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

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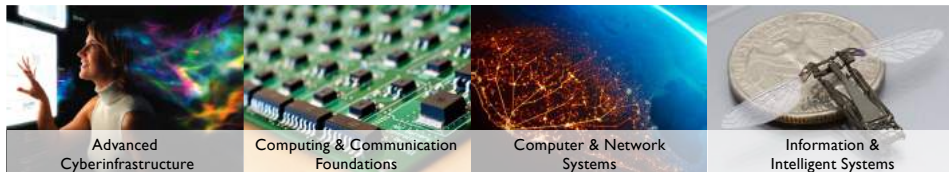
Jim Kurose
Assistant Director, NSF
Computer & Information Science & Engineering

CRA/CCC Meeting
March 2019

Outline

NSF/CISE Overview → Budget Overview → Selected Programmatics → Looking Forward

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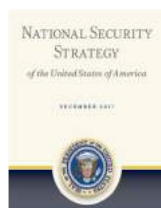
FY 2020 R&D Budget Priorities Memo
"Agencies should invest in fundamental and applied AI research, including machine learning, autonomous systems, and applications at the human-technology frontier. Agencies should prioritize QIS R&D,
… Agencies should prioritize investment in research and infrastructure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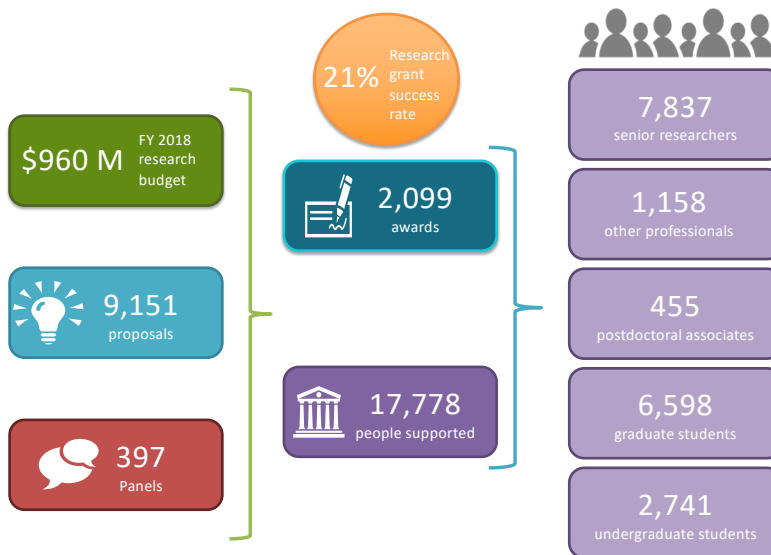
NATIONAL SECURITY STRATEGY
of the United States of America

National Security Strategy

Summary of the 2018 National Defense Strategy of The United States of America

National Defense Strategy

National Quantum Initiative Act

One Hundred Fifteenth Congress of the United States of America

Executive Order on Maintaining American Leadership in Artificial Intelligence

AI Executive Order

CISE by the Numbers: FY 2018

21% Research grant success rate

$960 M FY 2018 research budget

2,099 awards

9,151 proposals

397 Panels

17,778 people supported

7,837 senior researchers

1,158 other professionals

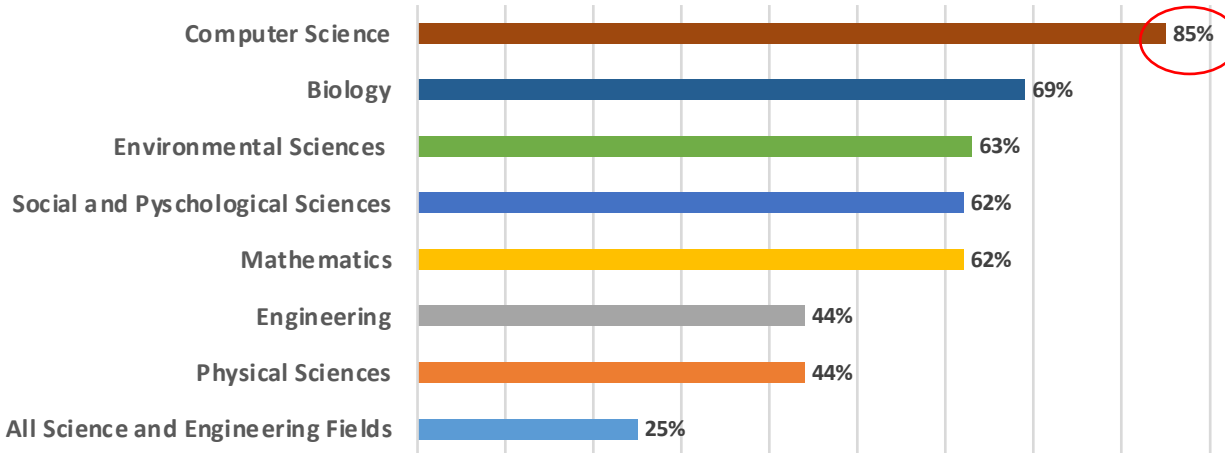**455** postdoctoral associates

6,598 graduate students

2,741 undergraduate students

# NSF Supports All Areas of Fundamental Research

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

| Field	Percentage
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
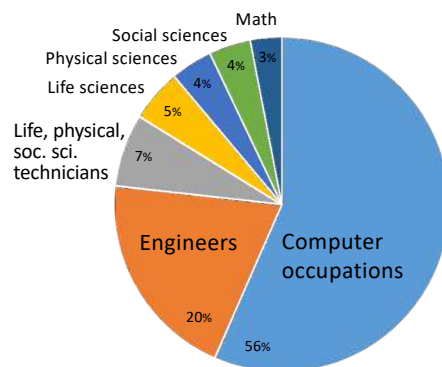
CISE Academic Community
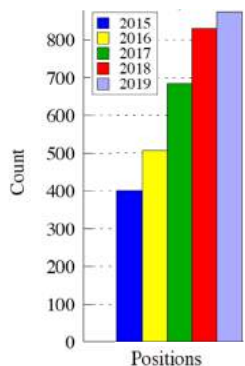
Advertised tenure
track positions in CS
2015-2019 (Wills, Nov. 2018)
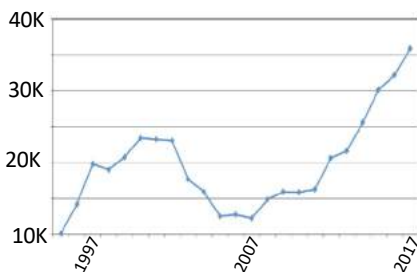
Newly Declared Undergraduate
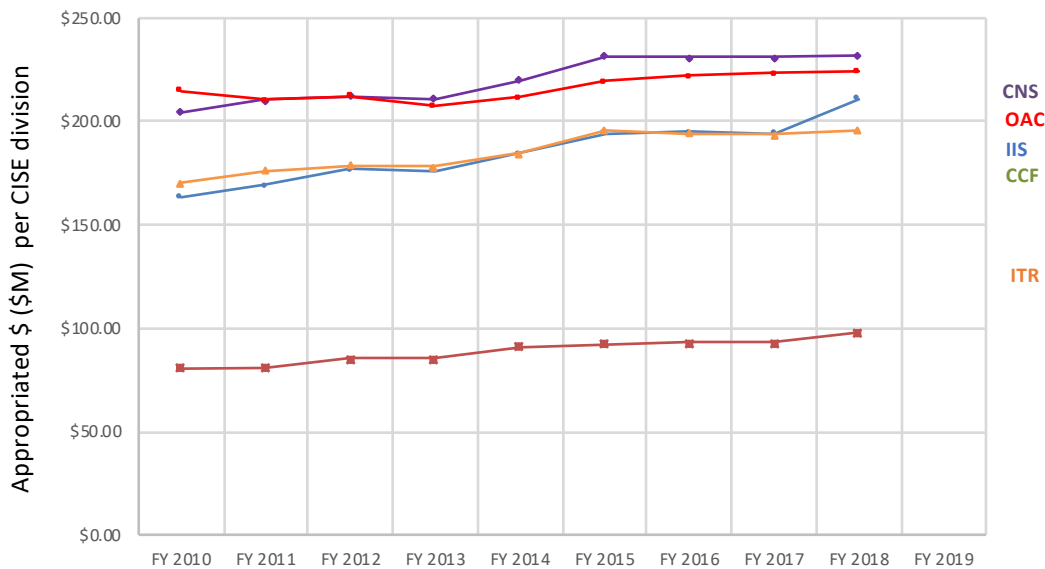CS, CE, I Majors (CRA Taulbee
Survey, Sept. 2018)

Job Openings
2016 – 2026:
National growth and
replacement
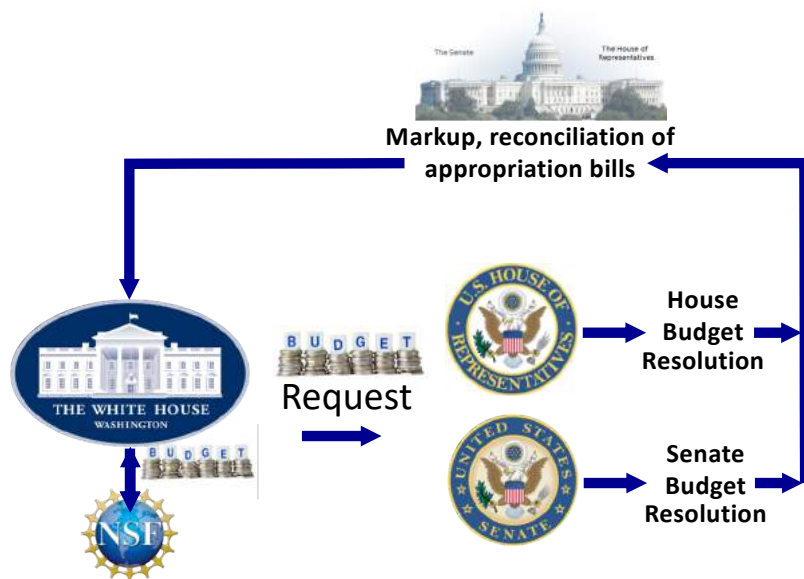(US Bureau of Labor Statistics)

Outline

NSF/CISE Overview → Budget Overview → Selected Programmatics → Looking Forward

NSF/CISE Division Budgets

Legend: CNS, OAC, IIS, CCF, ITR

Reminder: Budget Process

Markup, reconciliation of appropriation bills

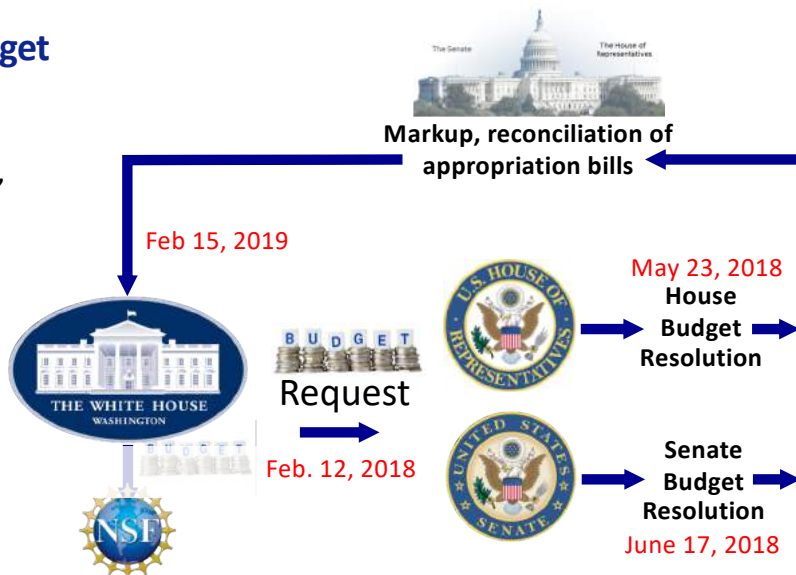THE WHITE HOUSE WASHINGTON

NSF

Request

House Budget Resolution

Senate Budget Resolution

2019 Budget Process: (almost) done

FY19 enacted budget

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

Markup, reconciliation of appropriation bills

Feb 15, 2019

Request

Feb. 12, 2018

May 23, 2018
House Budget Resolution

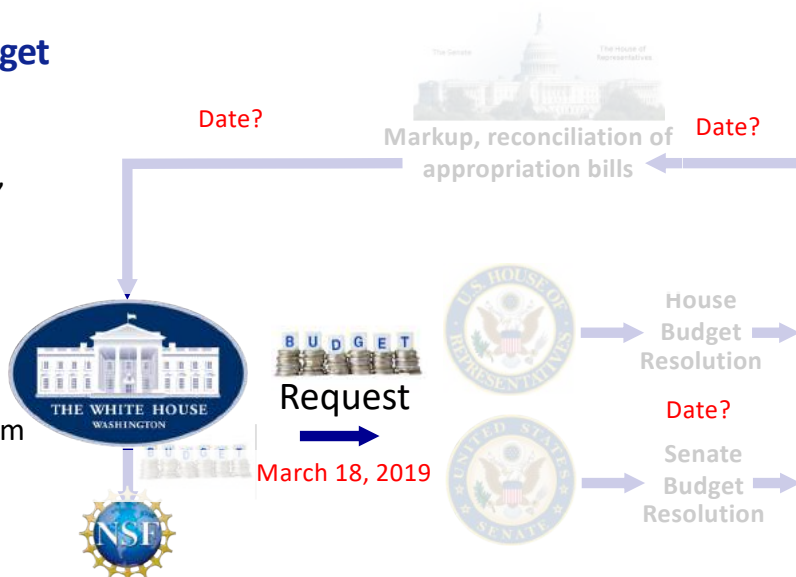**Senate Budget Resolution**
June 17, 2018

2020 Budget Process: just started

FY19 enacted budget

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

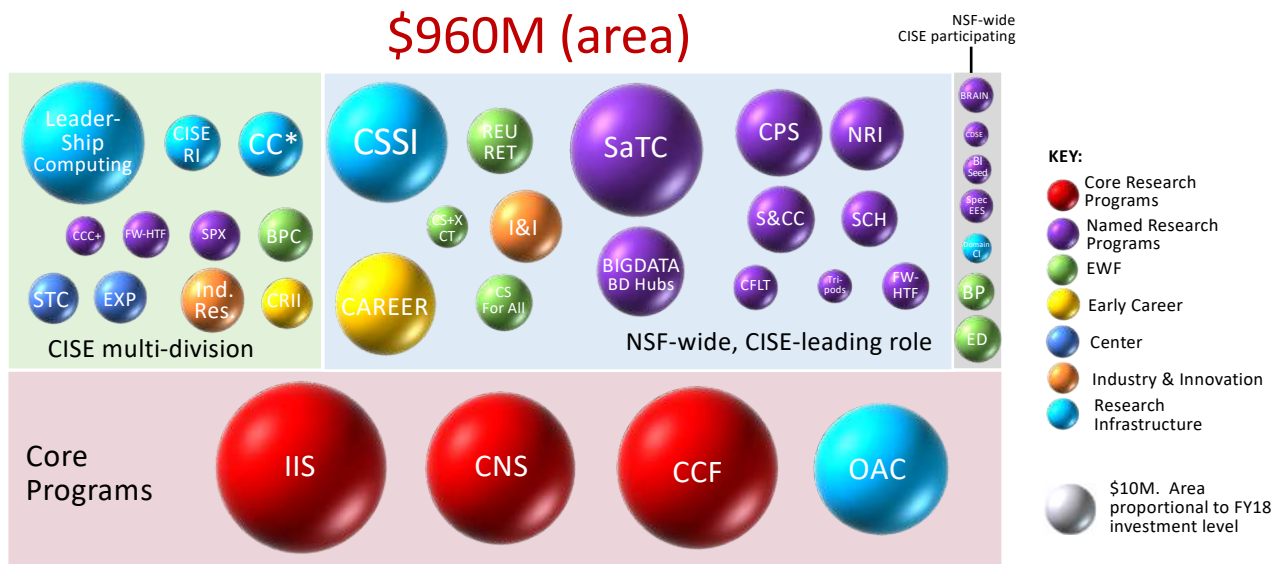**FY20 President's budget request**

- $7.100 Billion (R&RA: -13.2 % from FY 2019 enacted).
- CISE: - 8.1% wrt FY 2018 enacted

Date?

Markup, reconciliation of appropriation bills

Date?

Request

March 18, 2019

House Budget Resolution

Date?

Senate Budget Resolution

2018 CISE Programmatics: Overview

$960M (area)

NSF-wide CISE participating

CISE multi-division

Leader-Ship Computing · CISE RI · CC* · CCC+ · FW-HTF · SPX · BPC · STC · EXP · Ind. Res. · CRII

NSF-wide, CISE-leading role

CSSI · REU RET · SaTC · CPS · NRI · CS+X CT · I&I · S&CC · SCH · CAREER · BIGDATA BD Hubs · CS For All · CFLT · Tri-pods · FW-HTF

BRAIN · CDSE · BI Seed · Spec EES · Domain CI · BP · ED

KEY:

- Core Research Programs
- Named Research Programs
- EWF
- Early Career
- Center
- Industry & Innovation
- Research Infrastructure

$10M. Area proportional to FY18 investment level

Core Programs

IIS · CNS · CCF · OAC

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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. "

"AI is the universal connector that interweaves all of our Big Ideas; data science is changing the very nature of scientific inquiry, and AI's use of data has the potential to revolutionize everything we do in science."

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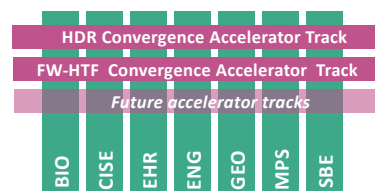
Mid-scale Research Infrastructure
- Mid-scale Research Infrastructure-2 (12/18)
- Mid-scale Research Infrastructure-1 (11/18)

Convergence Accelerator

Accelerating Discovery through Convergence Research

- accelerating the transition of convergence research into practice, in areas of national importance
  - use-inspired (Pasteur's quadrant)
  - testbeds, tools, living labs …
  - time-limited tracks: initially HDR, FW-HTF
- emphasis on translational research, partnerships
- projects with clear goals, milestones, directed deliverables
  - more intentional, more directed management; mission-driven evaluation
- separate from directorates in leadership, budget, programmatics (but building on foundational disciplinary research)
  - pilot: < 1% of NSF budget

NSF 19-050
Dear Colleague Letter: NSF Convergence Accelerator Pilot (NSF C-Accel)

March 15, 2019

HDR Convergence Accelerator Track
FW-HTF Convergence Accelerator Track
Future accelerator tracks

BIO | CISE | EHR | ENG | GEO | MPS | SBE

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

- AWS, Google, Microsoft, collaboration on BIGDATA
- Jan. 2018 CISE workshop, NSF 19-510

Research Infrastructure: Office of Advanced Cyberinfrastructure

Leadership Class Computing: Frontera (TACC)

NEW TEXAS SUPERCOMPUTER TO PUSH THE FRONTIERS OF SCIENCE

- most powerful supercomputer NSF has ever supported to serve the nation's science and engineering (S&E) research community: 5X over existing capability
- $60M
- project planning effort for a Phase 2, via MREFC

Exploring Clouds for Acceleration of Science

News Release 18-106

NSF and Internet2 to explore cloud computing to accelerate science frontiers

- investigate viability of commercial clouds for leading-edge computational science
- AWS, Google: initial cloud computing providers

Computing Education and Workforce

2007 — BPC Alliances
2010 — CS10K
2016 — CSforAll
2019 — CUE

Computer Science for All (CSforAll)

- access to rigorous, engaging CS education for *all K-12* students
- Computer Science Principles: *new* College Board CS AP exam (2017)

Computing in Undergraduate Education

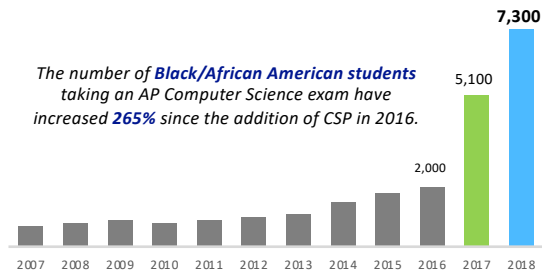- integrating computing with other fields of knowledge, challenge areas
- NSF 19-546

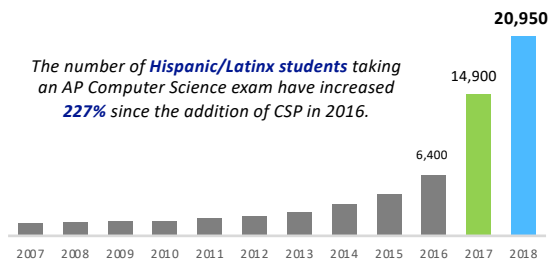# Students Taking the AP® Computer Science Exams

The number of *female students* taking an AP Computer Science exam have increased *185%* since the addition of CSP in 2016.

38,500

27,500

13,500

2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
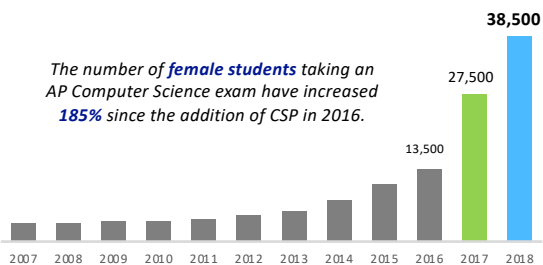
The number of *Black/African American students* taking an AP Computer Science exam have increased *265%* since the addition of CSP in 2016.

7,300

5,100

2,000

2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018

	2007	...	2016	2017	2018
women	18%	...	23%	27%	28%
minorities	12%	...	15%	20%	21%

The number of *Hispanic/Latinx students* taking an AP Computer Science exam have increased *227%* since the addition of CSP in 2016.

20,950

14,900

6,400

2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018

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| NSF/CISE Overview | Budget Overview | Selected Programmatics | Looking Forward |

Looking back

- **Partnerships:** Intel, SRC, VMware, Google, Amazon, Microsoft, IBM, PAI, PAWR consortium
- **National Initiatives:** Smart Cities, Advanced Wireless, Computer Science for All, American AI
- **Cyberinfrastructure:** Leadership class, multiple cloud initiatives, Office of Advanced Cyberinfrastructure, CCRI

- **NSF Big Ideas:** HDR, FW-HTF, Quantum Leap, and Convergence Accelerator
- **Education:** CS for All, CUE, BPC
- **AI:** increased funding, OSTP, international (OECD, G7)
- **Inter-agency activities:** NSTC Select Committee on AI, Subcommittee on Open Science, Machine Learning and AI, NITRD
- **Inter-directorate collaborations:** TRIPODS, AI and Ethics, Future of Work, Big Ideas (HDR, FW-HTF, QL)

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
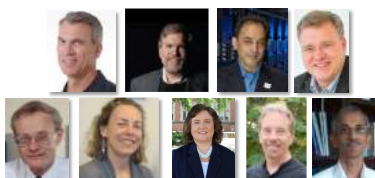- Cyberinfrastructure as research infrastructure

Looking forward

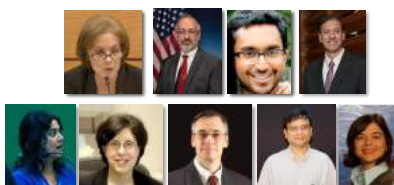## Important: CISE science leadership – dedicated, creative IPA/Fed mix
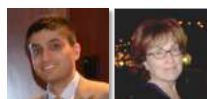
Deputy Assistant Directors

Division/Office Directors

Advisors

Deputy Division/Office Directors

Looking forward

CISE education

- high growth in undergrad CS
- 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

Science and Security

Opinion **The New York Times**

China's Challenge Is America's Opportunity

By L. Rafael Reif
Dr. Reif is president of the Massachusetts Institute of Technology.

October 24, 2018

Statement of the National Science Board on Security and Science

Looking forward

Candidate Search - Assistant Director for Computer and
Information Science and Engineering (CISE)

CISE AD search committee:
    Dr. Vinton C. Cerf, Committee Chair
    Dr. Charles Isbell
    Dr. Ed Lazowska
    Dr. Padma Raghavan
    Dr. Jennifer Rexford
    Dr. Daniela Rus
    Dr. Fred Schneider

Looking forward

Important: strong academic computing presence in agencies, White House

Looking forward

Important: interagency leadership, e.g., in AI

Office of Science & Technology Policy

National Science and Technology Council (NSTC)

Looking forward: thank you!

Important: strong academic computing information, advisory resources
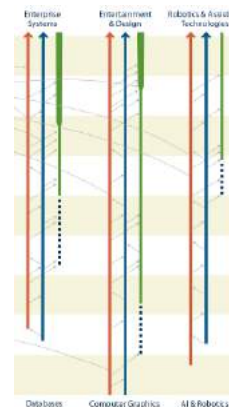
An *amazing* time to be in CISE!

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!*

Follow us on Twitter @NSF_CISE

Join CISE-ANNOUNCE email
cise-announce-subscribe-request@listserv.nsf.gov

From: "Kurose, James" <JKUROSE@nsf.gov>
Date: Monday, February 12, 2018 at 6:19 PM
To: "cise-announce@listserv.nsf.gov" <cise-announce@listserv.nsf.gov>
Subject: President's FY 2019 Budget Request for NSF

Dear CISE Community,

Each year, the President transmits to Congress a budget request for the Executive Branch of the Federal Government, including a request for the National Science Foundation (NSF). Today, the President officially submitted that request for fiscal year (FY) 2019, which begins October 1, 2018, and continues through September 30, 2019. **The President's FY 2019 Budget**

CISE priority setting: science community and other inputs

National Academies
• CSTB (bi-annual)
• NAS studies (e.g., ACI)

CRA, CCC
• 2, 3 meetings/yr
• Academia, industry
• Visioning workshops, consensus whitepapers

CISE AC
• Biannual meetings
• Academia, industry
• Subcommittees

CoV
• Every 4 years
• Academia, industry

Science community
• Visits to campuses, industry
• Visits to NSF

Input & advice from science community

Congress

White House

Integration & Decision making

Data-driven portfolio analysis

OD
Other NSF directorates

Science community input   *Priorities and Programmatics*