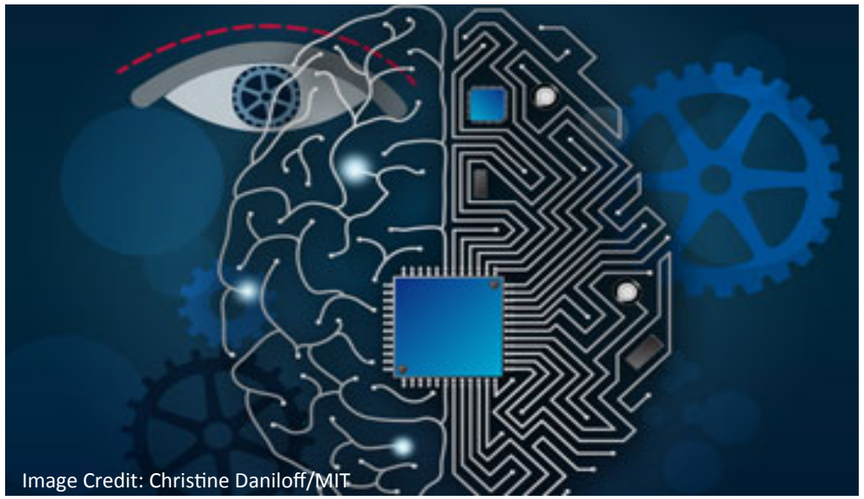
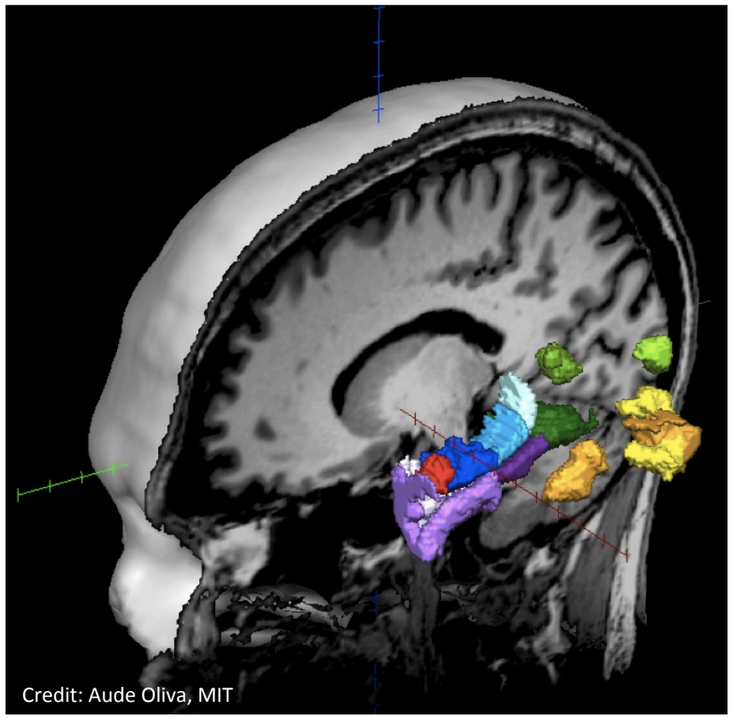


Image Credit: Christine Daniloff/MIT

National Brain Observatory

Achieving a comprehensive understanding of the brain

- Partnership among CISE, BIO, MPS
- Development, deployment of shared research tools, and computational and data infrastructure
- Support multidisciplinary, collaborative and team science
- Allow rapid integration, analysis and modeling of brain data from multi-disciplinary projects
- Facilitate coordination of large-scale data collection efforts nationally and internationally to advance understanding of brain function



Secure and Trustworthy Cyberspace (SaTC)

Securing our Nation's cyberspace

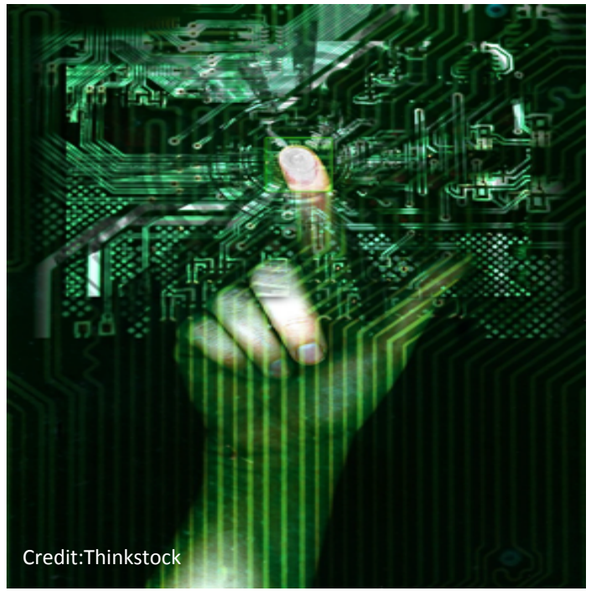
CISE Investment: $70.50 M

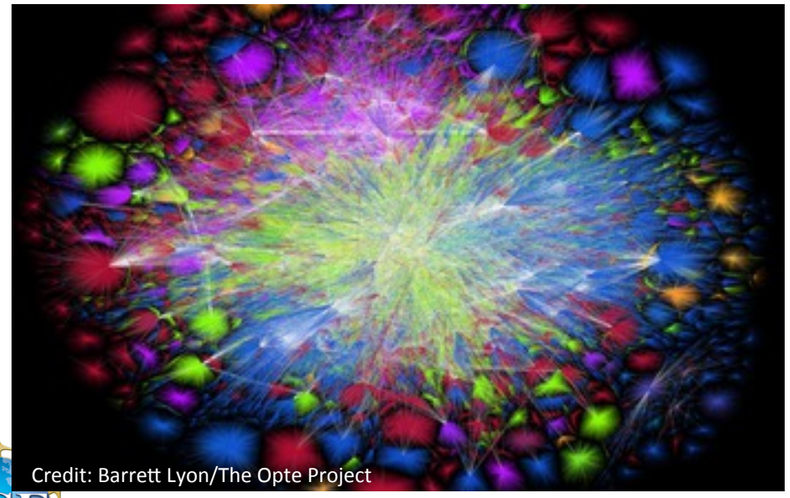
- Partnership among CISE, EHR, ENG, MPS, and SBE
- Aligns with the *Federal Cybersecurity Research and Development Strategic Plan* (released today!).
- CISE emphases:
  - Secure and Trustworthy Cyberspace program
  - *NSF/Intel Partnership on Cyber-Physical Systems Security and Privacy (CPS-Security)*
- Emerging areas:
  - Experimental testbeds
  - Science of privacy
  - Network and cloud security


Image Credit: ThinkStock

Image Credit: ThinkStock

FY 2016 SaTC Solicitation


Credit:Thinkstock


Credit: Barrett Lyon/The Opte Project

- SaTC solicitation perspectives:
  - Trustworthy Computing Systems
  - Social, Behavioral and Economic Sciences
  - *Secure, Trustworthy, Assured and Resilient Semiconductors and Systems (STARSS), jointly offered with the Semiconductor Research Corporation (SRC)*
  - Transition to Practice (TTP)
- Cybersecurity education

NSF Inclusion across the Nation of Communities of Learners of Underrepresented Discoverers in Engineering and Science (NSF INCLUDES)

Broadening participation for those typically underrepresented in STEM fields

CISE Investment: $1.78 M

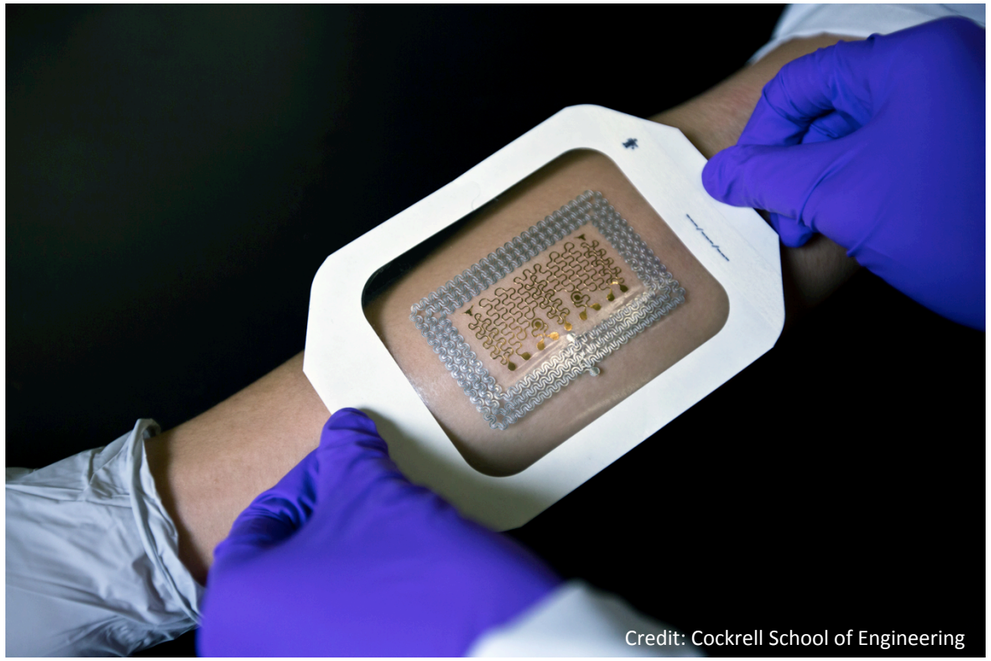
- Partnership among all NSF directorates
- Preparation, participation, and advancement of those traditionally underserved and/or underrepresented in STEM
- Builds on CISE's efforts in Broadening Participation in Computing

Image Credit: *John C. Williams, Humanoid Engineering & Intelligent Robotics (HEIR) Lab, Marquette University*

Smart and Connected Health

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

- Partnership with NIH and among CISE, ENG, SBE
- Fundamental technical and scientific challenges: preventive, proactive, evidence-based, personalized, person-centered and focused on health and wellbeing



Credit: Cockrell School of Engineering

Cyberlearning and Future Learning Technologies

Improving learning by integrating technologies with knowledge about how people learn

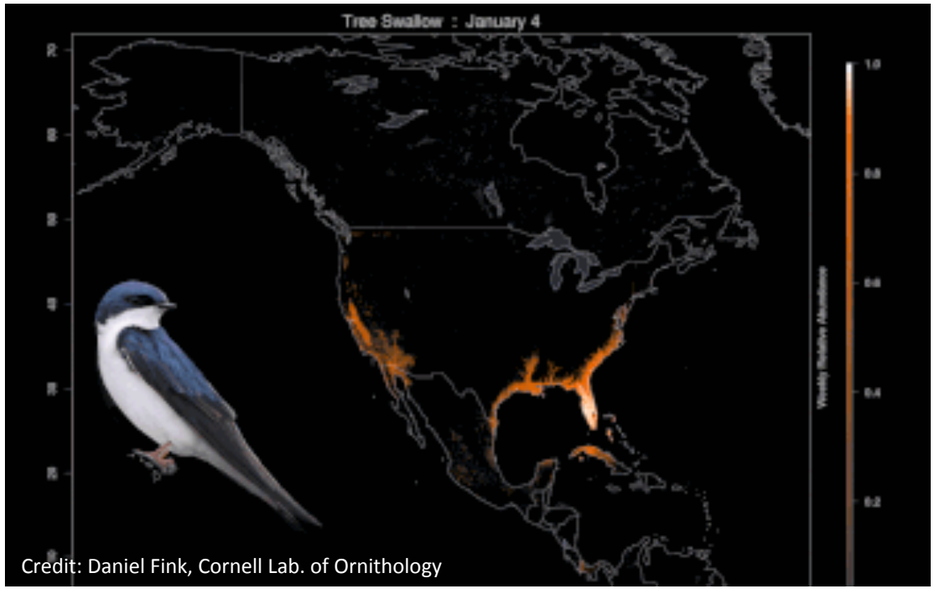
- Participation among CISE, EHR, ENG
- Program emphases:
  - Innovation
  - Advancing understanding of how people learn in technology-rich learning environments
  - Promoting broad use and transferability of genres


Credit: GA Computes! GA Tech

Expeditions-in-Computing FY 2016 Awards

Spanning theoretical computer science, synthetic biology and computational sustainability

- *The Science of Deep Specification*
  - Princeton, U Penn, Yale, MIT
- *Evolvable Living Computing – Understanding and Quantifying Synthetic Biological Systems' Applicability, Performance, and Limits*
  - BU, MIT, Lincoln Labs
- *CompSusNet: Expanding the Horizons of Computational Sustainability*
  - Cornell, Bowdoin College, CalTech, CMU, Georgia Tech, Howard, OSU, Princeton, Stanford, U Mass-Amherst, USC, Vanderbilt



Credit: Daniel Fink, Cornell Lab. of Ornithology

Overview

- Introduction
- FY 2017 Budget Priorities
- Beyond FY 2017

Computer Science Undergraduate Education

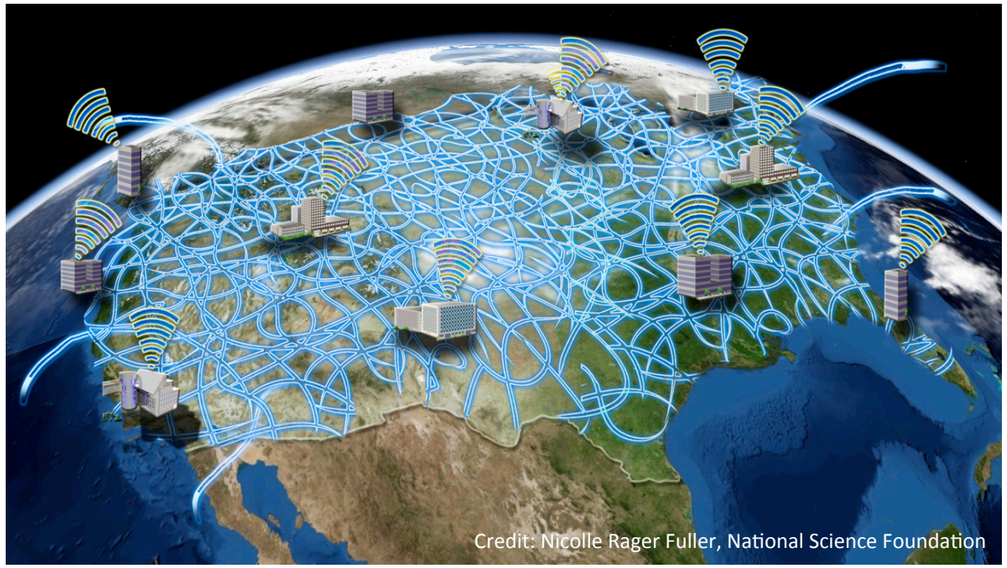
Knowledge of computer science is essential for solving critical problems across every discipline and domain

- Increasing undergraduate enrollments
- Growing interest in CS+X approaches
- Dynamic industry needs
- Builds on REvolutionizing engineering and computer science Departments (RED)
  - Pursuing significant sustainable changes to prepare students to solve 21st century challenges
  - Under the Improving Undergraduate STEM Education (IUSE) framework

Credit: Calvin Lin, UT Austin

Advanced Systems Testbeds

- Next generation software-defined infrastructure
- Wireless testbeds that enable experimental research
  - Radio access networks
  - Network control plane, services
  - Spectrum sharing, adaptability

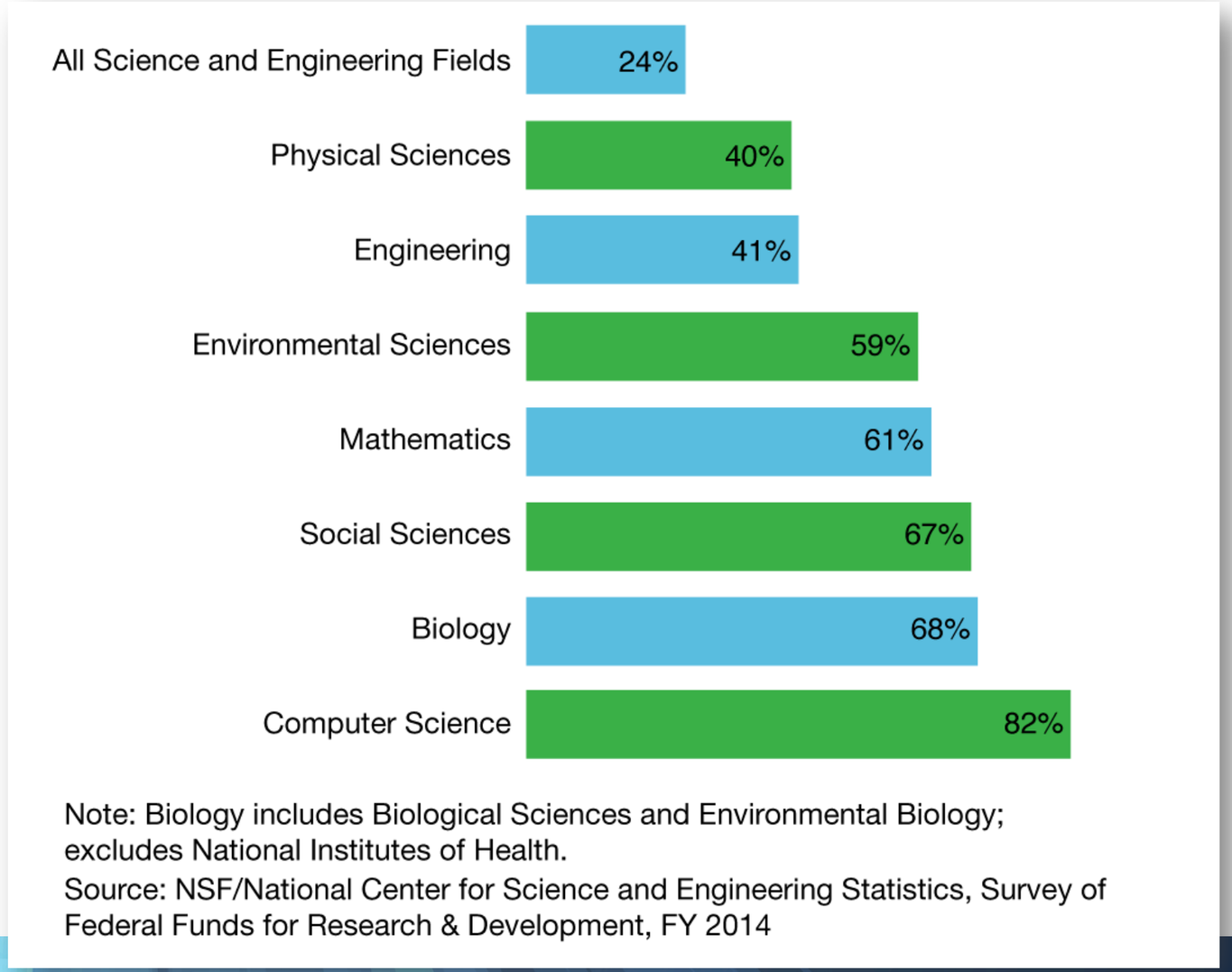


CISE's Commitment to Research and Education

- CISE: **rich intellectual agenda** – highly creative, highly interactive, with enormous possibilities for changing the world!
- Balanced portfolio of activities
- Thriving basic research community foundational for long-term **discovery** & **innovation**, **economic prosperity**, **national security**
- Growing investment in **cyberinfrastructure** is crucial to accelerating scientific discovery and engineering innovation across all disciplines
- Investments in **research, education, and infrastructure** have returned exceptional dividends to our Nation

NSF Support of Academic Basic Research

(as a percentage of total federal support)



Note: Biology includes Biological Sciences and Environmental Biology; excludes National Institutes of Health.

Source: NSF/National Center for Science and Engineering Statistics, Survey of Federal Funds for Research & Development, FY 2014

An *amazing* time to be in CISE!

Ubiquity

Computing is *everywhere* – across all of science and engineering, and all of society

Engagement

Computing intertwines with many *communities*

Urgency

Computing is *rapidly expanding and evolving*
There is tremendous opportunity … *now!*

Thanks!