NSF/CISE: an update and a look at, and over, the horizon

| Advanced Cyberinfrastructure | Computing & Communication Foundations | Computer & Network Systems | Information & Intelligent Systems |
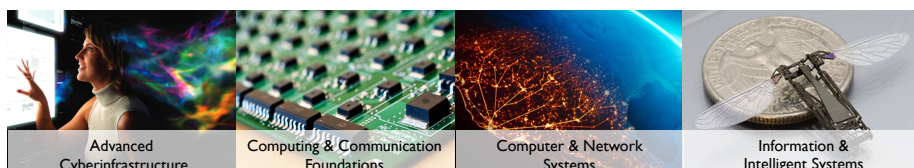
Jim Kurose
Assistant Director, NSF
Computer & Information Science & Engineering

PEARC '19
August 1, 2019

Outline

NSF/CISE Overview → Selected Programmatics → Looking Forward

National Science Foundation's Mission

"To promote the progress of science;

National Science Foundation's Mission

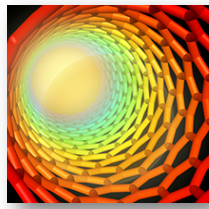*"To promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense..."*
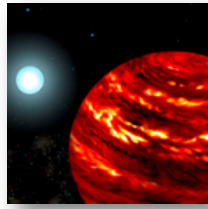
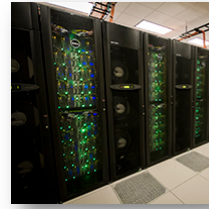## NSF Funds All Fields of Science and Engineering
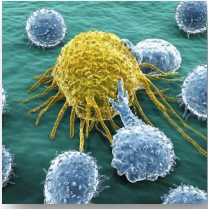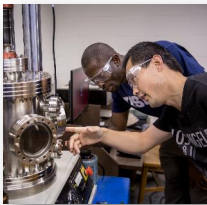

Biological Sciences

Engineering

Mathematical and Physical Sciences

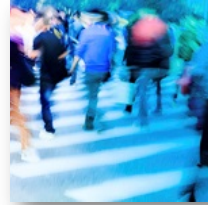Computer and Information Science and Engineering

Geosciences and Polar Programs

Integrative Activities

Education and Human Resources

Social, Behavioral, and Economic Sciences

International Science and Engineering
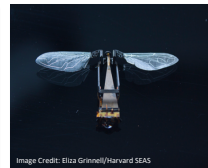
National Science Foundation

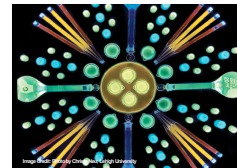# CISE programs address national priorities

AI and Big Data

Cybersecurity

Robotics & Manufacturing

Quantum Information Sciences

Advanced Cyberinfrastructure

Smart Communities

Computer Science Education

Advanced Wireless Research

Aligned with Administration and Congressional Priorities

M-18-22

MEMORANDUM FOR THE HEADS OF EXECUTIVE DEPARTMENTS AND AGENCIES

FROM: MICK MULVANEY
DIRECTOR, OFFICE OF MANAGEMENT AND BUDGET

MICHAEL KRATSIOS
DEPUTY ASSISTANT TO THE PRESIDENT
OFFICE OF SCIENCE AND TECHNOLOGY POLICY

SUBJECT: FY 2020 Administration Research and Development Budget Priorities

FY 2020 R&D Budget Priorities Memo
"Agencies should invest in fundamental and applied AI research, including machine learning, autonomous systems, and applications at the human-technology frontier. Agencies should prioritize QIS R&D,
… Agencies should prioritize investment in research and infrastructure to maintain U.S. leadership in strategic computing, from edge devices to high-performance computing, … use of embedded sensors, data analytics, and machine learning "

National Security Strategy

National Defense Strategy

National Quantum Initiative Act

AI Executive Order

Executive Order on Maintaining American Leadership in Artificial Intelligence

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CISE by the Numbers: FY 2018

21% Research grant success rate

$960 M — FY 2018 research budget

9,151 proposals

397 Panels

2,099 awards

17,778 people supported

7,837 senior researchers

1,158 other professionals

455 postdoctoral associates

6,598 graduate students

2,741 undergraduate students
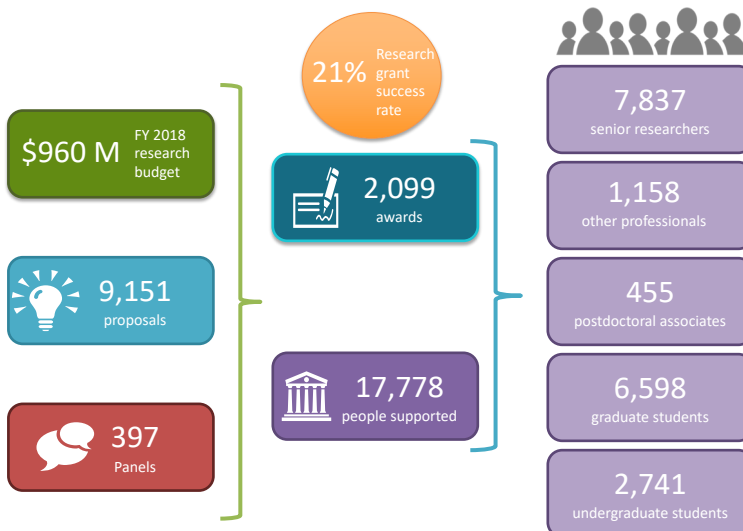
Budget Process: Reminder

Markup, reconciliation of appropriation bills

Request

House Budget Resolution

Senate Budget Resolution
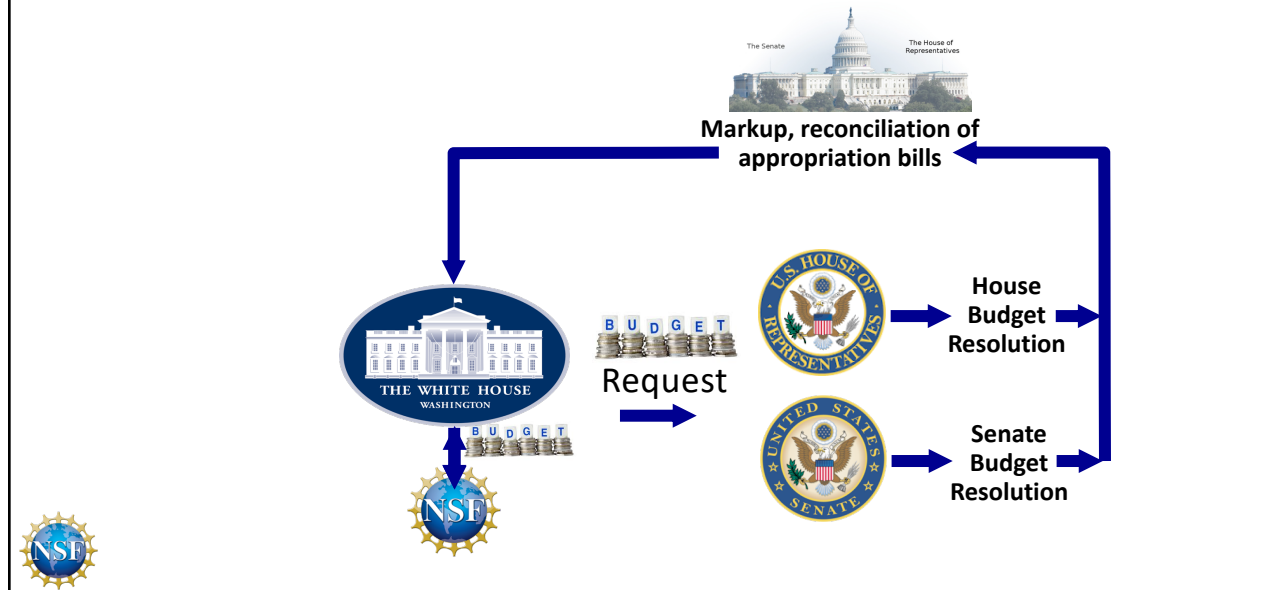
2019 Budget Process: done!

FY19 enacted budget

- $8.075 Billion (+4% over FY 2018, which was +5% over 2017)

Markup, reconciliation of appropriation bills

Feb 15, 2019

June 2019

Request

Feb. 12, 2018

May 23, 2018
House Budget Resolution
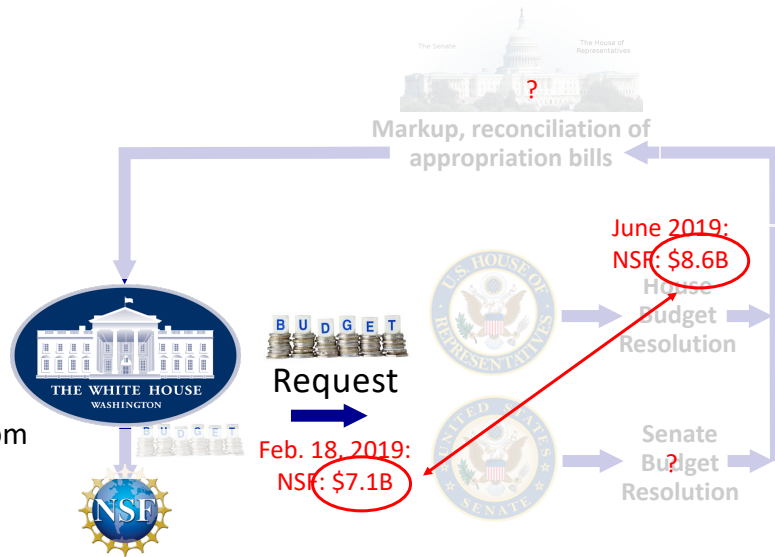
Senate Budget Resolution
June 17, 2018
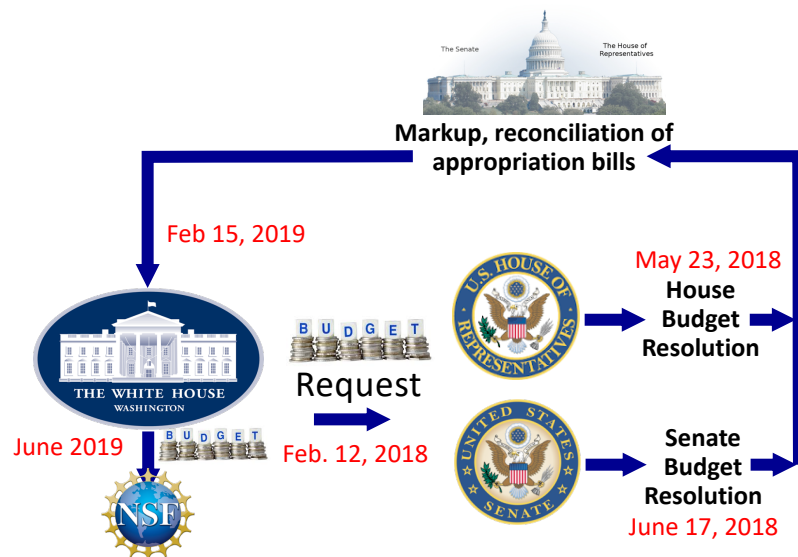
2020 Budget Process: underway
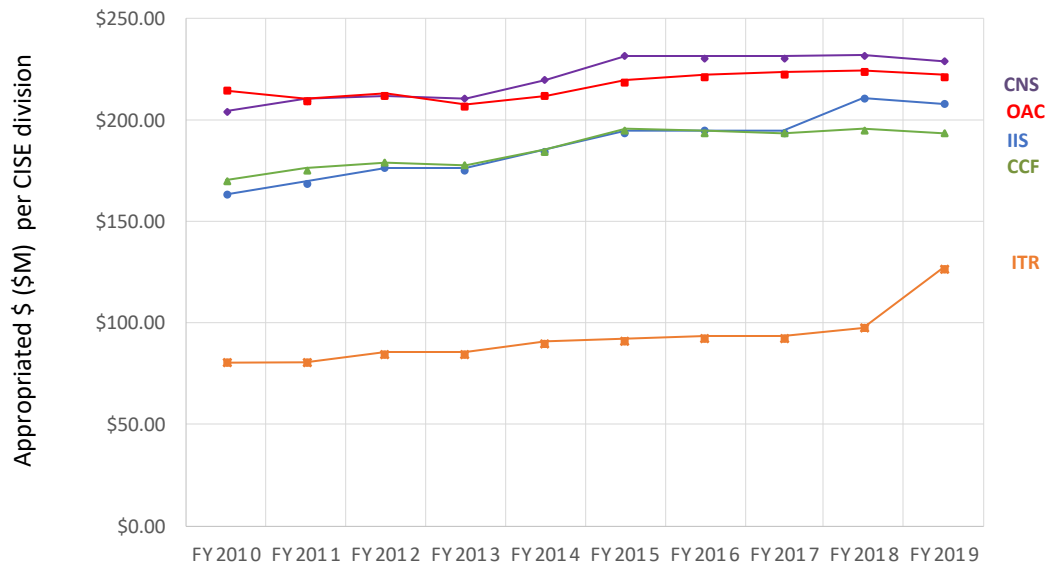
FY19 enacted budget

- $8.075 Billion (+4% over FY 2018, which was +5% over 2017)

FY20 President's budget request

- $7.100 Billion (R&RA: -13.2 % from FY 2019 enacted).

?

Markup, reconciliation of appropriation bills

BUDGET

Request

June 2019: NSF: $8.6B

Feb. 18, 2019: NSF: $7.1B

House Budget Resolution

Senate Budget Resolution

NSF/CISE Division Budgets

Appropriated $ ($M) per CISE division

CNS
OAC
IIS
CCF

ITR

FY 2010 FY 2011 FY 2012 FY 2013 FY 2014 FY 2015 FY 2016 FY 2017 FY 2018 FY 2019

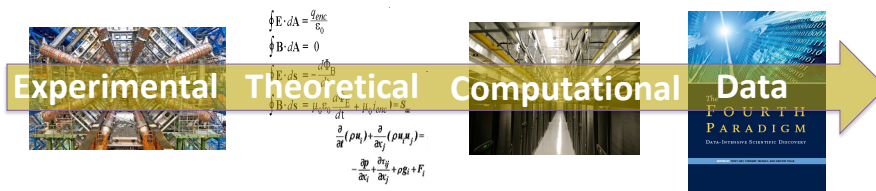## NSF Supports All Areas of Fundamental Research

NSF support as a percentage of total federal support for basic academic research

Computer Science — 85%
Biology — 69%
Environmental Sciences — 63%
Social and Pyschological Sciences — 62%
Mathematics — 62%
Engineering — 44%
Physical Sciences — 44%
All Science and Engineering Fields — 25%
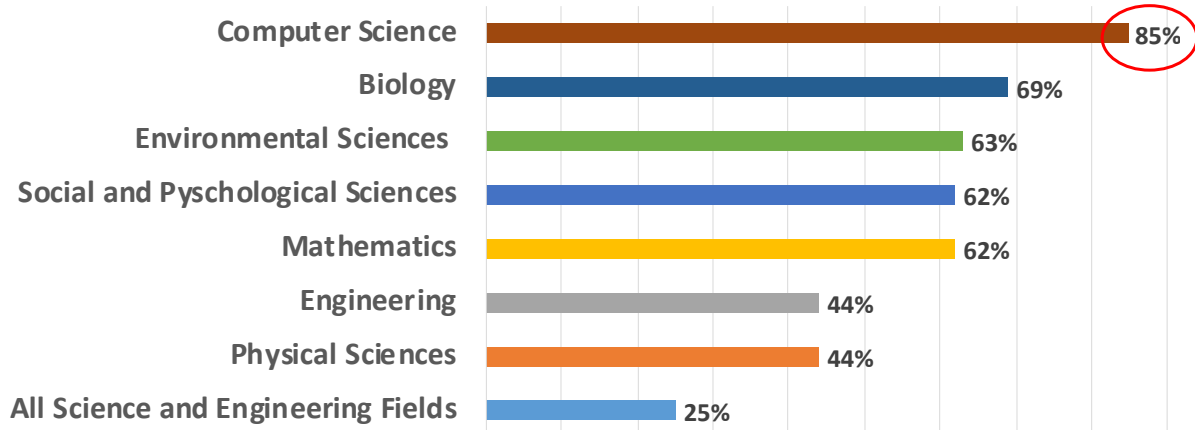
Source: NSF/NCSES, "Survey of Federal Funds for Research and Development." In FY20 NSF Budget Request to Congress
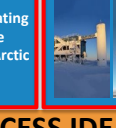
Computation, Data: 21st Century Research Paradigms

Experimental   Theoretical   Computational   Data

Neuroscience: EEG, fMRI
Fusion: KSTAR
Oceanography: OOI
Economics: POS Terminals
SMART CITY
Crisis Management
Sociology: The Web
Physics: LHC
Astronomy: LSST   Personalized Medicine   Internet of Things   Biology: Sequencing

OAC Fosters a *CI Ecosystem* for all of S&E

Discovery

Science idea

Science portals, gateways

Research facilities

Application frameworks

Middleware Infrastructure: Authentication , Access, Distributed Workflows

Data   Cloud   Computing   Instruments   R&E Networks, Security

XSEDE — Coordination, User support

Pilots, Testbeds

People, organizations, communities

Outline

NSF/CISE Overview

Selected Programmatics

Looking Forward

NSF Big Ideas

RESEARCH IDEAS

Harnessing Data for 21st Century Science and Engineering

Work at the Human-Technology Frontier: Shaping the Future

Windows on the Universe: Multi-messenger Astrophysics

Quantum Leap: Leading the Next Quantum Revolution

Navigating the New Arctic

Understanding the Rules of Life: Predicting Phenotype

PROCESS IDEAS

Mid-scale Research Infrastructure

NSF 2026

Growing Convergence Research at NSF

NSF INCLUDES: Enhancing STEM through Diversity and Inclusion

" … bold questions that will drive NSF's long-term research agenda -- questions that will ensure future generations continue to reap the benefits of fundamental S&E research. "

NSF Big Ideas: full steam ahead in FY 19

- Convergence research: many disciplines required
- Budget model: 5-year funding, $30M/idea/yr, *outside* directorates

Harnessing the Data Revolution (HDR)

- HDR: TRIPODS Phase I (2/19)
- HDR: Institutes for Data-Intensive Research in Science and Engineering - Frameworks (2/19); Ideas Labs (12/18)
- HDR: Data Science Corps (DSC) (10/18)

Future of Work at the Human-Technology Frontier (FW-HTF)

- FW-HTF: Core Research (2/19)
- "advancing fundamental understanding of future work, and potential improvements to work, workplaces, workforce preparation, or work outcomes for workers and society"

Quantum Leap (QL)

- QL: Challenge Institutes (2/19)
- QL: Idea Incubator for Transformational Advances in Quantum Systems (10/18)
- QL: Quantum Materials Science, Engineering, and Information (8/18)

Mid-scale Research Infrastructure

- Mid-scale Research Infrastructure-2 (12/18)
- Mid-scale Research Infrastructure-1 (11/18)

Convergence Accelerator

WHY: Leverage the science across all fields of NSF research to produce use-inspired outcomes in an accelerated timeframe, with nimble, more-directed management

WHAT: A new organizational structure to accelerate the transition of convergence research into practice, in areas of national importance

Characteristics	Management
• Use-inspired research • Testbeds, tools, living labs… • Larger, national scale • Requires partnerships with industry • Clear goals, milestones, directed deliverables	• Time-limited "tracks" • Teams and Cohorts • Cooperation and Competition • More directed management • Mission-driven evaluation

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CISE Research Infrastructure

CISE _Community_ Research Infrastructure

CISE Community Research Infrastructure (CCRI)

PROGRAM SOLICITATION
NSF 19-512

- Larger, longer awards for new infrastructure
  - Grand Ensemble: 5 years, $5M
  - Medium Ensemble: 3 years, $1.5M
- Emphasis on projects that benefit and involve the CISE community

Cloud Access

Enabling Access to Cloud Computing Resources for CISE Research and Education (Cloud Access)

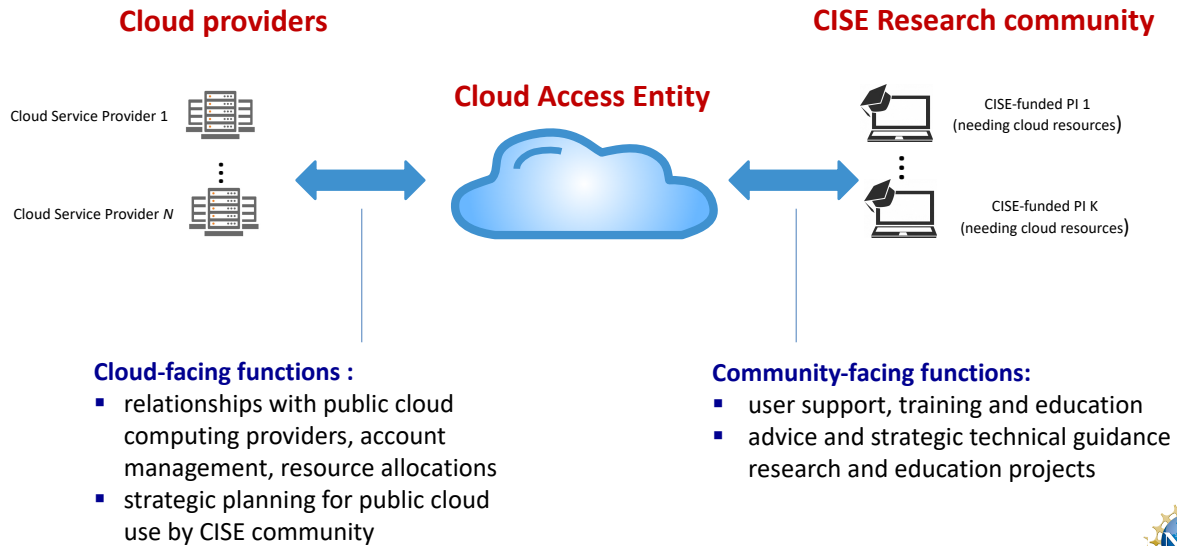**PROGRAM SOLICITATION**
NSF 19-510

National Science Foundation
Directorate for Computer & Information Science & Engineering
Division of Computing and Communication Foundations
Division of Information & Intelligent Systems
Division of Computer and Network Systems
Office of Advanced Cyberinfrastructure

- Builds on AWS, Google, Microsoft, IBM collaboration on BIGDATA
- Informed by Jan. 2018 NSF/CISE workshop (report available)

NSF/CISE's Cloud Access Solicitation (NSF 19-510)

Cloud providers

CISE Research community

Cloud Access Entity

Cloud Service Provider 1

Cloud Service Provider *N*

CISE-funded PI 1
(needing cloud resources)

CISE-funded PI K
(needing cloud resources)

Cloud-facing functions :
- relationships with public cloud computing providers, account management, resource allocations
- strategic planning for public cloud use by CISE community

Community-facing functions:
- user support, training and education
- advice and strategic technical guidance research and education projects

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Outline

NSF/CISE Overview | Selected Programmatics | Looking Forward

Looking back: Research Cyberinfrastructure

- **Discovery science** in all NSF-supported disciplines
- **Leadership Computing:** Blue Waters, Frontera
  - MREFC track for LCCF Phase 2
- **Innovative HPC** (Bridges, Comet, Jetstream, Stampede2)
  - Advanced Systems and Services (NSF 19-534)
- **CI Services**: XSEDE2
- **Networking, Software, Security, Data, People:**
  - CC*, CICI, CSSI (DIBBs, SI2), CyberTraining
- **Cloud initiatives:**
  - Cloud Access, E-CAS, NSFFutureCloud (CloudLab, Chameleon), BIGDATA cloud collaboration (AWS, GCP, IBM, Microsoft Azure)
- **Midscale** Big Idea
- **Large Facilities** and CI

Looking back: Research Cyberinfrastructure

Future Directions for
**NSF ADVANCED
COMPUTING
INFRASTRUCTURE**
to Support U.S. Science
and Engineering
in 2017–2020

National Academies
ACI report

ACI/OAC placement review

Dear Colleague Letter: Seeking Community Input on Advance Cyberinfrastructure

NSF 17-031

Dear Colleague Letter: Request for Information on Future Needs for Advanced Cyberinfrastructure to Support Science and Engineering Research (NSF CI 2030)

OAC blueprint

Transforming Science Through Cyberinfrastructure

NSF's Blueprint for a National Cyberinfrastructure Ecosystem for Science and Engineering in the 21st Century

Executive Summary

HSST: Cyberinfrastructure as Science Infrastructure

Looking forward

Growing Importance of CI

- growth of computation, data as research paradigms
- an expansive UG education: computing, data science, informatics
- maintaining a vibrant academic research ecosystem: "eating our seedcorn"

Research funding

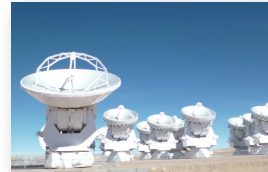- money matters
- relatively flat investments, historically

Partnerships at scale

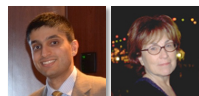*Prescription 3:* Establishing a More Robust National Government-University-Industry Research Partnership

CI and Large Facilities

Looking forward

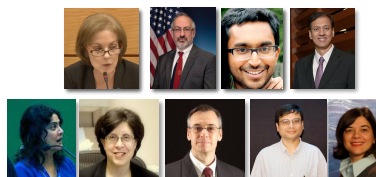## Important: CISE/OAC science leadership – dedicated, creative IPA/Fed mix

Deputy Assistant Directors

Division/Office Directors

Advisors

Deputy Division/Office Directors

Looking forward

Important: OAC PDs and advisers – dedicated, creative IPA/Fed mix
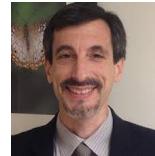
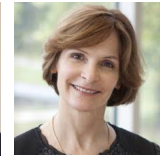Micah Beck   Bob Chadduck   Vipin Chaudhary   Bill Miller   Beth Plale   Stefan Roblia
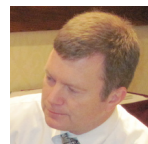
Sushil Prasad   Al Suarez   Alan Sussman   Kevin Thompson   Ed Walker   Amy Walton
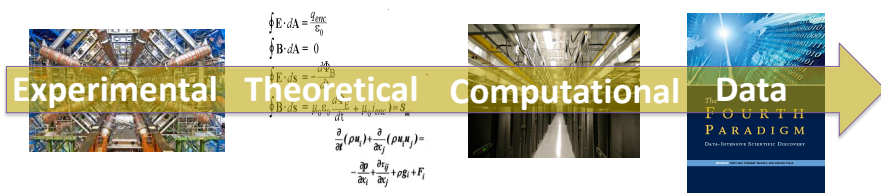

Looking forward

Experimental   Theoretical   Computational   Data

OAC, CISE, and NSF leadership all deeply understand and appreciate the crucial role of cyberinfrastructure in all areas of science and engineering research; and are committed to supporting OAC in the development, acquisition, and provision of state-of-the-art cyberinfrastructure resources, tools, services, and people essential to the advancement and transformation of science and engineering.

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!

2018 CISE Programmatics: Overview

$960M (area)