



# Overview of NSF's Office of Advanced Cyberinfrastructure and Future Directions

September 27, 2023

Katie Antypas

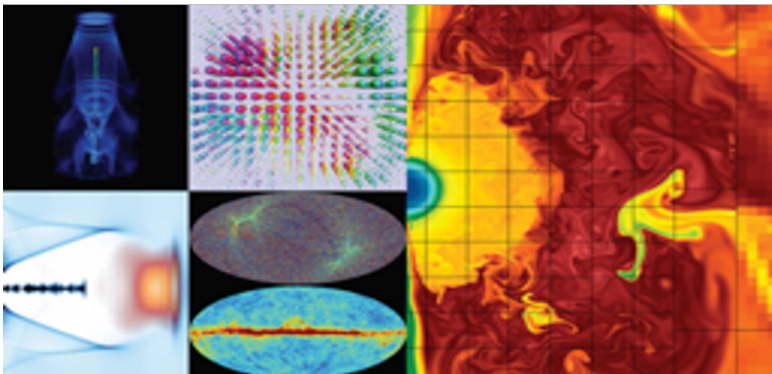
Office Director, NSF Office of Advanced Cyberinfrastructure

# My background and experience engaging with and supporting the research community on advanced computational and data systems



NERSC Staff in front of Cori Supercomputer


- Scientific Parallel Programmer, University of Chicago, Flash Center, 2004-2006
- HPC Consultant, User Services Group, NERSC-6 Project Team, NERSC 2006-2010
- Group Lead, User Services Group, 2010-2013
- Scientific Computing and Data Services Department Head, 2013-2015
- NERSC-8 (Cori) Project Director, 2013-2017
- Data Department Head, 2015-2022
- Fellow, DOE Oppenheimer Science and Energy Leadership Program 2016-2017
- NERSC Division Deputy 2017- 2023
- NERSC-9 (Perlmutter) Project Director, 2018-2019
- Director of Hardware and Integration, Exascale Computing Project, 2020-2023
- NERSC-10 Project Director, 2021-2023



National Energy Research  
Scientific Computing Center



# Office of Advanced Cyberinfrastructure




**Katie Antypas**  
Director




**Carl Anderson**  
Staff Associate for Operations




**Amy Walton**  
Deputy Office Director




**Appolinaire Abo**




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**Jalexus Ashley**




**Sharmistha Bagchi-Sen**




**Rob Beverly**




**Daniel Bullock**




**Bob Chadduck**




**Christine Christy**




**Varun Chandola**




**Sharon Geva**




**Sheikh Ghafoor**




**Tom Gulbransen**



**Bill Miller**  
Senior Advisor




**Andrey Kanaev**




**Juan (Jen) Li**


**Gabrielle Marshal**




**Marlon Pierce**




**Plato Smith**




**Ashok Srinivasan**




**Alejandro Suarez**




**Kevin Thompson**




**Annabel Virella**



**Ed Walker**



**Deborah White-Wilkins**



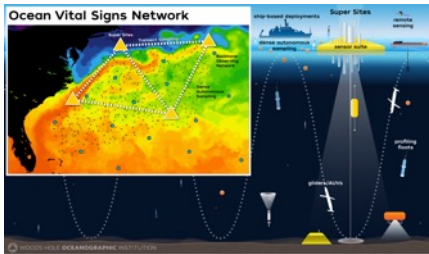
**Rediet Woldelessie**



# FY23 was an exciting year for OAC



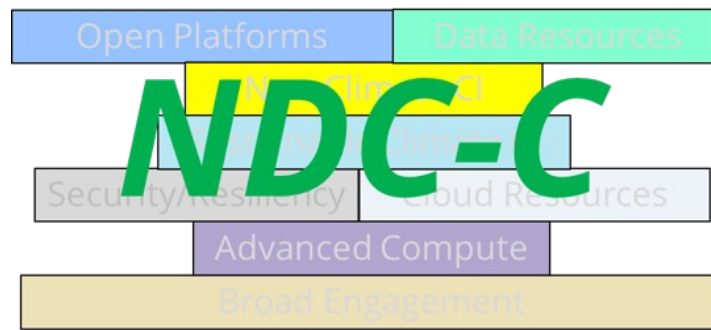
Expansion of MS-CC



Software and Data Infrastructure investments through CSSI



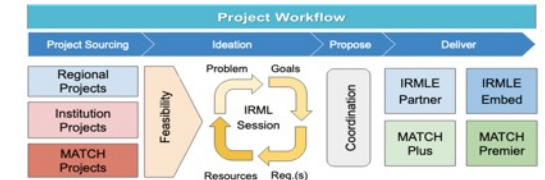
Awards for DeltaAI and Stampede 3



National Discovery Cloud - Climate



NAIRR pilot



New Pathway for CI professionals

**ICICLE: Intelligent CyberInfrastructure with Computational Learning in the Environment**

Systems AI Foundational Research for CI

Intelligent Cyber Infrastructure

CI for AI      AI for "CI for AI"

Sponsor of AI Institute



Cybersecurity Innovation

# OAC investment areas

## Advanced Computing

Production and operational level advanced computing and data capabilities and services

## Networking & Cybersecurity

Advanced networking capabilities that preserve security and privacy

## Learning & Workforce Development

Foster a national research workforce for creating, utilizing, and supporting advanced CI

## Software & Data CI

Develop a cohesive, federated, national-scale approach to research data infrastructure

## Strategic Investments

Special opportunities, cross-cutting and national initiatives, CI for open science and public access



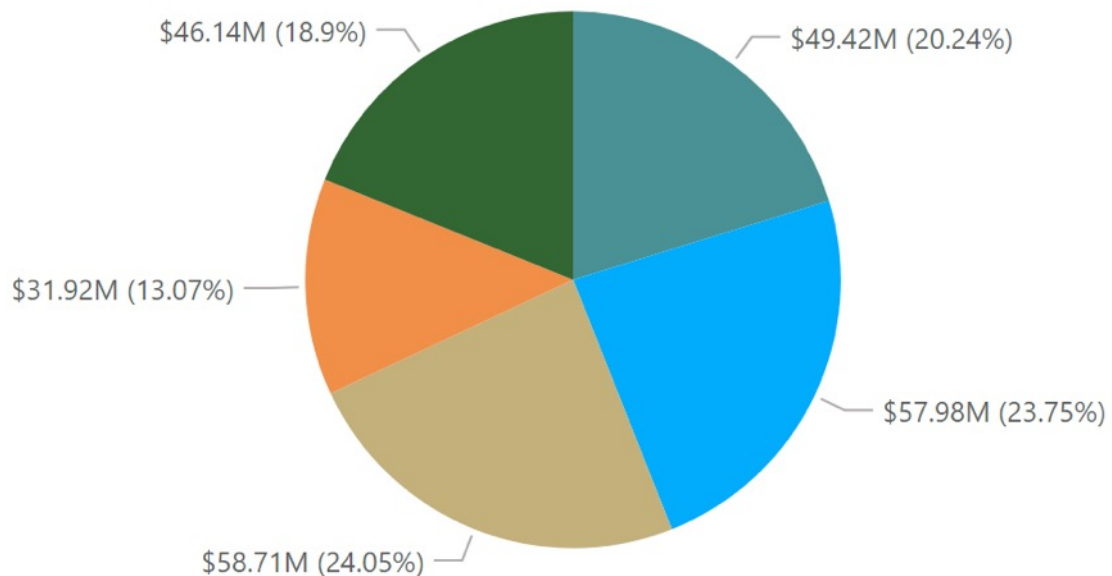
# OAC FY23 by the numbers

## \$246.46M

Total Spent

### Program Area

- Learning & Workforce Develop.
- Advanced Computing
- Software & Data
- Networking & Cybersecurity
- Special Projects & DD Reserve

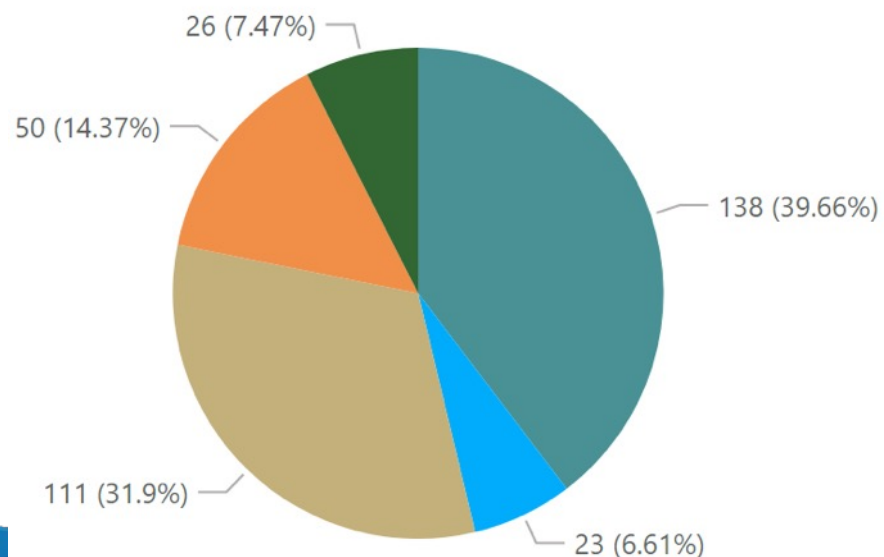


## 351

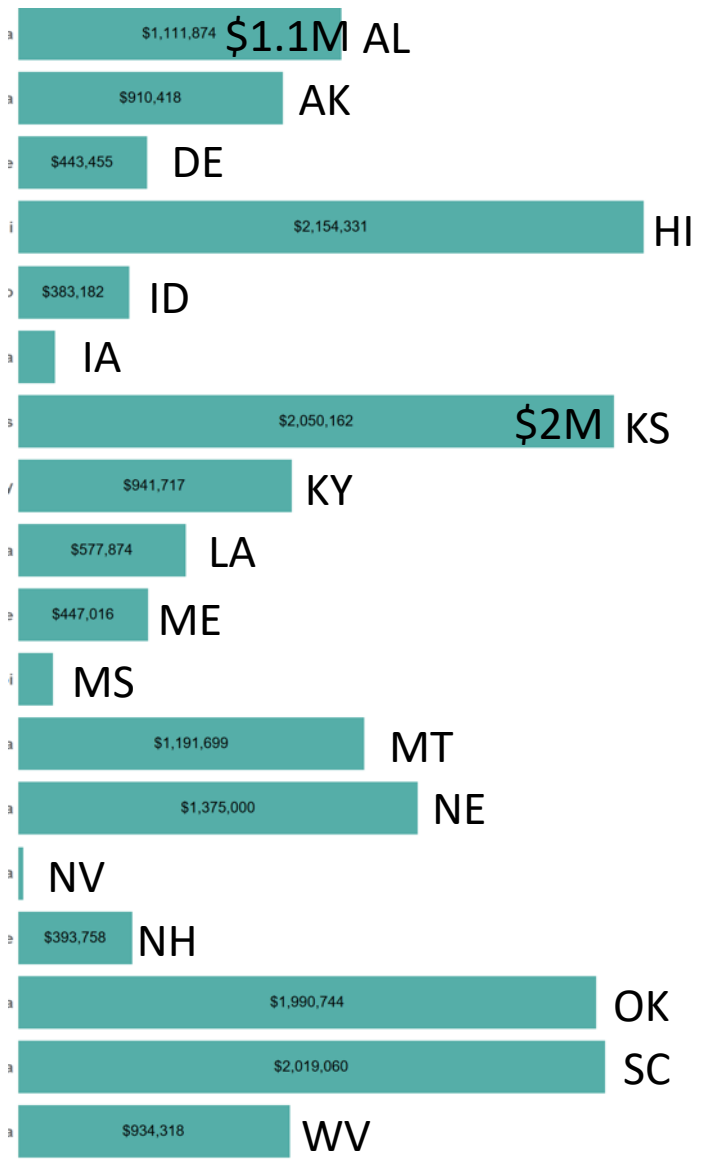
Total Award Count

### Program Area

- Learning & Workforce Develop.
- Advanced Computing
- Software & Data
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- Special Projects & DD Reserve



# OAC managed \$17M funding in EPSCOR states with significant matches from other directorates

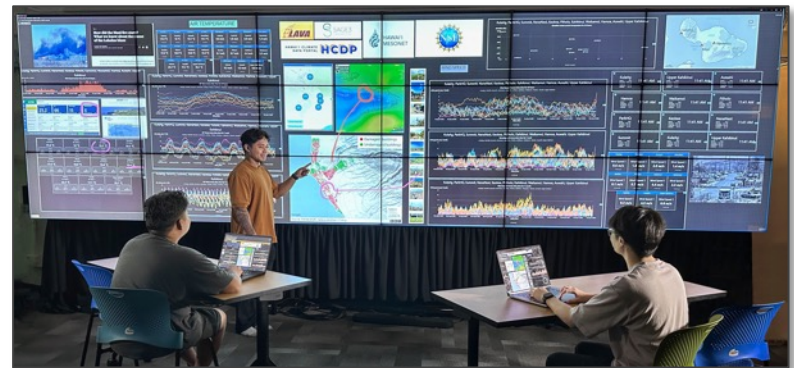


## RAPID – an Evaluation of an Artificial Intelligence-enhanced Edge Sensor System for Multi-Hazard Monitoring and Detection (Award #2346568)

- Estimated recovery will cost **\$5.5B** and years
- RAPID builds on 3 OAC activities – Hawai'i Mesonet, Sage, and SAGE3
- Data gathering to aid recovery efforts, serve as proof-of-concept for future hazard monitoring scenarios



↓
Hawai'i Climate Data Portal  
 (EPSCoR Change Hawai'i 2117975)
 ↓

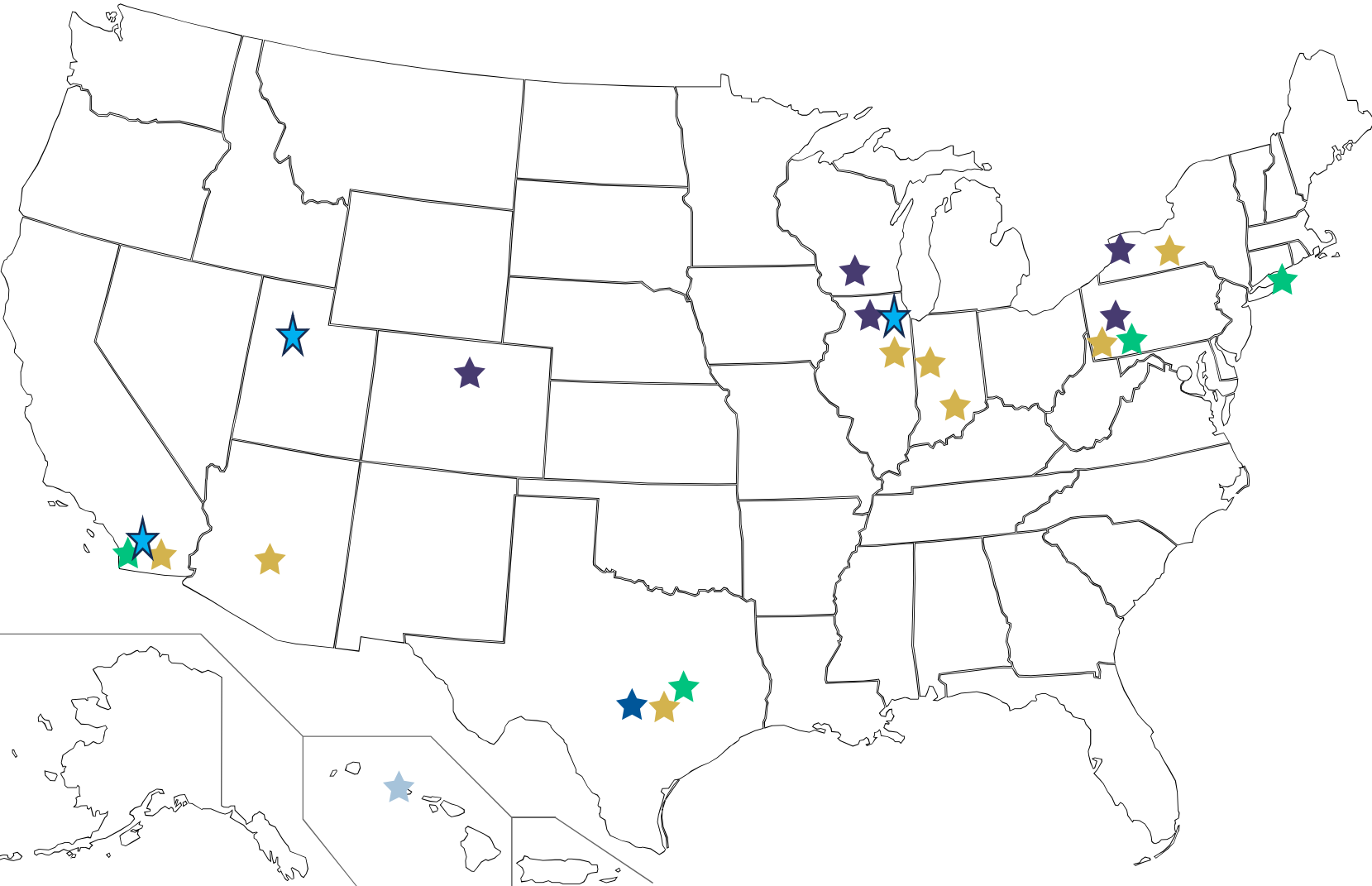


# OAC investments in OK in past 5 years

Award ID	Award Title	Institution	Start date	Award Amount
<u>1925744</u>	CC* Regional: Extended Vital Education Reach Multiple Organization Regional OneOklahoma Friction Free Network (EVER-MORE-OFFN)	Oral Roberts	07/15/2019	\$500,000.00
<u>2018453</u>	CC* Regional: Small Institution Multiple Organization Regional OneOklahoma Friction Free Network (SI-MORE-OFFN)	Osrhe	08/01/2020	\$232,275.00
<u>2118193</u>	CyberTraining: Pilot: A Professional Development and Certification Program for Cyberinfrastructure Facilitators	U Of Oklahoma	09/01/2021	\$299,993.00
<u>2126285</u>	CC* Regional: Extended Small Institution - Multiple Organization Regional - OneOklahoma Friction Free Network (ESI MORE OFFN)	Osrhe	09/15/2021	\$414,595.00
<u>2118180</u>	Collaborative Research: CyberTraining: Implementation: Medium: Establishing Sustainable Ecosystem for Computational Molecular Science Training and Education	Oklahoma State	10/01/2021	\$104,997.00
<u>2201435</u>	CC* Compute: GPU HPC Cluster Partition for Research, Education, and Student Success	Oral Roberts	05/15/2022	\$431,382.00
<u>2201479</u>	CC* Compute: Collaboration in Computing Infrastructure for Research and Education (CO-InResE)	Langston	05/15/2022	\$399,262.00
<u>2201561</u>	CC* Compute: OneOklahoma Cyberinfrastructure Initiative Research Accelerator for Machine Learning (OneOCII-RAML)	U Of Oklahoma	06/01/2022	\$400,000.00
<u>2201442</u>	CC* Regional: Campus Research & Education Multiple Organization Regional OneOklahoma Friction Free Network (CaRE-MORE-OFFN)	Osrhe	07/01/2022	\$942,263.00
<u>2216084</u>	MRI: Acquisition of a High-Performance Computational System for OAK Region to Enable Computing and Data Driven Discovery	Oklahoma State	08/15/2022	\$4,000,000.00
<u>2311442</u>	Elements: An Integrated Software Platform for Simulating Polariton Photochemical and Photophysical Processes	U Of Oklahoma	7/1/23	\$599,597
<u>2319895</u>	Collaborative Research: CyberTraining: Pilot: PowerCyber: Computational Training for Power Engineering Researchers	Oklahoma State	1/1/24	\$180,000
<u>2321401</u>	CC* Regional Networking: Setting Up Research Foundations for a Multiple Organization Regional and OneOklahoma Friction Free Network	Osrhe	9/1/23	\$1,179,147



# NSF-supported Advanced Cyberinfrastructure Resources



## Innovative Production Systems

- Anvil
- Bridges 2
- Delta
- Delta AI
- Expanse
- Jetstream 2
- Stampede 2
- Stampede 3

## Innovative Prototypes/Testbeds

- Neocortex
- Voyager
- Ookami
- NRP
- ACES

## Leadership-class

- Frontera

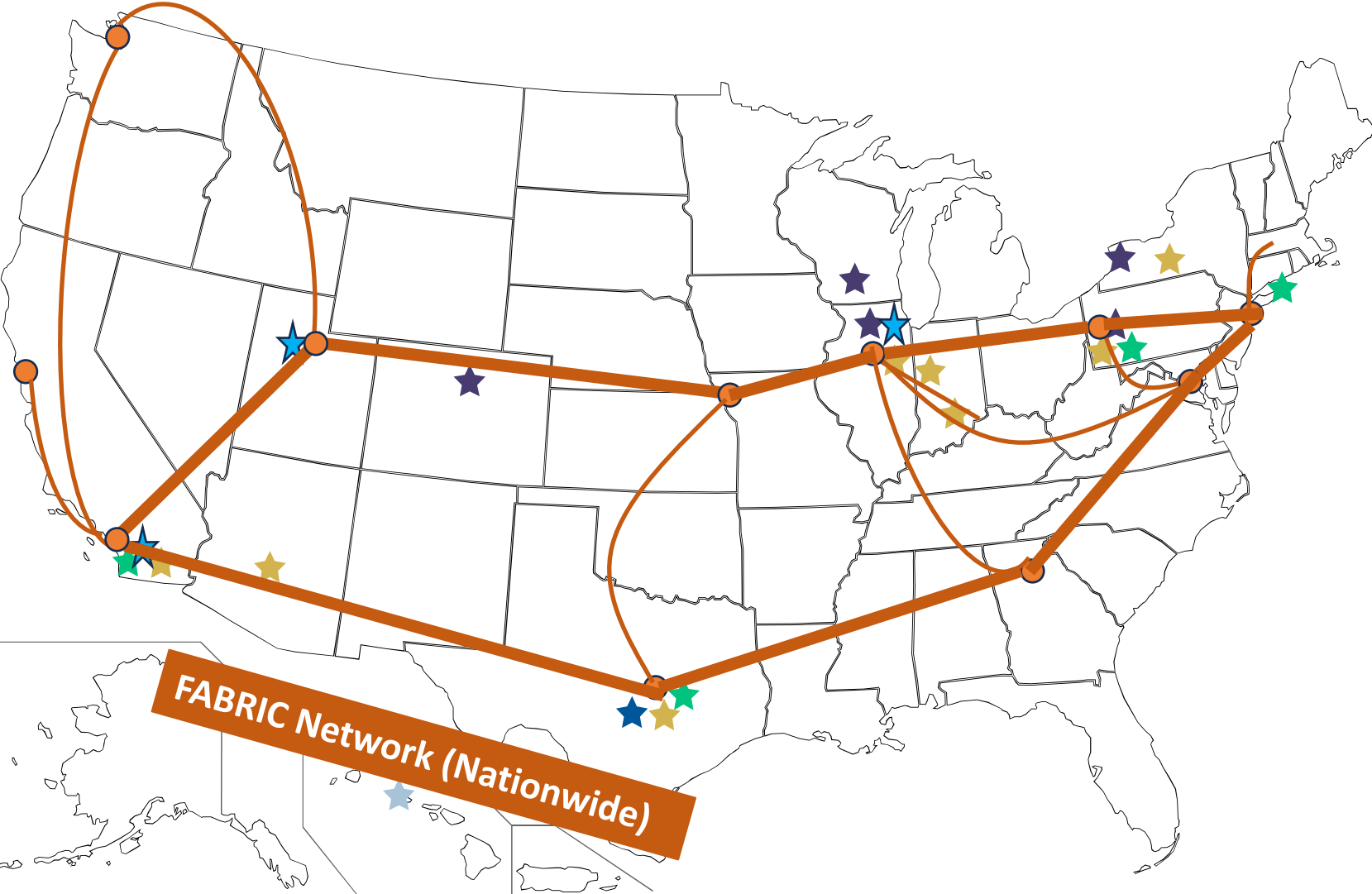
## Distributed Services

- PATH / Open Science Grid
- ACCESS

## Cloud Technologies/Access

- Cloudbank
- Cloudlab
- Chameleon Lab

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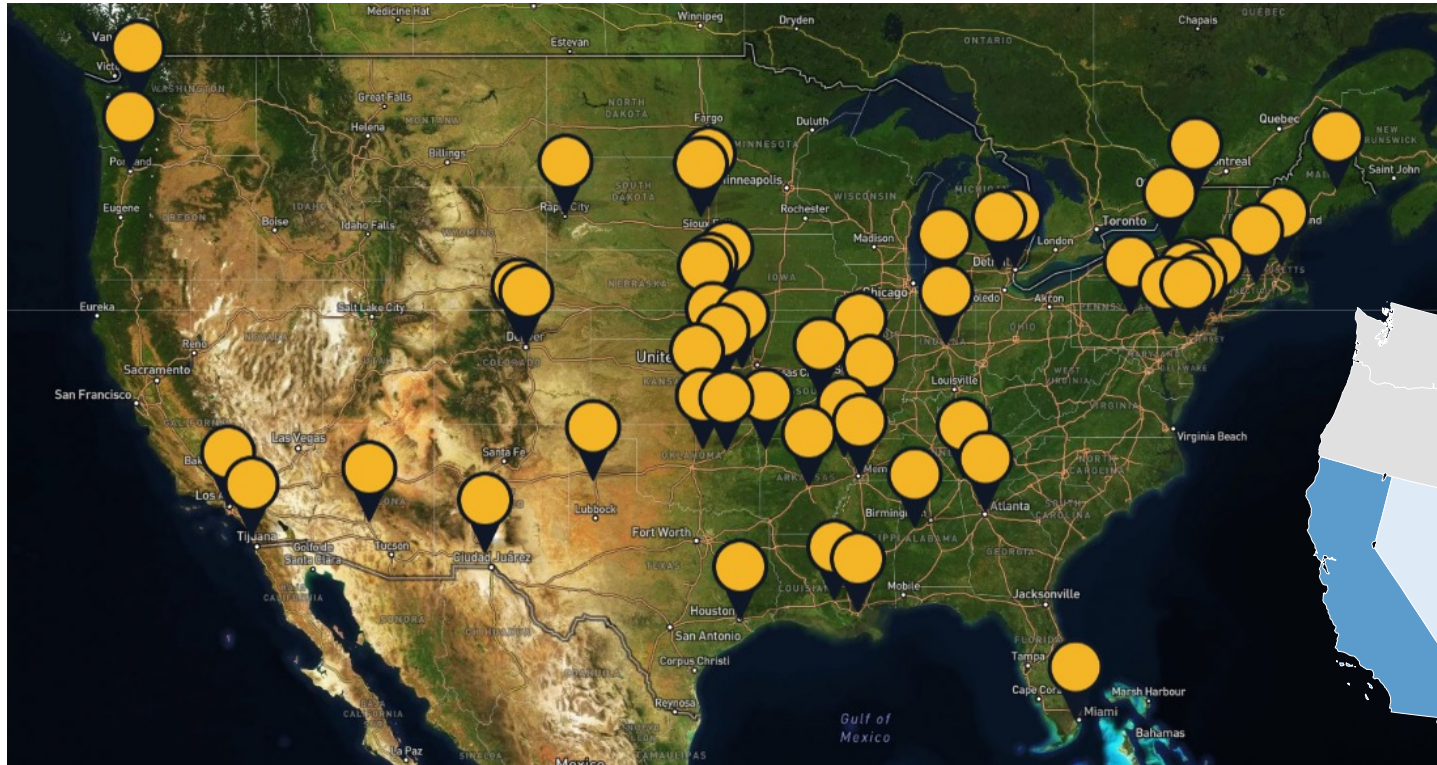
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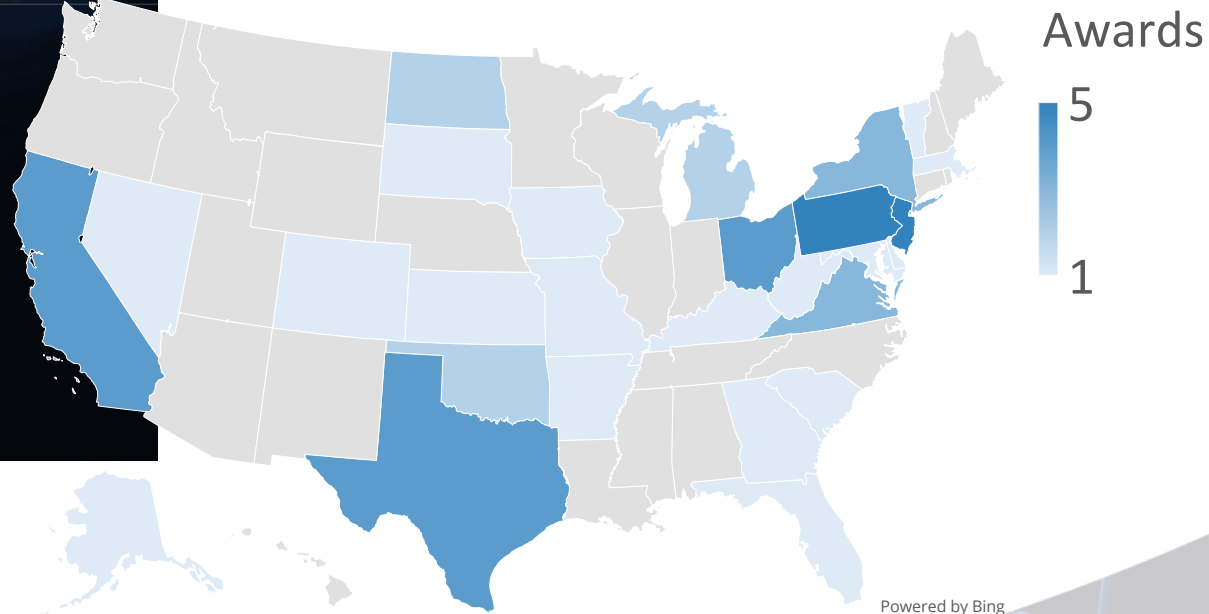
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- Cloudbank
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# Campus and region infrastructure supported by CC\*, EPSCOR and NSF's Major Research Instrumentation (MRI) awards



CC\* compute/storage sites in Open Science Grid's general science pool



MRI Campus/regional computing awards



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© GeoNames, Microsoft, TomTom

# Leadership-Class Computing Facility (LCCF)

Advanced Computing



LEADERSHIP-CLASS  
COMPUTING FACILITY

The LCCF led by the Texas Advanced  
Computing Center (TACC)

5 Distributed Sites

27 academic partners, including 10  
MSI partners:

5 HBCUs

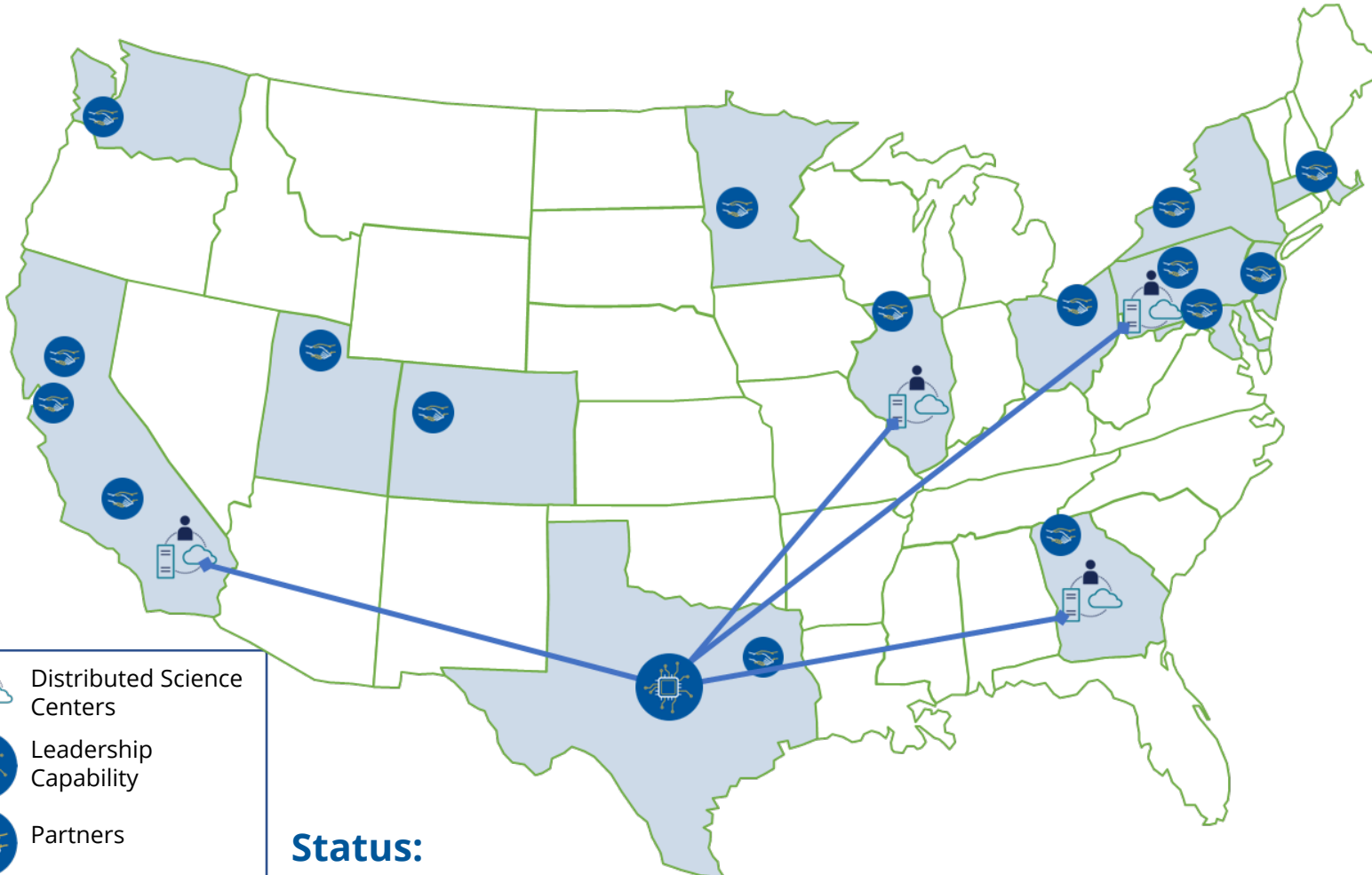
4 HSIs

1 AANAPISI

Broadening Participation partners:



Distributed Science Centers:



- Distributed Science Centers
- Leadership Capability
- Partners

## Status:

- Total Project Cost \$520M (FY24 NSF budget request)
- Completed Final Design Review – Early 2023
- Currently undergoing internal NSF review – target to begin construction in FY24.

# Campus Cyberinfrastructure (CC\*)

Must be SCIENCE DRIVEN

Must have a campus CI plan (except planning grants)

Seek to create partnerships – researchers, educators, IT organization



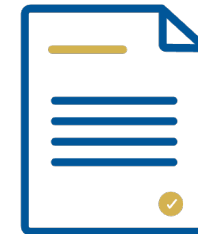
## Network

1. **Campus** up to \$650K
  2. **Regional** up to \$1.2M
  3. **Innovation** up to \$1M
- Technical solution; network management plan and diagram



## Compute

4. **Campus** up to \$500K
  5. **Regional** up to \$1M
- Summary table of science drivers and needs; architecture; how 20% is shared



## Storage

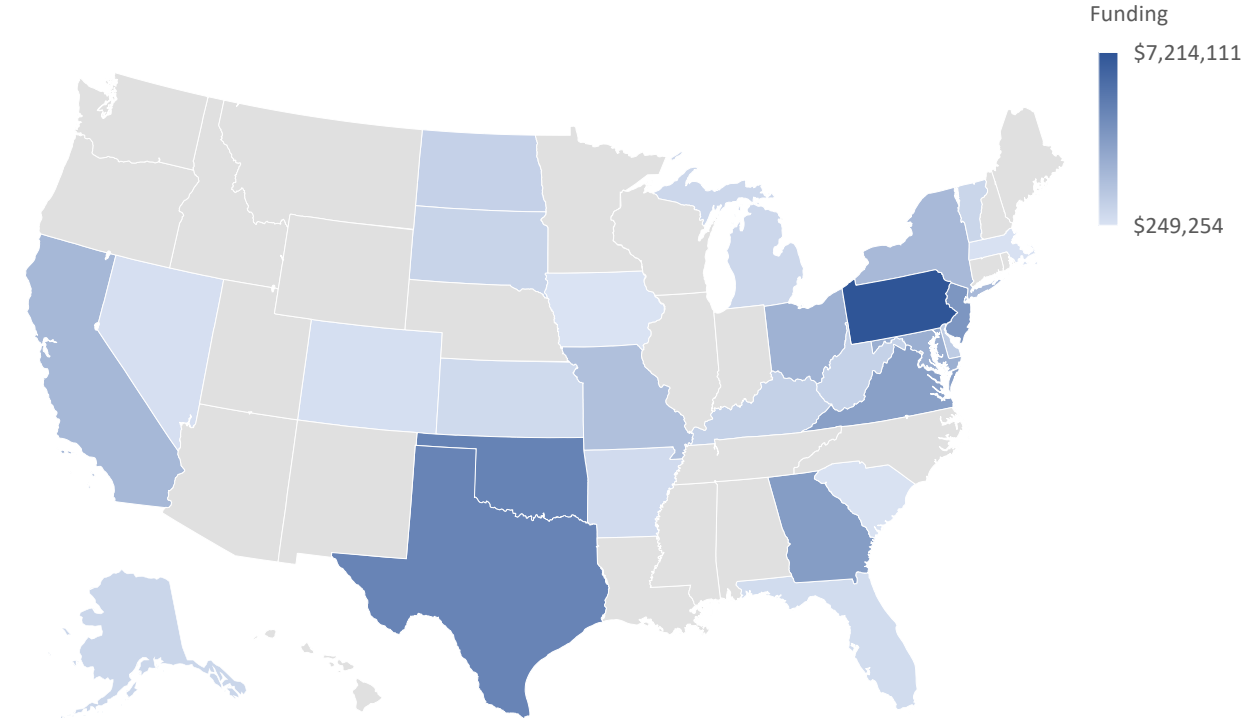
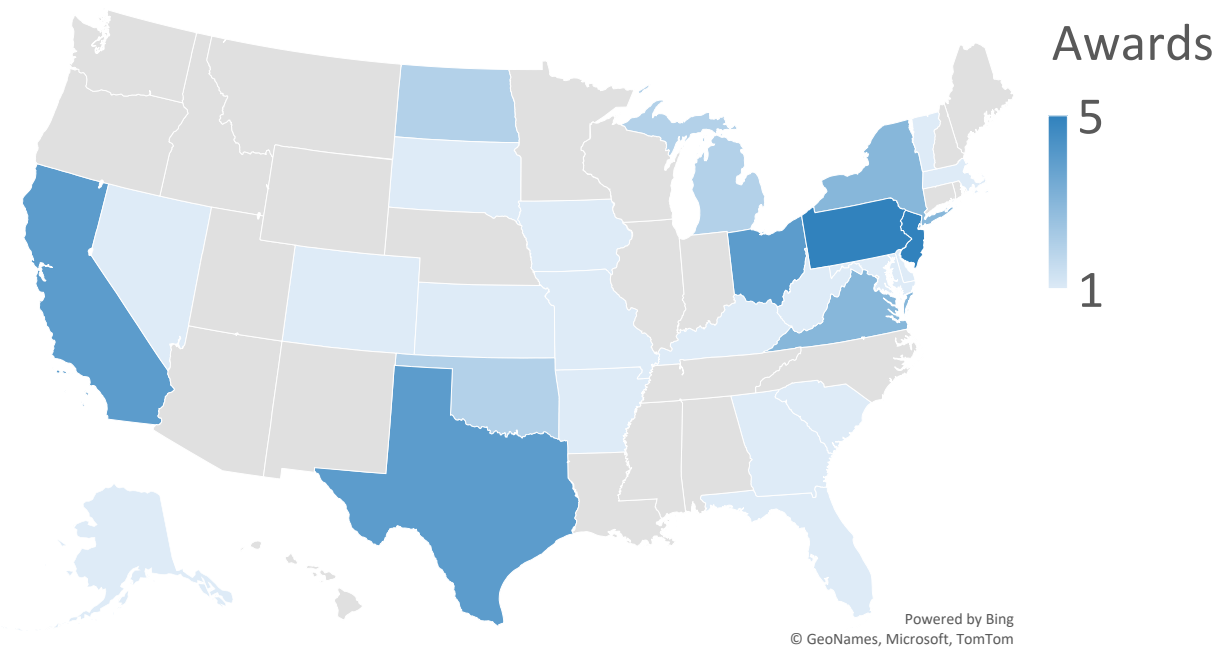
6. **Awards** up to \$500K
- Resource for multiple science projects; table of science drivers and needs; architecture; how 20% is shared extramurally



# NSF solicitation 23-526

# OAC MRI Portfolio FY2018 – FY2023

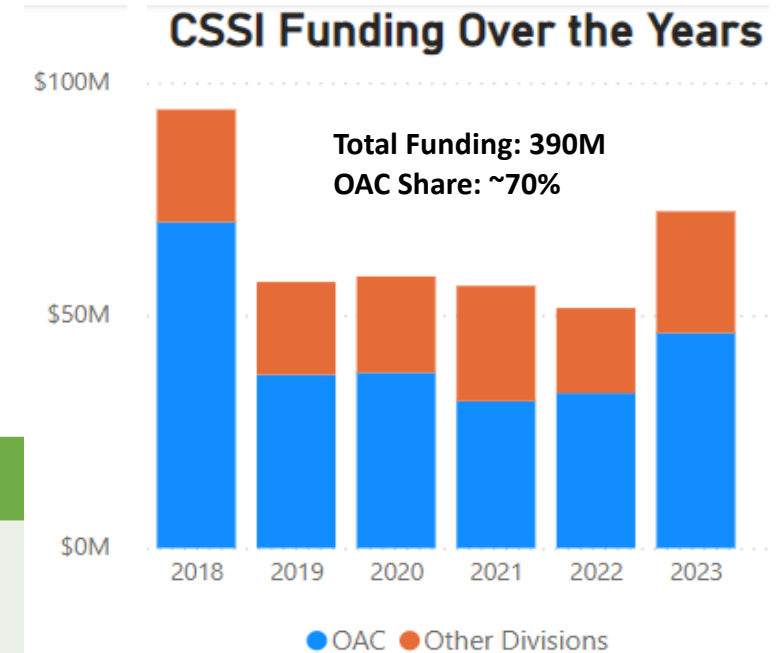
- 51 awards over last 5 years
- Over \$52M in awarded funds
- Most awards support multi-user high-performance computing instruments
- \$14.1M (27%) of funds to EPSCoR states
- Larger proposals have 'regional impacts' beyond host institution/state



# Cyberinfrastructure for Sustained Scientific Innovation (CSSI)

<https://www.nsf.gov/pubs/2022/nsf22632/nsf22632.htm>

- Supports the **development and deployment** of robust, reliable and sustainable **data and software cyberinfrastructure**
- Brings **innovative** capabilities towards sustained scientific innovation and discovery
- Provides a **cross-directorate** opportunity to advance common approaches to sustain and innovate research cyberinfrastructures



Project Class	Description
Elements	Small groups that will create and deploy robust capabilities (Awards <= \$600K, up to 3 years)
Framework Implementations	Larger, interdisciplinary teams developing common infrastructure aimed at solving common research resulting in a sustainable community framework. (Awards between \$600K - \$5 Million, between 3-5 years)
Transition to Sustainability	Groups executing a well-defined sustainability with demonstrated impact with focus on enabling new avenues of support for the long-term sustained impact. (Awards <= \$1 Million, up to 2 years)

Upcoming Dates	
Sept 26 – 27, 2023	PI Meeting, Houston TX
Dec 01, 2023	Program Deadline for FY24
Dec 02, 2024	Program Deadline for FY25



# Learning and Workforce Development

[Award Count, ~Impact Count]  
(Workforce Pipeline)

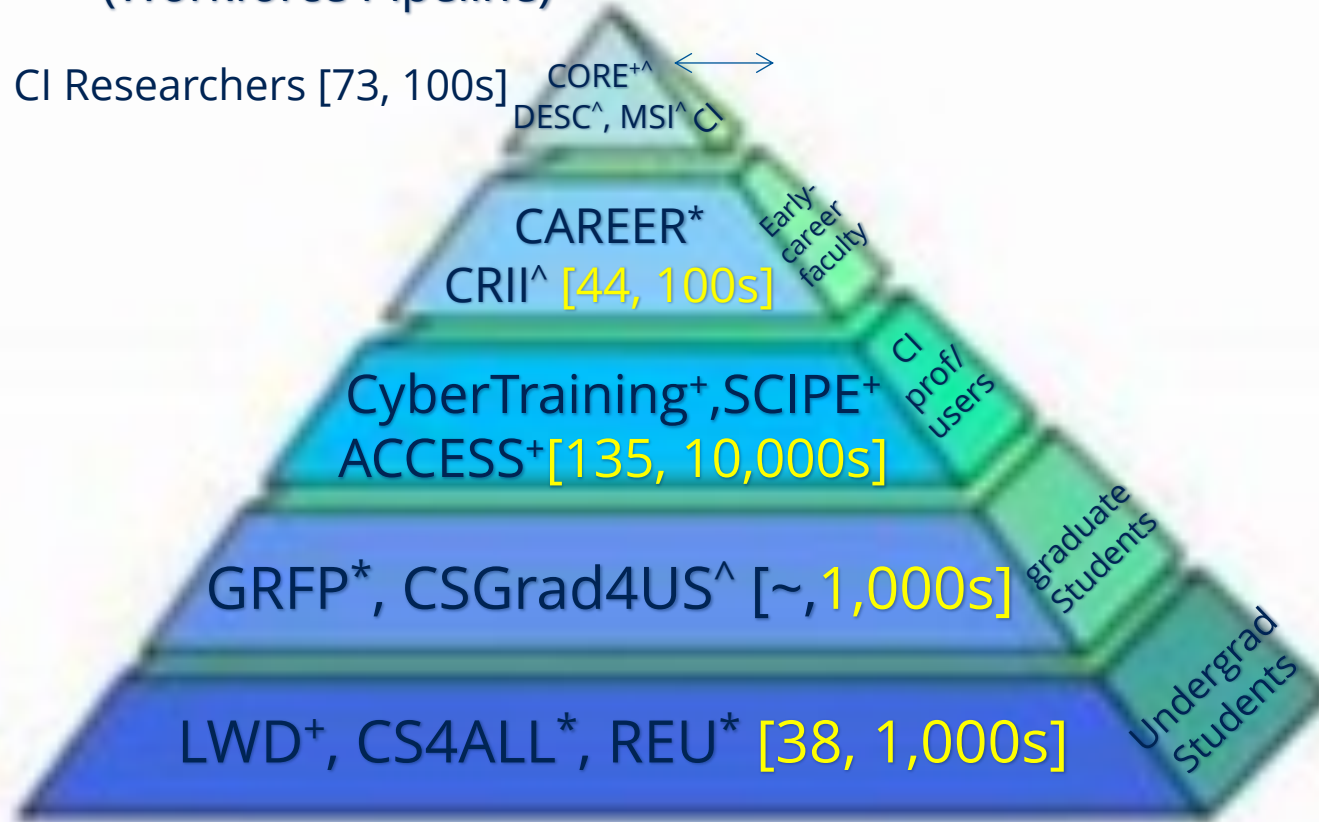


Figure Legend: \*NSF-Lead; ^CISE-Lead; +OAC-Lead.



# Cybersecurity Innovation for Cyberinfrastructure (CICI)

Support applied research to secure science data, workflows, and infrastructure that benefit the broader scientific community. Operationalize emerging cybersecurity techniques and develop new cybersecurity approaches specific to science CI domains



## Usable and Collaborative Security for Science (UCSS)

Collaboration, workflows, resource sharing



## Reference Scientific Security Datasets (RSSD)

Canonical science workflow datasets



## Transition to Cyberinfrastructure Resilience (TCR)

Improve the robustness, resilience of scientific CI



# NSF solicitation 23-517

# A look forward



# Changing user, technology, vendor and national landscape requires us to think deeply about our collective strategy for the future

New user communities requiring computing and data infrastructure

New technologies, hardware specialization, slowing of Moore's law, IAAS and SAAS

Rise of massive data and AI

New business models and entrants into the ecosystem

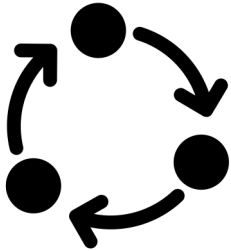
New and pending legislation and initiatives



PHOTO CREDITS: KIYOSHI TAKAHASE SEGUNDO/ALAMY STOCK PHOTO, SHUTTERSTOCK, AMD GPU



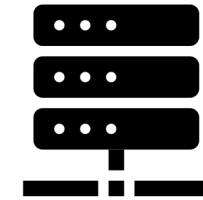
# Transform science and engineering research through an integrated cyberinfrastructure ecosystem



Defining, advancing and interconnecting broad CI ecosystem



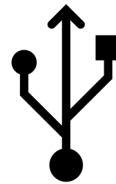
Growing and developing human infrastructure - expertise



Enabling discovery through data & software infrastructure

## **NAIRR**

Infrastructure for AI



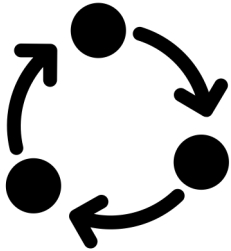
Investing in and transitioning to new technologies



Developing partnerships for long-term US leadership in research CI



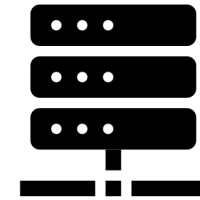
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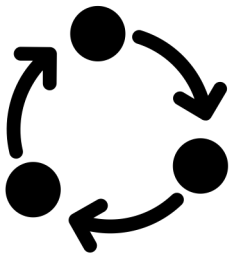


Investing in and transitioning to new technologies



Developing partnerships for long-term US leadership in research CI





# Defining, advancing, and interconnecting the broad CI ecosystem

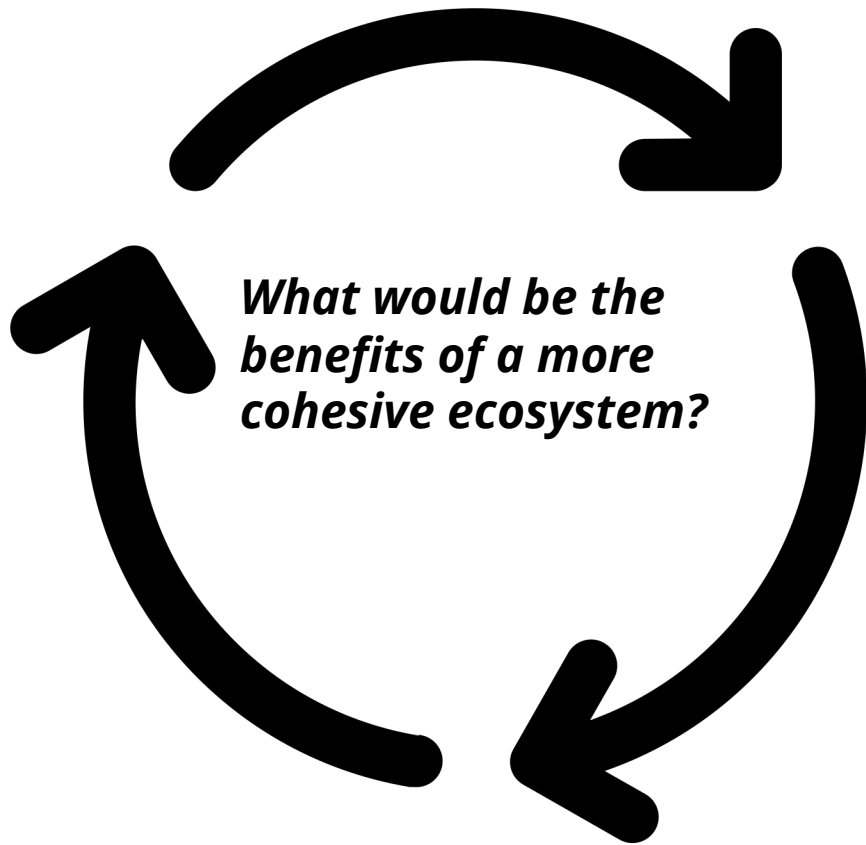
## *Challenges*

**OAC supports highly innovative, distributed systems, services and expertise**

- OAC portfolio of systems and services are hard for non-insider to understand
- While ACCESS has focused coordination of many resources, others are not included
- Difficult for OAC leadership to understand portfolio in aggregate, capabilities, users and workload that could inform future directions



# OAC Retreat last week addressed this topic



## ***Potential Benefits***

- Easier on-ramp for new communities to understand and access the portfolio of systems, services and capabilities
- Clear pathways for communities to transition from local and regional systems to national, cloud or other agency resources based on science need
- A single currency that can be exchanged for multiple types of resources
- Deeper understanding of the portfolio of OAC investments and workload





# Some key data challenges

- Democratizing access to datasets, decoupling data access from compute access
- Enabling AI ready community datasets
- Creating data pipeline tools and expertise
- Securing end-to-end complex workflows
- Enabling new modes of interacting with data and managing the data lifecycle



# National Discovery Cloud for Climate (NDC-C)

*In FY 2023, CISE will invest. . .in the development of a National Discovery Cloud (NDC) for Climate. This resource will federate advanced compute, data, software and networking resources, democratizing access to a cyberinfrastructure ecosystem that is increasingly necessary to further climate-related S&E. The NDC for Climate will serve as a pilot for future efforts to enable equitable access to an NDC across all fields of S&E. -- NSF FY 2023 Budget Request*

## Components of an NDC-C

Advanced Compute

Open Platforms

Data Resources

Broad Engagement

New Climate CI

Sustainable Climate CI

Security/Resiliency

Cloud Resources



# NDC-C Prototype Investments

## Advanced Compute

- DeltaAI
- Stampede3
- ACCESS/RAMPS

## Cloud Resources

- CloudBank
- CloudLab
- Chameleon

## Security/Resiliency

- Securing Hazard Workflows

## Open Platforms

- Pelican/OSDF
- National Data Platform Pilot
- Edge Computing Sage

## Data Resources

- NCAR/OSDF
- QGreenland-Net
- NOAA Sonar Data
- Campus Storage (EnviStor)

## Broad Engagement

- MS-CC
- AIHEC

## Sustainable Climate CI

- Atmospheric physics modeling
- Marine data access

## New Climate CI

- Glaciology, Ice Sheet Modeling
- Oceanographic Modeling
- Forest Ecosystems
- Permafrost Geomorphology



**National AI Research Resource:** a shared research infrastructure facilitating access to compute, software, datasets, models, training and user support for researchers and students

**Objective:** To strengthen and democratize the U.S. AI Innovation ecosystem in a way that protects privacy, civil rights, and civil liberties

**Goals:**



Spur  
**innovation**



Increase the **diversity**  
of talent in AI



Improve U.S.  
**capacity** for AI R&D



Advance  
**trustworthy AI**

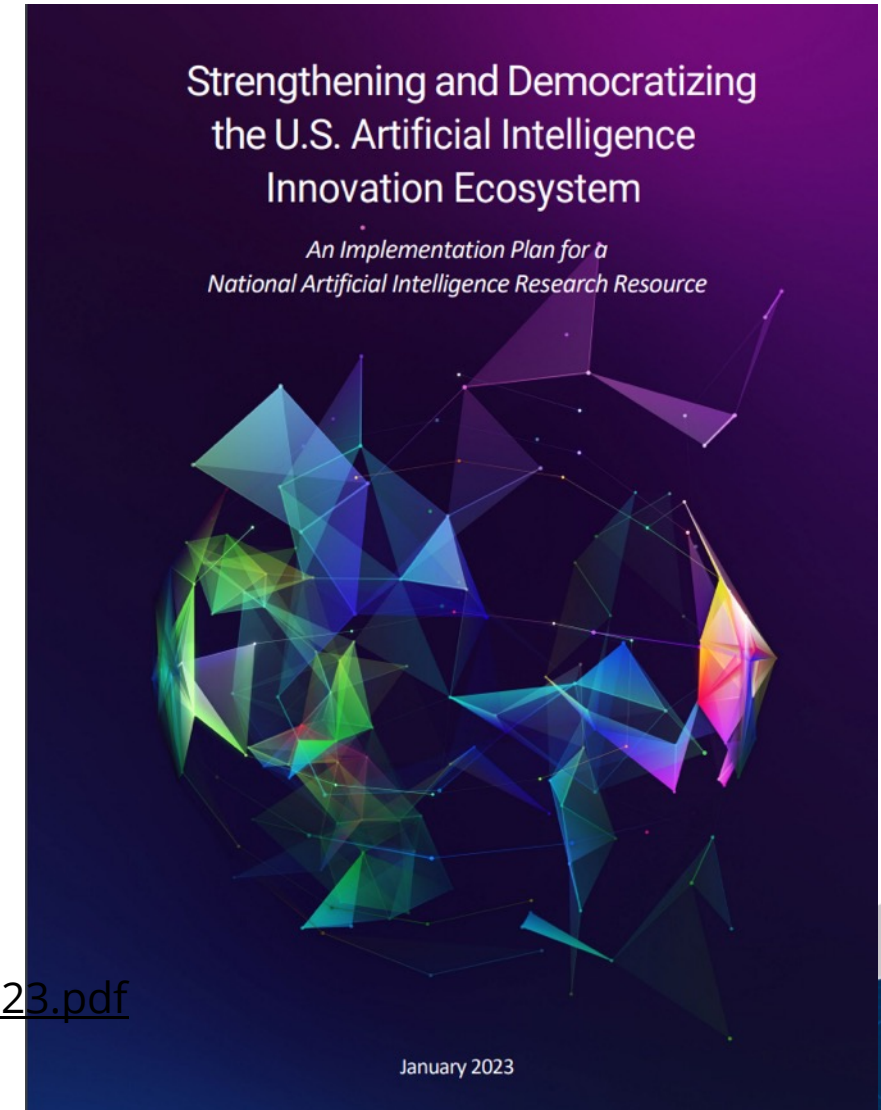


# National AI Research Resource (NAIRR) Background

- The National AI Initiative Act of 2020 mandated the creation of the NAIRR Task Force
- NAIRR Task Force launched in June 2021 to investigate feasibility of a NAIRR.
- Final report submitted in January 2023 provided roadmap for NAIRR implementation including an optional pilot.
- **Now:** An interagency working group is working together to plan and launch a pilot.

<https://www.ai.gov/wp-content/uploads/2023/01/NAIRR-TF-Final-Report-2023.pdf>

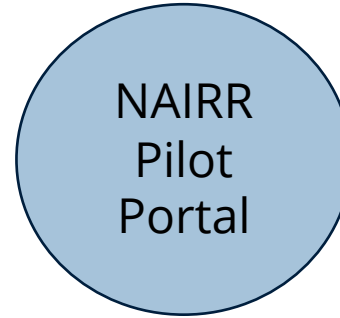
<https://www.ai.gov/nairrtf/>



# Initial NAIRR Pilot Components



Pilot Users



Community Design Process



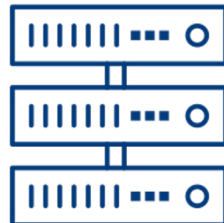
Pilot Governance



*Pilot goals:*

- *build momentum for full NAIRR*
- *demonstrate capabilities*
- *reach broad communities*
- *expose technical issues early*
- *test drive governance structure*

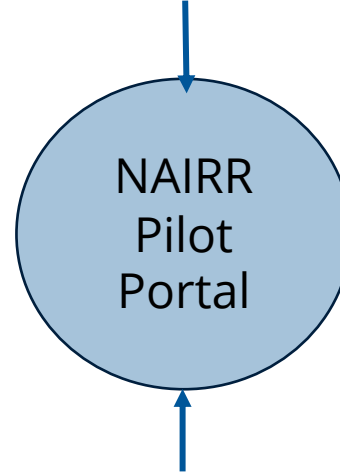
Resources, User Support, Training



# The pilot will demonstrate or investigate every major element envisioned in the NAIRR through:



## Pilot Users



## Pilot Governance

- Steering Committee
- Pilot Project Management Office
- Technical Committee
- Advisory committees

## Community Design Process

- Workshops
- Feedback from early users
- Outreach to new and underserved communities

## Resources, User Support, Training

Compute and Storage (agency and cloud)

Advanced Testbeds

Datasets and Models

NAIRR Secure

Software, tools, services

Classroom Education

User Support



# Initial Allocations Model

- Similar, agile approach as the COVID-19 HPC Consortium
  - Bringing together government, industry, and academic resource providers
  - Industry contributors will have the option to provide input on allocations or to delegate that authority to the consortium
  - Single **web portal** through which users will submit requests for resources
- Over time evolve to:
  - Agency-driven track
  - Open Peer-review track with start-up and research categories





# Growing the pilot users in every state and territory over time

- Targeted users supported by agencies that have an identified need for AI research resources
- Open call to research community
  - Focus areas:
    - AI researchers
    - Domain/applied researchers
- 'start-up' allocations to reach diverse communities across nation, smaller colleges and institutions and small businesses with federal grants
- Classroom educators/students from every state/territory

Enhanced AI capabilities for 50-100 research projects (~250-800 users)

Access and training for hundreds of new researchers

Classroom materials and hands-on access to AI resources for thousands of students

*Lessons learned from early users will help guide the buildout, scaling and configuration of future resources and services*



# Outreach and Community Design Process

- We are beginning the community outreach and design process this fall. We are planning:
  - A convening for potential resource providers
  - A meeting with community leaders on ethical and trustworthy AI
  - A call for user interest
  - Community workshops
    - AI software stack
    - Science/user workshop



# Initial NAIRR Pilot Timeline

- Expand pilot early users
- Integration of additional resources and capabilities
- Evolving towards tighter governance
- Continued community engagement

*Timeline could change or be accelerated based on congressional actions*

Fall 2023

Spring 2024

Fall 2024

Spring 2025

Fall 2025

- Initiate industry partner outreach and agency early resource commitments
- Convening/Community workshops
- Call for user interest
- Consortium launch

- More formal allocations process in place
- Continued evolution of capabilities and expansion of user base



# In closing and wrap-up

- There are many ways you can get involved in the community
- We have 2 new major initiatives, NDC-C and NAIRR that are launching this year
- I look forward to working with the community in the coming months and years

