Democratizing Science through Advanced Cyberinfrastructure

Manish Parashar, Office Director

Office of Advanced Cyberinfrastructure (OAC)

Computing and Information Science and Engineering (CISE)

MF CI Workshop

March 01, 2022

Outline

- NSF & OAC: Innovation at Speed and Scale
- Democratizing access to the National Cyberinfrastructure Ecosystem
- Perspectives on Major Facilities Cyberinfrastructure

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NSF'S MISSION

To promote the progress of science; to advance the national health, prosperity, and welfare; and to secure the national defense.

Director's Vision

- Advance the frontiers of research into the future
- Ensure accessibility and inclusivity
- Secure global leadership

We are in a **DEFINING MOMENT**

- Intensity of global competition
- Urgent need for domestic talent
- Broad support for science as path for solving global grand challenges

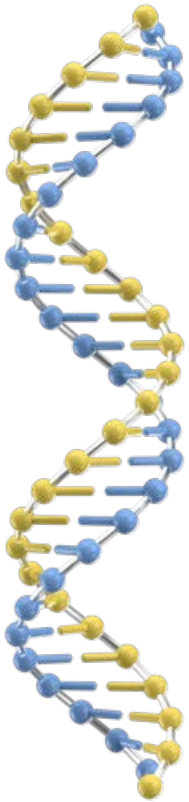
We can accomplish this vision with:

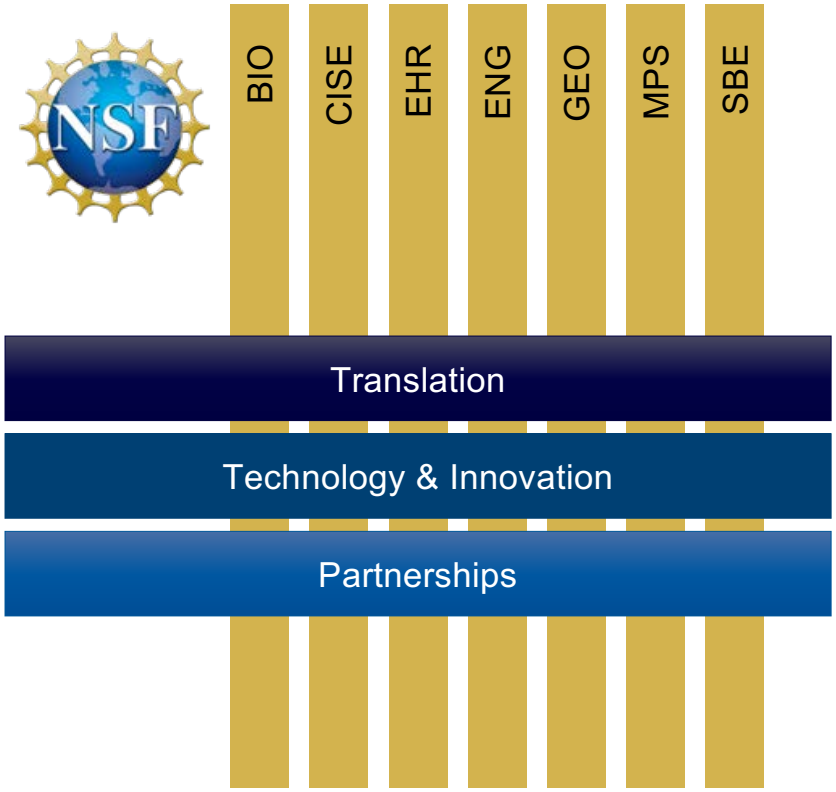
SPEED AND SCALE

FY 2022 NSF Priorities

- Enhance Fundamental Research and Development
  - Support research across the spectrum of science, engineering, technology, and education
- Strengthen U.S. Leadership in Emerging Technologies
  - Includes the establishment of a *new directorate for technology, innovation, and partnerships within NSF* to advance science and engineering research and innovation
- Advance Equity in Science and Engineering
  - Increase participation in science and engineering of individuals from racial and ethnic groups underrepresented in these fields
- Advance Climate Science and Sustainability Research
  - Advance use-inspired, solution-oriented research and innovation in climate and clean energy-related research
- Advance Forefront Infrastructure
  - Continue construction of major NSF research facilities

Designing for the Future: A New Horizontal





NSF Office of Advanced Cyberinfrastructure (OAC)

Foster a cyberinfrastructure ecosystem to transform science and engineering research… through Research CI and CI research

People, organizations, and communities

Coordination & User support

Gateways, Hubs, and Services

Data Infrastructure

Software and Workflow Systems

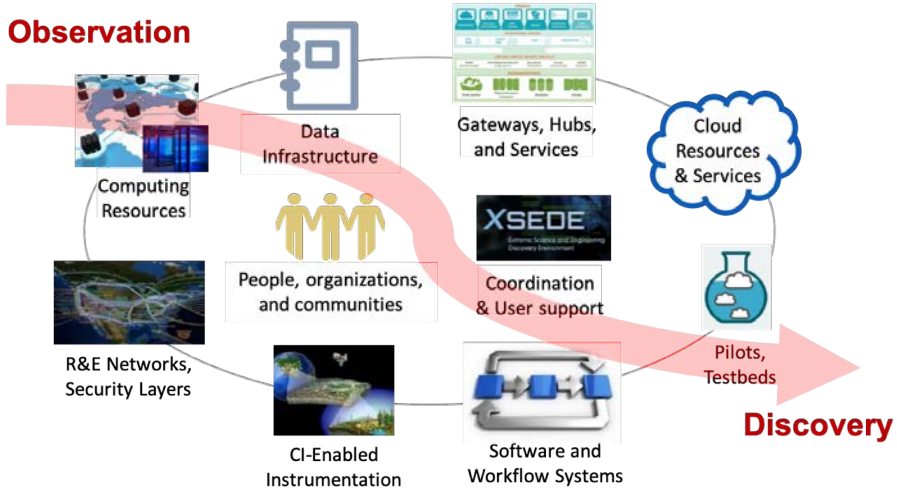
CI-Enabled Instrumentation

Pilots, Testbeds

Computing Resources

R&E Networks, Security Layers

Cloud Resources & Services



Rapid (disruptive) changes in S&E and CI landscapes → *Cyberinfrastructure ecosystem must evolve!*

NSF Office of Advanced Cyberinfrastructure (OAC)

NSF's vision for a National Cyberinfrastructure Ecosystem for Science and Engineering in the 21st Century

An agile, integrated, robust, trustworthy and sustainable CI ecosystem that drives new thinking and transformative discoveries in all areas of S&E research and education.

Overarching principles:

- View CI more holistically
- Support translational research
- Balance innovation with stability
- Couple discovery and CI innovation cycle
- Improve usability

http://go.usa.gov/xm8bU

Computing Resources

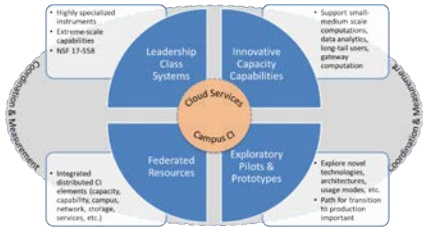
Security Layers

overy

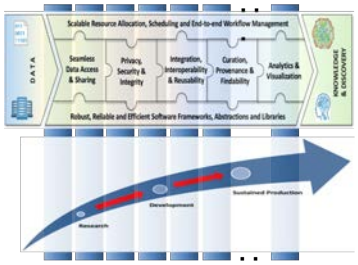
CI

NSF's vision for a National Cyberinfrastructure Ecosystem for Science and Engineering in the 21st Century

Community-informed blueprints provide implementation strategies for different elements of the CI ecosystem

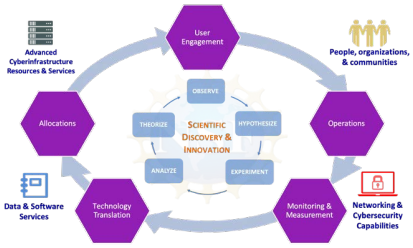


Computational Ecosystem

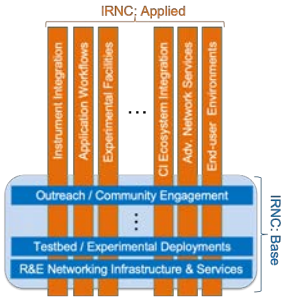


Software & Data Cyberinfrastructure

CI Learning & Workforce Development



CI Coordination Services



International R&E Networking

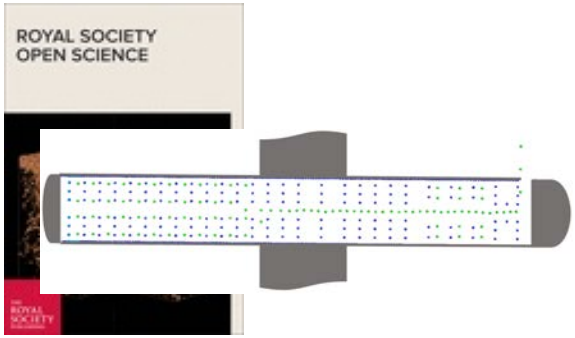
More information at: http://go.usa.gov/xm8bU

Transforming Science & Engineering via Cyberinfrastructure

Large-scale simulations on Frontera to better understand the icy plumes associated with supercell thunderstorms. *Leigh Orf, Univ. of Wisconsin-Madison, Science Vol. 373, No. 6560, 09/10/21.*

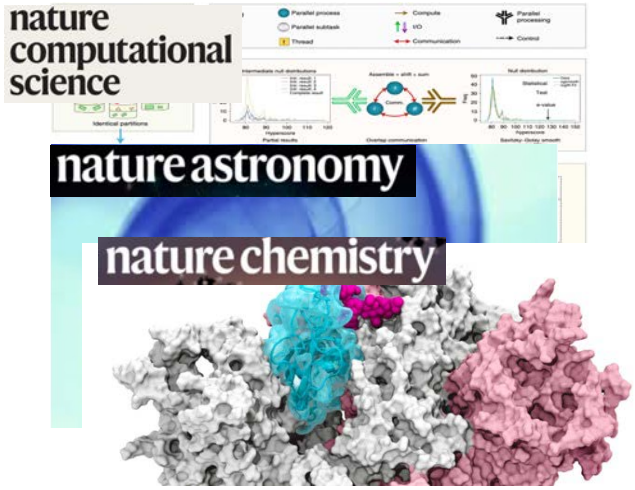
Exploring how natural ecosystems parallel U.S. supply chains, and how American cities can use the information to strengthen supply chains. *Benjamin Ruddell, N. AZ Univ., Nature. Vol 595, 07/08/21.*

Special issue dedicated to science enabled by Frontera spanning climate change, tornadoes and organic solar cells. *John West, TACC, IEEE CiSE, vol. 23, no. 3, 05-06/21.*



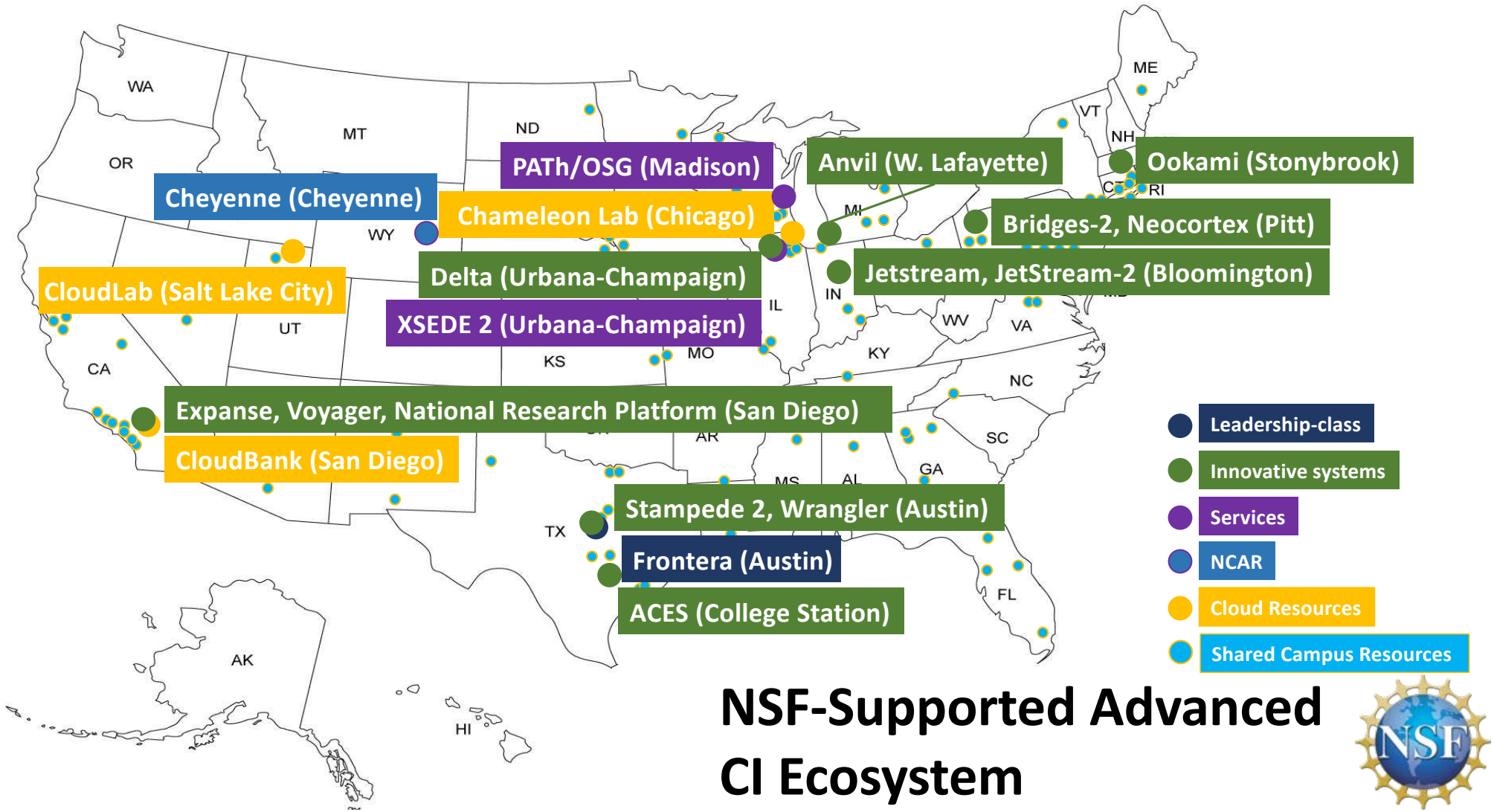
From bad to worse: airline boarding changes in response to COVID-19. *Ashok Srinivasan , Univ. of W FL, R. Soc. Open sci., Vol. 8, No. 4, 04/28/21.*

Space weather computer simulations and software to probe outbursts from the sun and understand their occasionally Earthbound paths. *Richard Linares, MIT, ScienceNews, 02/21.*

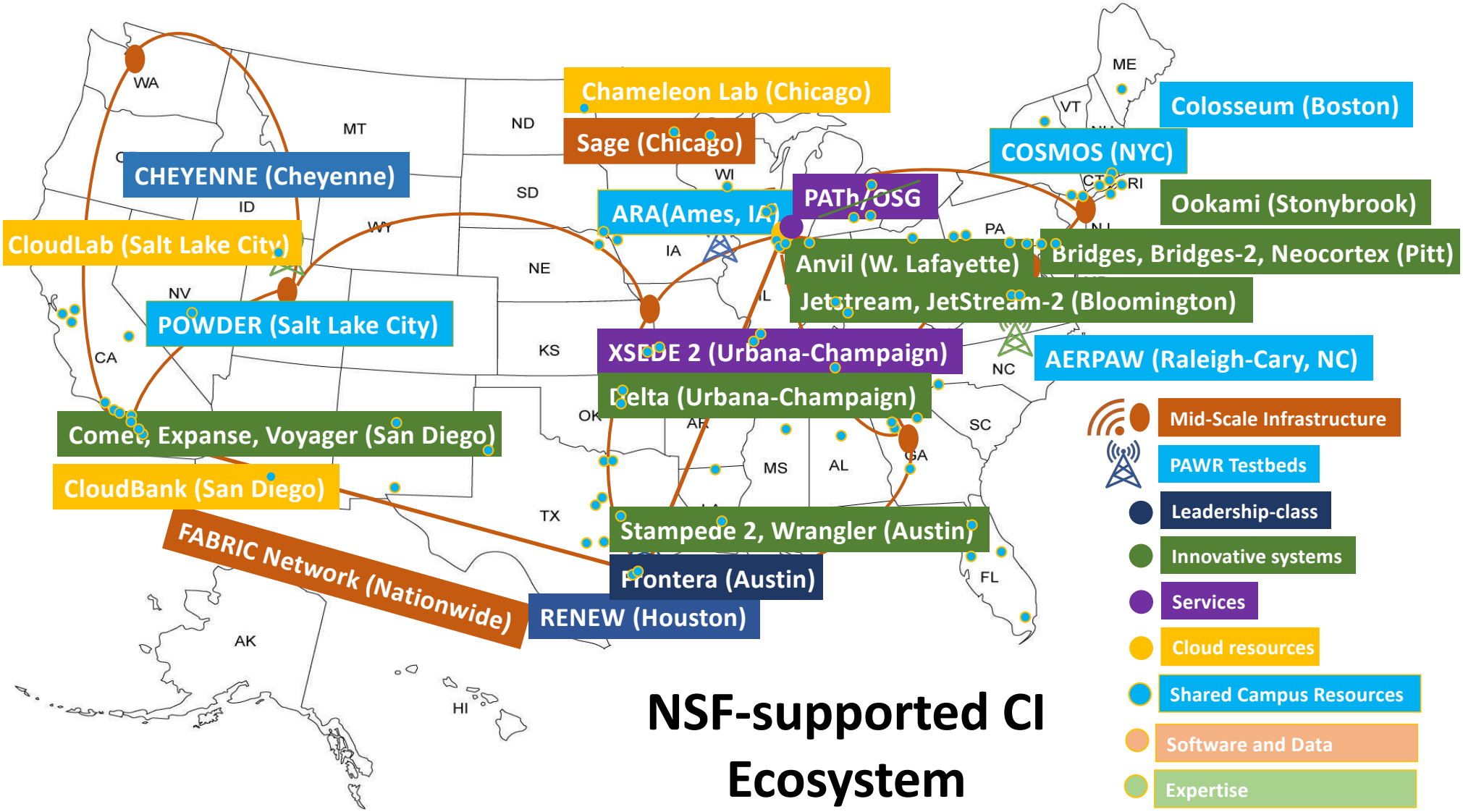


Outline

- NSF & OAC: Innovation at Speed and Scale
- Democratizing access to the National Cyberinfrastructure Ecosystem
- Perspectives on Major Facilities Cyberinfrastructure



NSF-Supported Advanced CI Ecosystem

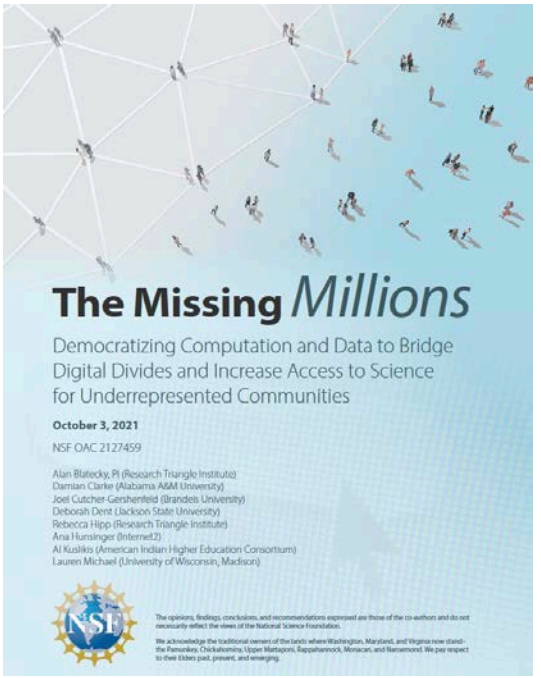


NSF-supported CI Ecosystem

Democratizing access to the National Research Infrastructure

Goals

- **Discovery & Access:** Provide unified access portals / mechanisms across the CI ecosystem
- **Allocation:** Support a diversity of allocation model, including on-demand (cloud-like), urgent access, etc.; expedite access to resources
- **Support:** Develop agile and scalable models for support; ensure support is responsive to local needs



The Missing Millions: Democratizing Computation and Data to Bridge Digital Divides and Increase Access to Science for Underrepresented Communities (A. Blatecky, EAGER)

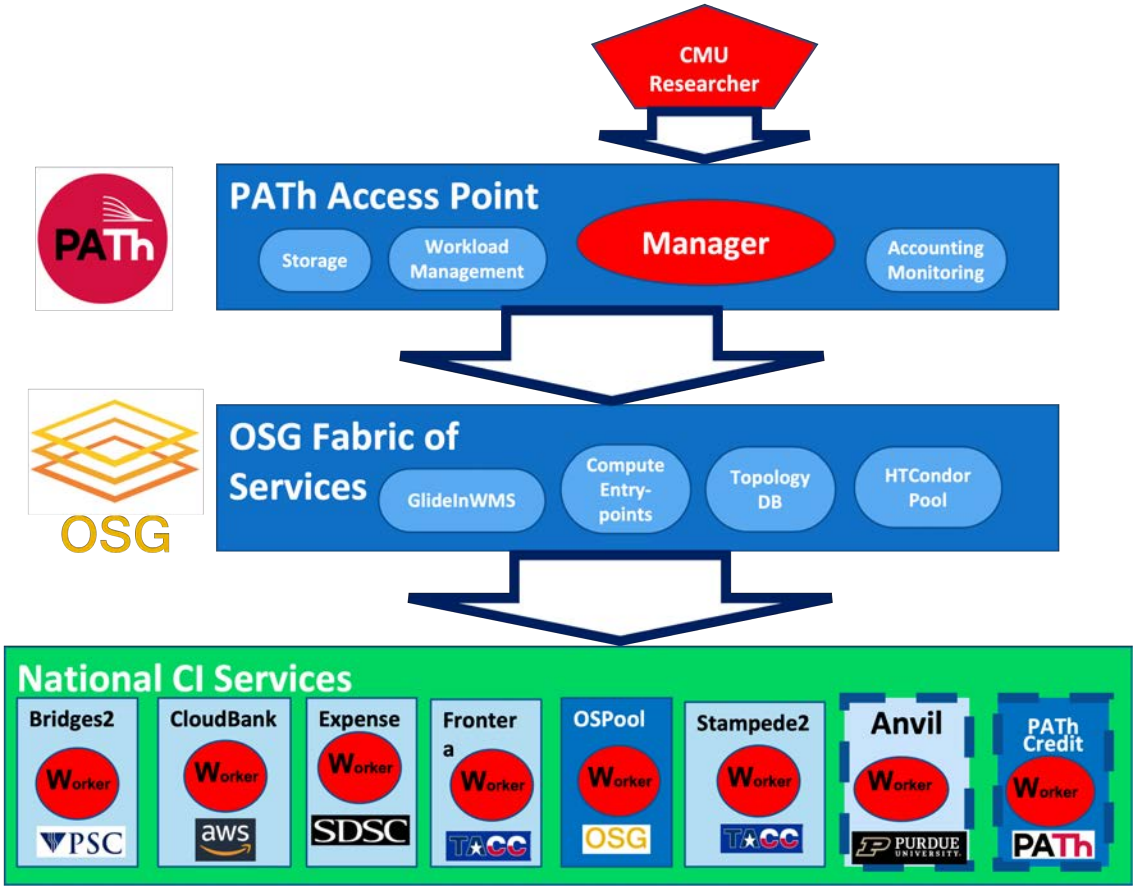
https://www.rti.org/publication/missing-millions/fulltext.pdf

Democratizing access to the National Research Infrastructure

Goal => Actions

- **Access:** Provide unified access portals / mechanisms across the CI ecosystem
  - **Research Resource Access Pilot:** Enable a user to launch a high-throughput workflow across a range of resources using existing allocations and credits
- **Allocation:** Support a diversity of allocation models; expedite access to resources
- **Support:** Develop agile and scalable models for support; accessibility and resource integration; ensure support is responsive to local needs

Democratizing access to the National Research Infrastructure



Democratizing access to the National Research Infrastructure

Goal => Actions

- **Access:** Provide unified access portals/mechanisms across the CI ecosystem
  - **Research Resource Access Pilot:** Enable a user to launch a high-throughput workflow across a range of resources using existing allocations and credits
- **Allocation:** Support a diversity of allocation models; expedite access to resources
  - **Research Resource Allocation Pilot:** Support allocations of high-throughput resources during proposal review (**DCL NSF 22-051**; 14 participating programs)
- **Support:** Develop agile and scalable models for support; accessibility and resource integration; ensure support is responsive to local needs
  - **OAC Vision & Blueprint: Cyberinfrastructure Learning & Workforce Development** https://www.nsf.gov/cise/oac/vision/blueprint-2019/
  - **Advanced Computing Cyberinfrastructure Ecosystem: Support Services** (ACCESS - NSF 21-555; ACCESS-ACO - NSF 21-556)

Strengthening the CI Professionals Workforce

Developing an NSF-wide Strategy for CI Professionals: Goals

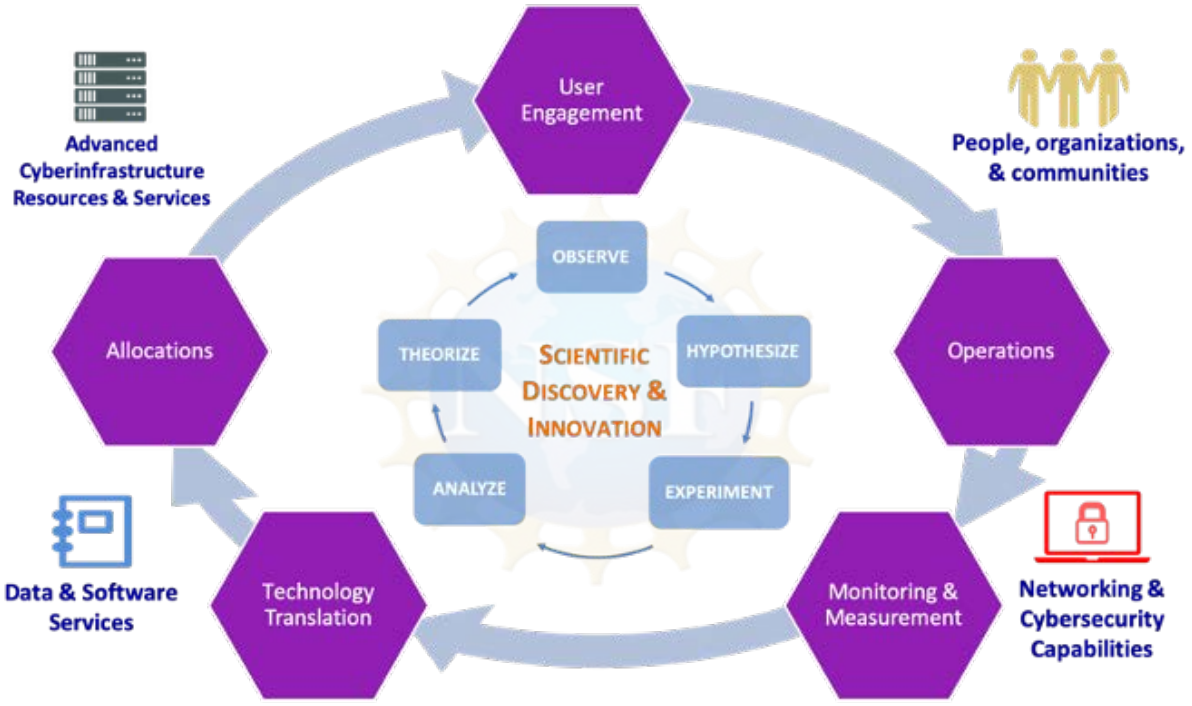
- Promote professional development, career paths; incentivize coordination; address sustainability
- Establish, foster and nurture a community
- Incentivize/support the development of necessary academic structures/career paths

Strengthening the CI Professionals Workforce

Developing and NSF-wide Strategy for CI Professionals: Goals => Actions

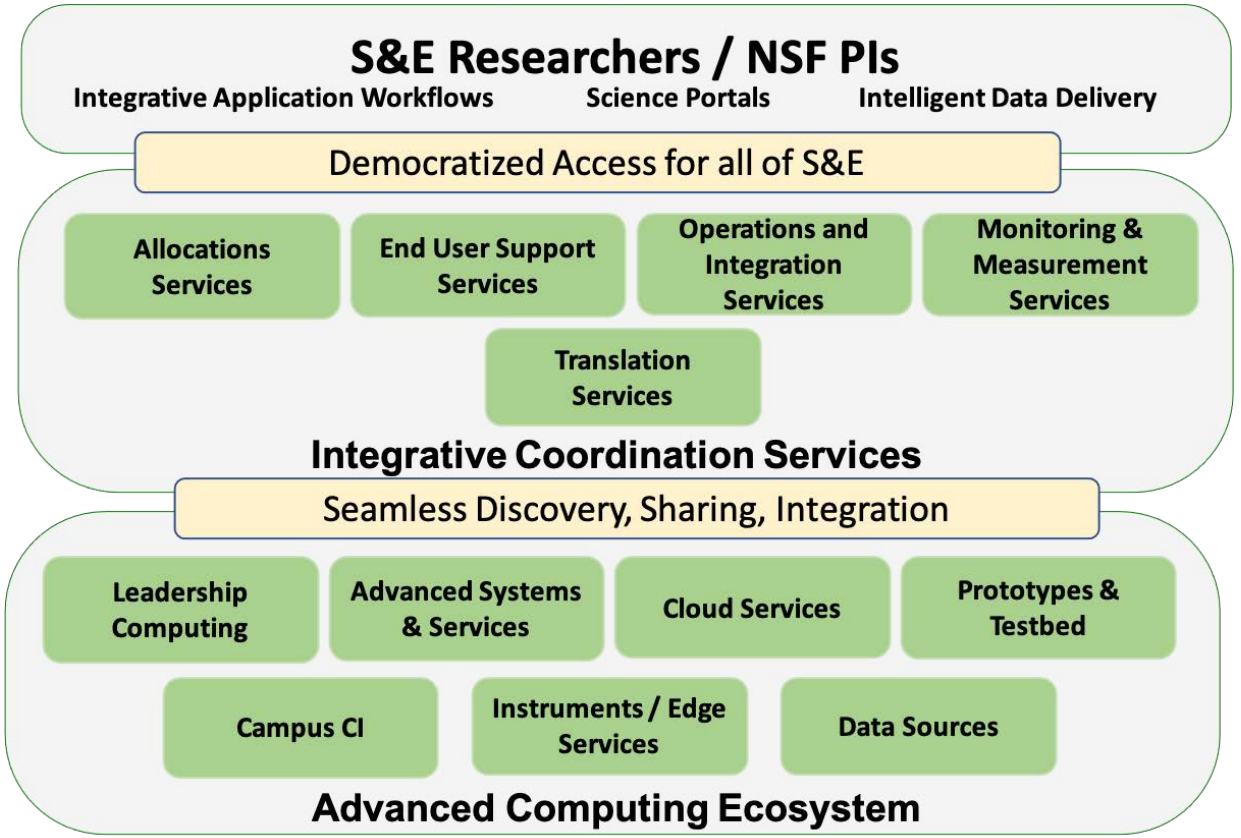
- Promote professional development, career paths, incentivize coordination; address sustainability
  - **Nurturing Diverse, Skilled, Capable, and Productive Communities of Cyberinfrastructure Professionals** (DCL; NSF 22-052)
    - **CI Professional Mentoring and/or Professional Development Plan** requirement in solicitations funding CI professionals
  - **Better Scientific Software Fellows** (https://bssw.io)
- Establish, foster, and nurture a community
  - CI CoE Pilot: **Minority Serving Cyberinfrastructure Consortium** (MSCC)
  - Research Coordination Networks: **Fostering and Nurturing a Diverse Community of CI Professionals** (RCN:CIP;-NSF 22-558)
  - **Training-based Workforce Development for Advanced Cyberinfrastructure** (CyberTraining; NSF 22-574; due May 16, 2022)
- Support the development of academic structures/career paths
  - CI CoE Pilot: **Research Computing and Data Resource and Career Center** (http://rcd-nexus.org)

Coordination Services: XSEDE/XMS => ACCESS



CI Coordination Services

Envisioning a National Research Ecosystem (Cloud)



Toward a National Research Ecosystem

FUTURE ADVANCED COMPUTING ECOSYSTEM

Integrating data, compute, software, and educational resources for the science and engineering community

SUBCOMMITTEE ON OPEN SCIENCE

Establishing an open data commons

NATIONAL AI RESEARCH RESOURCE

Integrating data, compute, software, and educational resources for the AI community

NITRD (SC AND IWGs) NATIONAL DISCOVERY CLOUD

Advancing research on the technical foundations of a discovery cloud environment

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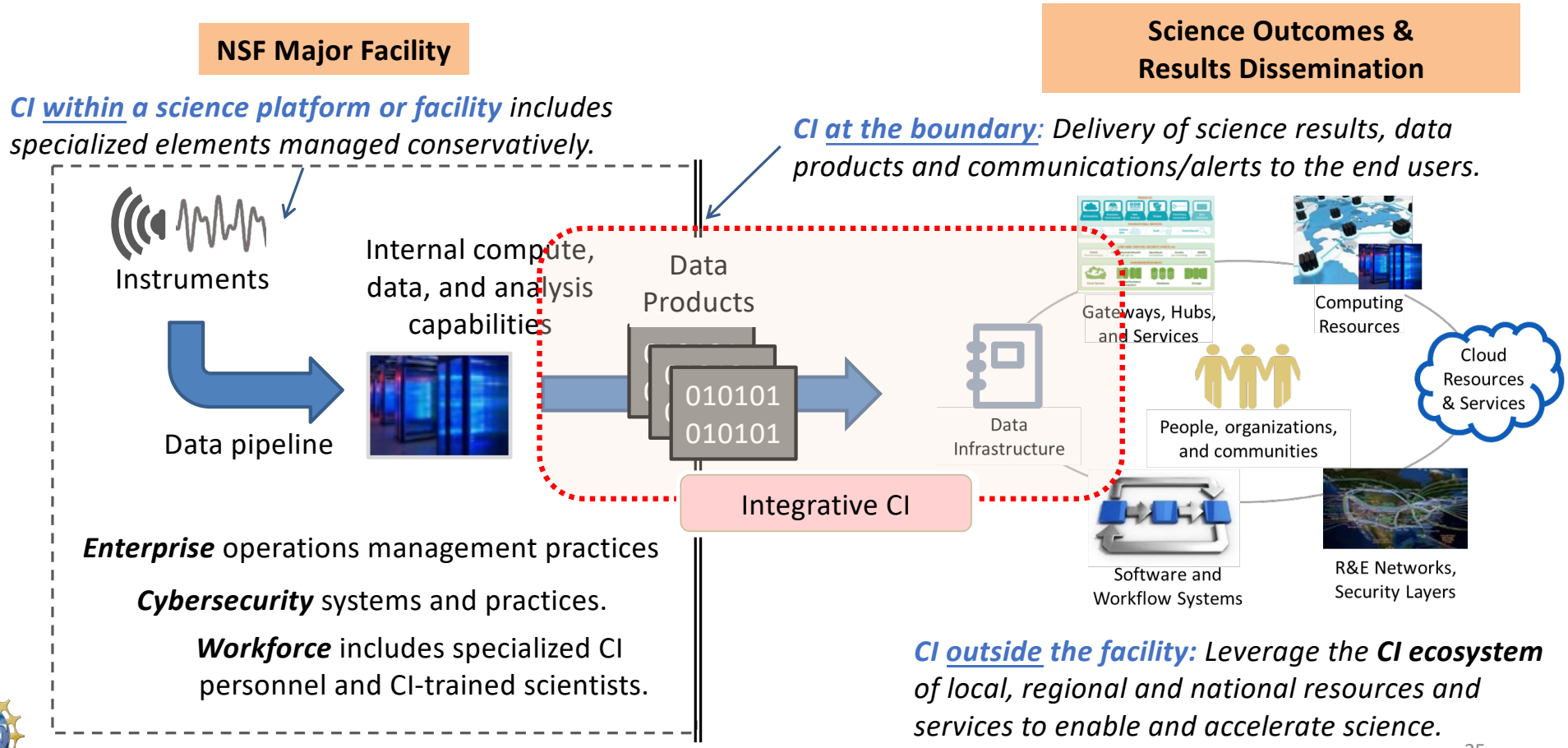
NSF Major Facilities & Cyber-infrastructure

NSF Major Facilities present CI challenges … and opportunities

- Major Facilities represent some of the largest NSF investments, producing scientific advances and discovery at scale
- CI is now essential to facility operations and scientific mission … but is complex, and evolves rapidly
- Facilities find it challenging to keep up with the state-of-the-art and maintain CI that is robust, secure, performant and scalable
  - Ensuring FAIR principles and equitable access
  - Supporting increasing remote use
  - Addressing dynamically-evolving science requirements,
  - Responding to growing security challenges/threats
- Significant gains in facility science and expansive impact can be achieved by leveraging the national CI ecosystem and expertise
- Ensure that facility science is transformed (not limited) by its CI

NSF Facilities CI Workshops: http://www.facilitiesci.org/

Deconstructing Facilities Cyberinfrastructure



NSF Major Facilities & Cyber-infrastructure

- What are the appropriate metrics to capture CI expectations across the MF lifecycle?
- How can we infuse appropriate CI considerations across all MF life-cycle stages, including at conceptual, preliminary, and final design?
- How can we instill an “evolutionary mindset” around CI at conception?
- How can MFs be better aligned with and leverage NSF’s broader investments in CI resources, services, and expertise?
- What other approaches and services can NSF offer to incentivize sustainable and portfolio-oriented CI considerations?

Thank You

"Make no little plans; They have no magic to stir men's blood …"

Daniel H. Burnham, Architect and City Planner Extraordinaire, 1907.

"If you want to travel fast, travel alone;
if you want to travel far, travel together"

African Proverb.

Manish Parashar

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Send an email to: OAC-ANNOUNCE-subscribe-request@listserv.nsf.gov

NSF Office of Advanced Cyberinfrastructure (OAC)

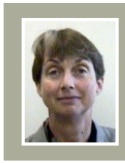
Foster a cyberinfrastructure ecosystem to transform science and engineering research… through Research CI and CI research

Manish Parashar *
Office Director

Kevin Thompson
Acting Deputy
Office Director

* IPA Appointment
** Federal Detail
*** NSF Detail

Bob Chadduck


Amy Walton

Tevfik Kosar *

Andrey Kanaev

Bogdan *** Mihaila (MPS/PHY)

Martin Halbert *

Ed Walker

Robert Beverly **

Alan Sussman *

Alejandro Suarez

Seung-Jong (Jay) Park *

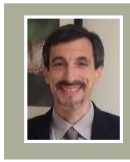
Juan (Jenny) Li *

We're hiring!

Varun Chandola *

Ashok Srinivasan *

Tom Gulbransen *


Bill Miller (on detail at DOE)