NSF Campus Cyberinfrastructure – Data, Networking and Innovation (CC*DNI)

NMTIE November 2015
Kevin Thompson
National Science Foundation
CISE/ACI
$7.3 billion FY 2015 appropriation

94% funds research, education and related activities

48,100 proposals

11,000 awards funded

1,826 NSF-funded institutions

320,900 NSF-supported researchers

All S&E disciplines funded

Funds research into STEM education

214 Nobel Prize winners

Other than the FY 2015 appropriation, numbers shown are based on FY 2014 activities.
NSF cyberinfrastructure investments led by the Division of Advanced Cyberinfrastructure (ACI)

ACI Mission: To support advanced cyberinfrastructure to accelerate discovery and innovation across all disciplines

Division Director: Irene Qualters
Deputy Division Director (Acting): Amy Friedlander

Science Advisor for Cross-cutting CI: Bill Miller

High Performance Computing
Bob Chadduck
Rudi Eigenmann
Ed Walker

Data
Bob Chadduck
Amy Walton

Networking/Cybersecurity
Anita Nikolich
Kevin Thompson

Software
Dan Katz
Rajiv Ramnath

Learning/Workforce Development
Sushil Prasad
NSF Cyberinfrastructure (ACI) is part of the CISE Directorate and responsible for NSF-wide CI coordination and support.
Research Infrastructure: collaborative, dynamic, and interoperable- changing in concert with modern science and engineering
Research Trends influencing NSF CI strategy

Research Context

- Globalization of Research Communities
- Digital technologies deeply permeating both research and education
- Research expectations high and funding flat
- Research frontiers increasingly multidisciplinary
- National demographics increasingly diverse

Cyberinfrastructure Response

- Cooperating multilayer, national and global CI at all scales
- Sustainability focus (especially software, data)
- Ubiquitous, capable, secure and facile CI access more researchers, educators, institutions, communities
- CI Collaborations and Partnership
- Learning and Workforce development for both CI creators and users
Laying a National Foundation for Research Innovation

- ACI supports
  - CI innovation & collaboration
  - National-scale capabilities
  - Inherently Multidisciplinary
    + International
    + Multi-institutional
    + Domain-specific
- Research CI: Networking, security, software, data, advanced computing, learning and workforce development
NSF-supported national resources provide a forward looking, cohesive computational foundation for researchers/educators.
The Open Science Grid

- Helps researchers speed up their research using high throughput computing methods
- Helps campus HPC administrators share local resources for multi-campus and national collaborative research
- Collects, archives and analyzes links between campuses and the national cyberinfrastructure
- A distributed computing partnership of over 125 campuses
- Data intensive:
  - 0.5 PB data transferred/day

- 500k jobs/day
- 925M CPU-hours/year
Simulations for high rate error correction codes for optical data communication and data compression

- David Mitchell, NMSU EE faculty
  - Ahmad Golmohammadi (EE graduate student)
  - Important for digital space and satellite communication & wireless data transmission
  - Whole system simulations - transmitter, decoder, receiver & stochastic noise, data compression
  - Computations are well-suited to HTC. Ahmad:

> I am so happy that could do my simulation that much fast. Instead of waiting for several weeks, right now I am getting them in hours. Thank you very much, Best wishes

Local contact: Piyasat Nilkaew, Dir. Telecom, Networking, User Support
NSF investments are leading to sustained software innovation

- Software is increasingly embedded in the scientific enterprise

- NSF investments create and sustain software infrastructure
  - Providing new capabilities that accelerate increasingly complex science across and within disciplinary boundaries
  - Supporting software’s long-term lifecycle
  - Enabling software architectures for innovation and reusability
NSF investments are training the next generation of scientific professionals

CI-focused **Cyber Scientists** to develop, pilot and deliver new capabilities

Computational Scientists
Data Scientists
Computer Scientists
Design Engineers
System Analysts

CI-enabled **Domain Scientists** to explore and exploit new capabilities
Cybersecurity Innovation for Cyberinfrastructure (CICI) NSF 15-549

Activities that impact the security of science, engineering and education environments
Target community is operational cyberinfrastructure

- FY15 $11M/13 awards. FY15 Areas:
  - Cybersecurity Center of Excellence ($5M award, still pending)
  - Secure Data Provenance ($500K awards)
  - Secure Architecture Design ($500K awards)
Networking Programs in CISE/ACI

- Networking as a fundamental layer and underpinning of CI

- CC-NIE/CC-IIE (Campus Cyberinfrastructure – Data, Networking, and Innovation): joint with CNS
  - Campus networking upgrade (re-design to scienceDMZ at campus border and 10/100Gbps) and innovation program

- IRNC – International R&E Network Connections: joint with OIA/ISE
  - Scientific discovery as a global collaborative endeavor
  - Provide network connections linking U.S. research with peer networks in other parts of the world
  - Stimulate the deployment and operational understanding of emerging network technology and standards in an international context
IRNC Links representation
Global topology r&e networking (NSF supports a part of this)
Zoom (note the different scales: international, national, regional, campus/local)
Regional Optical Networks
Strategic Recommendation to the NSF #3: The National Science Foundation should create a new program funding high-speed (currently 10 Gbps) connections from campuses to the nearest landing point for a national network backbone. The design of these connections must include support for dynamic network provisioning services and must be engineered to support rapid movement of large scientific data sets." - pg. 6, National Science Foundation Advisory Committee for Cyberinfrastructure Task Force on Campus Bridging, Final Report, March 2011

Campus Cyberinfrastructure – Data, Networking, and Innovation (CC*DNI) Program

- FY15 new solicitation, NSF 15-534
- 7 categories of proposals, 2 of them are New
- Data Infrastructure Building Blocks (DIBBs) - Multi-Campus/Multi-Institution Model Implementations
  - Models for potential future national scale network-aware data-focused cyberinfrastructure attributes, approaches, and capabilities – sharing data beyond a single institution
- Network-centric categories (from CC*IIE)
  - Data Driven Networking Infrastructure for the Campus and Researcher
  - Network Design and Implementation for Small Institutions awards
  - Network Integration and Applied Innovation
  - Campus CI Engineer
  - Regional Coordination and Partnership in Advanced Networking
  - Instrument Networking
2015 CC*DNI Program Areas

- Data Infrastructure Building Blocks (DIBBs) - Multi-Campus/Multi-Institution Model Implementations
  - Up to $5,000,000 for up to 5 years
- Data Driven Networking Infrastructure for the Campus and Researcher
  - Up to $500,000 for up to 2 years
- Network Design and Implementation for Small Institutions
  - Up to $350,000 for up to 2 years
- Network Integration and Applied Innovation
  - Up to $1,000,000 for up to 2 years
- Campus CI Engineer
  - Up to $400,000 for up to 2 years
- Regional Coordination and Partnership in Advanced Networking
  - Up to $150,000 for up to 2 years
- Instrument Networking
  - Up to $400,000 for up to 2 years

Please refer to the solicitation for complete detail.
CC*DNI Program-wide Criteria

- Science Drivers
- Partnerships between campus CI experts and scientists
- Campus Cyberinfrastructure plan
  - plan within which the proposed network infrastructure improvements are conceived, designed, and implemented in the context of a coherent campus-wide strategy and approach to CI
  - Maximum 5-pg supplementary document addressing:
    - Sustainability of proposed work in terms of ongoing operational and engineering costs
    - Refer to solicitation for guidance on technical areas to include such as IPv6, InCommon federation, and IP spoofing
  - See example CI plans from existing awardees at http://fasterdata.es.net/campusCIplanning/
This category invests in multi-campus and/or multi-institutional regional cyberinfrastructure, to leverage high performance network paths among campuses to enable integration of new data-focused services, capabilities, and resources to advance scientific discoveries, collaborations and innovations.

Awards will serve as models for potential future national scale network-aware data-focused cyberinfrastructure attributes, approaches, and capabilities.
CC*DNI Area#2 - Data Driven Networking Infrastructure for the Campus and Researcher

- Network infrastructure improvements at the campus level

- Network improvements include:
  - Network upgrades within a campus network to support a wide range of science data flows
  - Re-architecting a campus network to support large science data flows, for example by designing and building a "science DMZ" (see http://fasterdata.es.net/science-dmz/ for more information on the "science DMZ" approach)
  - Network connection upgrade for the campus connection to a regional optical exchange or point-of-presence that connects to Internet2

- Note – a new requirement in this category – proposals must include a summary table of the science drivers and their network requirements
A simple Science DMZ has several essential components. These include dedicated access to high-performance wide area networks and advanced services infrastructures, high-performance network equipment, and dedicated science resources such as Data Transfer Nodes. A notional diagram of a simple Science DMZ showing these components, along with data paths, is shown below:

The essential components and a simple architecture for a Science DMZ are shown in the Figure above. The Data Transfer Node (DTN) is connected directly to a high-performance Science DMZ switch or router, which is connected directly to the border router. The DTN’s job is to efficiently and effectively move science data to and from remote sites and facilities, and everything in the Science DMZ is aimed at this goal. The security policy enforcement for the DTN is done using access control lists on the Science DMZ switch or router, not on a separate firewall.
CC*DNI Area#3 – Network Design and Implementation for Small Institutions

- Applicable to smaller institutions with fundamental challenges to address in networking infrastructure and resources
- Guidance is identical to Area#2 (including the importance of science use cases) with these differences:
  - Network design proposed may defer complete technical solutions and propose to develop solution in Year1 with implementation in Year2
  - Partnering in the proposal is required
  - Planning grants and requests for professional network staff support are also allowed in this area
CC*DNI Area#4 – Network Integration and Applied Innovation

- End-to-end network CI through integration of existing and new technologies and applied innovation
- Applying network research results, prototypes, and emerging innovations to enable (identified) research and education
- May leverage new and existing investments in network infrastructure, services, and tools by combining or extending capabilities to work as part of the CI environment used by scientific applications and users
Area#4 Examples of Relevant Activities

- Integration of networking protocols/technologies with application layer
- Transitioning successful research prototypes in SDN, and activities supported by GENI and FIA programs, to distributed scientific environments and campus infrastructure
- Innovative network solutions to problems driven by distributed computing and storage systems including cloud services.
- Federation-based security solutions for dynamic network services extending end-to-end

See solicitation text for others
CC*DNI Area#5 – Campus CI Engineer

- Support for up to one campus cyberinfrastructure engineer for up to 2 years
- Proposals should describe institutional need and planned engagement on multiple science projects
- Preference to campus network engineering and high performance networking
- Proposals should address campus commitment long term and include a sustainability plan
- NSF sees potential to establish over time a national community of campus level CI engineering and participants will be expected to participate in community engagement and building events
This program area seeks to build regional centers for community building, coordination and partnership through leadership activities at institutions whose expertise and resources in advanced network engineering can be leveraged and applied to partnering with other local and regional institutions.

Proposals in this area should describe:

- Their approach to providing a focused set of resources for regional support of advanced r&e networking;
- Their institutional capacity and expertise in campus networking; their planned outreach and engagement activities in their jurisdiction or region - especially to smaller colleges and universities,
- and interactions with other regions and national entities such as Internet2 and other institutional partners. These partners may, for example, be current and future proposers at smaller institutions and EPSCoR jurisdictions.

Proposed activities may include

- Workshops;
- Direct and ongoing engagement at the network engineering level for coordination and support on network design and implementation
- Network performance measurement and analysis.

Planned activities should consider the dissemination of advanced networking techniques, building bridges to distributed science communities, and potential tailoring of advanced networking solutions to problems faced by science projects and communities.

Proposals should address deliverables and define their measures of success.
CC*DNI Area#7 – Instrument Networking

- Recognizing scientific instruments as a first-class element in research infrastructure requiring high performance reliable networking connectivity and integration
- Proposals in this area should describe the pivotal role of the scientific instrument or instruments in need of improved network connectivity and integration. Each instrument description should include a quantitative profile of data requirements driving the networking improvements
- Proposals may request funds for new and upgraded network connectivity, or the development of tools, techniques, and frameworks for network integration of instruments based on one or more specific examples
- Proposals describing new approaches to network integration of instruments are challenged to describe how those approaches can be applied to other sets of instruments in the NSF community
New Mexico Institutions in the Program

- “CC*IIE Networking Infrastructure: Network Expansion to Support Data Intensive Research and Computation at the University of New Mexico”
  - **University of New Mexico**
  - #1440779; **Principal Investigator: Gilbert Gonzales**; Co-Principal Investigator: Susan Atlas, Gregory Taylor, Brian Pietrewicz; Start Date: 09/01/2014; Award Amount: $498,620.00

- “CC*DNI Region: New Mexico Research and Economic Development Collaboration”
  - **University of New Mexico**
  - #1541340; **Principal Investigator: Gilbert Gonzales**; Co-Principal Investigator: Norma Grijalva; Start Date: 09/01/2015; Award Amount: $149,999.00

- “CC*DNI Campus Design: Northern's Network Expansion for Large Science and Engineering Data Flows”
  - **Northern New Mexico College**
  - #1541352; **Principal Investigator: Jorge Crichigno**; Co-Principal Investigator: Ivan Lopez-Hurtado, Travis Robbins; Start Date: 10/01/2015; Award Amount: $350,000.00
Pacific Research Platform: Enabling a science-driven, high-capacity data sharing network

- 5 year, $5M CC*DNI grant
- Will move scientific research data at speeds of 10 to 100 gigabits per second among the 10 UC campuses and 10 other CA research institutions

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**Research Scientists to Use Network Much Faster Than Internet**

By JOHN MARKOFF  JULY 31, 2015

SAN FRANCISCO — A series of ultra-high-speed fiber-optic cables will weave a cluster of West Coast university laboratories and supercomputer centers into a network called the Pacific Research Platform as part of a five-year $5 million dollar grant from the National Science Foundation.
NSF Supported Campus CI
CC*DNI 2012-2015

2012-2015 CC-
NIE/CC*IIE/CC*DNI Programs
Summary #s for NSF’s Campus CI Program 2012-2015

- 170+ awards
- $80.6M+ invested over 4 years
- 46 states and jurisdictions represented on award map
- Award categories:
  - Campus Networking Upgrades: 91
  - Network Integration/Innovation: 38
  - Network Design (small institutions): 14
  - CI Engineer: 13
  - Regional Coordination: 7
  - DIBBs: 4
  - IAM: 4
  - Instrument: 2
CC*IIE numbers for 2014

- 131 proposals received ($51M requested)
- 50 awards made
- 134 awards, 128 projects total in the program 2012-12014
  - All but 4 states participating
  - 120+ institutions
- $21M in award funding 2014
- Breakdown:
  - Regional: 5
  - IAM: 4
  - CI Engineer: 7
  - Small Institution: 8
  - Infrastructure: 21
  - Integration/Innovation: 5
Wrap up

- On behalf of NSF, thank you for serving on review panels!
- CC*DNI is expected to continue
  - It changes year over year
  - Broadening participation, under-resourced institutions
  - Multi-campus and regional thematic
  - Campus networking ----> campus CI
Thanks!