

# NSF 22-632: Cyberinfrastructure for Sustained Scientific Innovation (CSSI)

## Program Solicitation

### Document Information

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#### U.S. National Science Foundation

Directorate for Computer and Information Science and Engineering

Office of Advanced Cyberinfrastructure

Division of Computing and Communication Foundations

Division of Information and Intelligent Systems

Directorate for Biological Sciences

Directorate for STEM Education

Directorate for Engineering

Division of Electrical, Communications and Cyber Systems

Division of Chemical, Bioengineering, Environmental and Transport Systems

Division of Civil, Mechanical and Manufacturing Innovation

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Directorate for Mathematical and Physical Sciences

Division of Physics

Division of Astronomical Sciences

Division of Mathematical Sciences

Division of Materials Research

Division of Chemistry

Directorate for Social, Behavioral and Economic Sciences

**Full Proposal Deadline(s)** (due by 5 p.m. submitting organization's local time):

December 16, 2022

December 01, 2023



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## Important Information And Revision Notes

This solicitation continues the CSSI program's emphasis on integrated cyberinfrastructure services while also recognizing the importance of adaptation to the evolving research community needs as well as the continuing evolution of the computing landscape. Revisions are noted below:

- The CI Professional Mentoring and/or Professional Development Plan section has been revised to further clarify the definition of a CI Professional and the activities that fall under this category. Also, the page limitation for the plan has been increased to 2 pages.
- The Program Synopsis and the Program Description sections have been updated to include clarifications about extensions of existing CSSI Elements and Frameworks projects.
- The Proposal Preparation and Submission Instructions section has been revised to clarify the expected content of the prior support section when the team has received past CSSI funding.

- The Programmatic Areas of Interest section has been revised to reflect the most recent programmatic priority areas for the collaborating NSF directorates and divisions with respect to the CSSI solicitation. **PIs are strongly encouraged to contact program officer(s)** from the list of Cognizant Program Officers in the division(s) that typically support the scientists and engineers who would make use of the proposed cyberinfrastructure, to gain insight into the priorities for the relevant areas of science and engineering to which their proposals may be responsive.
- The criteria for proposals to be returned without review have been clarified.

Any proposal submitted in response to this solicitation should be submitted in accordance with the *NSF Proposal & Award Policies & Procedures Guide* (PAPPG) that is in effect for the relevant due date to which the proposal is being submitted. The NSF PAPPG is regularly revised and it is the responsibility of the proposer to ensure that the proposal meets the requirements specified in this solicitation and the applicable version of the PAPPG. Submitting a proposal prior to a specified deadline does not negate this requirement.

## Summary Of Program Requirements

### General Information

#### Program Title:

Cyberinfrastructure for Sustained Scientific Innovation (CSSI)

#### Synopsis of Program:

The Cyberinfrastructure for Sustained Scientific Innovation (CSSI) program seeks to enable funding opportunities that are flexible and responsive to the evolving and emerging needs in cyberinfrastructure (CI). The program continues to emphasize integrated CI services, quantitative metrics with targets for delivery and usage of these services, and community creation.

The CSSI program anticipates three classes of awards:

- **Elements:** These awards target small groups that will create and deploy robust services for which there is a demonstrated need, and that will advance one or more significant areas of science and engineering.
- **Framework Implementations:** These awards target larger, interdisciplinary teams organized around the development and application of services aimed at solving common research problems faced by NSF researchers in one or more areas of science and engineering, and resulting in a sustainable community framework providing CI services to a diverse community or communities.
- **Transition to Sustainability:** These awards target groups who would like to execute a well-defined sustainability plan for existing CI with demonstrated impact in one or more areas of science and engineering supported by NSF. The sustainability plan should enable new avenues of support for the long-term sustained impact of the CI.

NSF support for projects funded via CSSI Elements and Frameworks awards, or its predecessor programs, is intended to be of finite duration, limited to no more than 10 years. If appropriate for transition to sustainability, teams may request further one-time support through the "Transition to Sustainability" class of awards.

Prospective Principal Investigators (PIs) should be aware that this is a multi-directorate activity and that they are encouraged to submit proposals with broad, interdisciplinary interests. Further, not all divisions are participating at the same level, and division-specific priorities differ. Prospective PIs should also refer to the directorate/division-specific descriptions contained in Section II of this solicitation.

Finally, **it is strongly recommended that prospective PIs contact program officer(s)** from the list of Cognizant Program Officers in the division(s) that typically support the scientists and engineers who would make use of the proposed work, to gain insight into the priorities for the relevant areas of science and engineering to which their proposals should be responsive. As part of contacting Cognizant Program Officers, prospective PIs are also encouraged to ascertain that the focus and budget of their proposed work are appropriate for this solicitation.

## **Broadening Participation In STEM**

NSF recognizes the unique lived experiences of individuals from communities that are underrepresented and/or under-served in science, technology, engineering, and mathematics (STEM) and the barriers to inclusion and access to STEM education and careers. NSF highly encourages the leadership, partnership, and contributions in all NSF opportunities of individuals who are members of such communities supported by NSF. This includes leading and designing STEM research and education proposals for funding; serving as peer reviewers, advisory committee members, and/or committee of visitor members; and serving as NSF leadership, program, and/or administrative staff. NSF also highly encourages demographically diverse institutions of higher education (IHEs) to lead, partner, and contribute to NSF opportunities on behalf of their research and education communities. NSF expects that all individuals, including those who are members of groups that are underrepresented and/or under-served in STEM, are treated equitably and inclusively in the Foundation's proposal and award process.

NSF encourages IHEs that enroll, educate, graduate, and employ individuals who are members of groups underrepresented and/or under-served in STEM education programs and careers to lead, partner, and contribute to NSF opportunities, including leading and designing STEM research and education proposals for funding. Such IHEs include, but may not be limited to, community colleges and two-year institutions, mission-based institutions such as Historically Black Colleges and Universities (HBCUs), Tribal Colleges and Universities (TCUs), women's colleges, and institutions that primarily serve persons with disabilities, as well as institutions defined by enrollment such as Predominantly Undergraduate Institutions (PUIs), Minority-Serving Institutions (MSIs), and Hispanic Serving Institutions (HSIs).

"Broadening participation in STEM" is the comprehensive phrase used by NSF to refer to the Foundation's goal of increasing the representation and diversity of individuals, organizations, and geographic regions that contribute to STEM teaching, research, and innovation. To broaden participation in STEM, it is necessary to address issues of equity, inclusion, and access in STEM education, training, and careers. Whereas all NSF programs might support broadening participation components, some programs primarily focus on supporting broadening participation research and projects. Examples can be found on the NSF [Broadening Participation in STEM](#) website.

### **Cognizant Program Officer(s):**

*Please note that the following information is current at the time of publishing. See program website for any updates to the points of contact.*

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**Applicable Catalog of Federal Domestic Assistance (CFDA) Number(s):**

- 47.041 --- Engineering
- 47.049 --- Mathematical and Physical Sciences
- 47.050 --- Geosciences
- 47.070 --- Computer and Information Science and Engineering
- 47.074 --- Biological Sciences
- 47.075 --- Social Behavioral and Economic Sciences
- 47.076 --- STEM Education

**Award Information**

**Anticipated Type of Award:** Standard Grant or Continuing Grant

**Estimated Number of Awards:** 35

The number of awards of each type will be determined by separate review processes and will be based on quality of proposals, availability of funds, and responsiveness to priorities of the participating directorates/divisions.

Up to 20 Elements awards, up to 10 Framework Implementations awards, and up to 5 Transition to Sustainability awards are anticipated, subject to the availability of funds and quality of proposals received.

**Anticipated Funding Amount:** \$34,000,000

Estimated program budget, number of awards, and average award size/duration are subject to the availability of funds.

Up to \$10,000,000 is expected to be available for Elements awards, up to \$20,000,000 is expected to be available for Framework Implementations awards, and up to \$4,000,000 is expected to be available for the Transition to Sustainability

awards, all subject to the availability of funds.

## **Eligibility Information**

### **Who May Submit Proposals:**

Proposals may only be submitted by the following:

- Institutions of Higher Education (IHEs) - Two- and four-year IHEs (including community colleges) accredited in, and having a campus located in the US, acting on behalf of their faculty members. Special Instructions for International Branch Campuses of US IHEs: If the proposal includes funding to be provided to an international branch campus of a US institution of higher education (including through use of sub-awards and consultant arrangements), the proposer must explain the benefit(s) to the project of performance at the international branch campus, and justify why the project activities cannot be performed at the US campus.
- Non-profit, non-academic organizations: Independent museums, observatories, research laboratories, professional societies and similar organizations located in the U.S. that are directly associated with educational or research activities.
- NSF-sponsored federally funded research and development centers (FFRDCs) may apply, provided that they are not including costs for which federal funds have already been awarded or are expected to be awarded.

### **Who May Serve as PI:**

There are no restrictions or limits.

### **Limit on Number of Proposals per Organization:**

There are no restrictions or limits.

### **Limit on Number of Proposals per PI or co-PI: 1**

An individual may participate as PI, co-PI, or other Senior Personnel on at most one proposal across the Elements, Framework Implementations, and Transition to Sustainability classes for this solicitation. Thus, if an individual participates on an Elements proposal, the individual may not participate on a Framework Implementations or Transition to Sustainability proposal, and vice-versa. Note that any individual whose biographical sketch is provided as part of the proposal will be considered as Senior Personnel in the proposed activity, with or without financial support from the project.

In the event that any individual exceeds this limit, any proposal submitted to this solicitation with this individual listed as PI, co-PI, or Senior Personnel after the first proposal is received at NSF will be returned without review. No exceptions will be made. For this purpose, a multi-organization collaborative project is treated as one proposal that is considered submitted when the last component proposal is submitted.

## **Proposal Preparation and Submission Instructions**

### **A. Proposal Preparation Instructions**

- **Letters of Intent:** Not required
- **Preliminary Proposal Submission:** Not required
- **Full Proposals:**
  - Full Proposals submitted via Research.gov: *NSF Proposal and Award Policies and Procedures Guide (PAPPG)* guidelines apply. The complete text of the PAPPG is available electronically on the NSF website at: [https://www.nsf.gov/publications/pub\\_summ.jsp?ods\\_key=pappg](https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg).

- Full Proposals submitted via Grants.gov: *NSF Grants.gov Application Guide: A Guide for the Preparation and Submission of NSF Applications via Grants.gov* guidelines apply (Note: The *NSF Grants.gov Application Guide* is available on the Grants.gov website and on the NSF website at: [https://www.nsf.gov/publications/pub\\_summ.jsp?ods\\_key=grantsgovguide](https://www.nsf.gov/publications/pub_summ.jsp?ods_key=grantsgovguide)).

## B. Budgetary Information

- **Cost Sharing Requirements:**

Inclusion of voluntary committed cost sharing is prohibited.

- **Indirect Cost (F&A) Limitations:**

Not Applicable

- **Other Budgetary Limitations:**

Not Applicable

## C. Due Dates

- **Full Proposal Deadline(s)** (due by 5 p.m. submitting organization's local time):

December 16, 2022

December 01, 2023

December 1, Annually Thereafter

## Proposal Review Information Criteria

### Merit Review Criteria:

National Science Board approved criteria. Additional merit review criteria apply. Please see the full text of this solicitation for further information.

### Award Administration Information

#### Award Conditions:

Additional award conditions apply. Please see the full text of this solicitation for further information.

#### Reporting Requirements:

Standard NSF reporting requirements apply.

## I. Introduction

The Office of Advanced Cyberinfrastructure (OAC) enables science and engineering (S&E) research and education by developing, creating, and supporting secure, advanced, scalable, and global research CI. OAC investments emphasize CI that is:

- **Science-driven:** Promotes science and engineering excellence, enabling fundamentally new scientific and engineering advances; benefits science and engineering communities beyond initial targets;
- **Innovative:** Emphasizes unique NSF contributions; builds the capability, capacity, and cohesiveness of a national CI ecosystem; considers both human and technical aspects of the CI;
- **Collaborative:** Fosters partnerships and community development; actively engages CI experts, specialists, and scientists working in concert with domain scientists who are users of CI;

- **Leveraged:** Builds on existing, recognized capabilities;
- **Strategic:** Encourages measurement of progress and sharing of results; and
- **Sustained:** Provides benefits beyond the participants and the lifetime of the award.

NSF envisions 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 (as summarized in the [Transforming Science Through Cyberinfrastructure: NSF's Blueprint for a National Cyberinfrastructure Ecosystem for Science and Engineering in the 21st Century](#)). Supporting this vision, OAC seeks to fund projects that translate core innovations into tools and services that enable a sustainable CI for broad use by the S&E research communities. OAC's Data and Software programs have been long-term investments, focused on catalyzing new thinking, paradigms, and practices in developing and using data and software CI services to understand natural, human, and engineered systems. Science and engineering challenges and use cases drive CI development, and successful CI systems strike a balance that reflects, both the underlying technology and disciplinary research needs. OAC's Data and Software programs have also continued to evolve in response to rapid changes in the underlying hardware and networks, the accelerated use of new data representations and processing paradigms and the convergence of data, software and services into unified instruments essential to all science and engineering domains as outlined in [NSF's Blueprint for a National Data and Software Cyberinfrastructure](#).

The CSSI program targets services that address all aspects of CI, from embedded sensor systems and instruments, to desktops and high-end data and computing systems, and on to major instruments and facilities. The program will continue to nurture the interdisciplinary processes required to support the entire data and software life-cycle and will successfully integrate the development, deployment, and support of CI services with innovation and research.

Furthermore, the program aims to catalyze the development of sustainable CI communities that transcend scientific and geographical boundaries. To that end, the CSSI program aims to create a software and data CI ecosystem that scales from individuals or small groups of researchers/innovators to large communities. Recognizing the need to rapidly respond to evolving research community priorities, NSF envisions support for the creation of such an ecosystem to be complemented by investments in foundational CI community services.

The program envisions vibrant partnerships among academia, government laboratories and industry, including international entities, for the development and stewardship of sustainable CI services that can enhance productivity and accelerate innovation in science and engineering. Furthermore, the program also envisions integrated education activities that will play a key role in developing and sustaining the CI over time and in creating a workforce capable of fully realizing its potential to transform science and engineering.

## II. Program Description

This solicitation welcomes proposals in the following three classes:

- **Elements:** These awards target small groups that will create and deploy robust services for which there is a demonstrated need, and that will advance one or more significant areas of science and engineering. It is expected that the created elements will be disseminated to the community as reusable services, with the potential for sustainability. The development approach may support the hardening of early prototypes and/or expanding functionality to increase end-user relevance. The expected budget for an Elements proposal is up to \$600,000 for up to 3 years (up to \$200,000 per year).
- **Framework Implementations:** These awards target larger, interdisciplinary teams organized around the development and application of services aimed at solving common research problems faced by NSF researchers in one or more areas of science and engineering, and resulting in a sustainable community framework providing CI services to a diverse community or communities. The resulting CI is expected to be sharable, easily findable and accessible, interoperable, and reusable by broad communities. Proposers are encouraged to engage multiple disciplines and/or emerging multi-disciplinary communities in the design, development, evaluation, and/or demonstration phases of the proposed CI. Some awards are anticipated to be continuing grants, where funds will be released annually subject to agreed-upon milestones, based on approval by NSF and the availability of funds.



The expected budget for a Framework Implementations proposal is between \$600,001 and \$5,000,000 for 3-5 years (\$200,000 to \$1,000,000 per year).

- **Transition to Sustainability:** These awards target groups who would like to execute a well-defined sustainability plan for existing CI with demonstrated impact in one or more areas of science and engineering supported by NSF. The sustainability plan should enable new avenues of support for the long-term sustained impact of the CI. Competitive proposals will clearly demonstrate the current level of adoption of the CI in the community and its impact on science and education so far, justify the need to sustain these impacts, and describe how this award will help to achieve long-term sustainability of the CI with clearly defined metrics of success. Requests may include funds to support activities such as further community outreach and engagement; user training, documentation, and technical support; improvements of code quality, scalability, and accessibility; and any other activity needed to achieve the long-term sustainability of the CI. It is expected that the projects funded under this project class will identify and transition to other avenues of support (e.g., open-source community support; revenue from memberships, subscriptions, or donations; funding from industry or other federal agencies) for the operation of the CI to be sustained. The expected budget for a Transition to Sustainability proposal is up to \$1,000,000 for up to 2 years (up to \$500,000 per year). It is not necessary for the existing CI to be funded by a past award funded by CSSI or one of its predecessor programs.

Proposers are asked to identify whether their proposal is an "Elements," "Frameworks" (for Framework Implementations), or "Sustainability" (for Transition to Sustainability) in the beginning of the proposal title (see Section V.A for details).

### **General Considerations**

There is a need for scalable community-driven CI to support innovative scientific inquiry based on software and data that are findable, accessible, interoperable, reusable, provenance traceable, and sustainable. All projects must be designed to overcome significant bottlenecks to solving compelling S&E questions. Proposers are encouraged to demonstrate how the proposed software and data CI can support current NSF priority areas such as Artificial Intelligence (AI), including data CI that facilitates access to Artificial Intelligence (AI)-ready data sets. Data CI may additionally combine the elements of algorithms, software, computation, networks, task automation or exploiting custom hardware to support data-centric approaches to S&E. Data may be derived from experimentation, observation, or computation, and may be diverse, consistent with S&E across all disciplines.

Proposers should consider how efforts for education and community development in software and data CI can be designed as part of the CI development. Proposals that, as part of the CI development or community engagement, include visitor support, postdoctoral opportunities, or short training courses that increase interactions of domain scientists and software and/or CI specialists are encouraged. Proposals that include innovative educational activities to train next-generation creators of CI, and to train the community at all levels on using CI in ways that broaden participation, are welcome. Educational and broadening participation activities should not, however, be the focus of the proposal, but integrated within the main effort of developing the CI. PIs wishing to submit projects that focus primarily on CI education and curriculum should submit to the [Training-based Workforce Development for Advanced Cyberinfrastructure \(CyberTraining\)](#) solicitation.

A competitive proposal will:

- Identify science and engineering challenges where the proposed CI services enable fundamental new science and engineering advances, and describe how the proposed project fosters partnerships and community development that will have a significant impact on science and engineering research;
- Indicate how the proposed CI services build capability, capacity and cohesiveness of a national CI ecosystem;
- Clearly articulate the delivery and outreach mechanism with quantifiable targets for metrics to measure impact;
- Provide a compelling discussion of the CI's potential use by a wider audience and its contribution to a national CI; and
- Address how the benefits of the proposed CI services will be sustained beyond the funding period.

(See Section VI.A.2 for details on the merit review criteria.)

**If the proposal is an extension of a previous CSSI funded Frameworks project, the proposal should clearly justify the need for such an extension, instead of targeting the Transition to Sustainability award class. The justification should briefly describe the outcomes of the previous project, including: 1). the status of the CI (software or data services) developed as part of the project, 2). the current level of adoption of the CI in the community, and 3). outcomes of efforts to translate the CI to a sustainable community framework.**

NSF encourages participation by industry and international collaborators in all classes of awards where such participation clearly strengthens the proposed activity (e.g., involvement of specific and unique expertise or resources, or addressing sustainability).

International participants are encouraged to seek support from their funding organizations. NSF funds may not be used to support the expenses of international researchers at their home organizations. However, NSF funds may be used for integral travel expenses for U.S. scientists, engineers, and students, or for integral international collaborators to participate in activities in the U.S. For those who plan to submit a proposal with international counterparts, please contact the NSF Office of International Science and Engineering (OISE) Program Officer who covers that country:

<https://www.nsf.gov/od/oise/country-list.jsp>. Procedures for participation by category of proposer, including foreign organizations, may be found in Chapter I.E of the PAPPG.

OAC recognizes that CI cuts across academic, government, civic, and commercial organizations. The program encourages proposals to explore novel partnerships beyond academe wherever beneficial and permissible within the guidelines of the PAPPG.

#### ***Programmatic Areas of Interest***

**Important Note: Prospective PIs are strongly encouraged to consult with program officers from the list of Cognizant Program Officers in the relevant research area(s) prior to submitting a proposal to ascertain that the focus and budget of the proposed work are appropriate for this solicitation.**

The CSSI program is led by OAC in the Directorate for Computer and Information Science and Engineering (CISE) and has participation from the NSF directorates and divisions as described below. Not all directorates / divisions are participating at the same level, and some have specific research and education priorities. Successful proposals are expected to be of interest to one or multiple directorates, divisions, or offices participating in the CSSI program and are expected to be responsive to programmatic areas of interest for these participating directorates/offices.

Below are programmatic areas of interest for FY 2023.

The **Directorate for Biological Sciences (BIO)** is primarily interested in the CSSI program as a means to collaborate with other NSF directorates to support proposals that impact a multidisciplinary community that includes BIO-supported researchers. PIs wishing to submit projects that focus primarily on biological sciences should submit to the [Infrastructure Capacity for Biological Research \(Capacity\)](#) program and reference the Cyberinfrastructure Programmatic Area.

The **Directorate for Computer and Information Science and Engineering (CISE)** is interested in software or data engineering and infrastructure projects that support research in all areas that sustain progress in the CISE field or that advance and adapt CISE research to impact the data and software sustainability needs of other scientific and engineering disciplines. CISE is also particularly interested in broad applicability projects that support the development of CI that sustains discovery across all fields.

The **Directorate for STEM Education (EDU)** is interested in fostering multidisciplinary research and development approaches that use large data sets to improve STEM teaching and learning environments (formal and informal) and, over the longer term, revolutionize STEM learning.

The **Directorate for Engineering (ENG)** will support proposals that provide broad access to novel CI with the potential to address emerging research challenges and enable potentially transformative research advances in the engineering research community. ENG seeks proposals that promote innovation across the CI ecosystem and address the evolving needs of the engineering research community to enable major advances in fundamental discovery in the research areas of its divisions.

The *Chemical, Bioengineering, Environmental and Transport Systems (CBET)* Division seeks proposals outlining potentially transformative and extensible approaches to establish data and software infrastructure that advance fundamental research in areas of division interest. Successful proposals will directly address the myriad challenges research communities face in harnessing advanced computing infrastructure and the associated data handling required to solve engineering problems; challenges include, but are not limited to: (1) the availability of robust methods for experimental and computational data generation, analysis, and storage, as well as straightforward approaches for sharing and curation; and/or (2) model, code, and software development or modernization. See program descriptions for details: <https://www.nsf.gov/div/index.jsp?div=CBET>. Topics of special interest include:

- The development of enhanced modeling and data analysis tools and software for applications related to: (1) water pollution; (2) metagenomics and applied environmental microbiology; (3) Earth systems engineering; (4) industrial ecology; (5) built environments; (6) air pollution; (7) sustainable chemical manufacturing and process systems; (8) complex chemical reaction networks; (9) catalysis; (10) energy conversion processes; (11) food systems; (12) turbulent flows; (13) flows of complex fluids; (14) heat and mass transport processes; (15) combustion and fire spread and mitigation; (16) nanoparticle interactions; (17) industrially-relevant biomolecular recognition mechanisms and reactions or regulatory metabolic pathways; (18) tissue and organ system processes; (19) disease or injury diagnostic, monitoring, and treatment systems; (20) neuroengineering and neural science, and (21) characterization and restoration of human function and cognition;
- Large-scale, real-time machine learning, data analytics, and other AI methods to advance data infrastructure and data-enabled science in human and ecological health science and engineering, resilience and sustainability, clean energy technologies, and other related areas;
- The design of open-source, dynamic data and/or software infrastructure to facilitate multi-scale modeling approaches that bridge the gap between molecular-, nano-, micro-, and macro-length and time scale phenomena;
- Archival-quality data handling tools and repository development, with integrated relevant meta data, to provide effortless, sustained access to community-generated research data; and
- The development of tools that improve predictive accuracy of computational methods and/or error assessment, including uncertainty analysis.

The *Division of Civil, Mechanical and Manufacturing Innovation (CMMI)* supports the integration of modeling, computation, data analysis and interdisciplinary research partnerships and perspectives to advance fundamental knowledge. CMMI seeks proposals that provide pathways for discovering, developing, accessing, sharing, understanding, and using powerful CI tools, data and platforms to enhance CMMI researchers' productivity and impact. The division seeks proposals to develop CI ecosystems that will enable the CMMI research community to more effectively employ software, data, and computational methods to enable new modes of discovery and to lead CI development. For additional information on CMMI CI priorities, please see <https://www.nsf.gov/eng/Emmi/about.jsp>.

The *Division of Electrical, Communications and Cyber Systems (ECCS)* seeks proposals with innovative approaches to establish data and software infrastructure that will advance the fundamental research areas supported by the Division. Examples of topics of interest include, but are not limited to:

- Data and software infrastructure to support innovations in devices, circuits, and systems for sensing, communications, and control;
- Large-scale, real-time machine learning and dynamic data analytics to advance national infrastructure, e.g., wireless communication infrastructure or electrical power grid; and
- Data and software infrastructure to support networked engineering cyber-physical testbeds that are remotely accessible.

The **Directorate for Geosciences (GEO)** is interested in the following research fields: atmospheric and geospace science, Earth science, ocean science, and polar science. The directorate welcomes proposals that focus on the development and implementation of advanced CI tools and methodologies that:

- Are capable of real- and near-real-time archiving and manipulation of sensor and other field-based data, including experimental and/or simulation data;
- Promote seamless discovery, access, and transfer of data and meta data across data resources and centers that are supported by GEO;
- "Leverage through sharing" of existing investments in university, federal, and commercial computing and infrastructure;
- Engage community models for the assimilation and use of data for initialization, state estimation, or sensitivity analysis;
- Encourage the development or reuse of computational techniques (e.g., high-performance distributed computing, machine learning, artificial intelligence, cloud computing, data mining, etc.) to stimulate data enabled science through enhanced large-scale simulations and analysis of large volumes of data;
- Streamline findability and accessibility of high-quality data, visualization tools, and modeling and analysis codes to help scientists and educators maximize the value of geosciences data and to generate transparent and reproducible research outcomes; and
- Enable engagement with people and communities historically underrepresented in the geosciences, such as women, persons with disabilities, and minority groups, those from geographically underrepresented areas in science, technology, engineering, and mathematics, and veterans of the U.S. Armed Forces.

All projects must be designed to overcome significant bottlenecks to solving compelling geoscience questions. Programmatic areas of interest within GEO are below.

The *Office of Polar Programs (OPP)* is interested in activities that advance understanding of the current and future states of high latitude ocean circulation, atmospheric conditions, marine and terrestrial ecosystems, and biogeochemistry, and the mechanisms that drive the seasonal evolution of sea and land ice melt. OPP welcomes interdisciplinary research that focuses on how the components of the polar regions (land, atmosphere, ocean, sea, land ice, etc.) interact as a system, with feedbacks and unanticipated emergent properties. OPP also welcomes proposals related to polar astrophysics and geospace research. OPP's Arctic Social Sciences program is interested in research on human systems, past and present. Investigators who are interested in Arctic social science research are encouraged to also read the SBE Programmatic Areas of Interest below, and to contact the cognizant OPP and SBE program officers.

The *Division of Atmospheric and Geospace Sciences (AGS)* is interested in answering fundamental science questions related to atmospheric and geospace research, including a wide variety of important processes that impact humans and society, such as space weather, tropospheric weather, physical and dynamic meteorology, climate, and air quality.

The *Division of Earth Sciences (EAR)* is interested in improving our understanding of the structure, composition, and evolution of the Earth, the life it supports, and the processes that govern the formation and behavior of the Earth's materials. EAR interests include the fields of terrestrial and "solid-earth" science (geology and paleontology, geochemistry, geophysics, continental hydrology, geomorphology, tectonics, and geobiology).

The *Division of Ocean Sciences (OCE)* is interested in activities that advance understanding of all aspects of the global oceans and ocean basins, including their interactions with people and the integrated Earth system.

The **Directorate for Mathematical and Physical Sciences (MPS)** appreciates that software and data CI enable scientific advances and discovery across MPS. The following are division-specific CSSI priorities within MPS.

The *Division of Astronomical Sciences (AST)* is interested in proposals to support the development and dissemination of sustainable software and tools for data handling and computational activities that enable progress on key questions in astronomy and astrophysics.

The *Division of Chemistry (CHE)* encourages proposals that focus on innovative software tools and data infrastructure that enable advances in CHE research areas and at the interface of chemistry and other research domains. CHE is particularly interested in the development of data and software tools that support experimental and computational investigations of multiple and diverse interactions in complex systems and/or enable data-driven discovery in molecular science. Priority

will be given to new areas such as those having a less-developed publicly available aggregate of software and algorithms and those enable creative research in NSF priority areas, such as sustainable chemistry, clean energy, biotechnology, quantum information science, and artificial intelligence/data-enabled chemical research.


The *Division of Materials Research (DMR)* encourages proposals that focus on innovative and effective software tools and/or data CI that enable advances in the division's research areas and at the interfaces of materials research with other areas of S&E. The division is particularly interested in projects that develop innovative software tools and data CI to enable and support research that integrates experiment, computation, and theory through data-intensive approaches. DMR encourages proposals to further develop or to address gaps in CI to support data-intensive materials research and discovery in all forms and at all scales of research activities. This solicitation provides opportunities to develop CI to enable autonomous materials research, and to make data gathered through DMR-supported National Facilities and Instrumentation (NaFI), Materials Innovation Platforms (MIP), DMREF projects, Materials Research Science and Engineering Centers (MRSEC), and Partnerships in Research and Education in Materials (PREM) accessible to the research and education community in accordance with FAIR principles.

The *Division of Mathematical Sciences (DMS)* welcomes proposals that either (a) build computational and graphical tools that have broad application in mathematical sciences and related areas, or (b) translate significant and recently-developed mathematical and statistical models, algorithms, and methods into software tools that address substantial problems or data sets in fields outside the mathematical sciences.


The *Division of Physics (PHY)* will consider proposals that focus on innovative CI that enables advances in the division's research areas.

The **Directorate for Social, Behavioral, and Economic Sciences (SBE)** is interested in fostering the development of innovative data and software CI that furthers the directorate's research priorities. SBE is particularly interested in using CSSI to support projects building on other infrastructure activities such as Human Networks and Data Science-Infrastructure (HNDS-I), formerly Resource Implementations for Data Intensive Research in the Social, Behavioral and Economic Sciences (RIDIR). SBE also is interested in projects that further the accessibility and use of SBE research results or SBE data, including data collected by NSF's National Center for Science and Engineering Statistics. SBE welcomes innovative approaches to big data and software problems in SBE-focused domains consistent with NSF's Harnessing the Data Revolution Big Idea. SBE encourages proposals that further the goals of SBE and at least one other participating NSF directorate.

### ***High-Throughput Computing Resources***

Proposals may request high-throughput computing (HTC) resources through the Partnership to Advance Throughput Computing ( [PATH](#)  ) project supported by NSF.

Proposers should describe the request in a Supplementary Document no longer than two pages with a technical description of, and justification for, the requested HTC resources that includes (a) the expected number of self-contained tasks per ensemble – note that each task can be packaged into one or more batch job; (b) the resource requirements for each task type in the ensemble – for example, requirements for cores, memory, wall-time, and scratch space; (c) the expected number of ensembles; (d) the expected input and output data requirements for each task type; and (e) the expected number and size of shared input files within an ensemble – expected number of times each file is read per ensemble.

Proposers should include "HTCAccess" (one word without spaces) as a keyword on the Project Summary page, at the end of the Overview section (before the section on Intellectual Merit) if incorporating this request into the proposal. Proposers may visit PATH credit accounts web page (see <https://path-cc.io/services/credit-accounts/> ) for more information on the available HTC resources which can be allocated through this program.


See Section V.A. Proposal Preparation Instructions, Supplementary Documents, for more information on how to describe the HTC/PATH request.

### ***Cloud Computing Resources***

Proposals may request cloud computing resources to use public clouds such as Amazon Web Services (AWS), Google Cloud Platform (GCP), IBM Cloud, and Microsoft Azure. Cloud computing resources described in proposals may be obtained through the NSF funded CloudBank.

Proposers should describe the request in a Supplementary Document no longer than two pages with (a) which public cloud provider will be used, (b) anticipated annual and total costs for accessing the desired cloud computing resources, based on pricing currently available from the public cloud computing providers; and (c) a technical description of, and justification for, the requested cloud computing resources. The NSF Budget should not include any such costs for accessing public cloud computing resources via CloudBank.org. The total cost of the project, including this cloud computing resource request from CloudBank.org, may not exceed the budget limit described in this solicitation.

For example, consider a proposal submitted to the Elements class, which has a total proposal budget limit of \$600,000. If a PI wishes to request \$20,000 in cloud computing resources through CloudBank, then his/her proposal should request, as part of the proposal budget, no more than \$580,000. The remaining \$20,000 for cloud computing resources should be specified in the Supplementary Document. If a proposal is a collaborative project with two PIs from two different organizations, then each PI may request cloud computing resources separately through independent Supplementary Documents as long as the total budget (on the budget pages plus in the Supplementary Documents) does not exceed \$600,000.

Proposers should include "CloudAccess" (one word without spaces) as a keyword on the Project Summary page, at the end of the Overview section (before the section on Intellectual Merit) if incorporating this request into the proposal. Proposers may contact CloudBank.org (see <https://www.cloudbank.org/faq> ) for consultation on estimating the budget for using cloud computing resources.

See Section V.A. Proposal Preparation Instructions, Supplementary Documents, for more information on how to describe the CloudAccess request as well as the associated budget.

### III. Award Information

Estimated program budget, number of awards and average award size/duration are subject to the availability of funds.

**Elements** awards shall not exceed a total of \$600,000 and 3 years of duration (up to \$200,000 per year).

**Framework Implementations** awards shall range between \$600,001 and \$5,000,000 for 3-5 years of duration (\$200,000 to \$1,000,000 per year).

**Transition to Sustainability** awards shall not exceed a total of \$1,000,000 and 2 years of duration (up to \$500,000 per year).

Projects in the upper portion of the ranges must be exceptional in terms of scientific impact, and as with all proposals, should be discussed with program officers from the divisions that fund the researchers that would be impacted. Proposed funding amounts should be commensurate with the work being proposed, the size of the community that will be affected, and the level of impact anticipated.

It is strongly recommended that prospective PIs contact a program officer from the list of Cognizant Program Officers in the division(s) closest to the major disciplinary impact of the proposed work to ascertain that the scientific focus and budget of the proposed work are appropriate for this solicitation.

### IV. Eligibility Information

#### Who May Submit Proposals:

Proposals may only be submitted by the following:

- Institutions of Higher Education (IHEs) - Two- and four-year IHEs (including community colleges) accredited in, and having a campus located in the US, acting on behalf of their faculty members.

Special Instructions for International Branch Campuses of US IHEs: If the proposal includes funding to be provided to an international branch campus of a US institution of higher education (including through use of sub-awards and consultant arrangements), the proposer must explain the benefit(s) to the project of performance at the international branch campus, and justify why the project activities cannot be performed at the US campus.

- Non-profit, non-academic organizations: Independent museums, observatories, research laboratories, professional societies and similar organizations located in the U.S. that are directly associated with educational or research activities.
- NSF-sponsored federally funded research and development centers (FFRDCs) may apply, provided that they are not including costs for which federal funds have already been awarded or are expected to be awarded.

#### **Who May Serve as PI:**

There are no restrictions or limits.

#### **Limit on Number of Proposals per Organization:**

There are no restrictions or limits.

#### **Limit on Number of Proposals per PI or co-PI: 1**

An individual may participate as PI, co-PI, or other Senior Personnel on at most one proposal across the Elements, Framework Implementations, and Transition to Sustainability classes for this solicitation. Thus, if an individual participates on an Elements proposal, the individual may not participate on a Framework Implementations or Transition to Sustainability proposal, and vice-versa. Note that any individual whose biographical sketch is provided as part of the proposal will be considered as Senior Personnel in the proposed activity, with or without financial support from the project.

In the event that any individual exceeds this limit, any proposal submitted to this solicitation with this individual listed as PI, co-PI, or Senior Personnel after the first proposal is received at NSF will be returned without review. No exceptions will be made. For this purpose, a multi-organization collaborative project is treated as one proposal that is considered submitted when the last component proposal is submitted.

## **V. Proposal Preparation And Submission Instructions**

### **A. Proposal Preparation Instructions**

**Full Proposal Preparation Instructions:** Proposers may opt to submit proposals in response to this Program Solicitation via [Research.gov](https://www.nsf.gov) or [Grants.gov](https://www.nsf.gov).

- Full Proposals submitted via [Research.gov](https://www.nsf.gov): Proposals submitted in response to this program solicitation should be prepared and submitted in accordance with the general guidelines contained in the *NSF Proposal and Award Policies and Procedures Guide* (PAPPG). The complete text of the PAPPG is available electronically on the NSF website at: [https://www.nsf.gov/publications/pub\\_summ.jsp?ods\\_key=pappg](https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg). Paper copies of the PAPPG may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-8134 or by e-mail from [nsfpubs@nsf.gov](mailto:nsfpubs@nsf.gov). The Prepare New Proposal setup will prompt you for the program solicitation number.
- Full proposals submitted via [Grants.gov](https://www.nsf.gov): Proposals submitted in response to this program solicitation via [Grants.gov](https://www.nsf.gov) should be prepared and submitted in accordance with the *NSF Grants.gov Application Guide: A Guide for the Preparation and Submission of NSF Applications via Grants.gov*. The complete text of the *NSF Grants.gov Application Guide* is available on the [Grants.gov](https://www.nsf.gov) website and on the NSF website at: [https://www.nsf.gov/publications/pub\\_summ.jsp?ods\\_key=grantsgovguide](https://www.nsf.gov/publications/pub_summ.jsp?ods_key=grantsgovguide)). To obtain copies of the Application Guide and Application Forms Package, click on the Apply tab on the [Grants.gov](https://www.nsf.gov) site, then click on the Apply Step 1: Download a Grant Application Package and Application Instructions link and enter the funding opportunity

number, (the program solicitation number without the NSF prefix) and press the Download Package button. Paper copies of the Grants.gov Application Guide also may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-8134 or by e-mail from [nsfpubs@nsf.gov](mailto:nsfpubs@nsf.gov).

In determining which method to utilize in the electronic preparation and submission of the proposal, please note the following:

**Collaborative Proposals.** All collaborative proposals submitted as separate submissions from multiple organizations must be submitted via Research.gov. PAPPG Chapter II.E.3 provides additional information on collaborative proposals.

See PAPPG Chapter II.D.2 for guidance on the required sections of a full research proposal submitted to NSF. Please note that the proposal preparation instructions provided in this program solicitation may deviate from the PAPPG instructions.

**The following provides additional guidance beyond that contained in the PAPPG or NSF Grants.gov Application Guide.**

**Proposal Set-Up:** Select "Prepare New Full Proposal" in Research.gov. Search for and select this solicitation title in Step One of the Full Proposal wizard. Provide a short informative title for the proposed project. To assist NSF staff in sorting proposals for review, proposal titles should begin with "Elements:", "Frameworks:", or "Sustainability:".

**Senior/Key Personnel:** The system allows one PI and at most four co-PIs to be designated for each proposal. If needed, additional lead personnel should be designated as Other Senior/Key Personnel on the proposal.

**Cover Sheet:**

- **International Partners:** If your project involves international partners, check the international activities box and list the countries involved.

**Project Summary (1-page limit):**

The overview includes a summary description of the project, the innovative CI being proposed, its research and education goals, and the community (communities) that will be impacted. The statement on intellectual merit should describe the potential of the proposed CI to advance knowledge. The statement on broader impacts should describe the potential of the proposed activity to benefit society and contribute to the achievement of specific, desired societal outcomes.

If cloud computing resources are being requested from CloudBank.org, then the keyword "CloudAccess" (one word without space) should be included at the end of the Overview section (before the section on Intellectual Merit) of the Project Summary page. Similarly, if high-throughput computing (HTC) resources are being requested, then the keyword "HTCAccess" (one word without space) should be included at the end of the Overview section (before the section on Intellectual Merit) of the Project Summary page.

**Project Description (15-page limit):**

The Project Description should define a plan that will lead to sustainable software and data cyberinfrastructure services capable of enabling transformative, robust, and reliable science and engineering and driven by a strong community engagement.

In addition to the guidance specified in the PAPPG, including a separate section labeled **Broader Impacts**, the Project Description must explicitly address the following three major themes. For each theme, the specific sub-themes noted below must also be explicitly addressed in the Project Description. For some of the sub-themes, additional details should also be provided through supplementary documents (as noted below). An explanation of each sub-theme is provided below.

**Project Motivation and Impact**



- **Science-driven:** The project outcomes should address well-recognized science outcomes. The project outcomes must fill well-recognized science and engineering needs of the research community, and advance research



capability within a significant area or areas of science and engineering. The project will also be evaluated on how it will result in benefits to science and engineering communities beyond initial targets, and enable participation of underrepresented communities, as well as on education and workforce development.

- **Innovation:** CSSI proposals are expected to describe how they will achieve innovation in CI development and use as well as enable research innovation. The project outcomes should address what innovative and transformational capabilities the project will bring to its target communities and how the project will integrate innovation and discovery into the project activities. The projects can result in Data and Software CI innovations essential to address disruptive changes in applications, adaptability to new technologies and to changing requirements, as well as the emergence of new concerns (e.g., privacy, trust, transparency, reproducibility, AI/ML support, energy efficiency, etc.).

### **Cyberinfrastructure Plans**

- **Project plans, and system and process architecture:** The proposal should include user interactions and a community-driven approach and provide a timeline including a proof-of-concept demonstration of the key components. Software or data cyberinfrastructure services should be sufficiently described and follow industry best practices, including the architecture of the CI and the engineering process to be used for the design, development, documentation, testing, validation, and release of the software, its deployment to the end-user community, and an acceptance and evaluation plan that involves end users. The description of the CI architecture and processes should explain how security/privacy, trustworthiness, provenance, transparency, reproducibility, and usability will be addressed by the project and integrated into the proposed system and the engineering process, and how adaptability to new technologies and changing requirements will be addressed by the project and built into the proposed system, as appropriate. It is important to balance the security and usability of the infrastructure in a way that directly supports the underlying science drivers and objectives. In this context, the proposers should discuss how the infrastructure will support the integrity and provenance of the scientific workflow and resulting data artifacts. Furthermore, where appropriate, the proposal should describe how the proposed CI will be secured and protected against attack, and against being used as an attack vector; and how the CI will facilitate secure sharing of data or software artifacts. In terms of usability, the proposal should include descriptions of what approaches will be utilized to aid users. While all proposals must also include a high-quality management plan, for Framework Implementations proposals, the details of this plan would be expected to be covered in detail in the supplementary document as described below.
- **Building on existing, recognized capabilities:** Over the past decades, NSF, and more specifically OAC, have supported a series of programs and activities that develop, deploy, and provision advanced cyberinfrastructure, recently including the [National Artificial Intelligence Research Resource \(NAIRR\) Pilot](#), the [Advanced Cyberinfrastructure Coordination Ecosystem: Services & Support \(ACCESS\) program](#) , and the [Science Gateways Center of Excellence \(SGX3\)](#) . CSSI proposals should describe how the project activities will build on and leverage existing NSF and national cyberinfrastructure investments, as appropriate.
- **Close collaborations among stakeholders:** Project activities are expected to engage CI experts, specialists, and scientists and engineers working in concert with the relevant domain scientists and engineers who are users and, where appropriate contributors to the CI. The management of the project, including collaboration and community engagement mechanisms, should be explained in detail and be appropriate to the type of project proposed.

### **Measurable Outcomes**

- **Deliverables:** NSF encourages exploration of various delivery mechanisms, including but not limited to, those leveraging the Advanced Cyberinfrastructure Coordination Ecosystem of Services & Support (ACCESS program), leadership-class computing resources, OAC Software Institutes, Big Data Regional Innovation Hubs, individual organizational resources, and well-known public and private cloud services. The proposed project must articulate in a clear way the services and capabilities to be delivered, and how they are to be delivered.
- **Sustained and sustainable impacts:** The project outcomes and activities should have long-term impacts, and be sustained beyond the lifetime of the award, as appropriate. Manuals and tutorials for using the developed CI should be delivered to the community. Software or data cyberinfrastructure services must identify the intended

license to be used for the released CI, and the justification for the choice of this license. PIs who have been funded under previous CI awards should show quantifiable evidence of the use, impact and sustainability of the previously funded work (and include a citation to the published CI in their biographical sketches as one of their relevant products, if appropriate). All proposals will be evaluated on how the project's outcomes and its activities will have long-term impacts, and how these will be sustained beyond the lifetime of the award, as appropriate. While the CSSI solicitation does not prescribe a specific path towards achieving sustainability, it should be noted that various approaches have been adopted with success in the past. Whereas for Elements proposals, the focus is mostly on the potential of project's outcome to lead to sustainability, Framework Implementations are expected to result in a sustainable community framework providing CI services. Transition to Sustainability proposals should clearly identify and execute a well-defined sustainability plan which should enable new avenues of support for the long-term sustained impact of the CI.

- **Metrics:** Success of the project must be articulated through sound mechanisms that assess the development and delivery of the services and capabilities to be delivered by the project, as well as the community adoption, usage, or other type of engagement. This assessment must be based on quantitative metrics with targets identified for each year of the award. These should be simple but should also clearly show what the project will accomplish each year, the impact on science, and the breadth of the user community. These metrics should also be appropriate for the programmatic specific areas the project targets as well as for the proposed type of CI to be developed. The viability of the mechanisms employed for collecting the metrics should be described.

**In addition, the project must explicitly discuss to which directorates, divisions or offices the proposal is aligned.**

**If the PI and co-PIs have received prior CSSI funding (including through programs that preceded CSSI), the proposal should briefly discuss what CI (software or data services) resulted from their prior CSSI award(s) as well as significant outcomes and impacts, including the level of adoption of the CI in the community. For previously funded CSSI frameworks projects, the proposal should also discuss the outcomes of the efforts to translate the CI to a sustainable community framework. This can be done as part of the Results from Prior NSF Support section if appropriate.**

#### **Budget:**

Award recipients must participate in annual PI meetings near NSF with travel costs supported by the award. These travel costs must be included in the proposal budget. Collaborative awards do not need to send PIs and co-PIs for all of the lead and non-lead partners.

The total budget of the project, including any cloud computing resource request from CloudBank.org, may not exceed the budget limits described for the respective project classes described in this solicitation. The total cost of the cloud computing resources requested from CloudBank.org should not be included in the NSF budget, and should be specified only in the associated supplementary document (see below for additional instructions).

**While prospective PIs considering including cloud computing request access are strongly encouraged to use the CloudAccess approach described above, other avenues, such as directly including cost of cloud resources as part of the budget, are also allowed. In this case, the need for cloud resources must be discussed as part of the budget justification.**

#### **Other Supplementary Documents:**

In addition to the guidance specified in the PAPPG, the following Supplementary Documents should be included (if required). Proposals missing any of the required documents may be **returned without review**.

- **Delivery Mechanism and Community Usage Metrics** (required for all award categories): The proposal must include a Supplementary Document of no more than 2 pages labeled "Delivery Mechanism and Community Usage Metrics." This Supplementary Document should explicitly address the following:
  - **Deliverables:** How will the services and capabilities be delivered by the project?

- **Metrics:** How will the project be measured through quantifiable metrics for development and delivery of the services and capabilities to be delivered by the project, and for the anticipated community adoption and usage? What quantitative metrics and what specific yearly targets for each metric will be used to assess success? How will these metrics be collected?
- **Management and Coordination Plan** (*Framework Implementations only; 3-page limit, to be submitted as a Supplementary Document. For Elements and Transition to Sustainability proposals, this information should be included in the Project Description*): Every Framework Implementation proposal must contain a clearly labeled "Management and Coordination Plan", which includes: 1) the specific roles of the PI, co-PIs, other senior personnel, and paid consultants at all organizations involved; 2) how the project will be managed across organizations and disciplines; 3) identification of the specific coordination mechanisms that will enable cross-organization and/or cross-disciplinary scientific integration (e.g., yearly workshops, graduate student exchanges, project meetings at conferences, use of video conferences, use of common software repositories, build process and/or test suites, etc.); and 4) pointers to the budget line items that support these management and coordination mechanisms.
- **CI Professional Mentoring and/or Professional Development Plan** (*if applicable*): Any proposal that requests funding to support CI professionals must upload a document titled "CI Professional Mentoring and/or Professional Development Plan" in the Supplementary Documentation section of Research.gov. CI Professionals are the professional staff who develop, deploy, manage, and support effective use of the CI (e.g., research software engineers, programmers, IT professionals, data scientists, system and network administrators, cybersecurity experts, CI facilitators, etc.) The document must describe the mentoring, career path and/or professional development activities that will be provided for such individuals. In no more than two pages, the planned activities must be described that are targeted specifically for CI professionals supported by the project must be described, regardless of whether they reside at the submitting organization, any sub-recipient organization, or at any organization participating in a simultaneously submitted collaborative proposal. The mentoring, career path and professional development activities provided to CI professionals supported on the project will be evaluated under the Broader Impacts review criterion. Examples of mentoring, career path and professional development activities include, but are not limited to: career counseling and pathway; training in preparation of and opportunities to prepare grant proposals, publications and presentations; guidance on finding opportunities for professional training and career advancement: guidance on effectively collaborating with researchers and other professionals from diverse backgrounds and across multiple science and engineering disciplines; and providing information on and training in responsible professional practices.
- **High-Throughput Computing Resources** (*if applicable*): If requesting high-throughput computing (HTC) resources, include a description of the requests (not to exceed 2 pages) as a supplementary document that includes (1) title of the proposal; (2) institution name; (3) the anticipated total HTC resources required, with yearly breakdown; and (4) a technical description and justification for the request. The latter should include information regarding (a) the expected number of self-contained tasks per ensemble – note that each task can be packaged into one or more batch job; (b) the resource requirements for each task type in the ensemble – for example, requirements for cores, memory, wall-time, and scratch space; (c) the expected number of ensembles; (d) the expected input and output data requirements for each task type; and (e) the expected number and size of shared input files within an ensemble – expected number of times each file is read per ensemble. Proposers should include "HTCAccess" (one word without space) as a keyword on the Project Summary page, at the end of the Overview section (before the section on Intellectual Merit).
- **Cloud Computing Resources** (*if applicable*): If requesting cloud computing resources, include a description of the requests (not to exceed 2 pages) as a supplementary document that includes: (1) title of the proposal; (2) institution name, (3) the anticipated total cost of computing resources, with yearly breakdown; (4) which public cloud providers will be used; and (5) a technical description and justification of the request, along with how the cost was estimated. The NSF Budget should not include any such costs for accessing public cloud computing resources via CloudBank.org. The total cost of the project, including this cloud computing resource request from CloudBank.org, may not exceed the budget limits for project class of the proposal, as described in this solicitation. Proposers should include "CloudAccess" (one word without space) as a keyword in the Project Summary page, at the end of the Overview section (before the section on Intellectual Merit).

- **Letters of Collaboration** (*optional*): Include documentation of funded or unfunded collaborative arrangements of significance to the proposal through Letters of Collaboration. Letters of Collaboration should be limited to stating the intent to collaborate and should not contain endorsements or evaluation of the proposed project. The recommended format for Letters of Collaboration is as follows:

"If the proposal submitted by Dr. [insert the full name of the Principal Investigator] entitled [insert the proposal title] is selected for funding by NSF, it is my intent to collaborate and/or commit resources as detailed in the Project Description or the Facilities, Equipment or Other Resources section of the proposal."

Do not submit letters of support. For example, letters of endorsement and letters of a laudatory nature for the proposed project are not acceptable.

- **Project Personnel and Partner Organizations**(*required for all award categories*): Provide current, accurate information for all personnel and organizations involved in the project. The list must include all PIs, co-PIs, Senior/Key Personnel, funded/unfunded Consultants or Collaborators, Sub-awardees, Postdocs, project-level advisory committee members, and writers of letters of collaboration. This list should be numbered and include (in this order) Full name, Organization(s), and Role in the project, with each item separated by a semi-colon. Each person listed should start a new numbered line. For example:

- Mary Smith; XYZ University; PI
- John Jones; University of PQR; Senior/Key Personnel
- Jane Brown; XYZ University; Postdoc
- Bob Adams; ABC Inc.; Funded Consultant
- Mary White; Welldone Institution; Unfunded Collaborator
- Tim Green; ZZZ University; Subawardee

No other items or appendices are to be included. Full proposals containing items other than those required above or by the PAPPG will be **returned without review**.

## **B. Budgetary Information**

### **Cost Sharing:**

Inclusion of voluntary committed cost sharing is prohibited.

### **Budget Preparation Instructions:**

Award recipients are expected to participate in annual PI meetings with travel costs supported by the award. These travel costs should be included in the proposed budget. Collaborative awards do not need to send PIs and co-PIs for all of the lead and non-lead partners.

Prospective PIs are reminded that the Proposals with budgets exceeding the maximum total will be **returned without review**. For this purpose, a multi-organization collaborative project is treated as one proposal for which the above limits apply.

## **C. Due Dates**

- **Full Proposal Deadline(s)** (due by 5 p.m. submitting organization's local time):

December 16, 2022

December 01, 2023

December 1, Annually Thereafter

## **D. Research.gov/Grants.gov Requirements**

### **For Proposals Submitted Via Research.gov:**

To prepare and submit a proposal via Research.gov, see detailed technical instructions available at: [https://www.research.gov/research-portal/appmanager/base/desktop?\\_nfpb=true&\\_pageLabel=research\\_node\\_display&\\_nodePath=/researchGov/Service/Desktop/ProposalPreparation](https://www.research.gov/research-portal/appmanager/base/desktop?_nfpb=true&_pageLabel=research_node_display&_nodePath=/researchGov/Service/Desktop/ProposalPreparation) For Research.gov user support, call the Research.gov Help Desk at 1-800-381-1532 or e-mail [rgov@nsf.gov](mailto:rgov@nsf.gov). The Research.gov Help Desk answers general technical questions related to the use of the Research.gov system. Specific questions related to this program solicitation should be referred to the NSF program staff contact(s) listed in Section VIII of this funding opportunity.

### **For Proposals Submitted Via Grants.gov:**

Before using Grants.gov for the first time, each organization must register to create an institutional profile. Once registered, the applicant's organization can then apply for any federal grant on the Grants.gov website. Comprehensive information about using Grants.gov is available on the Grants.gov Applicant Resources web page: <https://www.grants.gov/applicants>. In addition, the NSF Grants.gov Application Guide (see link in Section V.A) provides instructions regarding the technical preparation of proposals via Grants.gov. For Grants.gov user support, contact the Grants.gov Contact Center at 1-800-518-4726 or by email: [support@grants.gov](mailto:support@grants.gov). The Grants.gov Contact Center answers general technical questions related to the use of Grants.gov. Specific questions related to this program solicitation should be referred to the NSF program staff contact(s) listed in Section VIII of this solicitation.

**Submitting the Proposal:** Once all documents have been completed, the Authorized Organizational Representative (AOR) must submit the application to Grants.gov and verify the desired funding opportunity and agency to which the application is submitted. The AOR must then sign and submit the application to Grants.gov. The completed application will be transferred to Research.gov for further processing.

The NSF [Grants.gov Proposal Processing in Research.gov informational page](#) provides submission guidance to applicants and links to helpful resources including the NSF [Grants.gov Application Guide](#), [Grants.gov Proposal Processing in Research.gov how-to guide](#), and [Grants.gov Submitted Proposals Frequently Asked Questions](#). Grants.gov proposals must pass all NSF pre-check and post-check validations in order to be accepted by Research.gov at NSF.

When submitting via Grants.gov, NSF strongly recommends applicants initiate proposal submission at least five business days in advance of a deadline to allow adequate time to address NSF compliance errors and resubmissions by 5:00 p.m. submitting organization's local time on the deadline. Please note that some errors cannot be corrected in Grants.gov. Once a proposal passes pre-checks but fails any post-check, an applicant can only correct and submit the in-progress proposal in Research.gov.

Proposers that submitted via Research.gov may use Research.gov to verify the status of their submission to NSF. For proposers that submitted via Grants.gov, until an application has been received and validated by NSF, the Authorized Organizational Representative may check the status of an application on Grants.gov. After proposers have received an e-mail notification from NSF, Research.gov should be used to check the status of an application.

## **VI. NSF Proposal Processing And Review Procedures**

Proposals received by NSF are assigned to the appropriate NSF program for acknowledgment and, if they meet NSF requirements, for review. All proposals are carefully reviewed by a scientist, engineer, or educator serving as an NSF Program Officer, and usually by three to ten other persons outside NSF either as *ad hoc* reviewers, panelists, or both, who are experts in the particular fields represented by the proposal. These reviewers are selected by Program Officers charged with oversight of the review process. Proposers are invited to suggest names of persons they believe are especially well qualified to review the proposal and/or persons they would prefer not review the proposal. These suggestions may serve as one source in the reviewer selection process at the Program Officer's discretion. Submission of

such names, however, is optional. Care is taken to ensure that reviewers have no conflicts of interest with the proposal. In addition, Program Officers may obtain comments from site visits before recommending final action on proposals. Senior NSF staff further review recommendations for awards. A flowchart that depicts the entire NSF proposal and award process (and associated timeline) is included in PAPPG Exhibit III-1.

A comprehensive description of the Foundation's merit review process is available on the NSF website at: [https://www.nsf.gov/bfa/dias/policy/merit\\_review/](https://www.nsf.gov/bfa/dias/policy/merit_review/).

Proposers should also be aware of core strategies that are essential to the fulfillment of NSF's mission, as articulated in *Leading the World in Discovery and Innovation, STEM Talent Development and the Delivery of Benefits from Research - NSF Strategic Plan for Fiscal Years (FY) 2022 - 2026*. These strategies are integrated in the program planning and implementation process, of which proposal review is one part. NSF's mission is particularly well-implemented through the integration of research and education and broadening participation in NSF programs, projects, and activities.

One of the strategic objectives in support of NSF's mission is to foster integration of research and education through the programs, projects, and activities it supports at academic and research institutions. These institutions must recruit, train, and prepare a diverse STEM workforce to advance the frontiers of science and participate in the U.S. technology-based economy. NSF's contribution to the national innovation ecosystem is to provide cutting-edge research under the guidance of the Nation's most creative scientists and engineers. NSF also supports development of a strong science, technology, engineering, and mathematics (STEM) workforce by investing in building the knowledge that informs improvements in STEM teaching and learning.

NSF's mission calls for the broadening of opportunities and expanding participation of groups, institutions, and geographic regions that are underrepresented in STEM disciplines, which is essential to the health and vitality of science and engineering. NSF is committed to this principle of diversity and deems it central to the programs, projects, and activities it considers and supports.

## **A. Merit Review Principles and Criteria**

The National Science Foundation strives to invest in a robust and diverse portfolio of projects that creates new knowledge and enables breakthroughs in understanding across all areas of science and engineering research and education. To identify which projects to support, NSF relies on a merit review process that incorporates consideration of both the technical aspects of a proposed project and its potential to contribute more broadly to advancing NSF's mission "to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense; and for other purposes." NSF makes every effort to conduct a fair, competitive, transparent merit review process for the selection of projects.

### **1. Merit Review Principles**

These principles are to be given due diligence by PIs and organizations when preparing proposals and managing projects, by reviewers when reading and evaluating proposals, and by NSF program staff when determining whether or not to recommend proposals for funding and while overseeing awards. Given that NSF is the primary federal agency charged with nurturing and supporting excellence in basic research and education, the following three principles apply:

- All NSF projects should be of the highest quality and have the potential to advance, if not transform, the frontiers of knowledge.
- NSF projects, in the aggregate, should contribute more broadly to achieving societal goals. These "Broader Impacts" may be accomplished through the research itself, through activities that are directly related to specific research projects, or through activities that are supported by, but are complementary to, the project. The project activities may be based on previously established and/or innovative methods and approaches, but in either case must be well justified.
- Meaningful assessment and evaluation of NSF funded projects should be based on appropriate metrics, keeping in mind the likely correlation between the effect of broader impacts and the resources provided to implement projects. If the size of the activity is limited, evaluation of that activity in isolation is not likely to be meaningful.

Thus, assessing the effectiveness of these activities may best be done at a higher, more aggregated, level than the individual project.

With respect to the third principle, even if assessment of Broader Impacts outcomes for particular projects is done at an aggregated level, PIs are expected to be accountable for carrying out the activities described in the funded project. Thus, individual projects should include clearly stated goals, specific descriptions of the activities that the PI intends to do, and a plan in place to document the outputs of those activities.

These three merit review principles provide the basis for the merit review criteria, as well as a context within which the users of the criteria can better understand their intent.

## 2. Merit Review Criteria

All NSF proposals are evaluated through use of the two National Science Board approved merit review criteria. In some instances, however, NSF will employ additional criteria as required to highlight the specific objectives of certain programs and activities.

The two merit review criteria are listed below. **Both** criteria are to be given **full consideration** during the review and decision-making processes; each criterion is necessary but neither, by itself, is sufficient. Therefore, proposers must fully address both criteria. (PAPPG Chapter II.D.2.d(i). contains additional information for use by proposers in development of the Project Description section of the proposal). Reviewers are strongly encouraged to review the criteria, including PAPPG Chapter II.D.2.d(i), prior to the review of a proposal.

When evaluating NSF proposals, reviewers will be asked to consider what the proposers want to do, why they want to do it, how they plan to do it, how they will know if they succeed, and what benefits could accrue if the project is successful. These issues apply both to the technical aspects of the proposal and the way in which the project may make broader contributions. To that end, reviewers will be asked to evaluate all proposals against two criteria:

- **Intellectual Merit:** The Intellectual Merit criterion encompasses the potential to advance knowledge; and
- **Broader Impacts:** The Broader Impacts criterion encompasses the potential to benefit society and contribute to the achievement of specific, desired societal outcomes.

The following elements should be considered in the review for both criteria:

1. What is the potential for the proposed activity to
  - a. Advance knowledge and understanding within its own field or across different fields (Intellectual Merit); and
  - b. Benefit society or advance desired societal outcomes (Broader Impacts)?
2. To what extent do the proposed activities suggest and explore creative, original, or potentially transformative concepts?
3. Is the plan for carrying out the proposed activities well-reasoned, well-organized, and based on a sound rationale? Does the plan incorporate a mechanism to assess success?
4. How well qualified is the individual, team, or organization to conduct the proposed activities?
5. Are there adequate resources available to the PI (either at the home organization or through collaborations) to carry out the proposed activities?

Broader impacts may be accomplished through the research itself, through the activities that are directly related to specific research projects, or through activities that are supported by, but are complementary to, the project. NSF values the advancement of scientific knowledge and activities that contribute to achievement of societally relevant outcomes. Such outcomes include, but are not limited to: full participation of women, persons with disabilities, and other underrepresented groups in science, technology, engineering, and mathematics (STEM); improved STEM education and educator development at any level; increased public scientific literacy and public engagement with science and technology; improved well-being of individuals in society; development of a diverse, globally competitive STEM workforce;

increased partnerships between academia, industry, and others; improved national security; increased economic competitiveness of the United States; and enhanced infrastructure for research and education.

Proposers are reminded that reviewers will also be asked to review the Data Management and Sharing Plan and the Mentoring Plan, as appropriate.

### **Additional Solicitation Specific Review Criteria**

All proposals must clearly address the following solicitation-specific review criteria through well-identified proposal elements. The criteria are grouped under three major themes:

#### ***Project Motivation and Impact***

- **Science-driven:** Do the project outcomes fill well-recognized science and engineering needs of the research community, and advance research capability within a significant area or areas of science and engineering? What are the broader impacts of the project, such as benefits to science and engineering communities beyond initial targets, underrepresented communities, and education and workforce development? What well-recognized science outcomes will be accomplished by the research community through the leveraging of the new CI?
- **Innovation:** How does the project achieve innovation in CI development and use as well as enable research innovation? What innovative and transformational capabilities will the project bring to its target communities? Does the project integrate innovation and discovery into the project activities?

#### ***Cyberinfrastructure Plans***

- **Project plans, and system and process architecture:** What is the proposed architecture, and what engineering process will be used for its design, development, documentation, testing, validation, and release? How will security/privacy, trustworthiness, provenance, transparency, reproducibility, and usability be addressed by the project and integrated into the proposed system and the engineering process? How will the CI be adaptable to new technologies and changing requirements?
- **Building on existing, recognized capabilities:** How will the project activities build on and leverage existing NSF and national cyberinfrastructure investments, as appropriate?
- **Close collaborations among stakeholders:** How will the project activities engage CI experts, specialists, scientists and engineers working in concert with the relevant domain scientists and engineers who are users of CI? How will the project (including collaboration) be managed? What are the community engagement mechanisms?

#### ***Measurable Outcomes***

- **Deliverables:** Does the proposed project clearly articulate the services and capabilities to be delivered, and how they are to be delivered?
- **Sustained and sustainable impacts:** How will the project's outcomes and its activities have long-term impacts, and how will these be sustained beyond the lifetime of the award, as appropriate? Are the sustainability approaches following well-established models?
- **Metrics:** Does the proposed project clearly articulate quantifiable metrics for development and delivery of the services and capabilities to be delivered by the project, and for the anticipated community adoption and usage? Are quantitative metrics with targets identified for each year of the award?

Each of these review criteria are relevant to all three project classes in this solicitation. Proposers should consider how each applies to the project class of the proposal and the level of its importance. For example, innovation may be more strongly weighted for Elements proposals; Framework Implementations proposals may have greater complexity with project planning, leveraging, and stakeholder engagement being particularly important; and Transition to Sustainability proposals may require more specific and *convincing* metrics demonstrating sustainable impact in community adoption and usage.

## **B. Review and Selection Process**



Proposals submitted in response to this program solicitation will be reviewed by Ad hoc Review and/or Panel Review.

Reviewers will be asked to evaluate proposals using two National Science Board approved merit review criteria and, if applicable, additional program specific criteria. A summary rating and accompanying narrative will generally be completed and submitted by each reviewer and/or panel. The Program Officer assigned to manage the proposal's review will consider the advice of reviewers and will formulate a recommendation.

After scientific, technical and programmatic review and consideration of appropriate factors, the NSF Program Officer recommends to the cognizant Division Director whether the proposal should be declined or recommended for award. NSF strives to be able to tell proposers whether their proposals have been declined or recommended for funding within six months. Large or particularly complex proposals or proposals from new recipients may require additional review and processing time. The time interval begins on the deadline or target date, or receipt date, whichever is later. The interval ends when the Division Director acts upon the Program Officer's recommendation.

After programmatic approval has been obtained, the proposals recommended for funding will be forwarded to the Division of Grants and Agreements or the Division of Acquisition and Cooperative Support for review of business, financial, and policy implications. After an administrative review has occurred, Grants and Agreements Officers perform the processing and issuance of a grant or other agreement. Proposers are cautioned that only a Grants and Agreements Officer may make commitments, obligations or awards on behalf of NSF or authorize the expenditure of funds. No commitment on the part of NSF should be inferred from technical or budgetary discussions with a NSF Program Officer. A Principal Investigator or organization that makes financial or personnel commitments in the absence of a grant or cooperative agreement signed by the NSF Grants and Agreements Officer does so at their own risk.

Once an award or declination decision has been made, Principal Investigators are provided feedback about their proposals. In all cases, reviews are treated as confidential documents. Verbatim copies of reviews, excluding the names of the reviewers or any reviewer-identifying information, are sent to the Principal Investigator/Project Director by the Program Officer. In addition, the proposer will receive an explanation of the decision to award or decline funding.

## **VII. Award Administration Information**

### **A. Notification of the Award**

Notification of the award is made to *the submitting organization* by an NSF Grants and Agreements Officer. Organizations whose proposals are declined will be advised as promptly as possible by the cognizant NSF Program administering the program. Verbatim copies of reviews, not including the identity of the reviewer, will be provided automatically to the Principal Investigator. (See Section VI.B. for additional information on the review process.)

### **B. Award Conditions**

An NSF award consists of: (1) the award notice, which includes any special provisions applicable to the award and any numbered amendments thereto; (2) the budget, which indicates the amounts, by categories of expense, on which NSF has based its support (or otherwise communicates any specific approvals or disapprovals of proposed expenditures); (3) the proposal referenced in the award notice; (4) the applicable award conditions, such as Grant General Conditions (GC-1)\*; or Research Terms and Conditions\* and (5) any announcement or other NSF issuance that may be incorporated by reference in the award notice. Cooperative agreements also are administered in accordance with NSF Cooperative Agreement Financial and Administrative Terms and Conditions (CA-FATC) and the applicable Programmatic Terms and Conditions. NSF awards are electronically signed by an NSF Grants and Agreements Officer and transmitted electronically to the organization via e-mail.

\*These documents may be accessed electronically on NSF's Website at [https://www.nsf.gov/awards/managing/award\\_conditions.jsp?org=NSF](https://www.nsf.gov/awards/managing/award_conditions.jsp?org=NSF). Paper copies may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-8134 or by e-mail from [nsfpubs@nsf.gov](mailto:nsfpubs@nsf.gov).

More comprehensive information on NSF Award Conditions and other important information on the administration of NSF awards is contained in the NSF *Proposal & Award Policies & Procedures Guide* (PAPPG) Chapter VII, available

electronically on the NSF Website at [https://www.nsf.gov/publications/pub\\_summ.jsp?ods\\_key=pappg](https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg).

## **Administrative and National Policy Requirements**

### **Build America, Buy America**

As expressed in Executive Order 14005, [Ensuring the Future is Made in All of America by All of America's Workers](#) (86 FR 7475), it is the policy of the executive branch to use terms and conditions of Federal financial assistance awards to maximize, consistent with law, the use of goods, products, and materials produced in, and services offered in, the United States.

Consistent with the requirements of the Build America, Buy America Act (Pub. L. 117-58, Division G, Title IX, Subtitle A, November 15, 2021), no funding made available through this funding opportunity may be obligated for infrastructure projects under an award unless all iron, steel, manufactured products, and construction materials used in the project are produced in the United States. For additional information, visit NSF's [Build America, Buy America](#) web page

### **Special Award Conditions:**

- Award recipients must participate in annual PI meetings with travel costs supported by the awards.

## **C. Reporting Requirements**

For all multi-year grants (including both standard and continuing grants), the Principal Investigator must submit an annual project report to the cognizant Program Officer no later than 90 days prior to the end of the current budget period. (Some programs or awards require submission of more frequent project reports). No later than 120 days following expiration of a grant, the PI also is required to submit a final annual project report, and a project outcomes report for the general public.

Failure to provide the required annual or final annual project reports, or the project outcomes report, will delay NSF review and processing of any future funding increments as well as any pending proposals for all identified PIs and co-PIs on a given award. PIs should examine the formats of the required reports in advance to assure availability of required data.

PIs are required to use NSF's electronic project-reporting system, available through [Research.gov](#), for preparation and submission of annual and final annual project reports. Such reports provide information on accomplishments, project participants (individual and organizational), publications, and other specific products and impacts of the project. Submission of the report via [Research.gov](#) constitutes certification by the PI that the contents of the report are accurate and complete. The project outcomes report also must be prepared and submitted using [Research.gov](#). This report serves as a brief summary, prepared specifically for the public, of the nature and outcomes of the project. This report will be posted on the NSF website exactly as it is submitted by the PI.

More comprehensive information on NSF Reporting Requirements and other important information on the administration of NSF awards is contained in the *NSF Proposal & Award Policies & Procedures Guide* (PAPPG) Chapter VII, available electronically on the NSF Website at [https://www.nsf.gov/publications/pub\\_summ.jsp?ods\\_key=pappg](https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg).

## **VIII. Agency Contacts**

*Please note that the program contact information is current at the time of publishing. See program website for any updates to the points of contact.*

General inquiries regarding this program should be made to:

- Varun Chandola, Program Director, CISE/OAC, telephone: (703) 292-2656, email: [CSSIQueries@nsf.gov](mailto:CSSIQueries@nsf.gov)
- Amy W. Apon, Program Director, CISE/OAC, telephone: (703) 292-5184, email: [CSSIQueries@nsf.gov](mailto:CSSIQueries@nsf.gov)
- Sharmistha Bagchi-Sen, Program Director, CISE/OAC, telephone: (703) 292-8104, email: [CSSIQueries@nsf.gov](mailto:CSSIQueries@nsf.gov)

- Sheikh Ghafoor, Program Director, CISE/OAC, telephone: (703) 292-7116, email: [CSSIQueries@nsf.gov](mailto:CSSIQueries@nsf.gov)
- Marlon Pierce, Program Director, CISE/OAC, telephone: (703) 292-7743, email: [CSSIQueries@nsf.gov](mailto:CSSIQueries@nsf.gov)
- Wen-Wen Tung, telephone: (703) 292-8386, email: [CSSIQueries@nsf.gov](mailto:CSSIQueries@nsf.gov)
- Purushotham V. Bangalore, Program Director, telephone: (703) 292-2656, email: [CSSIQueries@nsf.gov](mailto:CSSIQueries@nsf.gov)
- Reed S. Beaman, Program Director, BIO/DBI, telephone: (703) 292-7163, email: [CSSIQueries@nsf.gov](mailto:CSSIQueries@nsf.gov)
- Jennifer W. Weller, Program Director, BIO/DBI, telephone: (703) 292-2224, email: [CSSIQueries@nsf.gov](mailto:CSSIQueries@nsf.gov)
- Almadena Y. Chtchelkanova, Program Director, CISE/CCF, telephone: (703) 292-8910, email: [CSSIQueries@nsf.gov](mailto:CSSIQueries@nsf.gov)
- Sol Greenspan, Program Director, CISE/CCF, telephone: (703) 292-8910, email: [CSSIQueries@nsf.gov](mailto:CSSIQueries@nsf.gov)
- Sylvia Spengler, Program Director, CISE/IIS, telephone: (703) 292-8930, email: [CSSIQueries@nsf.gov](mailto:CSSIQueries@nsf.gov)
- ChunSheng Xin, Program Director, EDU/DGE, telephone: (703) 292-7353, email: [CSSIQueries@nsf.gov](mailto:CSSIQueries@nsf.gov)
- Ronald Joslin, Program Director, ENG/CBET, telephone: (703) 292-7030, email: [CSSIQueries@nsf.gov](mailto:CSSIQueries@nsf.gov)
- Shahab Shojaei-Zadeh, Program Director, ENG/CBET, telephone: (703) 292-8045, email: [CSSIQueries@nsf.gov](mailto:CSSIQueries@nsf.gov)
- Reha M. Uzsoy, Program Director, ENG/CMMI, telephone: (703) 292-2681, email: [CSSIQueries@nsf.gov](mailto:CSSIQueries@nsf.gov)
- Linkan Bian, Program Director, telephone: (703) 292-8136, email: [CSSIQueries@nsf.gov](mailto:CSSIQueries@nsf.gov)
- Rosa Lukaszew, Program Director, ENG/ECCS, telephone: (703) 292-8103, email: [CSSIQueries@nsf.gov](mailto:CSSIQueries@nsf.gov)
- Eric DeWeaver, Program Director, GEO/AGS, telephone: (703) 292-8527, email: [CSSIQueries@nsf.gov](mailto:CSSIQueries@nsf.gov)
- Sean C. Kennan, Program Director, GEO/OCE, telephone: (703) 292-7575, email: [CSSIQueries@nsf.gov](mailto:CSSIQueries@nsf.gov)
- Andreas A. Berlind, Program Director, MPS/AST, telephone: (703) 292-5387, email: [CSSIQueries@nsf.gov](mailto:CSSIQueries@nsf.gov)
- Richard Dawes, Program Director, MPS/CHE, telephone: (703) 292-7486, email: [CSSIQueries@nsf.gov](mailto:CSSIQueries@nsf.gov)
- Daryl W. Hess, Program Director, MPS/DMR, telephone: (703) 292-4942, email: [CSSIQueries@nsf.gov](mailto:CSSIQueries@nsf.gov)
- Yong Zeng, Program Director, MPS/DMS, telephone: (703) 292-7299, email: [CSSIQueries@nsf.gov](mailto:CSSIQueries@nsf.gov)
- Ludmil T. Zikatanov, telephone: (703) 292-2175, email: [CSSIQueries@nsf.gov](mailto:CSSIQueries@nsf.gov)
- Pedro Marronetti, Program Director, MPS/PHY, telephone: (703) 292-7372, email: [CSSIQueries@nsf.gov](mailto:CSSIQueries@nsf.gov)
- Bogdan Mihaila, Program Director, MPS/PHY, telephone: (703) 292-8235, email: [CSSIQueries@nsf.gov](mailto:CSSIQueries@nsf.gov)
- Cheryl L. Eavey, Program Director, SBE/SES, telephone: (703) 292-7269, email: [CSSIQueries@nsf.gov](mailto:CSSIQueries@nsf.gov)

For questions relating to Grants.gov contact:

- Grants.gov Contact Center: If the Authorized Organizational Representatives (AOR) has not received a confirmation message from Grants.gov within 48 hours of submission of application, please contact via telephone: 1-800-518-4726; e-mail: [support@grants.gov](mailto:support@grants.gov).

General questions on the solicitation should be sent to [CSSIQueries@nsf.gov](mailto:CSSIQueries@nsf.gov), or to the following Program Officers:

- Varun Chandola, Program Director, CISE/OAC, telephone: (703) 292-2656
- Sharmistha Bagchi-Sen, Program Director, CISE/OAC, telephone: (703) 292-8104
- Marlon Pierce, Program Director, CISE/OAC, telephone: (703) 292-7743
- Sheikh Ghafoor, Program Director, CISE/OAC, telephone: (703) 292-7116
- Wen-Wen Tung, Program Director, CISE/OAC, telephone: (703) 292-8386
- Purushotham Bangalore, Program Director, CISE/OAC, telephone: (703) 292-2656

## **IX. Other Information**

The NSF website provides the most comprehensive source of information on NSF Directorates (including contact information), programs and funding opportunities. Use of this website by potential proposers is strongly encouraged. In addition, "NSF Update" is an information-delivery system designed to keep potential proposers and other interested parties apprised of new NSF funding opportunities and publications, important changes in proposal and award policies and procedures, and upcoming NSF [Grants Conferences](#). Subscribers are informed through e-mail or the user's Web browser each time new publications are issued that match their identified interests. "NSF Update" also is available on [NSF's website](#).

Grants.gov provides an additional electronic capability to search for Federal government-wide grant opportunities. NSF funding opportunities may be accessed via this mechanism. Further information on Grants.gov may be obtained at <https://www.grants.gov>.

## About The National Science Foundation

The National Science Foundation (NSF) is an independent Federal agency created by the National Science Foundation Act of 1950, as amended (42 USC 1861-75). The Act states the purpose of the NSF is "to promote the progress of science; [and] to advance the national health, prosperity, and welfare by supporting research and education in all fields of science and engineering."

NSF funds research and education in most fields of science and engineering. It does this through grants and cooperative agreements to more than 2,000 colleges, universities, K-12 school systems, businesses, informal science organizations and other research organizations throughout the US. The Foundation accounts for about one-fourth of Federal support to academic institutions for basic research.

NSF receives approximately 55,000 proposals each year for research, education and training projects, of which approximately 11,000 are funded. In addition, the Foundation receives several thousand applications for graduate and postdoctoral fellowships. The agency operates no laboratories itself but does support National Research Centers, user facilities, certain oceanographic vessels and Arctic and Antarctic research stations. The Foundation also supports cooperative research between universities and industry, US participation in international scientific and engineering efforts, and educational activities at every academic level.

*Facilitation Awards for Scientists and Engineers with Disabilities (FASED)* provide funding for special assistance or equipment to enable persons with disabilities to work on NSF-supported projects. See the *NSF Proposal & Award Policies & Procedures Guide* Chapter II.F.7 for instructions regarding preparation of these types of proposals.

The National Science Foundation has Telephonic Device for the Deaf (TDD) and Federal Information Relay Service (FIRS) capabilities that enable individuals with hearing impairments to communicate with the Foundation about NSF programs, employment or general information. TDD may be accessed at (703) 292-5090 and (800) 281-8749, FIRS at (800) 877-8339.

The National Science Foundation Information Center may be reached at (703) 292-5111.

The National Science Foundation promotes and advances scientific progress in the United States by competitively awarding grants and cooperative agreements for research and education in the sciences, mathematics, and engineering.

To get the latest information about program deadlines, to download copies of NSF publications, and to access abstracts of awards, visit the NSF Website at <https://www.nsf.gov>

- **Location:** 2415 Eisenhower Avenue, Alexandria, VA 22314
- **For General Information** (NSF Information Center): (703) 292-5111
- **TDD (for the hearing-impaired):** (703) 292-5090

- **To Order Publications or Forms:**

Send an e-mail to: [nsfpubs@nsf.gov](mailto:nsfpubs@nsf.gov)

or telephone: (703) 292-8134

- **To Locate NSF Employees:** (703) 292-5111

## Privacy Act And Public Burden Statements

The information requested on proposal forms and project reports is solicited under the authority of the National Science Foundation Act of 1950, as amended. The information on proposal forms will be used in connection with the selection of qualified proposals; and project reports submitted by proposers will be used for program evaluation and reporting within the Executive Branch and to Congress. The information requested may be disclosed to qualified reviewers and staff assistants as part of the proposal review process; to proposer institutions/grantees to provide or obtain data regarding the proposal review process, award decisions, or the administration of awards; to government contractors, experts, volunteers and researchers and educators as necessary to complete assigned work; to other government agencies or other entities needing information regarding proposers or nominees as part of a joint application review process, or in order to coordinate programs or policy; and to another Federal agency, court, or party in a court or Federal administrative proceeding if the government is a party. Information about Principal Investigators may be added to the Reviewer file and used to select potential candidates to serve as peer reviewers or advisory committee members. See [System of Record Notices, NSF-50](#), "Principal Investigator/Proposal File and Associated Records," and [NSF-51](#), "Reviewer/Proposal File and Associated Records." Submission of the information is voluntary. Failure to provide full and complete information, however, may reduce the possibility of receiving an award.

An agency may not conduct or sponsor, and a person is not required to respond to, an information collection unless it displays a valid Office of Management and Budget (OMB) control number. The OMB control number for this collection is 3145-0058. Public reporting burden for this collection of information is estimated to average 120 hours per response, including the time for reviewing instructions. Send comments regarding the burden estimate and any other aspect of this collection of information, including suggestions for reducing this burden, to:

Suzanne H. Plimpton  
Reports Clearance Officer  
Policy Office, Division of Institution and Award Support  
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