National Science Foundation: Programmatics and Activities

| Advanced Cyberinfrastructure | Computing & Communication Foundations | Computer & Network Systems | Information & Intelligent Systems |
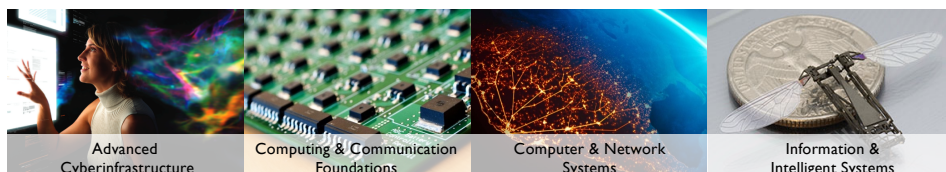
Jim Kurose
Assistant Director, NSF
Computer & Information Science & Engineering
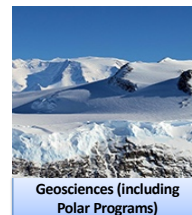
Northeast Region of the National Organization of Research
Development Professionals (NORDP)
July 25, 2019

Outline

NSF/CISE Overview → Convergence Big Ideas → Looking Forward

Partnerships
Science and security
Open science

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..."
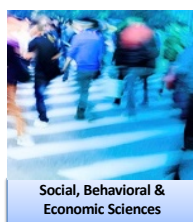
NSF Champions Research and Education across all Fields of Science and Engineering

NSF by the numbers
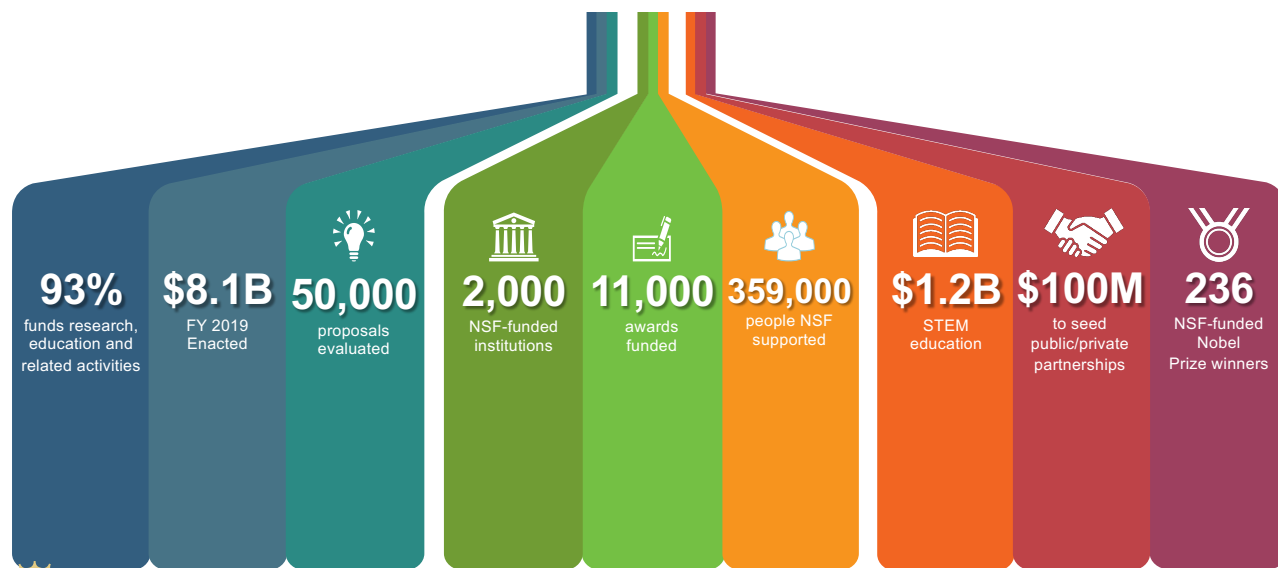
Most numbers based on FY 2018 activities.

CISE programs address national priorities

AI and Big Data

Cybersecurity

Robotics & Manufacturing
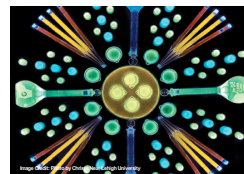
Quantum Information Sciences

Advanced Cyberinfrastructure

Smart Communities

Computer Science Education

Advanced Wireless Research

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%
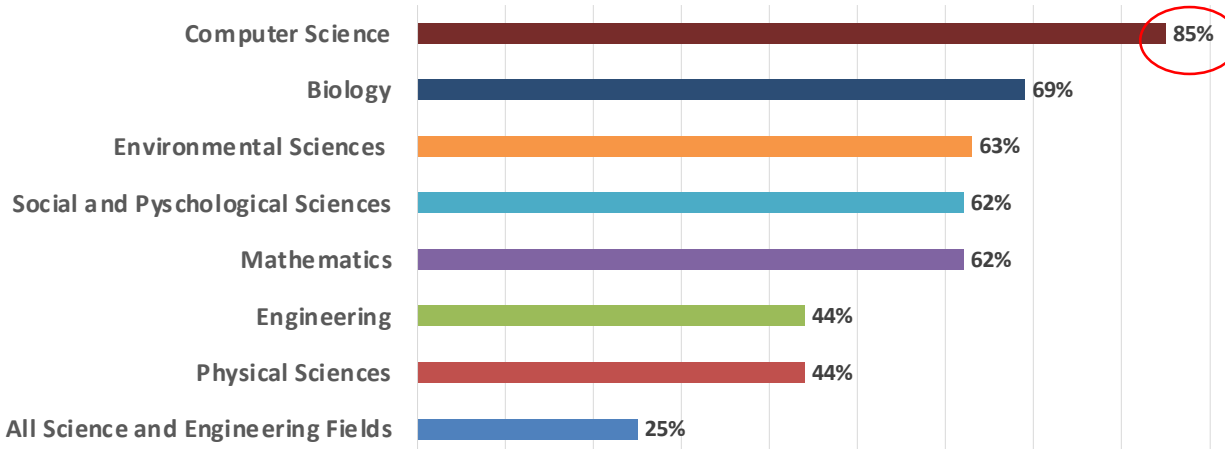
Source: NSF/NCSES, "Survey of Federal Funds for Research and Development." In FY20 NSF Budget Request to Congress

Economic impact of CISE: From Federally-funded research to billion-dollar industries

Advances in computing, communications, information technologies, and cyberinfrastructure:

- drives U.S. competitiveness
- profoundly impacts our daily lives
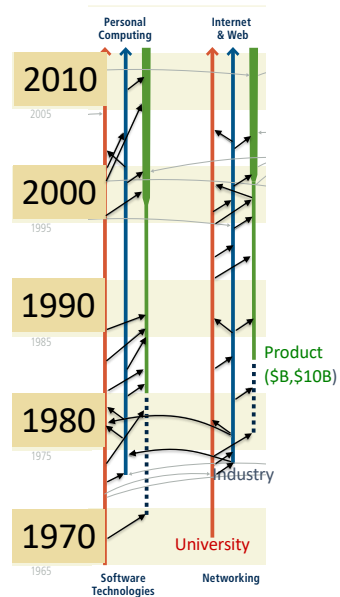
Source: National Research Council. 2016. *Continuing Innovation in Information Technology*.

.... across many industries

This impact continues today

Machine Learning

- Big Data Analytics Market: $125B (Forbes)
- Deep learning rooted in NSF-funded research on neural networks, reinforcement learning

"NSF is where all interesting research gets started…" - Eric Schmidt, Google / Alphabet

Software-Defined Networking (SDN)

- SDN Market: $18B in 2018 (IDC)
- SDN resulted from NSF-funded foundational research

Open Programmable Mobile Internet 2020 project funded by NSF/CISE Expeditions program, 2008, N. McKeown, Stanford U.
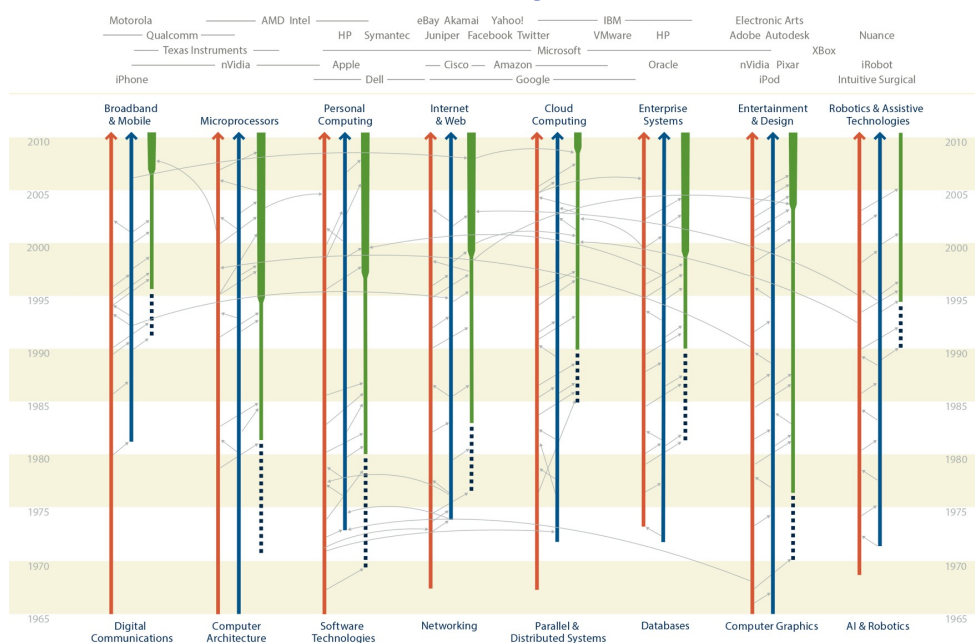
Fundamental research powers innovation

CISE: 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

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
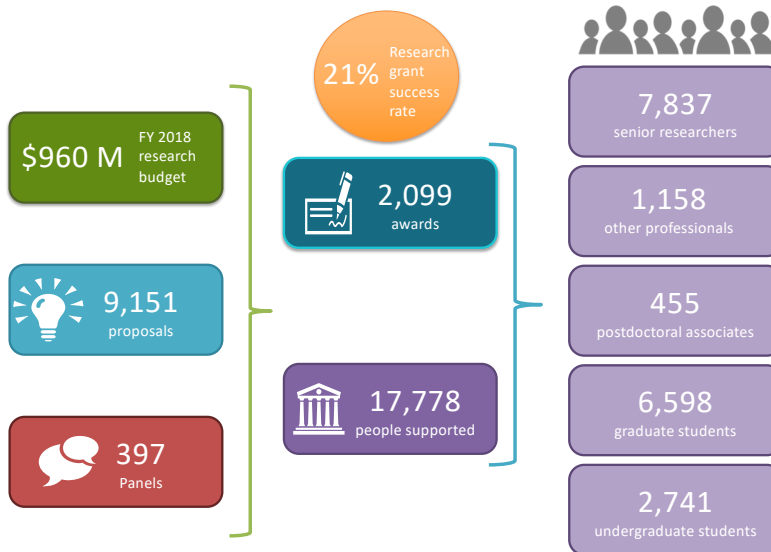
Budget Process: Reminder

The Senate

The House of Representatives

Markup, reconciliation of appropriation bills

THE WHITE HOUSE
WASHINGTON

Request

U.S. HOUSE OF REPRESENTATIVES

UNITED STATES SENATE

House Budget Resolution

Senate Budget Resolution
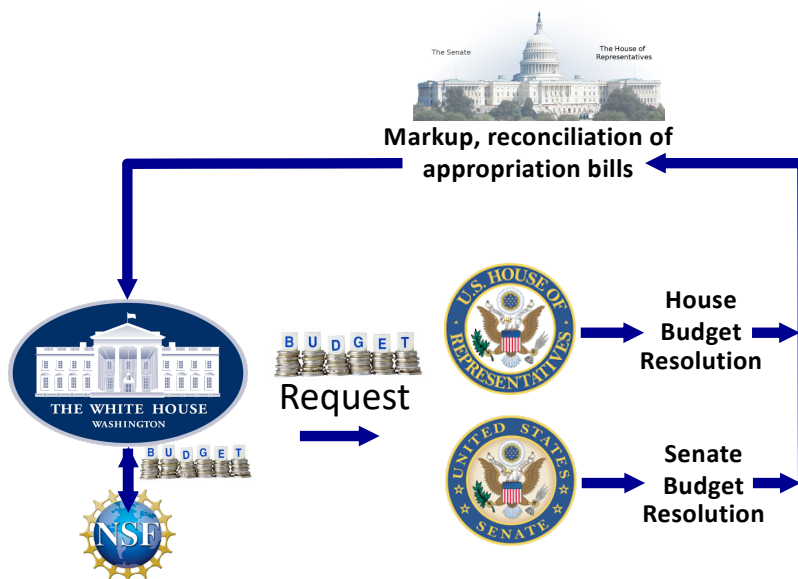
2019 Budget Process: done!

FY19 enacted budget

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

Markup, reconciliation of appropriation bills

Feb 15, 2019

Request

June 2019

Feb. 12, 2018

May 23, 2018
House Budget Resolution

Senate Budget Resolution
June 17, 2018
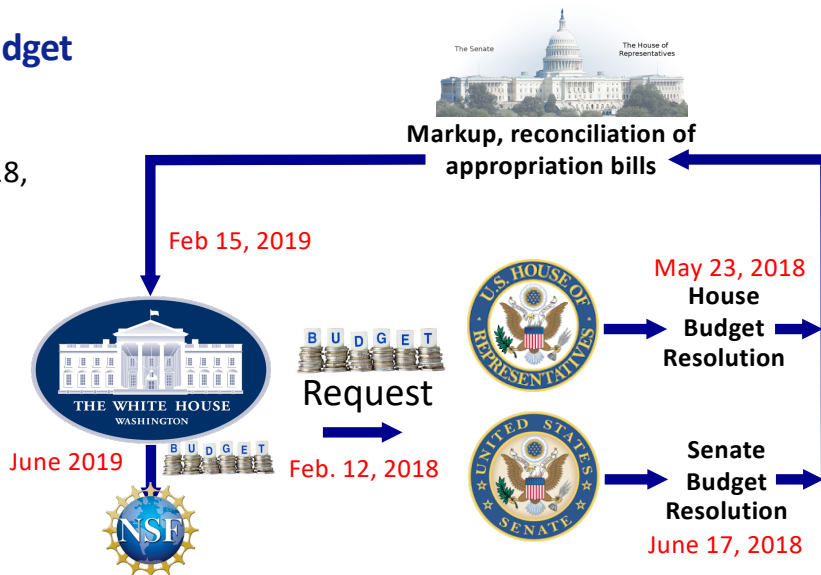
2020 Budget Process: underway

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

June 2019: NSF: $8.6B
House Budget Resolution

Request

Senate Budget Resolution

Feb. 18, 2019: NSF: $7.1B

Outline

```
NSF/CISE          Convergence          Looking
Overview          Big Ideas            Forward
```
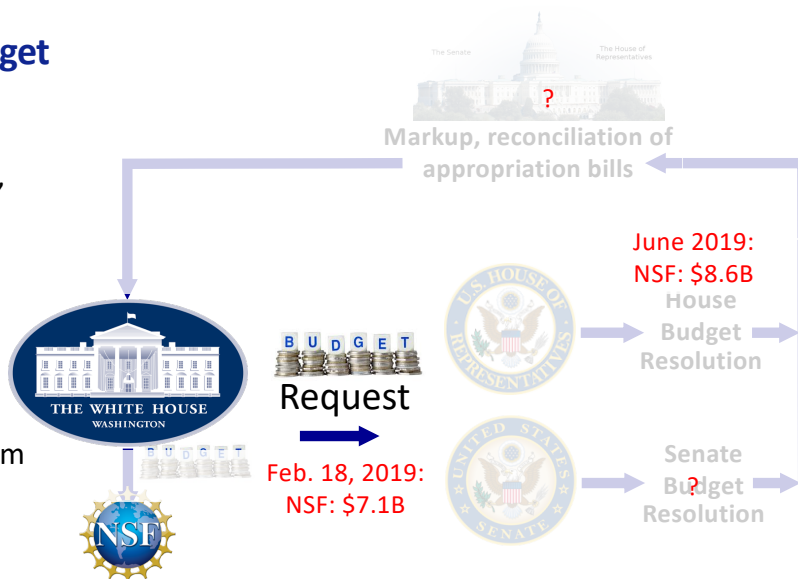
Convergence Research

Driven by a specific and compelling problem
- arising from deep scientific questions or pressing societal needs.

Deep integrating across disciplines
- integrating knowledge, methods, and expertise from different disciplines and forming novel frameworks

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

Outline

NSF/CISE Overview → Convergence Big Ideas → Looking Forward

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Open science
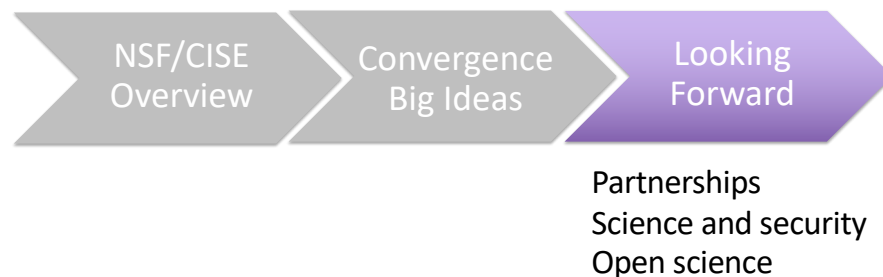
NSF partners with a range of stakeholders

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

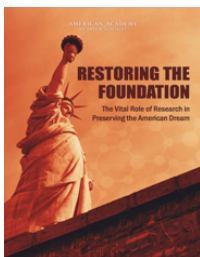".. The second pillar I'm proposing involves strengthening the connective tissue among the four components of our research and development ecosystem: federal government, academia not-for-profit foundations, and the private sector."
-Kelvin Droegemeier, AAAS, 2/15/2019

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NSF partners with a range of stakeholders

4 foundation partnerships in FY 18

- Simons Foundation: complex bio systems
- Breakthrough Foundation: Green Bank Observatory
- Stand Up To Cancer: IDEAS Lab
- Gates Foundation: BREAD

University-led, with industry partners

- Convergence Accelerator: industry collaboration required for all tracks
- I/UCRC: center co-funding ($1:$7 match, NSF:others). >1100 members in 75 I/UCRCs
- Engineering Research Centers
- GOALI: Grant Opportunities for Academic Liaison with Industry

8 industry partnerships in FY 18

- Joint funding opportunities
- Research infrastructure

57 interagency partnerships in FY 18

- Joint funding opportunities
- Research infrastructure
- Workforce training
- Individual projects

with 34 agencies/departments &
7 also included international partners

30 international partnerships in FY 18 (estimated)

- Joint funding opportunities
- Research infrastructure
- Individual projects

24

Industry partnerships: recent activities

Research Infrastructure
- Cloud credits for BIGDATA, BD Hubs & Spokes: AWS, Google, Microsoft, IBM (up to $12M)
- Platforms for Advanced Wireless Research (PAWR) (up to $50M each from NSF, a 28-member industry consortium)

Industry

Foundations & Non-profits

Federal Agencies

NSF

Universities

International Agencies

Education and Workforce
- Boeing: accelerated training, online materials in critical STEM skill areas; increase diversity ($21M total, starting in FY 19)

Joint Research Solicitations
- Joint NSF/industry research solicitations in targeted areas: Intel, SRC, VMware, Amazon ($3M – $10M from each partner)

25

Industry partnerships: value propositions

NSF

- **accelerating discovery and leveraging resources:** financial, expertise, infrastructure
- **accelerating translation** of discovery to deployment
- **growing workforce** capacity, including research
- **increasing NSF's visibility** to different audiences

Industry

ns & its

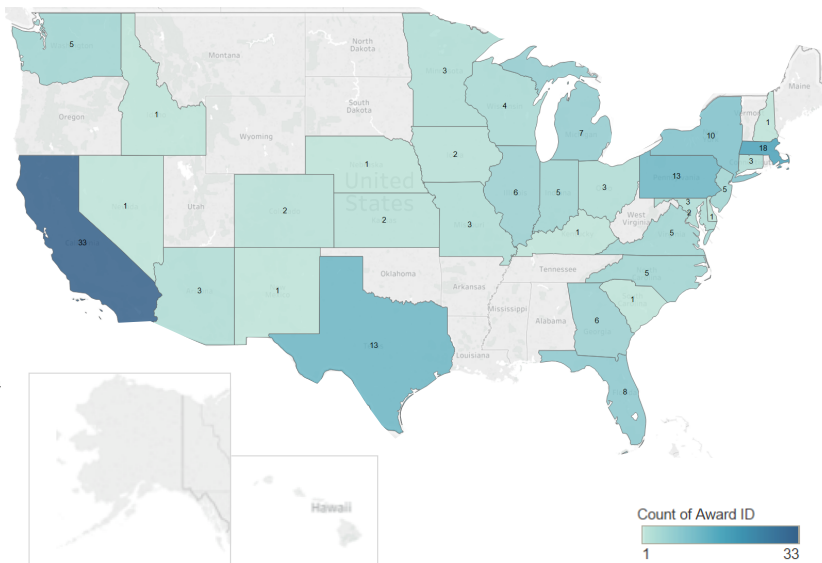Fed Agen

NSF

Universities

International Agencies

Industry Partners

- access to **national research community**
- gold-standard **merit review process**
- **accelerated discovery and leveraged resources:** financial, expertise, infrastructure
- **accelerated translation** of discovery to deployment
- **future workforce** access
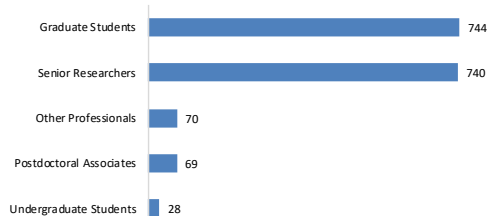- **potential intellectual property** for technical benefit

26

CISE industry partnerships: summary data
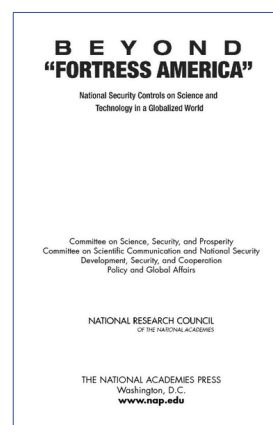### *reflecting partnership programs with active awards in FY 2018*

177 Awards

79 Institutions

1651 Person-Years

623 Publications

Cumulative Person-Years Supported by CISE Partnerships

Graduate Students	744
Senior Researchers	740
Other Professionals	70
Postdoctoral Associates	69
Undergraduate Students	28

Count of Award ID
1   33

Science Thrives in an Atmosphere of Openness and Transparency

"U.S. national security and economic prosperity depend on full global engagement in science, technology, and commerce. . ."

BEYOND "FORTRESS AMERICA"

National Security Controls on Science and Technology in a Globalized World

Committee on Science, Security, and Prosperity
Committee on Scientific Communication and National Security
Development, Security, and Cooperation
Policy and Global Affairs

NATIONAL RESEARCH COUNCIL
OF THE NATIONAL ACADEMIES

THE NATIONAL ACADEMIES PRESS
Washington, D.C.
www.nap.edu

National Academies. Beyond 'Fortress America': National Security Controls on Science and Technology in a Globalized World. 2009

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Foreign Talent in the U.S.

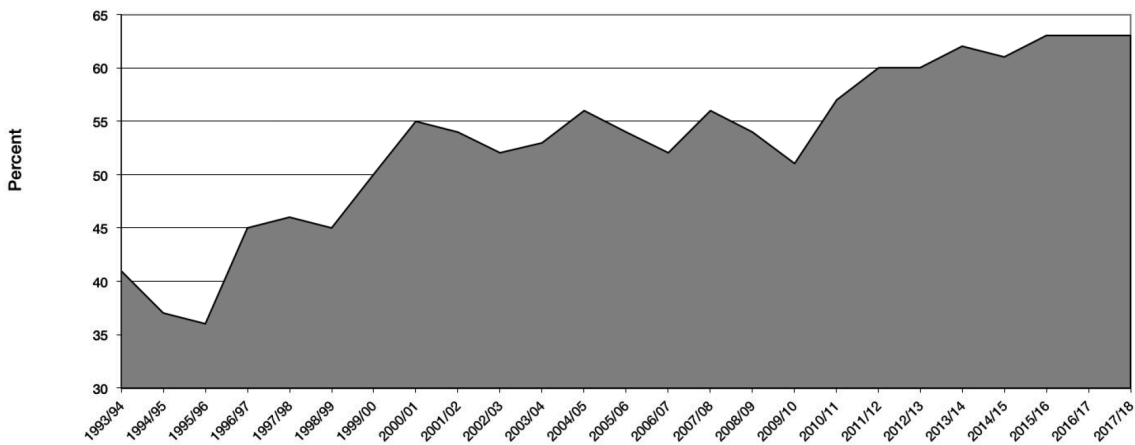Top 10 countries or economies of foreign citizenship for U.S. doctorate recipients with temporary visas: 2008–17
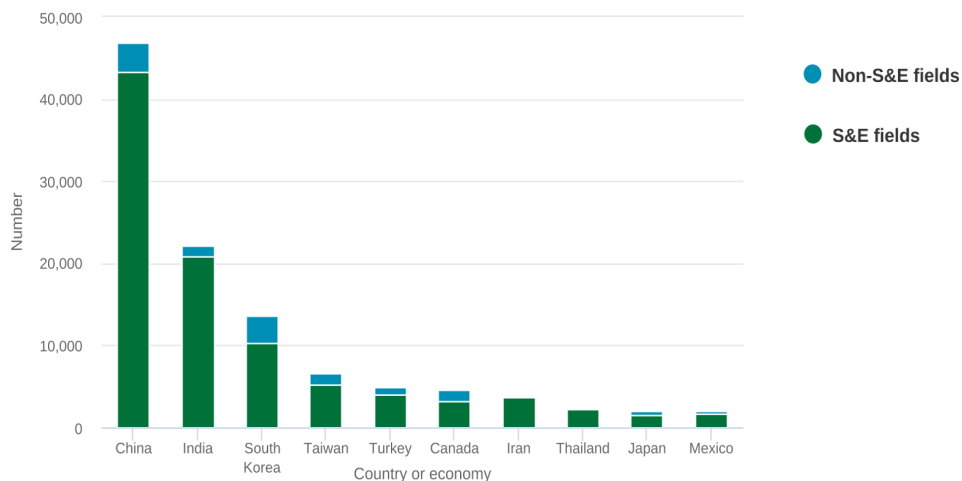
Source: NSF 2017 Survey of Earned Doctorates

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Foreign Talent in the U.S.

Computer Science: Nonresident Aliens as Fraction of US PhD Enrollments

Source: 2018 CRA Taulbee Survey

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Risks to U.S. Science and Security in a Global Research Ecosystem

Research Integrity
Risks to the responsible and ethical conduct of research, including the peer review process.

National Security
Risks to the national security of the U.S., including military competitiveness.

Economic Security
Risks to the economic competitiveness of the U.S., including the innovation base.

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Risks to U.S. Science and Security in a Global Research Ecosystem

Research Integrity:
- Conflicts of interest / commitment
- Confidentiality of merit review process
- Protection of pre-publication data

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Risks to U.S. Science and Security in a Global Research Ecosystem

NSF's approach emphasizes disclosure and risk assessment.

33

NSF Actions to Ensure the Integrity of Federally-Funded Research

- Improved transparency/clarification for disclosure (Revised PAPPG, Federal Register May 2019)
- NSF workforce: standardization of US citizenship requirements, foreign gov't talent-recruitment program participation restrictions
- JASONs; science and security risk
- Communication, awareness with the scientific community
- USG interagency coordination via NSTC

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National Science Board July 18, 2019
Science and Security Roundtable

- Rebecca Keiser, NSF

- Maria Zuber, MIT VPR, NSB member

- Toby Smith, AAU VP for Policy

- Kelvin Droegemeier, OSTP Director

- Arthur Bienenstock, NSB member, former OSTP staff, former APS president

https://www.youtube.com/watch?v=lqO0-8vN-2M (46:45 onwards)

National Science Board July 18, 2019
Science and Security Roundtable

Maria Zuber, a university view:

- MIT takes seriously the concern that foreign governments may be targeting US research to gain advantage over US interests

- MIT believes the US has benefited immeasurably from its open research system (share findings, attract top students and researchers)

- US law, policy must strike right balance between openness, protection
  - restrictions must be well targeted, not undermine fundamental strengths of US system
  - US must invest sufficiently in our own R&D, make it easier and more desirable for those we educate to remain in US

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NSF Open Science

clear and open communication of research results is central to the progress of science

- publications (traditional)
- data (newer!)

> [NSF] "continues its commitment to expand public access to the results of its funded research. Public access is intended to accelerate the dissemination of fundamental research results that will advance the frontiers of knowledge and help ensure the nation's future prosperity"
>
> *F. Cordova, Director, NSF, 3/18/15*

NSF Open Science: publications

clear and open communication of research results is central to the progress of science

- publications (traditional)

NSF Public Access Repository online (par.nsf.gov)
- Provide public access to journal, juried conference papers
- PI's must deposit publications in PAR, awards made FY 2016 onwards
- Integrated with university (PI), NSF (PD) workflows
- Collaboration with US Dept. of Energy (PAGES)

NSF Open Science: data

Data Management Plans (DMP):

- "data management is dynamic and practices vary substantially across the broad range of scientific disciplines supported by NSF" [NSF 15-52]

- "What constitutes reasonable data management and access will be determined by the community of interest *through the process of peer review and program management.*" [Data Management & Sharing FAQ]

- bottom-up implementation, top-down guiding principles
  - *"one size" does not fit all* of science and engineering

- updated DMP guidance, pilot projects ongoing

NSF Open Science: data

- proposals can not be *submitted* without DMPs: do not pass automated compliance test

- DMPs may be *evaluated* wrt intellectual merit, broader impact. PI performance may be considered.

- *grant conditions:* uniform guidance – change in condition or scope requires prior approval

- additional compliance considerations:
  - annual reports, final report
  - site, reverse-site visits
  - possible A133 audits, other audits (e.g., IG)

DMPs: similar to other parts of proposal (main body, or supplemental) with respect to compliance

Summary

- An exciting, challenging time!
- NSF executing on all dimensions of its mission: "To promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense…"
- Be engaged: university voices need to be heard in DC
  - state-level organizations
  - national organizations (e.g., APLU, AAU, GUIR, science societies)