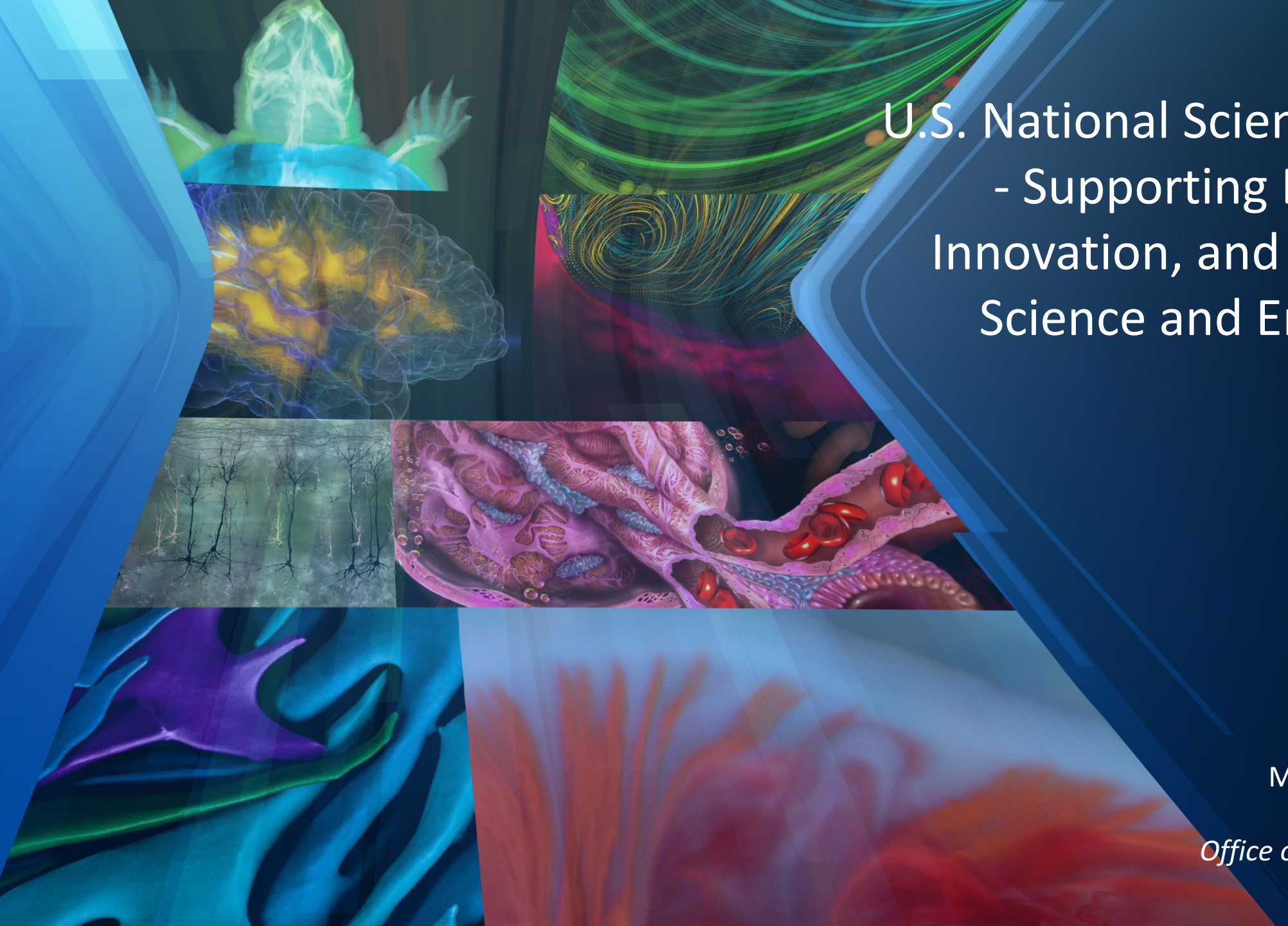


U.S. National Science Foundation - Supporting Discovery, Innovation, and Education in Science and Engineering

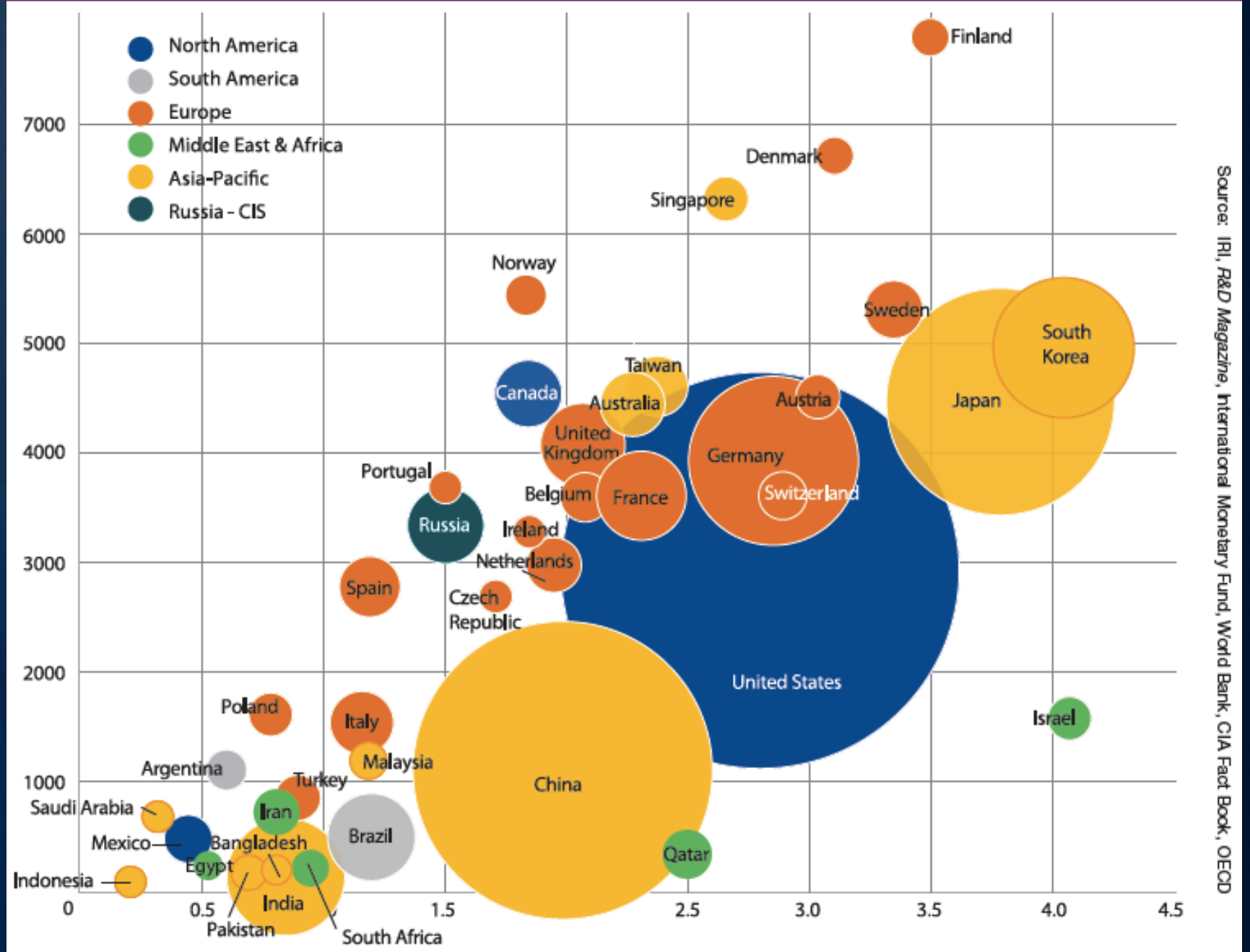
Mangala Sharma, Ph.D.
Program Director
Office of International Science and Engineering, NSF

Science is a global enterprise

Data from 2016

Horizontal axis = R&D as a % of GDP

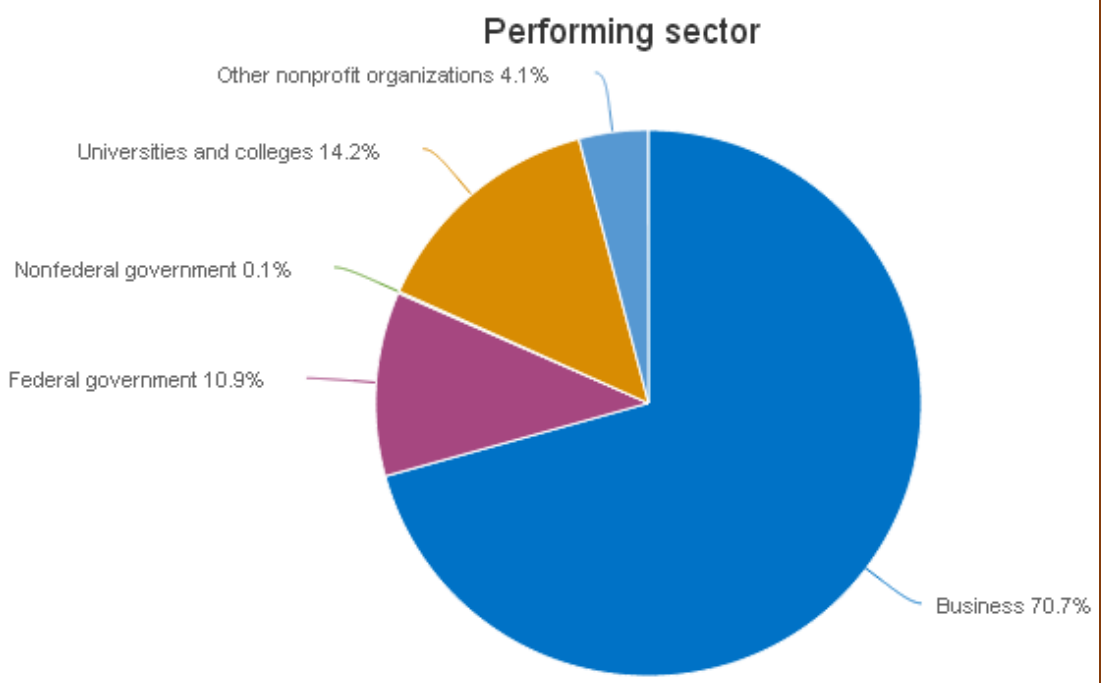
Vertical axis = Scientists & engineers per million people

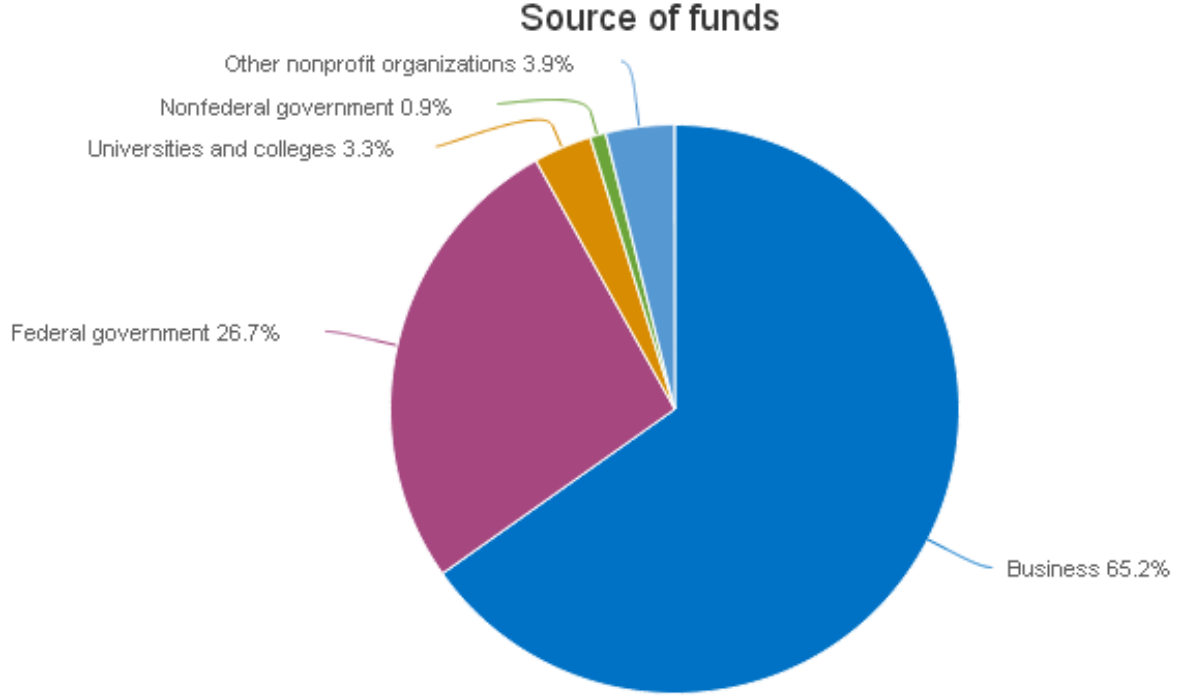


The size of the circles reflects the relative amount of annual R&D spending by the indicated country. Note the regional grouping of countries by the color of the balls.

US R&D – Funding & Performers

Shares of U.S. total R&D expenditures, by performing sector and source of funds: 2013

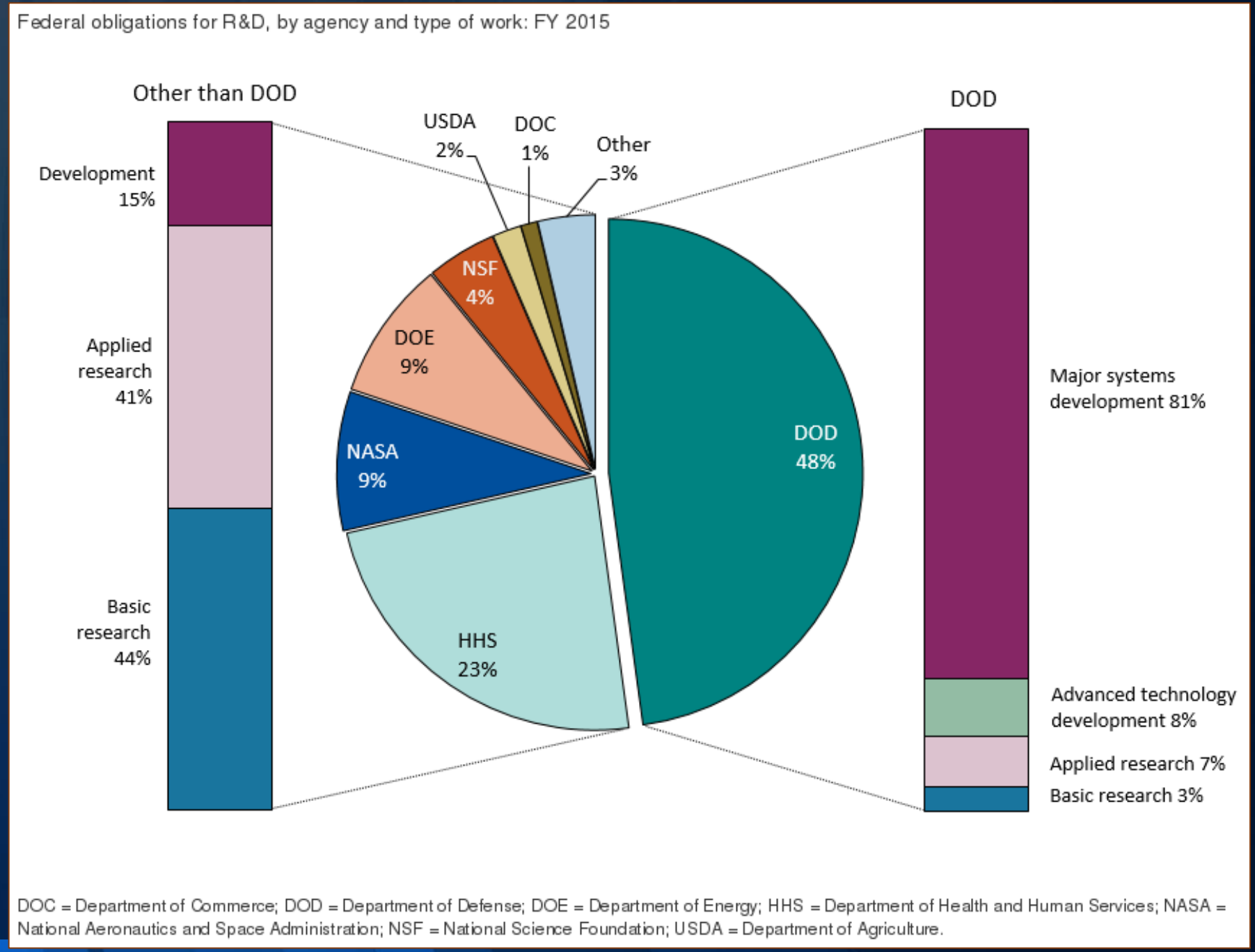




NOTES: U.S. R&D expenditures totaled $456.1 billion in 2013. The federal government performing sector includes federal agencies and federally funded R&D centers.

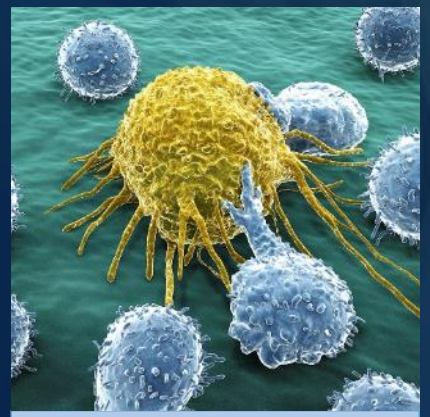
SOURCE: National Science Foundation, National Center for Science and Engineering Statistics, National Patterns of R&D Resources (annual series).

U.S. federal government funding of R&D



Source: www.nsf.gov/statistics

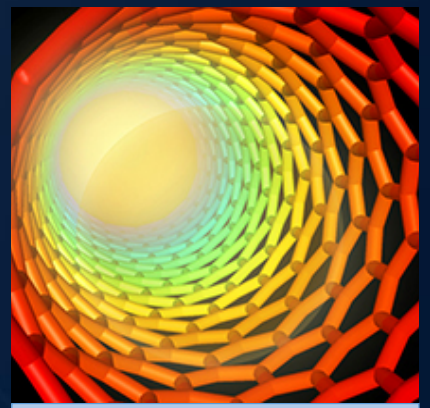
NSF champions research and education across all fields of science and engineering



Biological Sciences

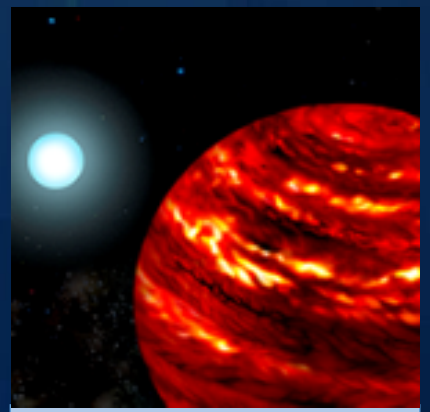
Computer & Information Science & Engineering

Education & Human Resources



Engineering

Geosciences (including Polar Programs)



Mathematical & Physical Sciences

Social, Behavioral & Economic Sciences

… and supports international collaborations

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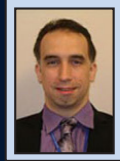

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Dorothy Aronson, Chief Information Officer
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Terminology:

NSF Directorate

- Division A…
  - Program A1
    - Receives *proposals*, *awards projects*
  - Program A2
  - …
- Division B…
  - Program B1
  - Program B2
  - …

Programs: Directorate for Computer & Information Science & Engineering (CISE)

This is a list of all the programs within the Directorate for Computer & Information Science & Engineering (CISE).

Key: C Crosscutting | N NSF-wide

Division of Computing and Communication Foundations (CCF)

Computing and Communication Foundations (CCF): Core Programs

- Algorithmic Foundations (AF)
- Communications and Information Foundations (CIF)
- Software and Hardware Foundations (SHF)

Additional Funding Opportunities for the CCF Community

- Algorithms in the Field (AitF)
- CISE Research Infrastructure (CRI)
- CISE-MPS Interdisciplinary Faculty Program in Quantum Information Science
- Computer and Information Science and Engineering (CISE) Research Initiation Initiative (CRII)
- Computer Science for All (CSforAll:RPP)
- Connections in Quantum Information Science (CQIS) C
- Critical Techniques, Technologies and Methodologies for Advancing Foundations and Applications of Big Data Sciences and Engineering (BIGDATA)
- Cyber-Physical Systems (CPS) C
- Designing Materials to Revolutionize and Engineer our Future (DMREF)

NSF funds U.S. institutions, students and postdocs

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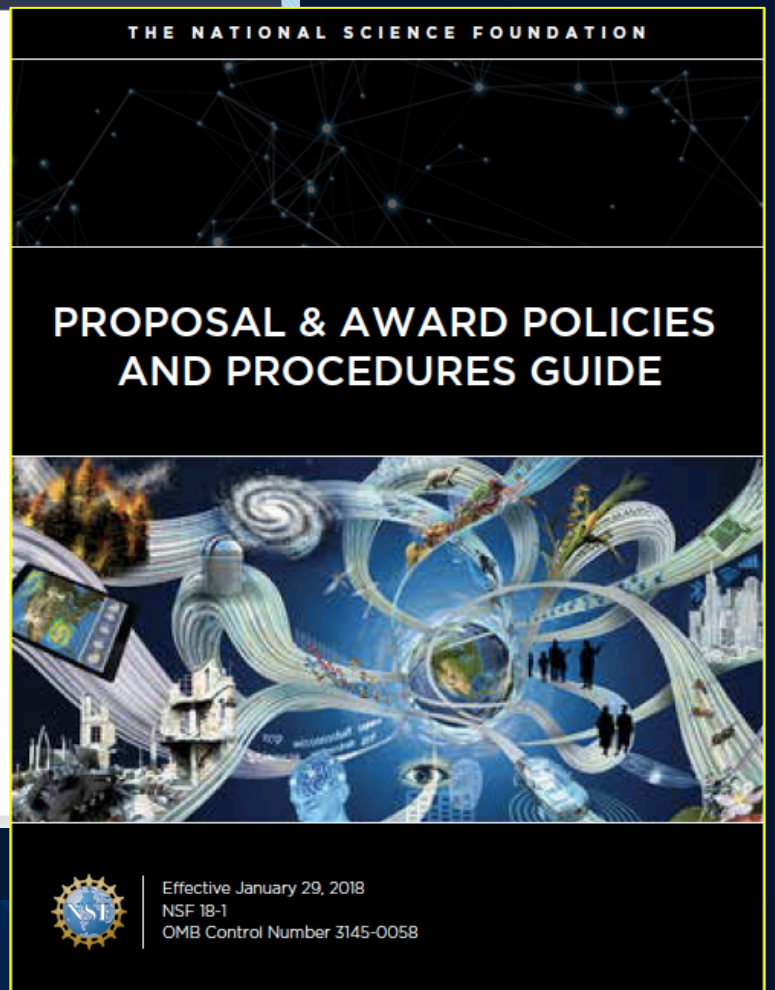


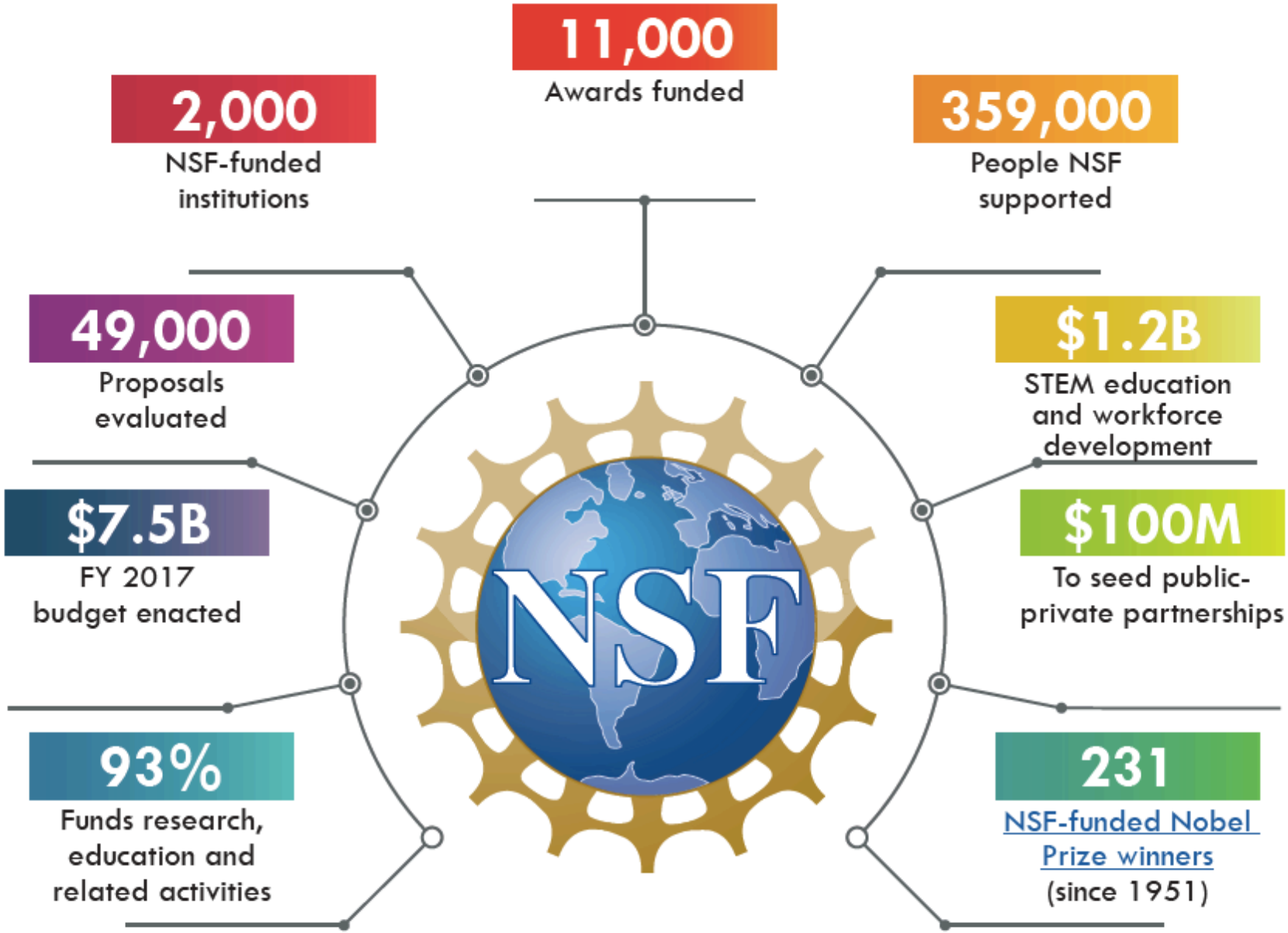
Merit Review

Proposals to NSF are evaluated on:

1. Intellectual Merit - potential to advance knowledge and understanding within its own field or across different fields
2. Broader Impacts - the potential to benefit society and contribute to the achievement of specific, desired societal outcomes.

- Proposal text not shared publicly
- Proposer receives decision - award or decline, and all (anonymized) reviews (+ panel summary, if any)
- Award information is public

- *Portfolio balance*
- *Broadening participation*



Numbers shown are based on fiscal year 2017 activities.

NSF-Funded Large Research Infrastructure

NATIONAL SCIENCE FOUNDATION
RESEARCH INFRASTRUCTURE SUMMARY
FY 2019 BUDGET REQUEST TO CONGRESS
(Dollars in Millions)

	FY 2017 Actual	FY 2018 (TBD)	FY 2019 Request
Facilities	**$703.76**	-	**$707.65**
Academic Research Fleet[1]	82.03	-	77.80
Arecibo Observatory	8.00	-	6.08
AST Portfolio Review Implementation[2]	0.09	-	6.74
Cornell High Energy Synchrotron Source (CHESS)	26.20	-	10.00
Gemini Observatory	24.24	-	21.66
Geodesy Advancing Geosciences and EarthScope (GAGE)	13.10	-	12.19
IceCube Neutrino Observatory (IceCube)	7.00	-	7.00
International Ocean Discovery Program (IODP)	48.00	-	48.00
Large Hadron Collider (LHC)	16.00	-	16.00
Laser-Interferometer Gravitational-wave Observatory (LIGO)	41.93	-	45.00
National High-Magnetic Field Laboratory (NHMFL)	23.15	-	35.76
National Nanotechnology Coordinated Infrastructure (NNCI)	15.55	-	14.78
National Superconducting Cyclotron Laboratory (NSCL) (MSU Cyclotron)	24.00	-	24.00
Natural Hazards Engineering Research Infrastructure (NHERI)	14.99	-	11.75
Ocean Observatories Initiative (OOI)[3]	0.34	-	40.00
Other Facilities[4]	2.78	-	2.79
Polar Facilities and Logistics	330.30	-	303.94
Seismological Facilities for Advancement of Geosciences and EarthScope (SAGE)	26.05	-	24.16
Major Research Facilities Construction Investments	**$297.01**	-	**$288.02**
Construction, Acquisition, and Commissioning (MREFC)[5]	222.45	-	93.65
Construction, Acquisition, and Commissioning (R&RA)[6]	-	-	103.70
Development and Design[7]	10.79	-	6.67
Initial Operations and Maintenance During Construction[8]	63.76	-	84.00
Federally Funded R&D Centers	**$221.54**	-	**$214.55**
National Center for Atmospheric Research (NCAR)	99.70	-	94.70
National Optical Astronomy Observatories (NOAO)	22.99	-	20.13
National Radio Astronomy Observatories (NRAO)[9]	76.66	-	79.13
Other Astronomical Facilities[10]	11.45	-	11.85
National Solar Observatory[11]	6.00	-	4.00
Science & Technology Policy Institute (STPI)	4.74	-	4.74
Other Research Instrumentation and Infrastructure	**$493.72**	-	**$500.58**
Major Research Instrumentation (MRI)	76.20	-	75.00
Mid-scale Research Infrastructure	39.38	-	75.31

- Science and Technology Centers: Integrative Partnerships: www.nsf.gov/od/oia/programs/stc/
- Industry-University Cooperative Research Centers (IUCRC): www.iucrc.org/centers
- Engineering Research Centers (ERC): erc-assoc.org
- Centers for Chemical Innovation (CCI): nsf-cci.com
- Materials Research Science and Engineering Center: www.mrsec.org/centers

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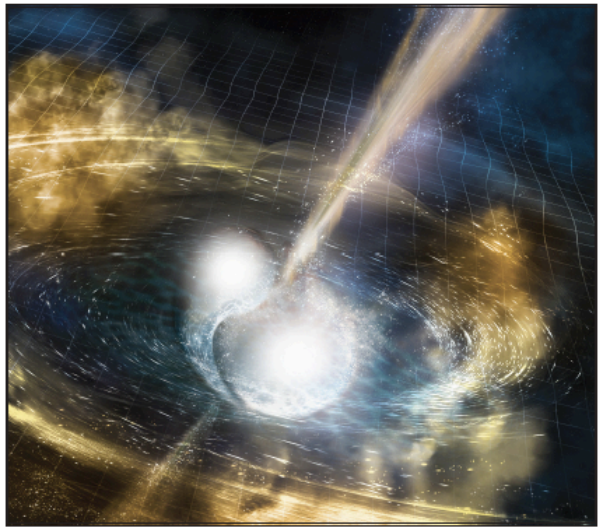
BUILDING THE FUTURE

INVESTING IN DISCOVERY AND INNOVATION

NSF Strategic Plan for Fiscal Years (FY) 2018-2022



VII. AGENCY PRIORITY GOAL

A Performance Plan for FY 2019 has been developed in concert with this Strategic Plan. It includes the following Agency Priority Goal.

Expand public and private partnerships to enhance the impact of NSF's investments and contribute to American economic competitiveness and security.

NSF Initiatives - example

Advisory Committee Reports - example

Windows on the Universe: The Era of Multi-Messenger Astrophysics

The Quantum Leap: Leading the Next Quantum Revolution

Understanding the Rules of Life: Predicting Phenotype

NSF'S 10 BIG IDEAS

In 2016, NSF unveiled a set of "Big Ideas" -- 10 bold, long-term research and process ideas that identify areas for future investment at the frontiers of science and engineering. With its broad portfolio of investments, NSF is uniquely suited to advance this set of cutting-edge research agendas and processes that will require collaborations with industry, private foundations, other agencies, science academies and societies, and universities and the education sector. The Big Ideas represent unique opportunities to position our Nation at the cutting edge -- indeed to define that cutting edge -- of global science and engineering leadership and to invest in basic research and processes that advance the United States' prosperity, security, health and well-being.

Harnessing the Data Revolution

The Future of Work at the Human-Technology Frontier

Navigating the New Arctic

Mid-scale Research Infrastructure

Growing Convergence Research at NSF

NSF INCLUDES: Enhancing STEM through Diversity and Inclusion

NSF 2026: Seeding Innovation

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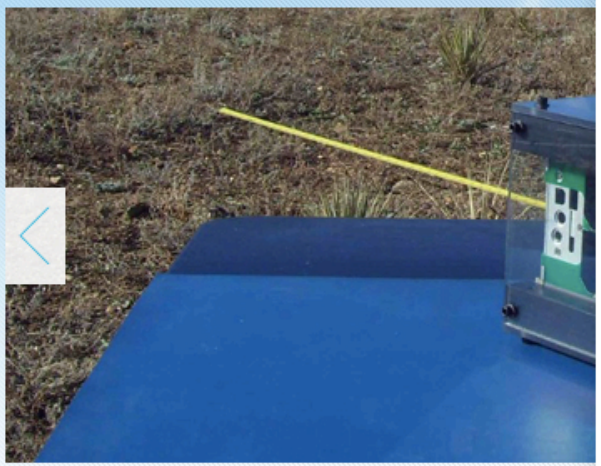

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CAREER: Transforming Residential Networks into Security Assets
Award Number:1651540; Principal Investigator:Craig Shue; Co-Principal Investigator:; Organization:Worcester Polytechnic Institute;NSF Organization:CNS Start Date:07/01/2017; Award Amount:$96,205.00; Relevance:47.69;

Collaborative Research: CICI: Secure and Resilient Architecture: NetSecOps -- Policy-Driven, Knowledge-Centric, Holistic Network Security Operations Architecture
Award Number:1642134; Principal Investigator:James Griffioen; Co-Principal Investigator:Jane Hayes, Vernon Bumgardner; Organization:University of Kentucky Research Foundation;NSF Organization:OAC Start Date:09/01/2016; Award Amount:$499,925.00; Relevance:47.69;

TWC: TTP Option: Small: Collaborative: SRN: On Establishing Secure and Resilient Networking Services
Award Number:1528099; Principal Investigator:Dijiang Huang; Co-Principal Investigator:; Organization:Arizona State University;NSF Organization:CNS Start Date:09/01/2015; Award Amount:$230,000.00; Relevance:47.69;

TWC: Medium: Handling a Trillion Unfixable Flaws on Billions of Internet-of-Things
Award Number:1564009; Principal Investigator:Vyas Sekar; Co-Principal Investigator:Srinivasan Seshan, Yuvraj Agarwal; Organization:Carnegie-Mellon University;NSF Organization:CNS Start Date:07/01/2016; Award Amount:$1,199,999. Relevance:47.69;

EAGER: USBRCCR: Improving Network Security at the Network Edge
Award Number:1740895; Principal Investigator:Donald Towsley; Co-Principal Investigator:Phillipa Gill; Organization:University of Massachusetts Amherst;NSF Organization:CNS Start Date:09/01/2017; Award Amount:$299,995.00; Relevance:47.69;

Collaborative Research: CICI: Secure and Resilient Architecture: S3D: A New SDN-Based Security Framework for the Science DMZ
Award Number:1642129; Principal Investigator:Guofei Gu; Co-Principal Investigator:; Organization:Texas A&M Engineering Experiment Station;NSF Organization:OAC Start Date:11/01/2016; Award Amount:$350,000.00; Relevance:47.69

Award Abstract #1523994

TWC: TTP Option: Small: Collaborative: SRN: On Establishing Secure and Resilient Networking Services

NSF Org:	CNS Division Of Computer and Network Systems
Initial Amendment Date:	September 11, 2015
Latest Amendment Date:	September 11, 2015
Award Number:	1523994
Award Instrument:	Standard Grant
Program Manager:	Kevin L. Thompson CNS Division Of Computer and Network Systems CSE Direct For Computer & Info Scie & Enginr
Start Date:	September 1, 2015
End Date:	August 31, 2018 (Estimated)
Awarded Amount to Date:	$237,000.00
Investigator(s):	Kishor Trivedi kst@ee.duke.edu (Principal Investigator)
Sponsor:	Duke University 2200 W. Main St, Suite 710 Durham, NC 27705-4010 (919)684-3030
NSF Program(s):	Secure &Trustworthy Cyberspace

ABSTRACT

Almost every organization depends on cloud-based services. The backend of cloud-based services are designed for multiple tenants and reside in data centers spread across multiple physical locations. Network security and security management are major hurdles in such a complex, shared environment. This research investigates mitigating the security challenges by taking a moving target defense (MTD) approach. Continually adjusting the system resources such as the topology of the data center, bandwidth allocation and traffic flow policies makes it difficult for attackers to compromise the system. New evaluations methods will be developed to ensure that these MTD mechanisms work properly in practice. The outcome of this research is to have cloud services that are more secure and resilient to attacks. This research is a collaborative effort conducted by researchers from three different universities, Arizona State University, Duke University, and the University of Missouri-Kansas City. Graduate students will be trained to serve the growing need for educating professionals in cyber security. The results of the proposed research will be incorporated into several courses taught at the respective institutions.

The MTD approach in a multi-location, multi-tenant data center environment requires a complex level of coordination. This research investigates defense mechanisms in the data center's virtual networking environment based on programmable networking solutions so that proactive attack countermeasures can be deployed with considerations of the system resource consumption, software bugs/vulnerabilities, effectiveness of countermeasures, and impact on consumers running applications. The research outcomes can be employed for applications that require security situation-awareness variables accurately predicted at a very fine grain resolution, from a few milliseconds to a few seconds. This introduces additional challenges, namely, developing new performance models for networking, data collection, big data-enabled security processing, and control. To address these challenges, this project has two interdependent fundamental research thrusts: (a) investigate a dynamic and adaptive defensive framework at both networking and software levels; and (b) deploy an adaptive security-enabled traffic engineering approach to select optimal countermeasures by considering the effectiveness of countermeasures and network bandwidth allocations while minimizing the intrusiveness to the applications and the cost of deploying the countermeasures. The outcomes of this project will include a set of software APIs and tools to integrate the measurement system and analytical models in a transition to practice effort.

PUBLICATIONS PRODUCED AS A RESULT OF THIS RESEARCH

Note: *When clicking on a Digital Object Identifier (DOI) number, you will be taken to an external site maintained by the publisher. Some full text articles may not yet be available without a charge during the embargo (administrative interval).*

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José M. Martínez, Kishor S. Trivedi, and Benny N. Cheng. "Efficient Computation of the Mean Time to Security Failure in Cyber Physical Systems," *the 10th EAI International Conference on Performance Evaluation Methodologies and Tools (VALUETOOLS 2016),*, 2016.

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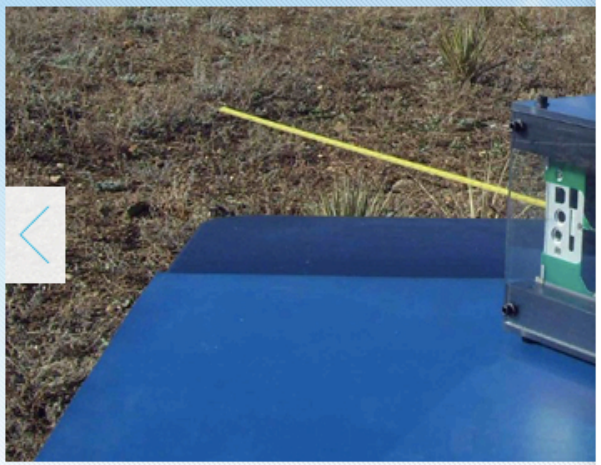

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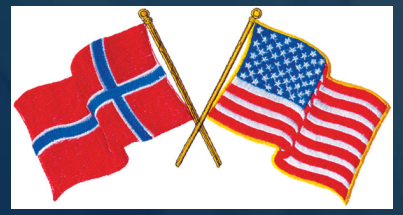


Norway-NSF Collaborative Awards: Examples

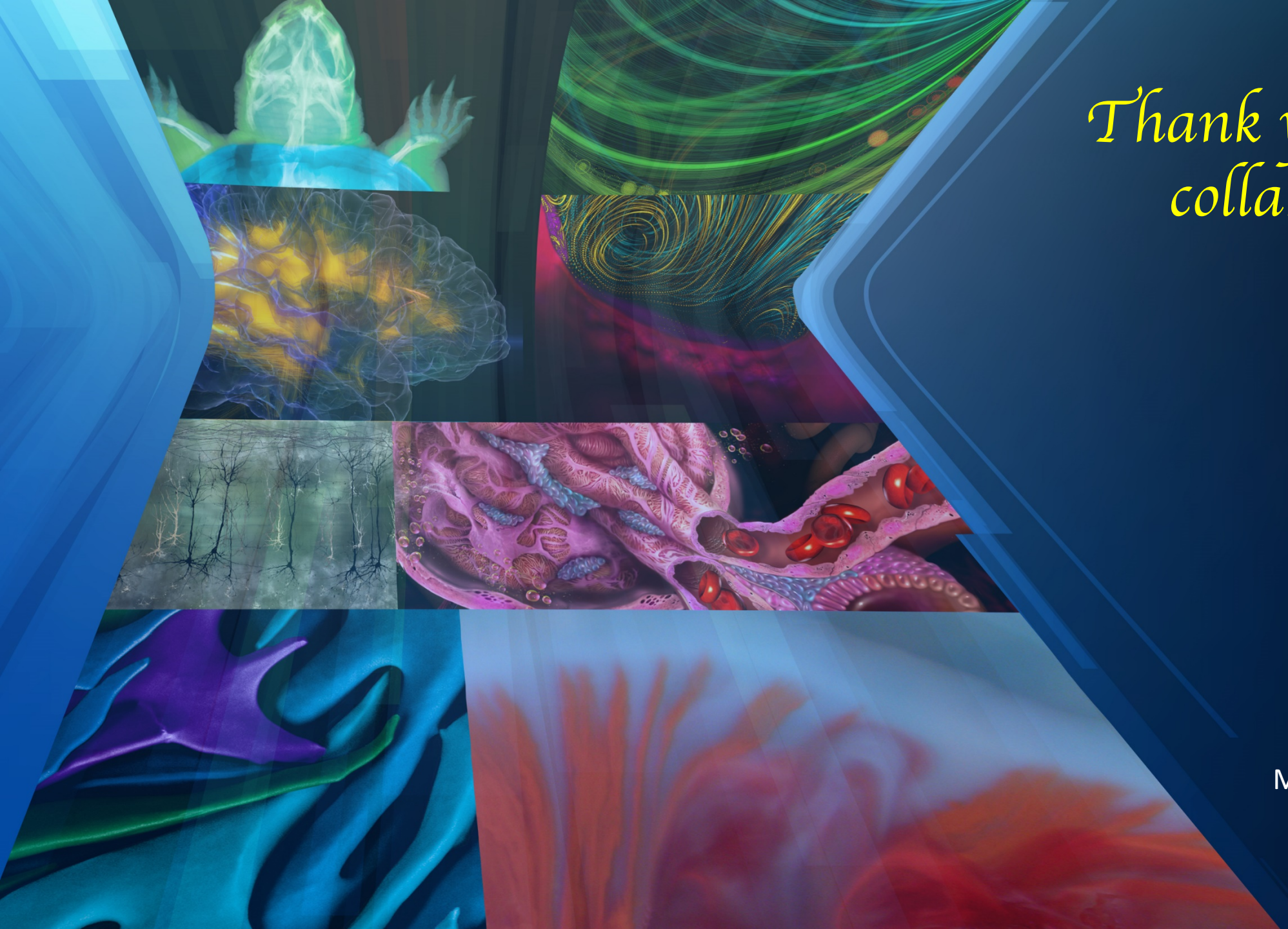
JST-NSF-DFG-RCN Workshop on Data-driven Real-time Control for Distributed Energy Management, Tokyo, Japan, June 11-14, 2017; Principal Investigator: Sairaj Dhople; Organization: University of Minnesota-Twin Cities; NSF Organization: ECCS; Award Amount:$45,000

PIRE Investigation of Multi-Scale, Multi-Phase Phenomena in Complex Fluids for the Energy Industries; Principal Investigator: Masahiro Kawaji; Organization: CUNY City College; NSF Organization: OISE; Award Amount:$901,283

Eurasian and Makarov basins observational network targets changes in the Arctic Ocean; Principal Investigator: Igor Polyakov; Organization: University of Alaska Fairbanks Campus; NSF Organization: OPP; Award Amount:$12,990,302

Belmont Forum Collaborative Research: Pan-Arctic Options: Holistic Integration for Arctic Coastal-Marine Sustainability (multiple PIs; 14 country initiative)

and more …



Thank you for your collaboration!

Mangala Sharma, Ph.D.
Program Director
MSharma@nsf.gov