Computer and Network Systems (CNS): Core Programs

PROGRAM SOLICITATION
NSF 18-569

REPLACES DOCUMENT(S):
NSF 17-570

National Science Foundation

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

Submission Window Date(s) (due by 5 p.m. submitter's local time):

September 24, 2018 - October 02, 2018

LARGE projects

September 24, 2018 - October 02, 2018

MEDIUM projects

November 01, 2018 - November 15, 2018

SMALL projects

September 09, 2019 - September 16, 2019

MEDIUM projects

September 18, 2019 - September 25, 2019

LARGE projects

October 31, 2019 - November 14, 2019

SMALL projects

IMPORTANT INFORMATION AND REVISION NOTES

This is a revision of NSF 17-570, the solicitation for the CISE/CNS Core Programs. Significant changes have been made to the program description. The revisions include:

- All proposals must be submitted to the “CNS Core” program, rather than the Research in Networking Technology & Systems (NeTS) or Computer Systems Research (CSR) programs.
- Additional solicitation-specific review criteria, addressing security by design, robustness, manageability, and understanding of the system or system component; evaluation of expected research outcomes; and dissemination plans for independent validation.
- A Results Dissemination Plan and a Data Management Plan are now required for all proposals.
- The requirement of a Collaboration Plan for all proposals with more than one investigator for MEDIUM proposals and all LARGE proposals.
- The addition of new submission taxonomy and keyword requirements; these are to be included at the end of the project summary.
- The Office of Advanced Cyberinfrastructure (OAC) is now part of the coordinated solicitation, along with CNS (this solicitation), Computing and Communication Foundations (CCF), and Information and Intelligent Systems (IIS).
- Broadening Participation in Computing plans are strongly encouraged for Medium and Large proposals, and approved plans are required before award.
- Proposers are asked not to request start dates between July 2 and September 30 of a given year.
- Eligibility requirements for PIs, co-PIs, and senior personnel are clarified.
- Evaluation plans are required.
- The section on Embedded REU Supplements has been removed. Requests for REU supplements may still be submitted in accordance with applicable NSF *Proposal & Award Policies & Procedures Guide* (PAPPG) and CISE guidance.

Any proposal submitted in response to this solicitation should be submitted in accordance with the revised *NSF Proposal & Award Policies & Procedures Guide* (PAPPG) (NSF 18-1), which is effective for proposals submitted, or due, on or after January 29, 2018.

SUMMARY OF PROGRAM REQUIREMENTS

General Information

Program Title:

Computer and Network Systems (CNS): Core Programs

Synopsis of Program:

CISE's Division of Computer and Network Systems (CNS) supports research and education projects that take a system-oriented approach to the development of novel computing and networking technologies, or to the enhancement of existing systems in any of several dimensions, or that explore new ways to make use of existing technologies.

Proposers are invited to submit proposals in three project classes, which are defined as follows:

- Small Projects - up to $500,000 total budget with durations up to three years;
- Medium Projects - $500,001 to $1,200,000 total budget with durations up to four years; and
- Large Projects - $1,200,001 to $3,000,000 total budget with durations up to five years.

A more complete description of the three project classes can be found in Section *II. Program Description* of this document.

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.

- John T. "Jack" Brassil, telephone: (703) 292-8950, email: jbrassil@nsf.gov
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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: 100 to 150

Anticipated Funding Amount: $60,000,000

$60 million per year, dependent upon the availability of funds.

Eligibility Information

Who May Submit Proposals:

Proposals may only be submitted by the following:

- Institutions of Higher Education (IHEs) - Two- and four-year IHEs (including community colleges) accredited in, and having a campus located in the US, acting on behalf of their faculty members. Special Instructions for International Branch Campuses of US IHEs: If the proposal includes funding to be provided to an international branch campus of a US institution of higher education (including through use of 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:

As of the submission deadline, PIs, co-PIs, or other senior project personnel must hold primary, full-time, paid appointments in research or teaching positions at US-based campuses/offices of organizations eligible to submit to this solicitation (see above), with exceptions granted for family or medical leave, as determined by the submitting institution. Individuals with primary appointments at for-profit, non-academic organizations, or overseas branch campuses of US IHEs are not eligible, even if they also have an appointment at a US campus.

Limit on Number of Proposals per Organization:

There are no restrictions or limits.

Limit on Number of Proposals per PI or Co-PI: 2

In any contiguous September through November period, an individual may participate as PI, co-PI or Senior Personnel in **no more than two** proposals across all size classes submitted in response to the *coordinated solicitations* (where *coordinated solicitations* are defined to include the *Computer and Network Systems (CNS): Core Programs*, *Computing and Communication Foundations (CCF): Core Programs*, *Information and Intelligent Systems (IIS): Core Programs*, and the *Office of Advanced Cyberinfrastructure (OAC): Core Programs* solicitations). For example, between September 2018 and November 2018, an individual may participate as PI, co-PI or Senior Personnel in one proposal submitted to a core program in CCF and in a second proposal submitted to a core program in CNS, or an individual may participate as PI, co-PI or Senior Personnel in two proposals submitted to an IIS core program, etc.

These eligibility constraints will be strictly enforced in order to treat everyone fairly and consistently. In the event that an individual exceeds this limit, proposals received within the limit will be accepted based on earliest date and time of proposal submission (i.e., the first two proposals received will be accepted and the remainder will be returned without review). **No exceptions will be made.**

The limit on the number of proposals per PI, co-PI or Senior Personnel applies only to the *coordinated solicitations.*

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 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:**

  Other budgetary limitations apply. Please see the full text of this solicitation for further information.

C. Due Dates

- **Submission Window Date(s)** (due by 5 p.m. submitter's local time):

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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

The Division of Computer and Network Systems (CNS) supports research and education activities that lead to novel or enhanced computing and networking technologies, or that explore new ways to make use of existing technologies. The Division seeks to develop

a better understanding of the fundamental properties and tradeoffs involved in computer and network systems as well as the abstractions and tools used in designing, building, measuring, and using them**.**

II. PROGRAM DESCRIPTION

The CNS core program deals with all aspects of computer and network systems. Society's reliance on such systems as infrastructure has grown dramatically in the last decade. At the same time, both the resources from which those systems are built—compute, storage, communication networks, and software—and the way those resources are organized and distributed, have continued to evolve rapidly.

Current and future systems need to satisfy various requirements, both generic and purpose-driven. General *system* requirements include security, reliability, manageability, usability, and sustainability, as well as cost-effectiveness and fitness for purpose. Depending on the context, other requirements may include performance, privacy-preservation, scalability, responsiveness, and survivability.

CNS solicits innovative research that considers technology trends and emerging challenges, while emphasizing a *systems* focus and awareness of the types of requirements mentioned above. This solicitation recognizes the interdependency and blurring of boundaries among computing, storage, and networking (sub)systems and the research associated with them. As such, specific sub-programs are not called out. It is *not* the intent to limit the scope of the program, compared to previous solicitations. Rather, the intent is to encourage cross-fertilization among areas of CNS research.

Research of interest for this solicitation:

- Explores fundamental principles and creates innovative technologies, protocols, and systems that define the future or—more realistically—harness current and emerging technologies, trends, and applications;
- Produces practical abstractions, techniques, tools, artifacts, or datasets that address/enhance both general and functional requirements such as those outlined above;
- Reflects a clear understanding of what each component does and how it interfaces with the rest of the system and the environment;
- Disseminates artifacts in such a way that others can repeat, reproduce, validate, or otherwise verify the results.

Although purely intellectual investigations are within scope, research that takes into account current and future societal needs is encouraged.

A hallmark of systems research is the investigation and understanding of design tradeoffs that must be navigated when designing and implementing systems against the requirements above. Proposals that expose underlying principles or tradeoffs having predictive value that extends across different domains are especially encouraged. Proposers should identify and describe the systems considered, the objectives or capabilities envisioned, and their expected contribution in the context of the overall system requirements. Three especially important example requirements are:

- **Secure by design:** How can one ensure integrity and confidentiality of networked systems and data? How can one enhance abstractions, delineate permissible actions, enforce compliance, and establish security defaults in design processes that anticipate vulnerabilities and provide defense against unforeseen attacks from adversaries?

- **Robustness:** How can systems—existing and future—be made more adaptable and resilient to natural and anthropogenic hazards (e.g., weather events, malware, sabotage), as well as other normal or expected events, such as component failures, misconfigurations, and overloads? What innovative approaches would enable one to ensure system robustness and to identify, communicate, and mitigate system anomalies in real-time for outages at both small and large scale?

- **Manageability:** What new architectures and protocols, measurement and monitoring capabilities are needed to support a growing set of diverse applications? How can these measurements and monitoring capabilities aid in overall system management? What are novel approaches to enable comprehensive, pervasive, accurate, and usable measurement capabilities, near real-time system analytics, and systems management when the systems are massive and at the scale of the Internet? What innovations are needed to enable truly autonomous systems, which are self-managing by definition?

In general, any topic having to do with augmenting, understanding, enhancing, or transforming computing and communication systems undertaken from a systems point of view is within scope.

Issues that reside primarily at the device or application level and that are highly context-specific **will not be considered a good fit** for this program. Projects that focus exclusively or primarily on cybersecurity threats and countermeasures may be a better fit for the Secure and Trustworthy Cyberspace (SaTC) program. Projects focused primarily on design or enhancement of sensing and control systems that interact with the physical world may be a better fit with the Cyber-Physical Systems (CPS) program.

Project Validation Plan: Proposers are strongly encouraged to include a project validation plan in the Project Description that describe the underlying setup, processes, mechanisms, and metrics to assess success of the proposed research. Proposers may validate hypotheses using simulations, emulations, testbeds, or a combination of these; architectural validation could happen at a time-scale larger than the project duration, in which case the approach to long-term architecture validation must be discussed in the proposal. Proposers are highly recommended to use, when appropriate, the wide array of community infrastructure testbeds that are available as part of their validation plan. The proposal must make clear the intended level of abstraction at which the underlying research will be validated.

Results Dissemination Plan: Proposals submitted to this solicitation must describe plans to ensure that the research results produced will be made available to the extent necessary to validate the findings independently, as indicated in the NSF *Proposal & Award Policies & Procedures Guide* (PAPPG) Chapter XI.D.4.

Data Management Plan: The data management plan must also describe steps to ensure that relevant software and hardware artifacts,

data and the results are available (for a reasonable time) beyond the end of the project lifecycle. For details, see the Directorate for Computer & Information Science & Engineering (CISE) Data Management Plan at https://www.nsf.gov/cise/cise_dmp.jsp.

Collaboration Plan: Since the success of collaborative research efforts is known to depend on thoughtful coordination mechanisms that regularly bring together the various participants of the project, a separate Collaboration Plan is required for all Large proposals and all Medium proposals with more than one investigator. Collaboration Plans are optional for Small proposals.

PROJECT CLASSES

Proposals submitted to this solicitation must be consistent with one of three project classes defined below. Proposals will be considered for funding within their project classes.

- **SMALL Projects**

  Small Projects, with total budgets up to $500,000 for durations of up to three years, are well suited to one or two investigators (PI and one co-PI or other Senior Personnel) and at least one student and/or postdoc. A Collaboration Plan (up to 2 pages) **may** be provided under Supplementary Documents. Please see *Proposal Preparation Instructions* Section V.A for additional submission guidelines.

- **MEDIUM Projects**

  Medium Projects, with total budgets ranging from $500,001 to $1,200,000 for durations up to four years, are well suited to one or more investigators (PI, co-PI and/or other Senior Personnel) and several students and/or postdocs. Medium project descriptions must be comprehensive and well-integrated, and should make a convincing case that the collaborative contributions of the project team will be greater than the sum of each of their individual contributions. Rationale must be provided to explain why a budget of this size is required to carry out the proposed work. Since the success of collaborative research efforts are known to depend on thoughtful coordination mechanisms that regularly bring together the various participants of the project, **a Collaboration Plan is required for any Medium project with more than one investigator**, even when the investigators are affiliated with the same institution. Up to 2 pages are allowed for Collaboration Plans and they must be submitted as a document under Supplementary Documents. The length and level of detail provided in the Collaboration Plan should be commensurate with the complexity of the proposed project. Collaboration Plans and proposed budgets should demonstrate that key personnel, and especially lead PIs, have allocated adequate time for both their individual technical contributions and the leadership of collaborative activities necessary to realize the synergistic effects of larger-scale research. **If a Medium project with more than one investigator does not include a Collaboration Plan, that proposal will be returned without review.** Please see *Proposal Preparation Instructions* Section V.A for additional submission guidelines.

- **LARGE Projects**

  Large Projects, with total budgets ranging from $1,200,001 to $3,000,000 for durations of up to five years, are well suited to two or more investigators (PI, co-PI(s), or other Senior Personnel), and a team of students and/or postdocs. Large project descriptions must be comprehensive and well-integrated, and should make a convincing case that the collaborative contributions of the project team will be greater than the sum of each of their individual contributions. Large projects will typically integrate research from various areas, either within a cluster or across clusters, or tackle ambitious goals not feasible with smaller projects. Rationale must be provided to explain why a budget of this size is required to carry out the proposed work. Since the success of collaborative research efforts are known to depend on thoughtful coordination mechanisms that regularly bring together the various participants of the project, **a Collaboration Plan is required for all Large projects**, regardless of the number of investigators. Up to 2 pages are allowed for Collaboration Plans and they must be submitted as a document under Supplementary Documents. The length and degree of detail provided in the Collaboration Plan should be commensurate with the complexity of the proposed project. Collaboration Plans and proposed budgets should demonstrate that key personnel, and especially lead PIs, have allocated adequate time for both their individual technical contributions and the leadership of collaborative activities necessary to realize the synergistic effects of larger-scale research. **If a Large project does not include a Collaboration Plan, that proposal will be returned without review**. Please see *Proposal Preparation Instructions* Section V.A for additional submission guidelines.

EVALUATION PLANS

PIs must include a plan to evaluate the approaches developed as part of the Project Description. Evaluation methods will depend on the research area; examples include results from development of theories, applications of techniques to specific domains, efficacy studies, scalability on local or global scales, generalization, quantifiable usability, robustness, reliability in benign or hostile environments, compatibility with existing environments, performance measures on benchmark datasets, and other such activities. The plan should be appropriate for the size and scope of the project.

BROADENING PARTICIPATION IN COMPUTING

CISE has long been committed to Broadening Participation in Computing (BPC). The under-representation of many groups—including women, African Americans, Hispanics, American Indians, Alaska Natives, Native Hawaiians, Native Pacific Islanders, and persons with disabilities—in computing deprives large segments of the population of the opportunity to be creators of technology and not only consumers. Ending underrepresentation will require a range of measures, including institutional programs and activities as well as culture change across colleges, departments, classes, and research groups.

With this solicitation, CISE is expanding a pilot effort started last year encouraging the research community to engage in meaningful BPC activities. This new activity builds on many of the programs, research, and resources created in CISE's long history of support for BPC, and it aligns with the recommendations of the Strategic Plan for Broadening Participation produced by the CISE Advisory Committee in 2011. Specifically:

- Each Medium and Large project must, by the time of award, have in place an approved BPC plan. In this ongoing pilot phase, CISE will work with each PI team following merit review and prior to making an award to ensure that plans are meaningful and include concrete metrics for success. CISE will also provide opportunities for PIs to share BPC experiences and innovations through program PI meetings. PIs of Medium and Large proposals are therefore strongly encouraged to consider this eventual

requirement as they develop their proposals, and to include one- to three-page descriptions of their planned BPC activities under Supplementary Documents in their submissions. Feedback will be provided on such plans.

- PIs submitting to the Small size class should note that CISE intends to conduct an evaluation of the effectiveness of the above approach and determine appropriate next steps, including potential further expansion of this effort in future years. PIs of Small proposals are therefore strongly encouraged to include plans, or begin preparing to include plans, for broadening participation activities in their proposals.

More information, including examples of BPC activities and metrics, can be found at: https://www.nsf.gov/cise/bpc/.

PROPOSALS FOR CONSIDERATION BY MULTIPLE CISE PROGRAMS

Proposals that intersect more than one CISE research program are welcome. In such cases, PIs must identify the most relevant programs in the proposal submission process (for information about submission and how to identify such proposals, see *Proposal Preparation Instructions* later in this document). CISE Program Officers will ensure that these proposals are co-reviewed as appropriate.

IMPORTANT PROJECT CHARACTERISTICS

The submission of far-reaching, creative research and education projects is encouraged. Funds will be used to support potentially transformative research with high-impact potential. In this way, CISE will catalyze exciting new research activities with the potential to make significant advances in the state of the art.

Interdisciplinary, international, and/or academic-industry collaborations that promise to result in major science or engineering advances are welcome. The directorate hopes to attract proposals from faculty at a broad range of academic institutions, including faculty at minority-serving and predominantly undergraduate institutions.

Proposals submitted should demonstrate that rich learning experiences will be provided for a diverse population of students and may propose the development of innovative curricula or educational materials that advance literacy about and expertise in areas supported by CISE.

Scientific progress often results by considering a special case of a general problem. If the proposed research falls into this category, PIs can help the reviewers and NSF staff better understand the intellectual merit and/or broader impacts of the proposal by discussing to what extent the findings are likely to generalize.

In the interest of completeness and transparency, PIs are strongly encouraged to describe, as part of their Data Management Plans, how they will provide access to well-documented datasets, modeling and/or simulation tools, and codebases to support reproducibility of their methods. For more information, see the Dear Colleague Letter “Encouraging Reproducibility in Computing and Communications Research” available at https://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf17022.

START DATES

In order to avoid overdue reports blocking award actions during the end of a fiscal year, institutions are discouraged from seeking project start dates between July 2 and September 30 of a given year. Awardee institutions may incur allowable pre-award costs within the 90-day period immediately preceding the start date of the grant subject to the conditions specified in the PAPPG; this will allow support for students or other relevant activities to begin over this period.

III. AWARD INFORMATION

Up to $60 million each year will support up to 150 awards, pending 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:

As of the submission deadline, PIs, co-PIs, or other senior project personnel must hold primary, full-time, paid appointments in research or teaching positions at US-based campuses/offices of organizations eligible to submit to

this solicitation (see above), with exceptions granted for family or medical leave, as determined by the submitting institution. Individuals with primary appointments at for-profit, non-academic organizations, or overseas branch campuses of US IHEs are not eligible, even if they also have an appointment at a US campus.

Limit on Number of Proposals per Organization:

There are no restrictions or limits.

Limit on Number of Proposals per PI or Co-PI: 2

In any contiguous September through November period, an individual may participate as PI, co-PI or Senior Personnel in **no more than two** proposals across all size classes submitted in response to the *coordinated solicitations* (where *coordinated solicitations* are defined to include the *Computer and Network Systems (CNS): Core Programs*, *Computing and Communication Foundations (CCF): Core Programs*, *Information and Intelligent Systems (IIS): Core Programs*, and the *Office of Advanced Cyberinfrastructure (OAC): Core Programs* solicitations). For example, between September 2018 and November 2018, an individual may participate as PI, co-PI or Senior Personnel in one proposal submitted to a core program in CCF and in a second proposal submitted to a core program in CNS, or an individual may participate as PI, co-PI or Senior Personnel in two proposals submitted to an IIS core program, etc.

These eligibility constraints will be strictly enforced in order to treat everyone fairly and consistently. In the event that an individual exceeds this limit, proposals received within the limit will be accepted based on earliest date and time of proposal submission (i.e., the first two proposals received will be accepted and the remainder will be returned without review). **No exceptions will be made.**

The limit on the number of proposals per PI, co-PI or Senior Personnel applies only to the *coordinated solicitations.*

Additional Eligibility Info:

Subawards are not permitted to overseas branch campuses/offices of US-based proposing organizations eligible to submit to this solicitation.

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.

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

Collaborative Proposals. All collaborative proposals submitted as separate submissions from multiple organizations must be submitted via the NSF FastLane system. PAPPG Chapter II.D.3 provides additional information on collaborative proposals.

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.

The following information SUPPLEMENTS (note that it does NOT replace) the guidelines provided in the NSF.

Cover Sheet: PIs submitting Grant Opportunities for Academic Liaison with Industry (GOALI) proposals should select “GOALI” from the Type of Proposal drop down list in the Proposal Preparation module in FastLane or Grants.gov. Please see Chapter II.E.4 of the PAPPG for additional information about preparing a GOALI proposal: https://www.nsf.gov/pubs/policydocs/pappg17_1/pappg_2.jsp#IIE4.

Proposal Titles:

Proposal titles should begin with "CNS Core", followed with a colon, then the project class followed by a colon, then the title of your project. For example, if you are submitting a Medium proposal, then your title would be **CNS Core: Medium: Title**.

If you submit a proposal as part of a set of collaborative proposals, the title of the proposal should begin with "CNS Core" followed by a colon, then the project class followed by a colon, then "Collaborative Research" followed by a colon, and the title. For example, if you are submitting a collaborative set of proposals for a Large project the title of each would be **CNS Core: Large: Collaborative Research: Title.**

Proposals from PIs in institutions that have RUI (Research in Undergraduate Institutions) eligibility should have a proposal title that begins "CNS Core", followed by a colon then the project class, followed by a colon then "RUI", followed by a colon and then the title, for example, **CNS Core: Small: RUI: Title.**

PIs submitting GOALI proposals should have a proposal title that begins "CNS Core", followed by a colon then the project class, followed by a colon then "GOALI", followed by a colon and then the title, for example, **CNS Core: Small: GOALI: Title**.

Proposals that extend beyond the scope of one CISE core program or area are welcome. Proposals should be submitted in response to the solicitation for the CISE division (CCF, CNS, IIS, or OAC) that includes the most relevant core program. In such cases, PIs should identify the acronym for the **most relevant** core program or area, followed by any other relevant program acronym(s) separated by colons (for example, **CNS Core: CHS: Medium: Title**). In this case, the proposal would be submitted to the CNS solicitation and would be considered by both the CNS Core and Cyber-Human Systems (CHS) programs. CNS Program Officers will work with their NSF and CISE colleagues to ensure that these proposals are appropriately reviewed and considered for funding. Please see the coordinated CCF, IIS, and OAC solicitations for information on other CISE core programs and the corresponding acronyms.

Project Summary:

The Project Summary consists of an overview, a statement on the intellectual merit of the proposed activity, a statement on the broader impacts of the proposed activity, and a set of keywords.

To assist the proposers and the NSF in identifying a “home” for submissions to this program, proposers are **required** to select keywords in each of the following four dimensions. The first dimension describes the most relevant systems topic area; the second dimension identifies the context or class of systems; the third dimension corresponds to the primary goal or objective of the proposed work, and the fourth indicates any specialized knowledge or techniques to be applied (for example machine learning, game theory, etc.). Proposers must select at least one keyword from each list below for the first three dimensions; the fourth dimension should be filled in if any specialized technique is proposed, otherwise "none" should be indicated.

The required keywords should be input in order, with each dimension delimited by square brackets ("[" and "]"), and multiple keywords within a dimension separated by commas.

Dimension 1: Topic Area

- Compilers and Programming Languages
- Computer Architecture
- Distributed Systems
- File Systems
- Middleware/Services
- Operating Systems
- Software Defined Infrastructure/Virtualization
- Wired Networks
- Wireless Networks

Dimension 2: Target Context or Platform Class

- Access Networks
- Application Services
- Content Delivery Networks
- Data Center Networks
- Mobile Systems
- Cluster/Data Center
- Cloud/Edge
- Enterprise Networks
- High Performance Computing
- Network Architecture
- Network Protocols
- Optical Networks
- Storage Systems
- Vehicular Networks

Dimension 3: Target Requirement

- Cost
- Fairness
- Quality of (experience, service)
- Manageability
- Measurability
- Performance (throughput, latency)
- Power/energy improvements
- Real-time
- Reliability
- Robustness

- Security
- Scalability
- Spectrum Coexistence

Dimension 4: Techniques

Projects contemplating application of particular knowledge or techniques (e.g., graph theory, game theory, control theory, machine learning, network coding, formal methods, and so on) should include keywords to indicate the specialized knowledge to be applied.

Up to 6 additional proposal specific keywords may be added following these four required classifiers, *without square bracket delimiters*.

For example, a proposal to use machine learning to develop low-cost file system abstractions for content delivery in low-latency edge environments might have the following string in the Keywords field:

[File Systems] [Access Networks] [Cost, Performance] [machine learning]

A project focused on compilers to enhance manageability in enterprise networks could have the following as Keywords:

[Compilers and Programming Languages] [Enterprise Networks] [Manageability] [none]

A proposal on mmWave beamforming using machine learning could have the following Keywords:

[Wireless Networks] [Access Networks] [Performance] [Machine Learning] mmWave, Beamforming

The list of keywords should be the last paragraph of the Overview section of the Project Summary.

Project Description:

Length of Project Description - Describe the research and education activities to be undertaken in **up to 15 pages for Small and Medium proposals and in up to 20 pages for Large proposals. Proposals that exceed these limits will be returned without review.**

PIs submitting to the Small size class should note that CISE intends to conduct an evaluation of the effectiveness of the BPC pilot approach and determine appropriate next steps, including potential further expansion of this effort in future years. PIs of Small proposals are therefore strongly encouraged to include plans, or begin preparing to include plans, for broadening participation activities in the Broader Impacts sections of their proposals.

Supplementary Documents:

In the Supplementary Documents section, upload the following information where relevant:

1. *A list of Project Personnel and Partner Institutions (Note: In collaborative proposals, the lead institution should provide this information for all participants):*

   Provide current, accurate information for all personnel and institutions involved in the project. NSF staff will use this information in the merit review process to manage reviewer selection. The list **must** include all PIs, Co-PIs, Senior Personnel, paid/unpaid Consultants or Collaborators, Subawardees, Postdocs, and project-level advisory committee members. This list should be numbered and include (in this order) Full name, Organization(s), and Role in the project, with each item separated by a semi-colon. Each person listed should start a new numbered line. For example:

   - Mary Smith; XYZ University; PI
   - John Jones; University of PQR; Senior Personnel
   - Jane Brown; XYZ University; Postdoc
   - Bob Adams; ABC Community College; Paid Consultant
   - Susan White; DEF Corporation; Unpaid Collaborator
   - Tim Green; ZZZ University; Subawardee

2. *Collaboration Plans for Medium and Large projects (if applicable):*

   Note: In collaborative proposals, the lead institution should provide this information for all participants.

   Since the success of collaborative research efforts are known to depend on thoughtful coordination mechanisms that regularly bring together the various participants of the project, **all Medium proposals that include more than one investigator and all Large proposals must include a Collaboration Plan of up to 2 pages**. The length of and degree of detail provided in the Collaboration Plan should be commensurate with the complexity of the proposed project. Where appropriate, the Collaboration Plan might include: 1) the specific roles of the project participants in all organizations involved; 2) information on how the project will be managed across all the investigators, institutions, and/or disciplines; 3) identification of the specific coordination mechanisms that will enable cross-investigator, cross-institution, and/or cross-discipline scientific integration (e.g., yearly conferences, graduate student exchange, project meetings at conferences, use of the grid for videoconferences, software repositories, etc.); and 4) specific references to the budget line items that support collaboration and coordination mechanisms. **If a Large proposal, or a Medium proposal with more than one investigator, does not include a Collaboration Plan of up to 2 pages, that proposal will be returned without review.**

3. *Data Management Plan (required):*

   Proposals must include a Supplementary Document of no more than two pages labeled "Data Management Plan." This Supplementary Document should describe how the proposal will conform to NSF policy on the dissemination and sharing of research results.

   See Chapter II.C.2.j of the PAPPG for full policy implementation.

For additional information on the Dissemination and Sharing of Research Results, see: https://www.nsf.gov/bfa/dias/policy/dmp.jsp.

For specific guidance for Data Management Plans submitted to the Directorate for Computer and Information Science and Engineering (CISE) see: https://www.nsf.gov/cise/cise_dmp.jsp.

4. *Results Dissemination Plan (required):*

   Proposals submitted to this solicitation must describe plans to ensure that the research results produced will be made available to the extent necessary to validate the findings independently, as indicated in the NSF Proposal & Award Policies & Procedures Guide (PAPPG) Chapter XI.D.4.

5. *Broadening Participation in Computing (BPC) Plans for Medium and Large projects:*

   Each Medium/Large project must, by the time of award, have in place an approved BPC plan. In this ongoing pilot phase, CISE will work with each PI team prior to making an award to ensure that plans are meaningful and include concrete metrics for success. CISE will also provide opportunities for PIs to share BPC experiences and innovations through program PI meetings. PIs of Medium/Large proposals are therefore strongly encouraged to consider this eventual requirement as they develop their proposals, and to include descriptions (of one to three pages) of their planned BPC activities under Supplementary Documents in their submissions. Feedback will be provided on such plans.

6. *Documentation of collaborative arrangements of significance to the proposal through Letters of Collaboration:*

   There are two types of collaboration, one involving individuals/organizations that are included in the budget, and the other involving individuals/organizations that are not included in the budget. Collaborations that are included in the budget should be described in the Project Description. Any substantial collaboration with individuals/organizations not included in the budget should be described in the Facilities, Equipment and Other Resources section of the proposal (see PAPPG Chapter II.C.2.i). In either case, whether or not the collaborator is included in the budget, **a letter of collaboration from each named participating organization *other than the submitting lead, non-lead, and/or subawardee institutions* should be provided at the time of submission of the proposal. Such letters should explicitly state the nature of the collaboration, appear on the organization's letterhead and be signed by the appropriate organizational representative. These letters must not otherwise deviate from the restrictions and requirements set forth in the PAPPG, Chapter II.C.2.j.**

   Please note that letters of support may not be submitted. Such letters do not document collaborative arrangements of significance to the project, but primarily convey a sense of enthusiasm for the project and/or highlight the qualifications of the PI or co-PI. **Reviewers will be instructed not to consider these letters of support in reviewing the merits of the proposal.**

7. *Other specialized information:*

   RUI Proposals: PIs from predominantly undergraduate institutions should include a Research in Undergraduate Institutions (RUI) Impact Statement and Certification of RUI Eligibility in this section.

   GOALI proposals: PIs submitting GOALI proposals should include industry-university agreement letters on intellectual property in this section.

   No other Supplementary Documents, except as permitted by the NSF PAPPG, are allowed.

   Single Copy Documents:

   Collaborators and Other Affiliations Information:

   Proposers should follow the guidance specified in Chapter II.C.1.e of the NSF PAPPG.

   Note the distinction to item (1) under Supplementary Documents above: the listing of all project participants is collected by the project lead and entered as a Supplementary Document, which is then automatically included with all proposals in a project. The Collaborators and Other Affiliations are entered for each participant within each proposal and, as Single Copy Documents, are available only to NSF staff.

   Collaborators and Other Affiliations due to participants listed on item (1) under Supplementary Documents above who are not PIs, co-PIs, or Senior Personnel can be uploaded under Additional Single Copy Documents using Transfer File.

Submission Checklist:

In an effort to assist proposal preparation, the following checklists are provided as a reminder of the items that should be checked before submitting a proposal to this solicitation. These are a summary of the requirements described above. For the items marked with (RWR), the proposal will be returned without review if the required item is noncompliant at the submission deadline. Note that there are four lists: (1) for all proposals, unique to this solicitation; (2) additional requirements for Small proposals; (3) additional requirements for Medium proposals; and (4) additional requirements for Large proposals.

1. *For all proposals, regardless of size:*
   - All proposals must be submitted to the “CNS Core” program, rather than the Research in Networking Technology & Systems (NeTS) or Computer Systems Research (CSR) programs.
   - Should include a Results Dissemination Plan and Data Management Plan.
   - The Project Summary must contain the set of required dimensional keywords, input in order, with each dimension delimited by square brackets ("[" and "]"), and multiple keywords within a dimension separated by commas.
2. *For Small proposals:*
   - The title should start with one of the following strings (submissions intended for CNS and also additional core programs described in the CCF, IIS, or OAC core solicitations should follow a similar pattern):

        - **CNS Core**: Small:
        - **CNS Core**: Small: Collaborative:
    - In addition to the above title prefixes, proposals from PIs in institutions that have RUI (Research in Undergraduate Institutions) eligibility should include "RUI:" immediately before the proposal title, for example, **CNS Core: Small: RUI: Title**, and should include a Research in Undergraduate Institutions Impact Statement and Certification of RUI Eligibility. Similarly, PIs submitting Grant Opportunities for Academic Liaison with Industry (GOALI) proposals should select “GOALI” from the Type of Proposal drop down list in the Proposal Preparation module in FastLane or Grants.gov; and include "GOALI:" immediately before the proposal title, for example, **CNS Core: Small: GOALI: Title.**
    - (RWR) Maximum budget shown on the Cover Sheet and on the budget pages must not exceed $500,000, including all institutions in a collaborative proposal, plus funds for embedded REU supplements.
    - (RWR) The Project Description is limited to no more than 15 pages.
    - A Collaboration Plan (up to 2 pages) **may** be provided as a Supplementary Document. If provided, the collaboration plan should include all institutions participating, not a separate plan for each institution.
3. *For Medium proposals:*
    - The title should start with one of the following strings (submissions intended for CNS and also additional core programs described in the in the CCF, IIS, or OAC core solicitations should follow a similar pattern):
        - **CNS Core**: Medium:
        - **CNS Core**: Medium: Collaborative:
    - In addition to the above title prefixes, proposals from PIs in institutions that have RUI (Research in Undergraduate Institutions) eligibility should include "RUI:" immediately before the proposal title, for example, **CNS Core: Medium: RUI: Title**, and should include a Research in Undergraduate Institutions Impact Statement and Certification of RUI Eligibility. Similarly, PIs submitting Grant Opportunities for Academic Liaison with Industry (GOALI) proposals should select “GOALI” from the Type of Proposal drop down list in the Proposal Preparation module in FastLane or Grants.gov; and include "GOALI:" immediately before the proposal title, for example, **CNS Core: Medium: GOALI: Title.**
    - (RWR) The budget shown on the Cover Sheet and on the budget pages **must** be $500,001 to $1,200,000, including all institutions in a collaborative proposal, plus funds for embedded REU supplements.
    - (RWR) The Project Description is limited to no more than 15 pages.
    - (RWR) If there is more than one investigator, a Collaboration Plan (up to 2 pages) **must** be provided as a Supplementary Document, even if all investigators are affiliated with the same institution. The Collaboration Plan should include all institutions participating, not a separate plan for each institution.
    - A BPC Plan (of one to three pages) should be provided as a Supplementary Document.
4. *For Large proposals:*
    - The title should start with one of the following strings (submissions intended for CNS and also additional core programs described in the CCF, IIS, or OAC core solicitations should follow a similar pattern, assuming that all listed programs are accepting Large proposals):
        - **CNS Core**: Large:
        - **CNS Core**: Large: Collaborative:
    - In addition to the above title prefixes, proposals from PIs in institutions that have RUI (Research in Undergraduate Institutions) eligibility should include "RUI:" immediately before the proposal title, for example, **CNS Core: Large: RUI: Title**, and should include a Research in Undergraduate Institutions Impact Statement and Certification of RUI Eligibility. Similarly, PIs submitting Grant Opportunities for Academic Liaison with Industry (GOALI) proposals should select “GOALI” from the Type of Proposal drop down list in the Proposal Preparation module in FastLane or Grants.gov; and include "GOALI:" immediately before the proposal title, for example, **CNS Core: Large: GOALI: Title.**
    - (RWR) The budget shown on the Cover Sheet and on the budget pages **must** be $1,200,001 to $3,000,000, including all institutions in a collaborative proposal, plus funds for embedded REU supplements.
    - (RWR) The Project Description is limited to no more than 20 pages.
    - (RWR) A Collaboration Plan (up to 2 pages) **must** be provided as a Supplementary Document, even if all investigators are affiliated with the same institution. The Collaboration Plan should include all institutions participating, not a separate plan for each institution.
    - A BPC Plan (of one to three pages) should be provided as a Supplementary Document.

Proposals that do not comply with the requirements marked as RWR will be returned without review.

B. Budgetary Information

Cost Sharing:

Inclusion of voluntary committed cost sharing is prohibited.

Other Budgetary Limitations:

Other budgetary limitations apply. Please see the full text of this solicitation for further information.

C. Due Dates

- **Submission Window Date(s)** (due by 5 p.m. submitter's local time):

    September 24, 2018 - October 02, 2018

        LARGE projects

September 24, 2018 - October 02, 2018

MEDIUM projects

November 01, 2018 - November 15, 2018

SMALL projects

September 09, 2019 - September 16, 2019

MEDIUM projects

September 18, 2019 - September 25, 2019

LARGE projects

October 31, 2019 - November 14, 2019

SMALL projects

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

For all proposals, reviewers will be asked to consider:

1. How well does the proposed work address and advance the following?
    - Secure-by-design systems;
    - Systems robustness;
    - Manageability of the system under consideration; and/or
    - Fundamental understanding of the system or system component.
2. How well does the proposal describe an evaluation plan that assesses and where appropriate quantifies the expected research outcomes?
3. How well does the proposal describe research dissemination plans to ensure that the research results can be validated independently?

For Large and relevant Medium proposals, reviewers will be asked to:

- Comment on the extent to which the project scope justifies the level of investment requested, and the degree to which the Collaboration Plan (if required) adequately demonstrates that the participating investigators will work synergistically to accomplish the project objectives.
- Comment on whether key personnel, and especially lead PIs, have allocated adequate time for both their individual technical contributions and the leadership of collaborative activities necessary to realize the synergistic effects of larger-scale research.

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:

- John T. "Jack" Brassil, telephone: (703) 292-8950, email: jbrassil@nsf.gov
- Darleen L. Fisher, telephone: (703) 292-8950, email: dlfisher@nsf.gov
- Monisha Ghosh, telephone: (703) 292-8746, email: mghosh@nsf.gov
- Samee Khan, telephone: (703) 292-8061, email: skhan@nsf.gov
- Sandip Kundu, telephone: (703) 292-8950, email: skundu@nsf.gov
- Mimi McClure, telephone: (703) 292-5197, email: mmcclure@nsf.gov
- Matt Mutka, telephone: (703) 292-7344, email: mmutka@nsf.gov
- Ann C. Von Lehmen, telephone: (703) 292-4756, email: avonlehm@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.

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.

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