



Division of Computing and Communication Foundations (CISE/CCF)

Division Director: TBD

Deputy Division Director: Dr. Thyaga Nandagopal

<https://www.nsf.gov/div/index.jsp?div=CCF>

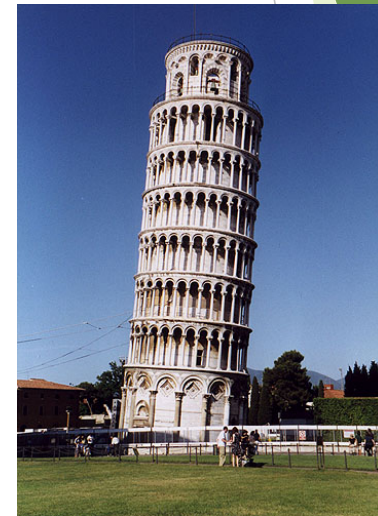
CCF at a glance

- ▶ 3 Core Programs (AF, CIF, SHF)
- ▶ 13 Program Officers, 8 Administrative Staff
- ▶ Multiple funding opportunities:
 - ▶ https://www.nsf.gov/funding/pgm_list.jsp?org=CCF

Why Foundations?

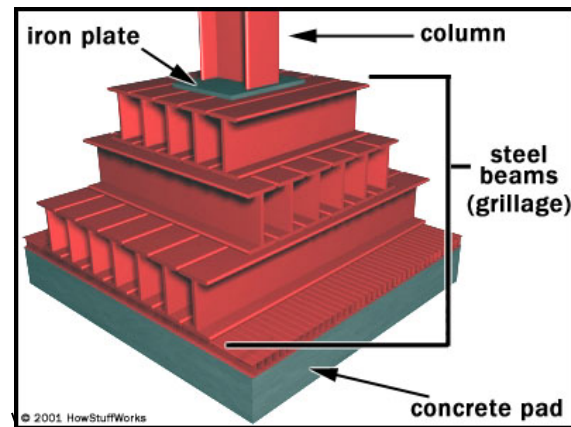
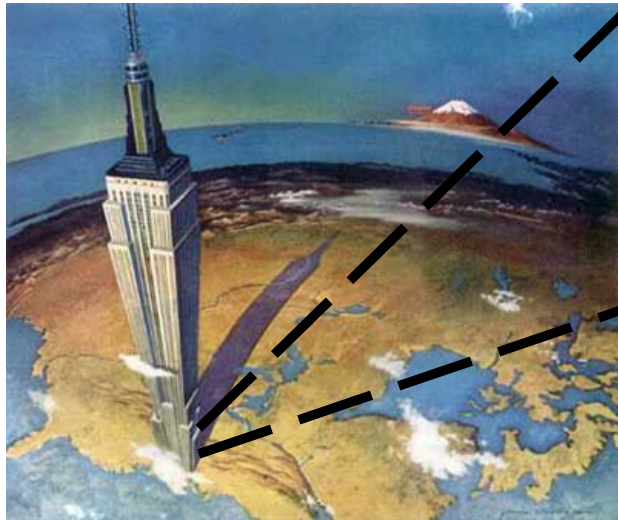


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Foundations Everywhere

Infrastructure



Systems

The design of computing systems can only properly succeed if it is well grounded in theory; the important concepts in a theory can only emerge through protracted exposure to application.

Robin Milner, Turing Award 1991

Algorithmic Foundations

- Design and analysis of algorithms and characterized by algorithmic thinking accompanied by rigorous analysis
- AF supports research in the following focus areas
 - Algorithms
 - Learning Theory
 - Comp. Game Theory/Econ
 - Parallel and Distributed Algs
 - Complexity
 - Symbolic Computing
 - Quantum Computing
 - Numeric Computing
 - Computational Geometry
 - Computational Biology

Practical problems all have theoretical core

- BIGDATA (streaming and sublinear algs)
- Security (crypto and differential privacy)
- Optimization (approximations and hardness)
- Knowledge discovery (machine learning)
- Internet economy (algorithmic game theory)

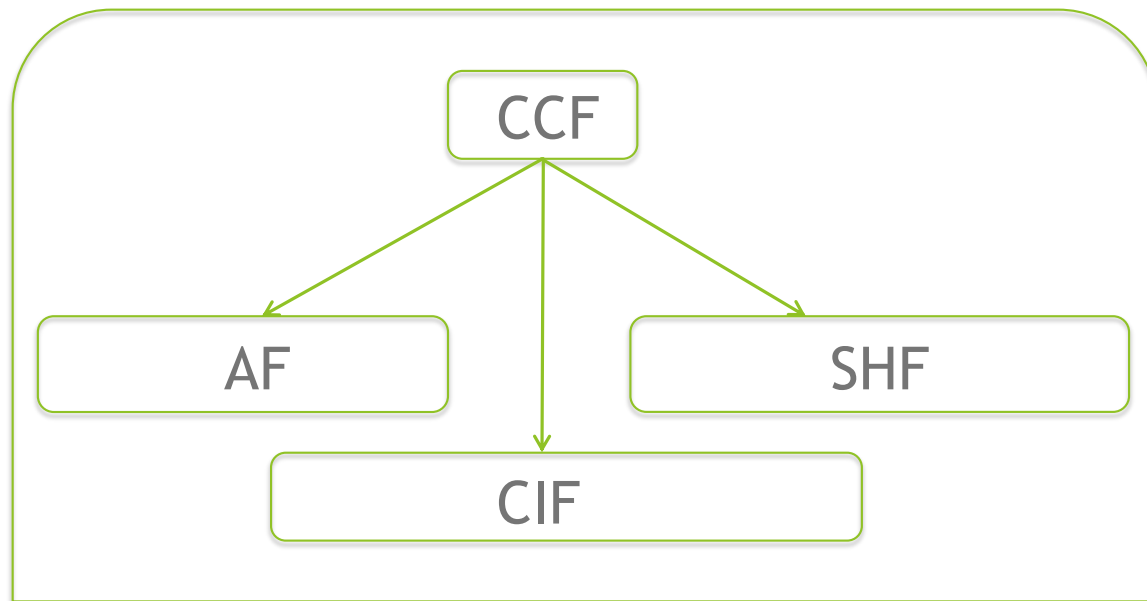
Communications and Information Foundations

- Signal Processing Systems (SPS)
 - Traditional DSP topics 1-D DSP, IMDSP, COMSP, ...
 - Emerging: largely applications driven inverse problems, convex optimization, compressed sensing, machine learning, new imaging modalities, new mathematical approaches to vision, whatever, e.g., differential geometry, algebraic topology - manifolds, homology theory, ...
- Communications and Information Theory
 - Multi-user interference management; wireless cell architectures; cooperative communications; network propagation (memes, diseases, influence, trust); advanced modulation (sub-Nyquist, millimeter-wave, massive MIMO); cross-layer optimization; cloud services for secure storage and computation
- The sub-disciplines that comprise CIF
 - Are all-pervasive
 - Provide the theoretical foundations and tools for cognate disciplines
 - Continue to have enormous local and societal impact, e.g., consumer electronics, medical imaging, radar, cloud and mobile services, ...

Software Hardware Foundations

- SHF advances foundations underlying the **development of all software and hardware**
- SHF addresses opportunities and challenges presented by emerging technologies and new application domains, but focuses on **underlying foundations**
 - Design automation of micro and nano systems
 - Design and analysis of computer system architectures
 - Formal methods for design, verification, analysis, synthesis
 - Design and implementation of programming languages and compilers
 - Fundamental research in HPC technologies for computing- & data-intensive applications
 - Software science and engineering including automation of software creation and evolution, software development and developers

Biology and Quantum @ CCF



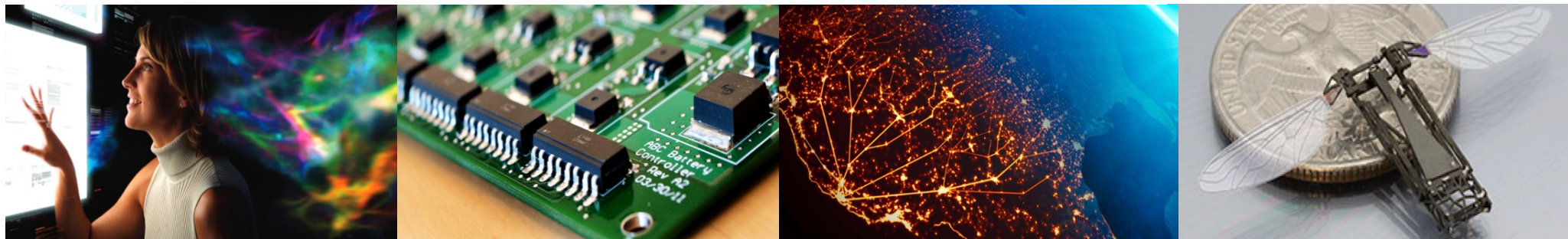
Collaborations & Partnerships

- Joint programs
 - Binational Science Foundation in Israel
 - SRC - ECCS program on Energy Efficient Computing
 - Intel

Program Director Teams

- AF:
 - Tracy Kimbrel, Rahul Shah and Jack Snoeyink
- CIF:
 - Phil Regalia and Rick Brown
- SHF:
 - Nina Amla, Anindya Banerjee, Sankar Basu, Almadena Chtchelkanova, Sol Greenspan
- Quantum programs:
 - Dmitry Maslov and Almadena Chtchelkanova
- Computational Biology:
 - Mitra Basu





Division of Computer & Network Systems (CNS) Research Programs

Ken Calvert
Division Director



<http://www.nsf.gov/CISE>

CNS Programs

*Exploring Systems, Building Research Infrastructure,
Preparing Future Generations, Encouraging Innovation*

Research

Core:

- Computer Systems Research (CSR)
- Network Technology & Systems (NeTS)

Crosscutting:

- Secure & Trustworthy Cyberspace (SaTC)
- Cyber-physical Systems (CPS)
- Smart & Connected Communities (S&CC)

Education & Workforce
Development

Infrastructure for
Systems Research

Industry &
Entrepreneurship
(Joint with ENG)

Cross-CISE, Cross-NSF:
CRI, REU Sites, RET Sites, MRI



CNS Core Programs

Computer Systems Research + Network Technology & Systems

- The infrastructure of the modern world!
 - Storage, network/interconnect, compute, OS, libraries ...
 - Novel architectures, techniques, datasets, ...
- Advanced technologies
 - wired/wireless, SDI, SGX, edge clouds,
- Considering all aspects
 - performance, scalability, mobility, security, resilience, ...
- Award Size: Small, Medium, (sometimes) Large
 - Also CRII, CAREER



Previous: NSF **17-570**

Core Program Submissions:
Typically in Fall (See solicitation)

Secure and Trustworthy Cyberspace (SaTC)

Securing Our Nation's Cyberspace

- Promoting cybersecurity research and development to "change the game"
 - Establish a science of cybersecurity
 - Minimize the misuses of cyber technology
 - Bolster education and training in cybersecurity
 - Transition promising cybersecurity research into practice
- Cross-NSF: CISE, SBE, MPS, ENG, EHR
- One of the largest research programs in NSF



Previous: NSF 17-576

Core Program
Submissions:
Typically in
Fall (See
solicitation)



Cyber-Physical Systems (CPS)

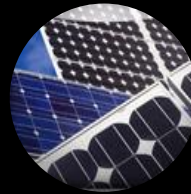
*Deeply integrating computation, communication,
and control into physical systems*

- Developing the core system science to engineer complex, “smart” systems that interact with the physical world
- Joint program with ENG directorate, other federal agencies
 - DHS/S&T, DoT, USDA, NIH
- Award sizes: small, medium, frontier



Transportation

- Faster and safer aircraft
- Improved use of airspace
- Safer, more efficient cars



Energy and Industrial Automation

- Homes and offices that are more energy efficient and cheaper to operate
- Distributed micro-generation for the grid



Healthcare and Biomedical

- Increased use of effective in-home care
- More capable devices for diagnosis
- New internal and external prosthetics



Critical Infrastructure

- More reliable power grid
- Highways that allow denser traffic with increased safety



Submissions:

9 May 2018

Current: NSF **18-538**

Smart & Connected Communities (S&CC)

Leveraging technology to improve quality of life

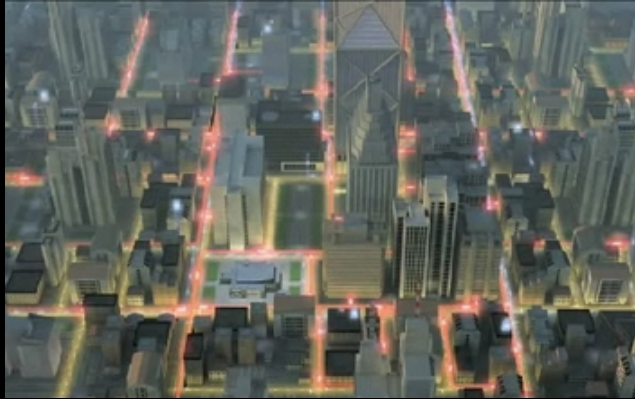


Image Credit: US Ignite



Image Credit: NSF

- Creating science & engineering foundations
- Emphasis on integration of technical & social dimensions with community engagement
- CISE, ENG, EHR, GEO, SBE
- Award size: \$750K-\$3M

Current: NSF **18-520**
See [nsf.gov/scc/](https://www.nsf.gov/scc/)

Submissions:

Likely early Spring
(See solicitation)



NSF/VMware Partnership on Edge Computing Data Infrastructure

NSF 18-540

- Challenge: design/develop/enhance **data-centric** architectures, programming paradigms, runtime environments, and **data sharing** frameworks for emerging multi-tier, multi-stakeholder context
Back-end cloud \Leftrightarrow **edge cloud** \Leftrightarrow **end system**
- Security, Privacy as first-order design considerations
- Awards up to \$3M/3 years; jointly funded by NSF and VMware



Submissions: 22 May 2018



CISE Research Infrastructure (CRI)

NSF 17-581

- Supports creation and enhancement of world-class infrastructure to support focused research agendas in CISE fields
- Community (CI): useful to a broad set of CISE researchers *beyond the awardee institution(s)*
 - Typically \$500K-\$1M; max \$2M
 - Planning: \$50K-\$100K
- Institutional (II): targets collaborating researchers at a smaller number of institutions
 - Most awards \$250K-\$750K range; max \$1M



Preliminary Proposal (req'd): Fall

Full Proposal: January

Computer Science for All

(CSforAll:RPP) **NSF 18-537**

- Goal: provide all US preK-12 students opportunity to learn CS/Computational Thinking
 - Researcher-Practitioner Partnerships
- Joint with Education & Human Resources
- Supports training & professional development for HS and preK-8 teachers to integrate CS/CT into their thinking
- Supports school districts to define and evaluate multi-grade pathways to/through CS/CT



Mid-scale Testbeds and Infrastructure

GENI



- Nationwide suite of infrastructure supporting "at scale" research in networking, distributed systems, security, and novel applications.

CloudLab



- 15,000 cores enable researchers to build their own cloud computing architectures, and experiment with the next generation of computing architectures.

US Ignite



- Fostering the develop of next generation broadband applications.

Chameleon



- Researchers can explore transformative concepts in deeply programmable cloud services on both virtualized and bare metal computing platforms.



Other Programs

- REU Sites
 - Research Experiences for Undergraduates
 - Summer programs for 8-10 students, 10 weeks
- RET Sites
 - Summer program for K-12 teachers
- NSF I-Corps
 - Nurturing an innovation ecosystem
- IUCRC
 - Industry-University Cooperative Research Centers
 - Accelerating translation to marketplace
- Platforms for Advanced Wireless Research
 - Creating 2-4 City-scale experimental testbeds
 - Research "beyond 5G" technologies



Information and Intelligent Systems: An Overview for CRA Career Mentoring Workshop



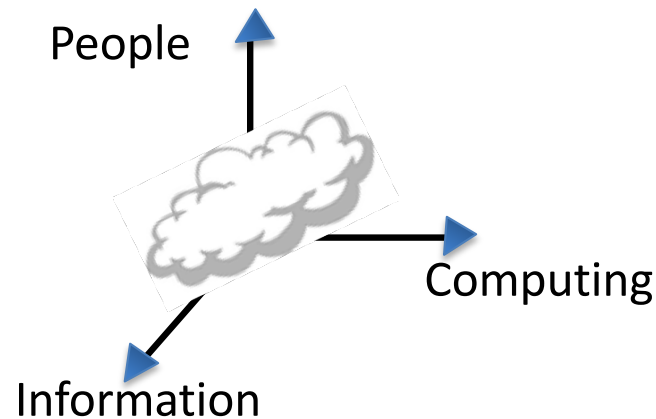
Joydip Kundu
Deputy Division Director
Information and Intelligent Systems
jkundu@nsf.gov

February 27, 2018



Information and Intelligent Systems (IIS):

Studies the interaction of people, computing, and information



All IIS Projects are Volumes in this Space

Robust Intelligence

artificial intelligence
machine learning
computer vision
human language
robotics
computational neuroscience
cognitive science

Information Integration & Informatics

data management
data mining
graph mining
(bio) informatics
information retrieval

Cyber-Human Systems

human-computer interaction
social computing
assistive technology
learning technology



IIS-led Cross-Cutting Programs

- Big Data Sciences and Engineering
 - See solicitation 18-539
 - Next deadline in May 2018
- Collaborative Research in Computational Neuroscience
 - See solicitation 18-501
 - Next deadline in November 2018
- Cyberlearning for Work at the Human Technology Frontier
 - See solicitation 17-598
 - Next deadline in January 2019
- National Robotics Initiative
 - See solicitation 18-518
 - Next deadline in February 2019
- Smart and Autonomous Systems
 - Solicitation is being revised
- Smart and Connected Health
 - See solicitation 18-541
 - Next deadline in May 2018



A time of tremendous opportunity for IIS community

- *Intellectual progress*
- *Public benefit*
- *Partnership*

For more info, go to
nsf.gov/div/index.jsp?org=iis





NSF/OAC: Overview

Advancing the Frontiers of Science and Engineering

MANISH PARASHAR, DIRECTOR
OFFICE OF ADVANCED CYBERINFRASTRUCTURE (OAC)
COMPUTER AND INFORMATION SCIENCE AND ENGINEERING
FEBRUARY 27, 2018

NSF Office of Advanced Cyberinfrastructure (OAC)

Program Staff

As of November 2017



Manish Parashar
Office Director



Amy Friedlander
Deputy Office
Director



Bill Miller*
Science
Advisor
(On Detail)

Computing

Data

Software

Networking &
Cybersecurity

Learning & Workforce
Development



Beth Plale*
Science
Advisor
Public Access



Bob
Chadduck



Amy Walton



Vipin
Chaudhary *



TBD



Sushil Prasad *



Alejandro
Suarez
Cooperative
Agreements



Ed Walker



Stefan
Robila *



Rajiv
Ramnath
(Part-Time) *



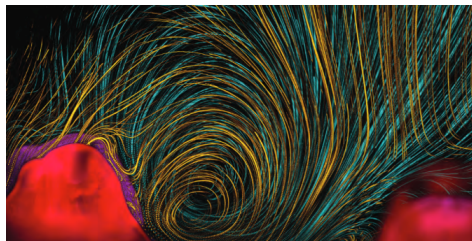
Kevin
Thompson



Scott Sellars
AAAS S&T
Policy Fellow

* IPA Appointment

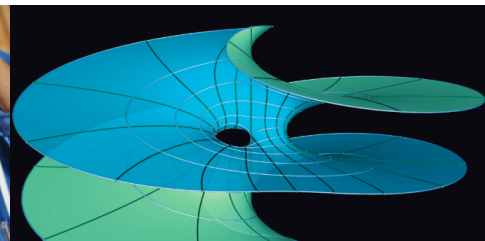
NSF advanced cyberinfrastructure transforming the frontiers of science, society



Engineering



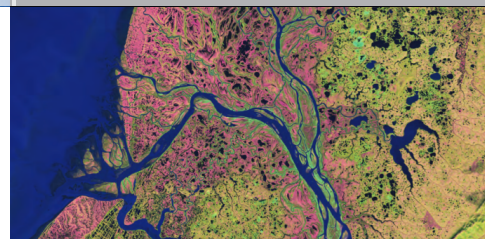
Education



Math & Physical Sciences



Social, Behavioral &
Economic Sciences



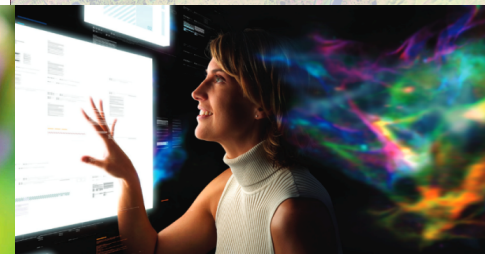
Geosciences



Integrative sciences

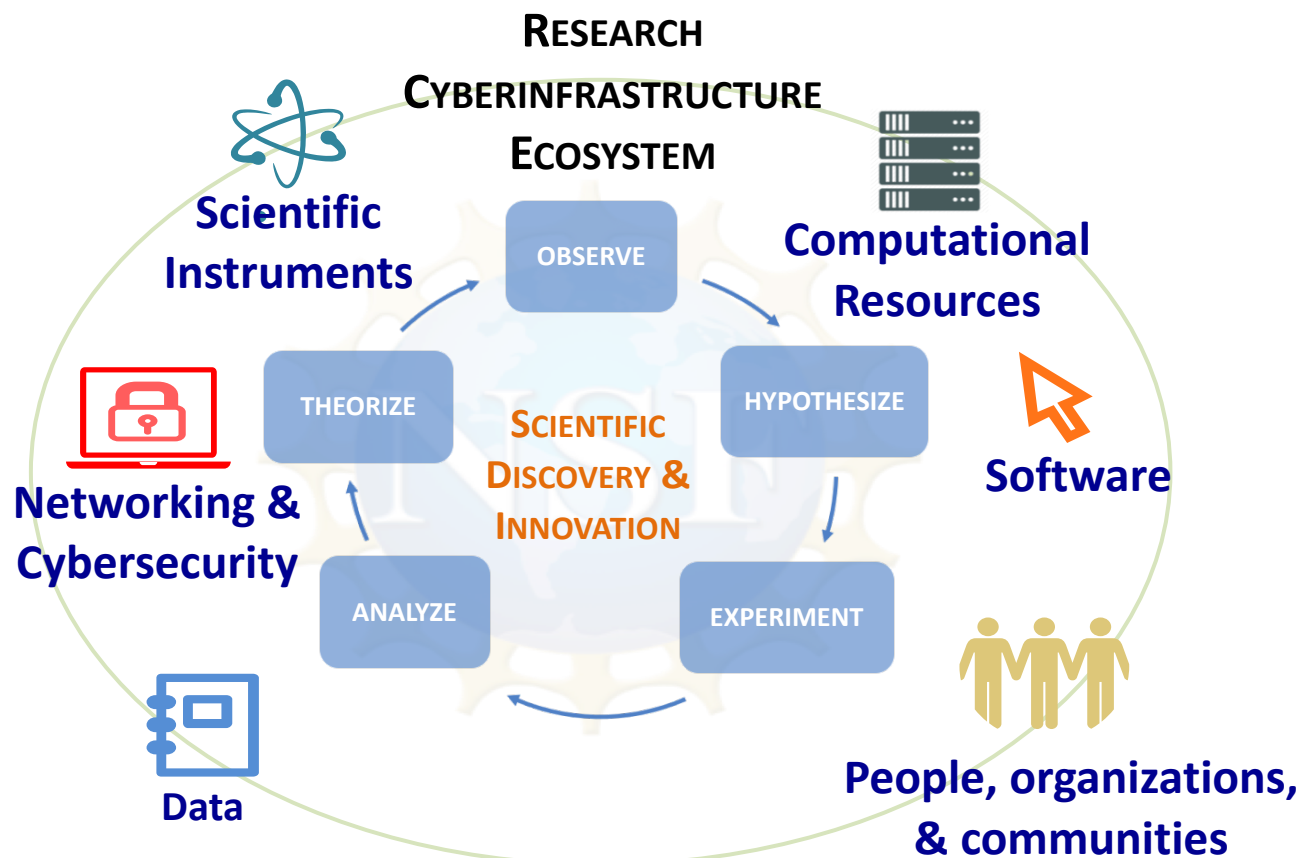


Biological sciences



Computing

Research Cyberinfrastructure Ecosystem for 21st Century Science & Engineering



OAC supports *Cyberinfrastructure Research & Research Cyberinfrastructure* to uniquely enable collaboration and discovery frontiers at all scales



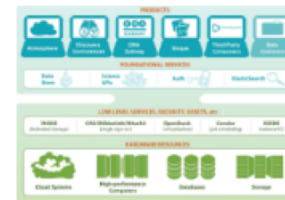
CI-Enabled
Instrumentation



Computing
Resources



Data
Infrastructure



Gateways, Hubs,
and Services



R&E Networks,
Security Layers



Coordination
& User support



Software and
Workflow Systems



Pilots,
Testbeds



People, organizations,
and communities



OAC supports *Cyberinfrastructure Research & Research Cyberinfrastructure* to uniquely enable collaboration and discovery frontiers at all scales

■ OAC Programs

- Office of Advanced Cyberinfrastructure Programs (OAC)Campus Cyberinfrastructure (CC*)
- Cyberinfrastructure for Emerging Science and Engineering Research (CESER)
- Cyberinfrastructure for Sustained Scientific Innovation (CSSI) - Data and Software:
- Cybersecurity Innovation for Cyberinfrastructure (CICI)
- International Research Network Connections (IRNC)
- Petascale Computing Resource Allocations (PRAC)
- Towards a Leadership-Class Computing Facility - Phase 1
- Training-based Workforce Development for Advanced Cyberinfrastructure (CyberTraining)

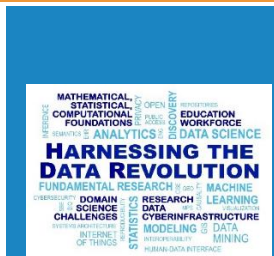
■ CISE/NSF-Wide Programs

- Computational and Data-Enabled Science and Engineering (CDS&E)
- Computer and Information Science and Engineering (CISE) Research Initiation Initiative (CRII)
- Computer Science for All
- Cyber-Physical Systems (CPS)
- EarthCube
- Expeditions in Computing
- Research Experiences for Undergraduates (REU)
- Scalable Parallelism in the Extreme (SPX)
- Secure and Trustworthy Cyberspace (SaTC)
- ...



NSF “Big Ideas” => Many Cyberinfrastructure Challenges

RESEARCH IDEAS



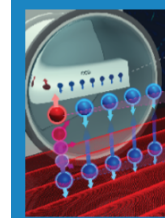
Harnessing Data for 21st Century Science and Engineering

Work at the Human-Technology Frontier: Shaping the Future



Navigating the New Arctic

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



PROCESS IDEAS

Mid-scale Research Infrastructure



NSF 2050: Seeding Innovation



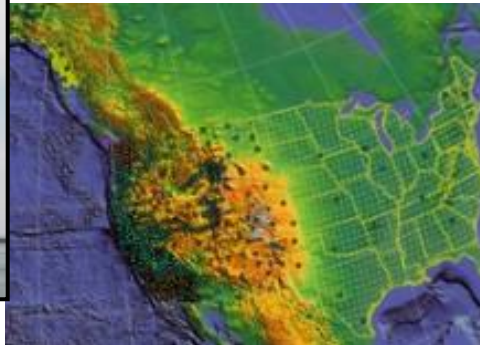
Growing Convergent Research at NSF



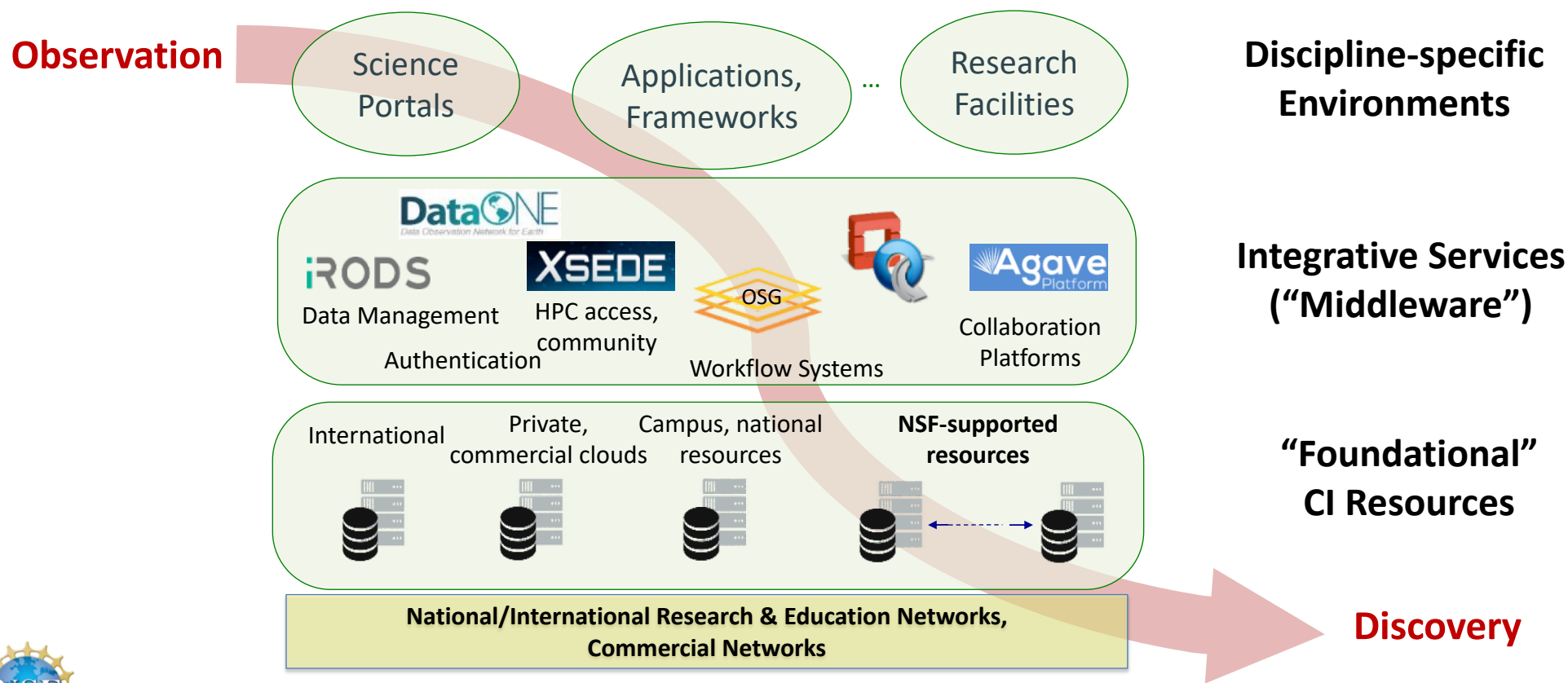
NSF-INCLUDES: Enhancing Science and Engineering through Diversity



Cyberinfrastructure is Central to Facilities -- Research success depends on robust, reliable, and highly connective cyberinfrastructure



Transforming Science through a Cyberinfrastructure Ecosystem: Dynamic discovery pathways at scale



Transforming Science through a Cyberinfrastructure Ecosystem: Dynamic discovery pathways at scale

CI enables Big Science

Gravitational wave detection enabled by NSF investments across the computational and data science workflow



einstein
toolkit

Pegasus



globus

XSEDE
Extreme Scale and Engineering
Discovery Environment



TEXAS ADVANCED COMPUTING CENTER
STAMPEDE

Open Science Grid

HTCondor
High Throughput Computing



Courtesy SXS.

- ✓ **Researcher access to sustained Advanced Computing resources**
 - New intensive simulations of relativity and magnetohydrodynamics. Massive, parallel event searches and validation (100,000 models).
 - Advanced computing resources and services sponsored by NSF, DOE, and commercial cloud services.
- ✓ **Interoperable Networking, Data Transfer, & Workflow Systems**
 - Pegasus, HTCondor, Globus workflow and data transfer management
 - NSF funded 100 Gbps upgrades enabled huge throughput gains.
- ✓ **Software Infrastructure**
 - Computational science advances embodied in Software Infrastructure, for simulations, visualizations, workflows and data flows

NSF programs: Data Building Blocks (DIBBs), Software Infrastructure (SI2), Campus Cyberinfrastructure Network Infrastructure and Engineering (CC*NIE, DNI), and others. OSG and Pegasus are also supported by the Dept of Energy.



Building on Community input

Accelerating Science into the Future

Future Directions of NSF Advanced Computational Infrastructure to Support US Science in 2017 – 2022

- National Academy of Sciences (NAS) Final Report (2016)
- <http://www.nap.edu/catalog/21886/future-directions-for-nsf-advanced-computing-infrastructure-to-support-us-science-and-engineering-in-2017-2020>

National Strategic Computing Initiative (2016)

- Community Workshops, RFIs, Reports, Plan, Interagency coordination
- <http://nsf.gov/cise/nscli/>

NSF Advisory Committee on Cyberinfrastructure (ACCI)

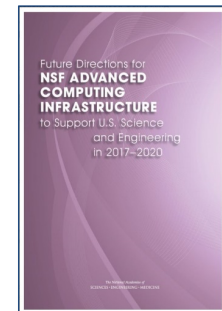
- Co-chairs: Thom Dunning/UW, Gwen Jacobs/UH
- Working Groups: LWD, Data, Software, Research CI Strategy
- <http://www.nsf.gov/cise/aci/advisory.jsp>

NSF 17-031 Dear Colleague Letter (CI 2030)

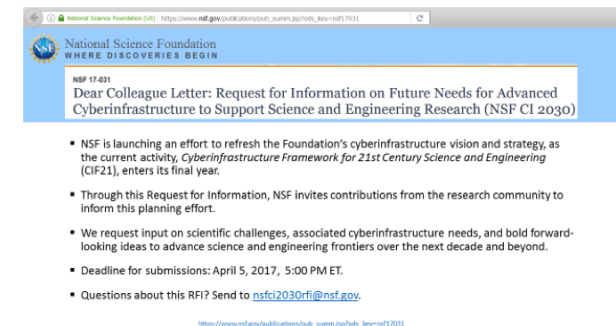
- Request for Information : CI Vision and strategy to uniquely enable research
- <https://www.nsf.gov/pubs/2017/nsf17031/nsf17031.jsp>

NSF 18-013 Dear Colleague Letter (Midscale Infrastructure)

- https://www.nsf.gov/pubs/2018/nsf18013/nsf18013.jsp?WT.mc_id=USNSF_179



Final report Co-chairs:
W. Gropp/UIUC
R. Harrison/Stony Brook



Thank you