This solicitation has been archived and replaced by NSF 20-507.

Campus Cyberinfrastructure (CC*)

PROGRAM SOLICITATION
NSF 19-533

REPLACES DOCUMENT(S):
NSF 18-508

National Science Foundation

Directorate for Computer & Information Science & Engineering
Office of Advanced Cyberinfrastructure
Division of Computer and Network Systems

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

February 20, 2019

IMPORTANT INFORMATION AND REVISION NOTES

This solicitation updates the Campus Cyberinfrastructure (CC*) solicitation NSF 18-508. The CC* program continues to support cyberinfrastructure (CI) needs at the campus level. This solicitation:

- Modifies and renames the Network Design and Implementation for Small Institutions program area, which is now the Regional Connectivity for Small Institutions of Higher Education program area;
- Adds two new program areas: Campus Computing and the Computing Continuum, and Cyber Team-Research and Education CI-based Regional Facilitation; and
- Removes the Network Performance Engineering and Outreach program area.

Any proposal submitted in response to this solicitation should be submitted in accordance with the revised *NSF Proposal & Award Policies & Procedures Guide* (PAPPG) (NSF 19-1), which is effective for proposals submitted, or due, on or after January 28, 2019.

SUMMARY OF PROGRAM REQUIREMENTS

General Information

Program Title:

Campus Cyberinfrastructure (CC*)

Synopsis of Program:

The Campus Cyberinfrastructure (CC*) program invests in coordinated campus-level networking and cyberinfrastructure improvements, innovation, integration, and engineering for science applications and distributed research projects. Learning and workforce development (LWD) in cyberinfrastructure is explicitly addressed in the program. Science-driven requirements are the primary motivation for any proposed activity.

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.

- Kevin Thompson, Program Director, CISE/OAC, telephone: (703) 292-4220, email: kthompso@nsf.gov
- Deepankar (Deep) Medhi, Program Director, CISE/CNS, telephone: (703) 292-8950, email: dmedhi@nsf.gov

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

- 47.070 --- Computer and Information Science and Engineering

Award Information

Anticipated Type of Award: Standard Grant or Continuing Grant

Estimated Number of Awards: 18 to 40

The estimated number of awards per program area is as follows: 5-10 Data-Driven Networking Infrastructure awards; 3-5 Regional Connectivity for Small Institutions awards; 2-5 Network Integration and Applied Innovation awards; 5-15 Campus Computing and the Computing Continuum awards; and 3-5 Cyber Team—Research and Education CI-based Regional Facilitation awards.

Anticipated Funding Amount: $10,000,000 to $17,000,000

pending availability of funds and quality of proposals received.

Each program area will support awards pursuant to the following budget and duration:

1. Data-Driven Networking Infrastructure for the Campus and Researcher awards will be supported at up to $500,000 total for up to 2 years;
2. Regional Connectivity for Small Institutions of Higher Education awards will be supported at up to $800,000 total for up to 2 years;
3. Network Integration and Applied Innovation awards will be supported at up to $1,000,000 total for up to 2 years;
4. Campus Computing and the Computing Continuum awards will be supported at up to $400,000 total for up to 2 years [in some cases these awards are limited to $100,000 total-see Program Area (4)(B) in Section II Program Description]; and
5. Cyber Team-Research and Education CI-based Regional Facilitation awards will be supported at up to $1,400,000 total for up to 3 years.

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 subawards 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 labs, professional societies and similar organizations in the U.S. associated with educational or research activities.

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:

There are no restrictions or limits.

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 FastLane: *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.
  - 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.
  - 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).

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. submitter's local time):

  February 20, 2019

Proposal Review Information Criteria

Merit Review Criteria:

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

Award Administration Information

Award Conditions:

Standard NSF award conditions apply.

Reporting Requirements:

Standard NSF reporting requirements apply.

TABLE OF CONTENTS

I. INTRODUCTION

Campuses today face challenges across multiple levels of cyberinfrastructure (CI), where meeting the needs of scientific research and education goes far beyond the networking layer in capacity and services, and extends to computing, data services, secure and trustworthy systems, and especially human expertise, collaboration and knowledge sharing. Recognition of the "data driven" nature of scientific advancement and discovery has led to an increased focus in addressing the data challenges posed by the NSF research and education community.

In recent years, NSF has addressed the growing requirements of the NSF community, and opportunities to innovate, in networking infrastructure through the CC* program, which invests in innovative, coordinated, and secure campus, multicampus and multiinstitution CI components. The Campus Cyberinfrastructure Network Infrastructure and Engineering (CCNIE) program in 2012 and 2013 focused on campus networking upgrades and rearchitecting, and innovative development and integration of new networking capabilities in support of driving scientific application requirements. Subsequent years saw the program expand beyond data networking to address a broader set of CI needs at the campus level, including computing, storage, multi-institution integrated CI, and learning and workforce development.

The FY 2019 CC* solicitation invests in coordinated campus-level networking and cyberinfrastructure improvements, innovation, integration, and engineering for science applications and distributed research projects. Learning and workforce development (LWD) in CI is explicitly addressed in the program. Science-driven requirements are the primary motivation for any proposed activity.

CC* awards will be supported in five program areas:

1. Data-Driven Networking Infrastructure for the Campus and Researcher awards will be supported at up to $500,000 total for up to 2 years;
2. Regional Connectivity for Small Institutions awards will be supported at up to $800,000 total for up to 2 years;
3. Network Integration and Applied Innovation awards will be supported at up to $1,000,000 total for up to 2 years;
4. Campus Computing and the Computing Continuum awards will be supported at up to $400,000 total for up to 2 years [in some cases these awards are limited to $100,000 total—see Program Area (4)(B) in Section II Program Description]; and
5. Cyber Team—Research and Education CI-based Regional Facilitation awards will be supported at up to $1,400,000 total for up to 3 years.

II. PROGRAM DESCRIPTION

Program wide Criteria

Science-driven requirements are the primary motivation for any proposed activity. Proposals will be evaluated on the strength of the science enabled (including research and education) as drivers for investment and innovation in data networking infrastructure, innovation and engineering.

A common theme across all aspects of the CC* program is the critical importance of the partnership among campus-level CI experts, including the campus Information Technology (IT)/networking/data organization, contributing domain scientists, research groups, and educators necessary to engage in, and drive, new networking capabilities and approaches in support of scientific discovery. Proposals across the program should reflect and demonstrate this partnership on campus. Proposals will be evaluated on the strength of institutional partnerships, as they are expected to play a central role in developing and implementing the eventual network and data infrastructure upgrades.

All proposals submitted to the CC* program must include a Campus CI plan within which the proposed CI improvements are conceived, designed, and implemented in the context of a coherent campus-wide strategy and approach to CI that is integrated horizontally intra- campus and vertically with regional and national CI investments and best practices. This Campus CI plan must be included as a Supplementary Document and is limited to no more than 5 pages.

Further, proposals are expected to address within the Campus CI plan the sustainability of the proposed work in terms of ongoing operational and engineering costs. Since security and resilience are fundamental issues in campus CI, the Campus CI plan should address the campus-wide approach to cybersecurity in the scientific research and education infrastructure, including the campus approach to data and privacy. Campuses are encouraged to consider emerging best practices in network routing security for network operators as expressed in the Mutually Agreed Norms for Routing Security (see https://www.manrs.org). The plan should include the campus status and plans with respect to federated identity and specifically InCommon, including: if the campus is registered with InCommon as supporting the Research and Scholarship (R&S) Entity Category to streamline integration with research applications (see https://spaces.internet2.edu/display/InCFederation/Research+and+Scholarship+Category); and if the campus meets the InCommon Baseline Expectations for Trust in Federation (see https://spaces.at.internet2.edu/display/TI/TI.34.1?preview=/110336475/110336479/TI.34.1-BaselineExpectations-v1-2016-09.pdf). The plan should also describe campus IPv6 deployment.

The website, http://fasterdata.es.net/campusCIplanning/, offers a number of Campus CI plans provided by existing CC* program awardees as examples. Proposals addressing a multi-institution or regional activity and approach to coordinated and integrated CI may submit a Campus CI plan representing the multi-institution group or region.

As noted in CISE/OAC's companion solicitation, Cybersecurity Innovation for Cyberinfrastructure (NSF 18-547), security is a shared requirement across collaborative scientific environments and the institutions supporting these activities. All proposals submitted to CC* are expected to address the relevant cybersecurity issues and challenges related to their proposed activities. Depending on the type of proposal, these issues may include, but are not limited to: data integrity, privacy, network security measures, federated access and identity management, and infrastructure monitoring.

As a campus CI program, funded activities should represent ongoing opportunities for student engagement, education, and training. Proposals that demonstrate opportunities to engage students directly in the deployment, operation, and advancement of the CI funded activities, consistent with the required Campus CI plan, are welcome.

Program Areas

The CC* program welcomes proposals in five program areas: (1) Data-Driven Networking Infrastructure for the Campus and Researcher; (2) Regional Connectivity for Small Institutions; (3) Network Integration and Applied Innovation; (4) Campus Computing and the Computing Continuum, and; (5) Cyber Team—Research and Education CI-based Regional Facilitation. These are described in detail below.

1. **Data-Driven Networking Infrastructure for the Campus and Researcher**

   Proposals submitted to this area should address network infrastructure improvements at the campus level to enable national and global high-performance end-to-end access to dynamic network services that in turn enable rapid, unimpeded movement of diverse and distributed scientific data sets and advanced computing. These networking improvements include, but are not limited to, the following types of activities:

   - Network upgrades within a campus network to support a wide range of science data flows (including large files, distributed data, sensor networks, real-time data sources, and virtualized instruments for computer systems research);
   - Re-architecting a campus network to support large science data flows, for example, by designing and building a Science DMZ (see http://fasterdata.es.net/science-dmz/ for more information on the Science DMZ approach); and/or
   - A network connection upgrade for the campus connection to a regional optical exchange or point of presence that connects to a state/regional/national network aggregation point prioritizing support for research and education.

   Proposals may wish to consider the application of new wireless technologies as an element of their engineering solution to network-based challenges in enabling scientific research and education on their campus. For example, include multi-gigabit or environment-constrained technologies to connect new instrumentation, resources, or communities relevant to the proposing institution. Note that any wireless solution proposed should address research and education needs as the singular priority, as opposed to a general campus wireless network.

   Proposals must address scientific and engineering projects and their research needs and must include application drivers that require network engineering or upgrades of their existing infrastructure. Proposals must also present project specific end-to-end scenarios for data movement, distributed computing, and other end-to-end services driving the networking upgrade. Proposals are strongly encouraged to include a quantitative element, for example, providing current or historical data flow rates, in their descriptions of data movement scenarios and use cases.

   Proposals should consider expected outcomes; they should explain the compelling need for proposed network improvements in light of the current state of the networking infrastructure, and the expected benefits to the identified science drivers and applications of the proposed improvements. All of the above elements should be included in the Project Description. Inclusion of itemized vendor quotes is required for all proposals in this program area and should be included as a Supplementary Document. Proposals must include a summary table of the science drivers and their network requirements in the Project Description; these requirements may be specified in terms of throughput ranges or as part of a composition or workflow profile for repeating cycles of scientific data movement.

   Proposals must also include a Project Plan addressing clear project goals and milestones resulting in a working system in the target environment in the Project Description. Proposals are encouraged to address end-to-end networking performance in considering metrics of success.

   All proposals in this area must document explicit partnerships or collaborations with the campus IT/networking organization, as well as one or more domain scientists, research groups, and educators in need of the new network capabilities. Partnership documentation from personnel not included in the proposal as PI, co-PI, or Senior Personnel should be in the form of a letter of collaboration located in the Supplementary Documents section of the proposal.

   Any budget request for professional services, such as IT staff support, must be documented in coordination with the institution's campus IT or CIO organization. Note that requests for significant human resources are not encouraged.

   Proposals are required to include a network management plan addressing responsibilities, support, and roles in the Project Description. The plan should spell out how science data flows will be supported. A letter of support from a campus leader is encouraged and should address sustainability and commitment from the institution.

   Target environments must be campus infrastructure residing within the U.S.

   Proposals are encouraged, but not required, to include a network diagram of the proposed network upgrades. Proposals are encouraged to document current utilization in the context of the proposed upgrades.

   Proposals are encouraged to address security considerations in the proposed design. The Energy Science Network's (ESnet) design guidance for the Science DMZ, includes this element: "Security policies and enforcement mechanisms that are tailored for high performance science environments." ESnet provides more detailed guidance on security considerations in the design of the Science DMZ at: http://fasterdata.es.net/science-dmz/science-dmz-security/.

   Preference will be given to proposals describing an operational role for IPv6, for example, describing native IPv6 support for one or more specific science applications. Proposals are expected to describe an approach to end-to-end network performance measurement based on the PerfSonar framework with associated tool installation and use; proposals may describe an alternative approach to PerfSonar with sufficient justification.

   Proposers are encouraged to reference the following community website for more information on PerfSonar: http://fasterdata.es.net/performance-testing/perfsonar/.

   An award in this program area is not the appropriate mechanism to provide support for individual faculty research projects. Requests for support of such projects should be directed to NSF's research grant programs.

Additional proposal preparation guidance for this area can be found in Section V.A. Proposal Preparation Instructions

Only Institutions of Higher Education are eligible to submit proposals in this program area. Current and previous awardees in this area are not eligible to apply to this area. Any proposal received from an organization having already received an award in this area will be returned without review.

Proposals in this area are required to have titles that begin with "CC* Networking Infrastructure:" followed by the title of the project.

2. **Regional Connectivity for Small Institutions**

This area supports broadening participation and significantly widening the set of institutions connected to the regional and national research and education network fabric. This area specifically targets groups of smaller institutions with fundamental challenges in networking infrastructure and resources. This area supports increased research and education (R&E) network connectivity across smaller institutions coordinated and led by an Regional Optical Network (RON) or a leadership institution in R&E networking in the region.

This area solicits proposals led by established regional and state research and education data networks and data network-based consortia. Example entities are listed as members of the national regional networks consortium called the Quilt (see https://www.thequilt.net/about-us/the-quilt-participants/). For areas of the US without a state or regional level coordinating entity and associated structure and network infrastructure, proposals will be accepted from self-declared leadership universities. **An institution may also lead a proposal in regions with an established RON with documented coordination with the RON.**

Proposals are required to address campus networking needs spanning multiple under-resourced institutions. Proposals addressing a single institution are not allowed in this area and will be returned without review. Proposals may choose to apply an alternative design framework to the conventional single institution context in Area (1) and consider an aggregation model where some or all associated resources and services (e.g., Science DMZ) are centralized at a regional level.

Proposals submitted to this area must address scientific research and education needs driving the proposed improvements in R&E networking connectivity on campus and/or externally.

Proposals may focus on upgrading an institution’s connectivity to the national research and education community and/or point to a need to redesign their campus network to better support academic data flows, such as the Science DMZ approach (see http://fasterdata.es.net/fasterdata/science-dmz for more information). Connectivity solutions between R&E buildings and sites are also in scope.

Proposals in this area should focus on establishing their institutions' science research and education needs and aspirations and discuss how that translates to the need for greater connectedness and investment in network capacity. Institutions whose missions are primarily education-focused may choose to present their scientific needs in the context of network-enabled education activities and distance education. Proposals are encouraged to discuss research and education drivers with specific descriptions of these drivers.

Proposals may wish to consider the application of new wireless technologies as an element of their engineering approach to network-based challenges in enabling scientific research and education—this may include, for example, multi-gigabit or environment-constrained technologies to connect campuses in rural areas, or existing campus networks to new instrumentation, resources, or communities relevant to the proposing institution. Note that any wireless solution proposed should address research and education needs as the singular priority, as opposed to a general campus wireless network.

Proposals in this area are not required to present a complete technical solution, with complete equipment specifications, and may choose to defer technical solutions and equipment purchases to the second year of activities. In these cases, vendor quotes are not required for this program area. Under this scenario, the year 1 annual report is required to provide these details with NSF approval, prior to expenditures in year 2. The NSF approval of the annual report is also subject to a successful review before the end of the first year of the technical design developed. Equipment is not expected to be fully specified in the budget; however equipment choices will be specified in the annual report and review.

Proposals are expected to address coordination activities with the participating small institutions by planning for one or more meeting events starting in year 1.

Proposals may include equipment and resources targeted for the state or regional network infrastructure. It is expected that such investments will be justified in the proposal in the context of needed improvements at the state and regional aggregation level in order to support the target institutions’ external connectivity regionally, nationally, and globally for enabling R&E collaborations.

The lead proposing entity is expected to be experienced in high-performance R&E networking and to be well-resourced and capable of actively working with the participating institutions on designing and implementing the proposed networking improvements. The partnering institutions’ engagement activities may be supported in the proposal and included as subawards.

Proposals will be evaluated mainly on the strength of the science use cases presented—including research and education—and their quantification. Proposals will also be evaluated on the strength of institutional partnerships as they are expected to play a central role in developing and implementing the eventual network upgrades.

Proposals are encouraged to provide a summary table of the science drivers and their network requirements in the Project Description. These requirements may be specified in terms of throughput ranges or as part of a composition or workflow profile for repeating cycles of scientific data movement.

Proposals are required to include, in the Project Description, a conceptual or functional network diagram of the proposed network upgrades and are encouraged to include the context of end system and user connectivity. Proposals are encouraged to document current utilization in the context of the proposed upgrades.

Proposals must include, in the Project Description, a Project Plan addressing clear goals and milestones resulting in a working system in the target environment. Proposals are encouraged to address end-to-end networking performance in considering metrics of success.

All proposals in this area must document explicit partnerships or collaborations with the participating campus' IT/networking organizations, as well as one or more domain scientists, research groups, and educators in need of the new network capabilities. Partnership documentation from personnel not included in the proposal as PI, coPI, or Senior Personnel should be in the form of a letter of collaboration located in the Supplementary Documents section of the proposal.

If a proposal chooses to discuss design of a proposed Science DMZ, NSF encourages adoption of guidance found on the ESnet website as referenced above, including security considerations in the design of the Science DMZ at: http://fasterdata.es.net/science-dmz/science-dmz-security/

Beyond modest configurations of a Data Transfer Node (DTN) as part of a Science DMZ, proposals in this area are discouraged from budgets reflecting significant investments in storage and computing. This is a networking area and proposal budgets are expected to reflect this simple theme.

Proposals are encouraged to describe an approach to endtoend network performance measurement based on the PerfSonar framework with associated tool installation and use; proposals may describe an alternative approach to PerfSonar with sufficient justification. Proposers are encouraged to reference the following community website for more information on PerfSonar: http://fasterdata.es.net/performance-testing/perfsonar/.

Any budget request for professional services at the campus level, such as IT staff support, must be documented in coordination with the institutions' campus IT or CIO organizations. The proposing entity may choose to include technical staff support required to carry out the work.

Proposals are required to include, in the Project Description, a network management plan addressing responsibilities, support, and roles. The plan should spell out how science data flows will be supported.

A letter of support from a campus leader at each participating campus is encouraged and should address sustainability and commitment from each participating institution.

An award in this program area is not the appropriate mechanism to provide support for individual faculty research projects. Requests for support of such projects should be directed to NSF's research grant programs.

Target environments must be campus infrastructure residing within the U.S.

Additional proposal preparation guidance for this area can be found in Section V.A. Proposal Preparation Instructions.

Institutions of Higher Education and Nonprofit, Non-academic Organizations are eligible to submit proposals in this program area.

Proposals in this area are required to have titles that begin with "CC* Regional:" followed by the title of the project.

3. **Network Integration and Applied Innovation**

This program area supports end-to-end network CI through integration of existing and new technologies and applied innovation. The goal is to take advantage of research results, prototypes, and emerging innovations to use them to enable specified researchers in a networking context. Proposals in this area may leverage new and existing investments in network infrastructure, services, and tools by combining or extending capabilities to work as part of the CI environment used by scientific applications and users.

Proposals in this area are expected to reflect innovation in advanced networking. As a result, this area is not appropriate for projects whose costs are dominated by equipment purchases.

Proposals in this area support the development and integration of innovative networking capabilities; network-related software development and deployment activities resulting in an operational environment prototype are expected to be part of the proposed activities.

A broad range of activities is covered by this area, including but not limited to:

- Integration of networking protocols and technologies with science application layer processes and workflows;
- Transition of successful research prototypes in Software Defined Networking (SDN) and wireless networking technologies to distributed scientific environments and campus infrastructure;
- Applications of networking hardware and software developed on NSFFutureCloud facilities (e.g., ChameleonCloud and CloudLab), including the integration of new technologies such as programmable network interfaces;
- Networking solutions exploiting virtualization, distributed computing and Software Defined Infrastructure (SDI), including cloud services and direct campustocloud connections;
- Innovative research prototypes integrating programmable packet processing components into campus infrastructure or exploring applications of software-defined data planes in support of high-performance data distribution; and
- Network engineering support through the creation and application of new and novel procedures and tools and network measurement and monitoring software for solving endtoend network performance issues, especially for dynamically constructed network services.

Proposals in this area must identify, in the Project Description, one or more supported science or engineering research projects or applications and describe how the proposed network integration activities will support those projects, particularly in the context of addressing data movement, throughput, and predictable performance end-to-end.

Where appropriate, proposals are encouraged to document explicit partnerships or collaborations with the campus

IT/networking organization.

Proposals in this area must include, in the Project Description, a Project Plan addressing clear project goals and milestones resulting in a working system in the target environment. Proposals must define base metrics relevant to the proposal goals and address measurement and evaluation of the resulting system. Any software development under proposed activities must be made available under an open source license.

Additional proposal preparation guidance for this area can be found in Section V.A. Proposal Preparation Instructions.

Only Institutions of Higher Education are eligible to submit proposals in this program area.

Proposals in this area require titles that begin with "CC* Integration:" followed by the title of the project.

4. **Campus Computing and the Computing Continuum**

Local campus computing resources have emerged as an important aggregated and shared layer of scientific computing, as evidenced by the growth in Open Science Grid (an NSF-funded distributed scientific computing fabric of shared computing clusters across more than 100 institutions) productivity that will approach two billion CPU hours delivered in scientific computing for the calendar year 2018.

This program area promotes coordinated approaches in scientific computing at the campus level through **three funding options**: (a) **Campus Cluster Resource**, seeding and augmenting shared computing resources at the campus level through investments in capacity computing in campus clusters; (b) **Cloud Computing Resources**, enabling campuses to explore the potential use of cloud computing services and its analytics platforms in supporting their community's scientific research computing assets and available resources; and (c) **Hybrid**, a combination of both local computing resources and access to remote cloud computing. For all the three funding options, the program promotes a coordinated approach incentivizing multi-campus and national resource sharing.

It is expected that campus-wide computing needs are addressed in the proposal; a proposal focusing on a single science domain or project use will not be considered for funding.

All proposals into this area must address:

- Scientific and engineering projects and their research computing needs, describing project-specific scenarios for scientific computing tied to the proposed computing resources;
- Features, capabilities, and software platforms representing the proposed computing resources; and
- Scientific computing codes expected to run on the resources.

All proposals should consider expected outcomes; they should explain the compelling need for proposed computing resource in light of the current state of available computing resources and the expected enabling benefits of the proposed resources to the identified science drivers and applications.

NSF encourages proposals in this program area from under-resourced institutions and preference will be given to proposals demonstrating a compelling need for access to campus/cloud resources, including institutions lacking necessary computing and storage resources on campus.

Proposals may target one of the three options—(a) Campus Cluster Resource; (b) Cloud Computing Resources, or (c) Hybrid—as described below.

a. **Campus Cluster Resource**

A Campus Cluster proposal requests funding for the acquisition of a shared, high-performance network-connected compute resource available to scientific computing users on campus and outside of campus.

Proposals must include in the Project Description:

- A summary table of the science drivers and their computing environments—these requirements may be specified in terms of compute job profile parameter ranges, core count ranges per job, times to completion or as part of a composition or scientific workflow profile;
- The platform architecture specifying cluster components, including compute node type and count, per-node memory, interconnect fabric, storage, and open source software/platform;
- An open source-based approach to cluster monitoring, measurement, management, and instrumentation;
- A sustainability plan addressing the institution's commitment to providing an ongoing level of sustained access to computational resources;
- A High-Performance Network Connectivity and Specification—see below for more details; and
- A description of the cluster as a Shared Resource Intra-campus and Inter-campus—see below for more details.

Proposals are encouraged to consider open source virtualization technologies.

Inclusion of itemized vendor quotes accompanying the budget is required for all proposals in this program area.

High-Performance Network Connectivity and Specification: Proposals should describe the network connectivity of the proposed computing resource, both intra-campus [for example, the campus network path(s) connecting the resource with the researchers and driving science applications on campus], and inter-campus (for example, showing the network path connecting with the regional exchange point or Internet2). Proposals should include in their plans the deployment of a PerfSonar based network performance measurement capability to initially measure achievable end-to-end network performance for scientific data flows between the resource and relevant end points of researchers.

The Cluster as a Shared Resource Intra-campus and Inter-campus: Proposals should describe (1) their approach to sharing the proposed computing resource across the science drivers and researchers at their institution; (2) how the resource will be accessed by external research groups; and (3) how the resource is coordinated with external resources allowing the institution's researchers to seamlessly access computing resources at other campuses, regional and national computing resources, and/or production cloud resources, if appropriate.

Proposals should commit to a minimum of 20% shared time on the cluster and describe their approach to making the cluster available as a shared resource external to the campus, with access and authorization according to local administrative policy. Conversely, the proposal should describe the approach to providing **on-demand** access to additional external computing resources to its targeted on-campus users and projects. One possible approach to implementing such a federated distributed computing solution is joining the Open Science Grid. Whatever opportunistic, federated, scalable, distributed computing platform is chosen, the proposal is expected to justify the choice by including a discussion on the shared platform's track record in the community, its current scientific computing production capability, and its scaling properties. Proposals are encouraged to include a letter of collaboration from the selected platform.

The proposal is expected to document campus IT and research leadership commitment to operations and maintenance (O&M) given that the proposal budget is expected to be dominated by equipment, with some travel and project coordination staff time. Costs associated with software license fees are not allowed.

Campus Cluster Resource proposals may request up to $400,000.

b. **Cloud Computing Resources**

A Cloud Computing Resource proposal includes a technical justification for use of cloud resources coupled with the cost computation used to arrive at the requested amount of credits/resources as well as the detailed annual plan for usage of these credits/resources over the duration of the project.

Amazon Web Service and Google Cloud Platform are participating in the CC* program to provide cloud credits/resources to campuses whose scientific research requires additional and external computational and storage resources. These providers are also expected to provide support and training to those campuses. If additional cloud providers join the program, resources/credits from those providers will be available under the same terms and conditions as described in this solicitation, and will be added to the NSF CC* program webpage.

While the technical description and justification for use of cloud resources are expected to be part of the Project Description, details of the cloud resource costing and annual cloud resource usage should be included in the Supplementary Documents section of the proposal. See Section V.A.5.b, Cloud Costing and Annual Usage Plan, for details on how to provide detailed costing and annual usage information for cloud resources under Supplementary Documents. Note that cloud providers participating in this program have explicitly waived ingress data charges and most educational and non-profit institutions are eligible for waiver of egress data charges.

The request for cloud credits/resources must adhere to a **maximum** of $100,000. The NSF budget may include nominal staff time, travel, training support, and necessary end system platforms and storage to coordinate job requests and data transfer between the campus and the external cloud resources. The NSF budget may be up to $100,000. The separate cloud credit/resource request of up to $100,000 **does not appear** in the NSF budget pages nor in the NSF Budget Justification section, but rather under Supplementary Documents as described in Section V.A.5.b.

A sustainability plan addressing the institution's commitment to providing an ongoing level of sustained access to computational resources is required.

Cloud Computing Resources proposals may request up to $100,000 in the NSF budget, and up to $100,000 in cloud credits/resources in the Supplementary Document.

c. **Hybrid**

Hybrid proposals describe an approach combining (a) Campus Cluster Resource and (b) Cloud Computing Resources.

All proposal guidance in (a) applies as well to this option for the justification and specification of a shared local compute cluster.

Proposals must include in the Project Description:

- A summary table of the science drivers and their computing environments - these requirements may be specified in terms of compute job profile parameter ranges, core count ranges per job, times to completion or as part of a composition or scientific workflow profiles;
- The platform architecture specifying cluster components, including compute node type and count, per-node memory, interconnect fabric, storage, and open source software/platform;
- An open source-based approach to cluster monitoring, measurement, management, and instrumentation;
- A sustainability plan addressing the institution's commitment to providing an ongoing level of sustained access to computational resources;
- A High-Performance Network Connectivity and Specification—see below for more details, and;
- A description of the cluster as a Shared Resource Intra-campus and Inter-campus—see below for more details.

Proposals are encouraged to consider open source virtualization technologies.

Inclusion of itemized vendor quotes accompanying the budget is required for all proposals in this program area.

High-Performance Network Connectivity and Specification: Proposals should describe the network connectivity of the proposed computing resource, both intra-campus [for example, the campus network path(s) connecting the resource with the researchers and driving science applications on campus], and inter-campus (for example, showing the network path connecting with the regional exchange point or Internet2). Proposals should include in their plans the deployment of a PerfSonar based network performance measurement capability to initially measure achievable end-to-end network performance for scientific data flows between the resource and relevant end points of researchers.

The Cluster as a Shared Resource Intra-campus and Inter-campus: Proposals should describe (1) their approach to sharing the proposed computing resource across the science drivers and researchers at their institution; (2) how the resource will be accessed by external research groups; and (3) how the resource is coordinated with external resources allowing the institution's researchers to seamlessly access computing resources at other campuses, regional and national computing resources, and/or production cloud resources, if appropriate.

Proposals should commit to a minimum of 20% shared time on the cluster and describe their approach to making the cluster available as a shared resource external to the campus, with access and authorization according to local administrative policy. Conversely, the proposal should describe the approach to providing **on-demand** access to additional external computing resources to its targeted on-campus users and projects. One possible approach to implementing such a federated distributed computing solution is joining the Open Science Grid. Whatever opportunistic, federated, scalable, distributed computing platform is chosen, the proposal is expected to justify the choice by including a discussion on the shared platform's track record in the community, its current scientific computing production capability, and its scaling properties. Proposals are encouraged to include a letter of collaboration from the selected platform.

The proposal is expected to document campus IT and research leadership commitment to O&M given that the proposal budget is expected to be dominated by equipment, with some travel and project coordination staff time. Costs associated with software license fees are not allowed.

This area supports the campus integration of commercial cloud computing and storage resources while challenging institutions to define a multi-layer resource strategy in meeting the needs of their scientific communities.

Proposals are expected to address their approach to using cloud resources in combination with campus resources as well as the national shared distributed computing fabric chosen.

Amazon Web Service and Google Cloud Platform are participating in the program to provide cloud credits/resources, as well as support and training, to campuses whose scientific research requires additional and external computational and storage resources, for example, to provide on-demand bursting capability during peak aggregate demand times. If additional cloud providers join the program, resources/credits from those providers will be available under the same terms and conditions as described in this solicitation, and will be added to the CC* Program Page.

While the technical description and justification for use of cloud resources are expected to be part of the Project Description, details of the cloud resource costing and annual cloud resource usage should be included in the Supplementary Documents section of the proposal. See Section V.A.5.b, Cloud Costing and Annual Usage Plan, for details on how to provide detailed costing and annual usage information for cloud resources under Supplementary Documents. Note that cloud providers participating in this program have explicitly waived egress data charges.

The request for cloud credits/resources must adhere to a **maximum** of $100,000 and cannot exceed 50% of the overall proposed budget. As an example, a proposal that requests $400,000 in NSF funds could request up to $100,000 in cloud credits/resources. The $400,000 would be requested in the NSF Budget, with the usual NSF Budget Justification; the cloud credit/resource request of $100,000, for this example, would **not appear** in the NSF Budget pages nor in the NSF Budget Justification section, but rather under Supplementary Documents as described in Section V.A.5.b.

The proposal is expected to document campus IT and research leadership commitment to O&M given that the proposal budget is expected to be dominated by equipment, with some travel and project coordination staff time. Costs associated with software license fees are not allowed.

Hybrid proposals may request up to $400,000 in the NSF budget and up to $100,000 in the supplementary document.

Additional proposal preparation guidance for this area can be found in Section V.A. Proposal Preparation Instructions.

Only Institutions of Higher Education are eligible to submit proposals in this program area.

Proposals in this area require titles that begin with "CC* Compute:" followed by the title of the project.

5. **Cyber Team - Research and Education CI-based Regional Facilitation**

This program area supports facilitation of campus cluster, cloud, and distributed computing resource use by scientists and scientific collaborations. This program area recognizes the enabling role of technical expertise, leadership, and engagement at the campus level in the successful research and educational pursuits across the NSF community.

NSF has in recent years supported similar types of expert facilitation through CC* CI Engineer awards, CC* Region awards, eXtreme Science and Engineering Discovery Environment (XSEDE) Campus Champions, and Advanced Cyberinfrastructure Research and Education Facilitators (ACI-REFs). Further, consortia and communities coordinating these activities have formed into active Research Coordination Networks, such as XSEDE Campus Champions and the Consortium for Advanced Research Computing (CaRC).

NSF views the facilitator role as an emerging professional role responding to, and helping to define, current needs and opportunities in advancing scientific discovery. This special function is not merely a research support role, but rather an integrative one that centers on partnering with research projects within the campus and across campuses on shared goals.

Proposals in this area should describe the multi-institutional science-driven needs and enabling impact of long-term access to and engagement with a shared Cyber Team. Proposals should describe planned engagement activities in multiple science and engineering projects across campuses, including plans to leverage existing campus CI and how these bridging services can be managed. Proposals should describe and justify the structure and make-up of the proposed Cyber Team, including the approach to its engagement, interactions, and partnerships with science and engineering research as well as education and training activities. Proposals should address details of the initial planned engagements.

Proposals may request up to four full-time equivalents for up to three years. Proposals must address institutionalization of positions and activities represented in this Cyber Team in the longer term through discussion of a viable sustainability plan. Proposals are encouraged to consider how the proposed Cyber Team interacts with related national CI entities (such as CaRC and Campus Champions), collaborations, participating campuses, and scientific virtual organizations where relevant. Proposals are encouraged to include letters of commitment from campuses and projects impacted by the proposed activities.

Proposals should describe their organizational and management structure and discuss their approach to accepting input and requests from campuses in the region, and prioritizing and responding to their needs for CI expertise. Proposals are encouraged to consider how researchers and users play a role, as well as local IT staff, for example, through an advisory or user committee providing feedback on direction. The treatment of these issues is one factor in determining long-term sustainability of the effort.

Proposals should describe plans for broadening participation, including how under-resourced institutions can be meaningfully engaged.

Tangible goals and milestones for the Cyber Team should be addressed in an explicit section of the Project Description. This section should address campus-level and/or science project-level engagements. Proposals are encouraged to discuss how the Cyber Team will be evaluated in the context of quality and quantity of services provided, and impact on science and engineering research and education projects.

Proposals are encouraged from multi-institution teams or regional network organizations and consortia representing and serving the cyberinfrastructure needs of academic institutions within a designated region of the U.S. Proposals are also allowed from an individual leadership institution representing a state or region, or group of institutions.

Proposals in this area are allowed to have their Campus CI plan represent a multi-institutional or regional CI plan, as opposed to a single campus. These plans have an opportunity to convey a future vision of inter-campus CI in support of distributed scientific research and education. As previously stated, the Campus CI Plan is a required component of all CC* proposals and must be included as a Supplementary Document.

Additional proposal preparation guidance for this area can be found in Section V.A. Proposal Preparation Instructions.

Institutions of Higher Education and Nonprofit, Non-academic Organizations are eligible to submit proposals in this program area.

Proposals in this area require titles that begin with "CC* Team:" followed by the title of the project.

III. AWARD INFORMATION

Approximately $10 million-$17 million will be made available in FY 2019 to support 18-40 awards, subject to the availability of funds.

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 subawards 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 labs, professional societies and similar organizations in the U.S. associated with educational or research activities.

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:

There are no restrictions or limits.

Additional Eligibility Info:

Institutions of Higher Education may submit proposals to any of the requested areas.

Nonprofit, Nonacademic Organizations may submit to program areas (2) Regional Connectivity for Small Institutions and (5) Cyber Team - Research and Education CI-based Regional Facilitation only.

Collaborative proposals submitted as simultaneous submission of proposals from different organizations, with each organization requesting a separate award are not allowed. Collaborative proposals submitted as a single proposal, in which a single award is being requested (with subawards administered by the lead organization) are allowed.

Current and past awardees in program area (1) Data-Driven Networking Infrastructure for the Campus and Researcher are not eligible to apply to this area. Any proposal received for program area (1) from an organization having already received an award in this area will be returned without review.

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 Grants.gov or via the NSF FastLane system.

- Full proposals submitted via FastLane: Proposals submitted in response to this program solicitation should be prepared and submitted in accordance with the general guidelines contained in the *NSF Proposal & Award Policies & 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. Paper copies of the PAPPG may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-7827 or by e-mail from nsfpubs@nsf.gov. Proposers are reminded to identify this program solicitation number in the program solicitation block on the NSF Cover Sheet For Proposal to the National Science Foundation. Compliance with this requirement is critical to determining the relevant proposal processing guidelines. Failure to submit this information may delay processing.

- Full proposals submitted via Grants.gov: Proposals submitted in response to this program solicitation via Grants.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 website and on the NSF website at: (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 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) 292-7827 or by e-mail from nsfpubs@nsf.gov.

See PAPPG Chapter II.C.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.

Proposals are encouraged to review the NSF/CISE Data Management Guidance for CISE Proposals and Awards available at https://https://www.nsf.gov/cise/cise_dmp.jsp.

For area (1) Data-Driven Networking Infrastructure for the Campus and Researcher Proposals:

Proposals in this area require titles that begin with "CC* Networking Infrastructure:" followed by the title of project.

Refer to Section II, Program Description, for additional information about requirements for CC* proposals. In particular, a Campus CI plan must be included, with a limit of up to 5 pages, as a Supplementary Document.

For area (2) Regional Connectivity for Small Institutions Proposals:

Proposals in this area require titles that begin with "CC* Regional:" followed by the title of project.

Refer to Section II, Program Description, for additional information about requirements for CC* proposals. In particular, a Campus CI plan must be included, with a limit of up to 5 pages, as a Supplementary Document.

If appropriate, proposals in this area are allowed to have their Campus CI plan represent a multi institutional or regional CI plan, as opposed to a single campus. These plans have an opportunity to convey a future vision of intercampus cyberinfrastructure in support of distributed scientific research and education.

For area (3) Network Integration and Applied Innovation Proposals:

Proposals in this area require titles that begin with "CC* Integration:" followed by the title of project.

Refer to Section II, Program Description, for additional information about requirements for CC* proposals. In particular, a Campus CI plan must be included, with a limit of up to 5 pages, as a Supplementary Document.

For area (4) Campus Computing and the Computing Continuum Proposals:

The following guidance is specific to (b) Cloud Computing Resources proposals and (c) Hybrid proposals:

Cloud Costing and Annual Usage Plan: Required of proposals requesting the cloud option (page limit: 2 pages). Projects that intend to request Amazon Web Services or Google Cloud Platform cloud credits/resources must include a detailed costing, showing a credit usage/resource consumption plan with the amount and type of compute and storage (and any other cloud resources needed that incur costs) to be used during each year of the project.

The two essential items of the costing plan are:

- The *total cost* of cloud resources—showing the distribution across compute and storage resources; and
- The *annual usage plan*, i.e., how much of these credits/resources will be used each year.

As described earlier in Section II, Program Description, the maximum cloud request is $100,000 and cannot exceed 50% of the total requested budget. Cloud credits and/or resource costs should be computed using the information provided by Amazon Web Services and Google Cloud Platform, respectively (see below). Proposers are strongly encouraged to contact the point of contact for each cloud provider to obtain assistance with estimating cloud resources needed for the project.

The estimate for cloud resources should account for the aggregate estimated resource requirements from specified scientific projects and any associated software development and testing required to port the scientific computing environment into the cloud.

Proposers must use the following resources in order to develop the total cost of cloud resources, and to develop an annual usage plan over the duration of the projects:

- Amazon Web Services (AWS):
- The website for computing AWS compute, storage and networking costs is https://calculator.s3.amazonaws.com/index.html.
- The website for computing AWS SPOT prices is https://aws.amazon.com/ec2/spot/pricing/.
- AWS cloud resources are provided as part of the AWS Promotional Credits program (https://aws.amazon.com/awscredits/). Use of AWS credits must adhere to this program. Please refer to the website for information about this program.
- The AWS technical point of contact is Sanjay Padhi, sanpadhi@amazon.com.
- Google Cloud Platform (GCP):
- The website for computing GCP credits/costs is https://cloud.google.com/products/calculator/.
- The GCP technical point of contact is Karan Bhatia, karanbhatia@google.com.

The request for cloud resources will be reviewed along with the rest of the proposal. Credits will be allocated either for the cloud provider requested in the proposal, or for equivalent resources from an alternative cloud provider.

Proposals in this area require titles that begin with "CC* Compute:" followed by the title of project.

Refer to Section II, Program Description, for additional information about requirements for CC* proposals. In particular, a Campus CI plan must be included, with a limit of up to 5 pages, as a Supplementary Document.

For area (5) Cyber Team - Research and Education CI-based Regional Facilitation Proposals:

Proposals in this area require titles that begin with "CC* Team:" followed by the title of project.

Refer to Section II, Program Description, for additional information about requirements for CC* proposals. In particular, a Campus CI plan must be included, with a limit of up to 5 pages, as a Supplementary Document.

If appropriate, proposals in this area are allowed to have their Campus CI plan represent a multi-institutional or regional CI plan, as opposed to a single campus. These plans have an opportunity to convey a future vision of inter-campus cyberinfrastructure in support of distributed scientific research and education.

B. Budgetary Information

Cost Sharing:

Inclusion of voluntary committed cost sharing is prohibited.

Budget Preparation Instructions:

Budgets should include travel funds for the project principal investigators and other team members as appropriate from all collaborating institutions to attend annual Principal Investigators' meetings.

C. Due Dates

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

  February 20, 2019

D. FastLane / Grants.gov Requirements

For Proposals Submitted Via FastLane:

To prepare and submit a proposal via FastLane, see detailed technical instructions available at: https://www.fastlane.nsf.gov/a1/newstan.htm. For FastLane user support, call the FastLane Help Desk at 1-800-673-6188 or e-mail fastlane@nsf.gov. The FastLane Help Desk answers general technical questions related to the use of the FastLane 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 webpage: http://www.grants.gov/web/grants/applicants.html. 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. 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 the NSF FastLane system for further processing.

Proposers that submitted via FastLane are strongly encouraged to use FastLane 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 acknowledgement 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/.

Proposers should also be aware of core strategies that are essential to the fulfillment of NSF's mission, as articulated in *Building the Future: Investing in Discovery and Innovation - NSF Strategic Plan for Fiscal Years (FY) 2018 – 2022*. 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.C.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.C.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 underrepresented minorities 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 Plan and the Postdoctoral Researcher Mentoring Plan, as appropriate.

Additional Solicitation Specific Review Criteria

All CC* projects will be reviewed with careful attention to the following:

- *The extent to which the work provides a needed capability required by science, engineering and education.*
- *The expected impact on the deployed environment described in the proposal, and potential impact across a broader segment of the NSF community.*
- *Where applicable, how resource access control, federated identity management, and other cybersecurity related issues and community best practices are addressed.*
- ***A Cyberinfrastructure (CI) plan:** To what extent is the planned cyberinfrastructure likely to enhance capacity for discovery, innovation, and education in science and engineering? How well does the plan as presented position the proposing institution(s) for future cyberinfrastructure development? How well does the cyberinfrastructure plan support and integrate with the institutions' science and technology plan? Are IPv6 deployment and InCommon Federation addressed? Are the activities described in the proposal consistent with the institution's cyberinfrastructure plan?*

Additionally, for proposals in area (1) Data Driven Networking Infrastructure for the Campus and Researcher and (2) Regional Connectivity for Small Institutions:

- ***A Project Plan** addressing clear goals and milestones resulting in a working system in the target environment.*

Additionally, for proposals in area (3) Network Integration and Applied Innovation:

- ***A Project Plan** addressing clear goals and milestones resulting in a working system in the target environment.*
- ***Tangible metrics** to measure the success of the integrated systems and any associated software developed, and the steps necessary to take the systems from prototype status to production use.*

Additionally, for proposals in area (4) Campus Computing and the Computing Continuum:

- *The extent to which science drivers and applications motivate the types of compute and cloud resources requested.*

Additionally, for proposals in area (4) Campus Computing and the Computing Continuum and (5) Cyber Team - Research and Education CI-based Regional Facilitation:

- ***A Project Plan** addressing clear goals and milestones.*
- ***Tangible metrics** to measure the success of the system or set of activities.*

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 applicants whether their proposals have been declined or recommended for funding within six months. Large or particularly complex proposals or proposals from new awardees 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 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 a Grants Officer in the Division of Grants and Agreements. 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. Paper copies may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-7827 or by e-mail from 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.

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 project report, and a project outcomes report for the general public.

Failure to provide the required annual or final 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 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.

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:

- Kevin Thompson, Program Director, CISE/OAC, telephone: (703) 292-4220, email: kthompso@nsf.gov
- Deepankar (Deep) Medhi, Program Director, CISE/CNS, telephone: (703) 292-8950, email: dmedhi@nsf.gov

For questions related to the use of FastLane, contact:

- FastLane Help Desk, telephone: 1-800-673-6188; e-mail: fastlane@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.

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 http://www.grants.gov.

Related Programs:

NSF Advisory Committee for Cyberinfrastructure Task Force on Campus Bridging, *Final Report,* March 2011.
Available from: https://www.nsf.gov/cise/oac/taskforces/TaskForceReport_CampusBridging.pdf

Reference material on the "Science DMZ" concept is available at: http://fasterdata.es.net/fasterdata/science-dmz/

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.E.6 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

  or telephone: (703) 292-7827
- **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 awardees 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 applicants 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 Systems of Records, NSF-50, "Principal Investigator/Proposal File and Associated Records," 69 Federal Register 26410 (May 12, 2004), and NSF-51, "Reviewer/Proposal File and Associated Records," 69 Federal Register 26410 (May 12, 2004). 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:

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Reports Clearance Officer
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