

Secure and Trustworthy Cyberspace Frontiers (SaTC Frontiers)

PROGRAM SOLICITATION

NSF 19-572



National Science Foundation

Directorate for Computer & Information Science & Engineering
Division of Computer and Network Systems
Division of Computing and Communication Foundations
Division of Information & Intelligent Systems
Office of Advanced Cyberinfrastructure

Directorate for Social, Behavioral & Economic Sciences
Division of Behavioral and Cognitive Sciences
Division of Social and Economic Sciences

Directorate for Mathematical & Physical Sciences
Division of Mathematical Sciences

Directorate for Education & Human Resources
Division of Graduate Education

Directorate for Engineering
Division of Electrical, Communications and Cyber Systems

Letter of Intent Due Date(s) (required) (due by 5 p.m. submitter's local time):

July 05, 2019

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

September 30, 2019

IMPORTANT INFORMATION AND REVISION NOTES

The SaTC Frontiers program specifically supports ambitious and potentially transformative **center-scale projects** in the area of security and privacy. This program is under the NSF SaTC umbrella, and prospective Principal Investigators (PIs) are encouraged to also consult the [SaTC program solicitation](#) for additional details about areas of interest as well as other proposal size classes.

Any proposal submitted in response to this solicitation should be submitted in accordance with the revised *NSF Proposal & Award Policies & Procedures Guide* (PAPP) ([NSF 19-1](#)), which is effective for proposals submitted, or due, on or after February 25, 2019.

SUMMARY OF PROGRAM REQUIREMENTS

General Information

Program Title:

Secure and Trustworthy Cyberspace Frontiers (SaTC Frontiers)

Synopsis of Program:

In today's increasingly networked, distributed, and asynchronous world, cybersecurity involves hardware, software, networks, data, people, and integration with the physical world. Society's overwhelming reliance on this complex cyberspace, however, has exposed its fragility and vulnerabilities that defy existing cyber-defense measures; corporations, agencies, national infrastructure and individuals continue to suffer cyber-attacks. Achieving a truly secure cyberspace requires addressing both challenging scientific and engineering problems involving many components of a system, and vulnerabilities that stem from human behaviors and choices. Examining the fundamentals of security and privacy as a multidisciplinary subject can lead to fundamentally new ways to design, build and operate cyber systems, protect existing infrastructure, and motivate and educate individuals about

cybersecurity.

The Secure and Trustworthy Cyberspace (SaTC) program welcomes proposals that address cybersecurity and privacy, and draw on expertise in one or more of these areas: computing, communication and information sciences; engineering; economics; education; mathematics; statistics; and social and behavioral sciences. Proposals that advance the field of cybersecurity and privacy within a single discipline or interdisciplinary efforts that span multiple disciplines are both encouraged. Please see [SaTC program solicitation](#) for more details.

Through this solicitation—under the SaTC umbrella—NSF specifically seeks ambitious and potentially transformative **center-scale projects** in the area of security and privacy that (1) catalyze far-reaching research explorations motivated by deep scientific questions or hard problems and/or by compelling applications and novel technologies that promise significant scientific and/or societal benefits, and (2) stimulate significant research and education outcomes that, through effective knowledge transfer mechanisms, promise scientific, economic and/or other societal benefits. The goal of the SaTC Frontiers program is to advance the frontiers of cybersecurity and privacy, and the areas listed in the [SaTC program solicitation](#) are meant to be illustrative but not exhaustive.

The SaTC Frontiers program will support proposals from \$5,000,000 to \$10,000,000 in total budget, with durations of up to five years.

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.

- Nina Amla, Program Director, CISE/CCF, telephone: (703) 292-7991, email: namla@nsf.gov
- Shannon I. Beck, Associate Program Director/Program Coordinator, CISE/CNS, telephone: (703) 292-2487, email: sbeck@nsf.gov
- Dan R. Cosley, Program Director, CISE/IIS, telephone: (703) 292-8491, email: dcosley@nsf.gov
- Sol Greenspan, Program Director, CISE/CCF, telephone: (703) 292-8910, email: sgreensp@nsf.gov
- Sara Kiesler, Program Director, SBE/SES, telephone: (703) 292 8643, email: skiesler@nsf.gov
- Wei-Shinn Ku, Program Director, CISE/IIS, telephone: (703) 292-8318, email: weiku@nsf.gov
- Sandip Kundu, Program Director, CISE/CNS, telephone: (703) 292-8950, email: skundu@nsf.gov
- Jenshan Lin, Program Director, ENG/ECCS, telephone: (703) 292-7950, email: jenlin@nsf.gov
- Victor P. Piotrowski, Program Director, EHR/DGE, telephone: (703) 292-8670, email: vp Piotrow@nsf.gov
- Andrew D. Pollington, Program Director, MPS/DMS, telephone: (703) 292-4878, email: adpollin@nsf.gov
- Indrajit Ray, Program Director, CISE/CNS, telephone: (703) 292-5387, email: iray@nsf.gov
- Phillip A. Regalia, Program Director, CISE/CCF, telephone: (703) 292-2981, email: pregalia@nsf.gov
- Alexander Sprintson, Program Director, CISE/CNS, telephone: (703) 292-8950, email: asprints@nsf.gov
- Janet P. Striuli, Program Director, MPS/DMS, telephone: (703) 292-2858, email: jstriuli@nsf.gov
- Kevin Thompson, Program Director, CISE/OAC, telephone: (703) 292-4220, email: kthomps@nsf.gov

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

- 47.041 --- Engineering
- 47.049 --- Mathematical and Physical Sciences
- 47.070 --- Computer and Information Science and Engineering
- 47.075 --- Social Behavioral and Economic Sciences
- 47.076 --- Education and Human Resources

Award Information

Anticipated Type of Award: Continuing Grant

Estimated Number of Awards: 2

Anticipated Funding Amount: \$15,000,000

Award Size: \$5,000,000 - \$10,000,000 in total budget, with durations of up to five years.

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

Eligibility Information

Who May Submit Proposals:

Proposals may only be submitted by the following:

- Institutions of Higher Education (IHEs) - Two- and four-year IHEs (including community colleges) accredited in, and having a campus located in the US, acting on behalf of their faculty members. Special Instructions for International Branch Campuses of US IHEs: If the proposal includes funding to be provided to an international branch campus of a US institution of higher education (including through use of 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 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 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: 1

An individual can participate as a PI, co-PI or Senior Personnel on no more than one SaTC Frontiers proposal. This limit is unrelated to any limits imposed in the SaTC solicitation ([NSF 18-572](#)) or any other NSF solicitations. **These eligibility constraints will be strictly enforced in order to treat everyone fairly and consistently.** In the event that an individual exceeds the one-proposal limit for this solicitation, the proposal received within the limit will be accepted based on earliest date and time of proposal submission (i.e., the first proposal received will be accepted and the remainder will be returned without review). **No exceptions will be made.**

Proposal Preparation and Submission Instructions

A. Proposal Preparation Instructions

- **Letters of Intent:** Submission of Letters of Intent is required. Please see the full text of this solicitation for further information.
- **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:**

Not Applicable

C. Due Dates

- **Letter of Intent Due Date(s) (required)** (due by 5 p.m. submitter's local time):

July 05, 2019
- **Full Proposal Deadline(s)** (due by 5 p.m. submitter's local time):

September 30, 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:

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

Reporting Requirements:

Standard NSF reporting requirements apply.

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I. INTRODUCTION

In today's increasingly networked, distributed, and asynchronous world, cybersecurity involves hardware, software, networks, data, people, and integration with the physical world. Society's overwhelming reliance on this complex cyberspace, however, has exposed its fragility and vulnerabilities that defy existing cyber-defense measures; corporations, agencies, national infrastructure and individuals continue to suffer cyber-attacks. Achieving a truly secure cyberspace requires addressing both challenging scientific and engineering problems involving many components of a system, and vulnerabilities that stem from human behaviors and choices. Examining the fundamentals of security and privacy as a multidisciplinary subject can lead to fundamentally new ways to design, build and operate cyber systems, protect existing infrastructure, and motivate and educate individuals about cybersecurity.

The *Secure and Trustworthy Cyberspace (SaTC)* program welcomes proposals that advance the field of cybersecurity and privacy within a single discipline or interdisciplinary efforts that span multiple disciplines. This solicitation—under the SaTC umbrella—specifically seeks ambitious and potentially transformative **center-scale projects** in the topic areas described in the SaTC program solicitation. SaTC Frontiers projects are expected to (1) catalyze far-reaching research explorations motivated by deep scientific questions or hard problems and/or compelling applications and novel technologies that promise significant scientific and/or societal benefits, and (2) stimulate significant research and education outcomes that, through effective knowledge transfer mechanisms, promise scientific, economic and/or other societal benefits.

II. PROGRAM DESCRIPTION

SaTC Frontiers projects, **with total budgets ranging from \$5,000,000 to \$10,000,000 for durations of up to five years**, are well suited to multiple investigators (PI, co-PIs, and/or other Senior Personnel), and a team of students and/or postdocs.

- SaTC Frontiers projects should be large, multidisciplinary, multi-organizational, and/or multi-institutional, and should provide high-level visibility to grand challenge research areas in cybersecurity. A SaTC Frontiers proposal should have a long-term vision, with integrative objectives that could not be attained simply by a collection of Small or Medium proposals provided similar resources. 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 separate Collaboration Plan is required for all SaTC Frontiers proposals. Up to 2 pages are allowed for the Collaboration Plan. The length of and level of detail provided in the Collaboration Plan should be commensurate with the complexity of the proposed project.

SaTC Frontiers projects that do **not** satisfy these requirements will be returned without review.

- The topics addressed in SaTC Frontiers projects must be in scope for the SaTC program as described in the [SaTC program solicitation](#).
- A SaTC Frontiers proposal must include a two-page Collaboration Plan. Please see *Proposal Preparation Instructions* Section V.A for additional submission guidelines.
- SaTC Frontiers projects must include a project director or project coordinator to assist with management and collaboration. The budget must include associated costs and the Collaboration Plan should discuss the specific responsibilities of this position.
- All SaTC Frontiers submissions must include one- to three-page descriptions of their planned Broadening Participation in Computing (BPC) activities under Supplementary Documents in their submissions. More information, including examples of BPC activities and metrics, can be found at: <https://www.nsf.gov/cise/bpc/>.

SaTC PI MEETINGS

The SaTC program plans to host PI meetings every other year with participation from all active SaTC projects. This meeting will be a community-wide event with representatives from federal agencies, academia, industry, and international institutions. PIs/co-PIs/Senior Personnel, or NSF-approved replacements, from all active SaTC awards are expected to participate in these meetings. The next SaTC PI meeting is expected to be held in Fall 2019.

For all awards pursuant to this program solicitation, one or more project representatives (PI/co-PI/Senior Personnel, or NSF-approved replacement) must attend all PI meetings held throughout the duration of the award.

SaTC FORUM

The SaTC program sponsors the [SaTC Forum](#), a community website for SaTC researchers, developers, and educators. All SaTC funded PIs are encouraged to maintain the project page corresponding to their SaTC project on the SaTC Forum. For the PI meeting, PIs or other project representatives **must** also provide a poster for the poster session and a slide describing their project(s), which will be made available on the SaTC Forum.

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

Anticipated Type of Award: Continuing Grant

Estimated Number of Awards: 2

Anticipated Funding Amount: \$15,000,000

Award Size: \$5,000,000 - \$10,000,000 in total budget, with durations of up to five years.

Estimated program budget, number of awards and average award size/duration are 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:

As of the submission deadline, PIs, co-PIs, or other Senior 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 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: 1

An individual can participate as a PI, co-PI or Senior Personnel on no more than one SaTC Frontiers proposal. This limit is unrelated to any limits imposed in the SaTC solicitation ([NSF 18-572](#)) or any other NSF solicitations. **These eligibility constraints will be strictly enforced in order to treat everyone fairly and consistently.** In the event that an individual exceeds the one-proposal limit for this solicitation, the proposal received within the limit will be accepted based on earliest date and time of proposal submission (i.e., the first proposal received will be accepted and the remainder will be returned without review). **No exceptions will be made.**

Additional Eligibility Info:

Subawards are not permitted to overseas campuses/offices of US-based proposing organizations.

V. PROPOSAL PREPARATION AND SUBMISSION INSTRUCTIONS

A. Proposal Preparation Instructions

Letters of Intent (*required*):

Submission of a Letter of Intent (LOI) is required to be eligible to submit a Full SaTC Frontiers proposal. Letters of Intent must be submitted via **FastLane** by 5 pm submitter's local time on the due date for SaTC Frontiers LOIs. **Failure to submit the required LOI will result in a full proposal being returned without review.**

Submitting a LOI does not oblige potential proposers to submit a full SaTC Frontiers proposal. LOIs are not subject to merit review, but rather are used for internal planning purposes. **Investigators will not receive any feedback on their LOI other than a message confirming receipt of the LOI.** There is no limit on the number of LOIs from any given organization. The lead PI and organization must remain the same for the associated full SaTC Frontiers proposal. However, the composition of the team (i.e., co-PIs, Senior Personnel, and partner organizations) may change at the discretion of the proposer.

An individual can be included or listed in at most one LOI.

For collaborative projects, a single LOI should be submitted via FastLane by the lead organization only. The collaborative partners should be indicated in the Collaborative Partners sections of the LOI as described below.

Letters of Intent must be no more than 2 pages, and contain the following:

- Proposal title: Title must be preceded by the words "**SaTC Frontiers**".
- Keywords: Include three keywords that best characterize the project.
- Projected budget (total of all collaborative pieces): This should be an estimated amount rather than a formal budget.
- Team: Names, departmental and university affiliations, and expertise of **all** the Senior Personnel.
- Synopsis: One-page description of the Intellectual Merit and Broader Impacts of the proposal.

Letter of Intent Preparation Instructions:

When submitting a Letter of Intent through FastLane in response to this Program Solicitation please note the conditions outlined below:

- Submission by an Authorized Organizational Representative (AOR) is required when submitting Letters of Intent.

- Submission of multiple Letters of Intent is not permitted

Full Proposal Preparation Instructions: Proposers may opt to submit proposals in response to this Program Solicitation via FastLane or Grants.gov.

- 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 *PAPPG*.

All proposals must be submitted to the CNS division, regardless of the proposal's designation.

Type of Proposal: The "Research" type of proposal should be selected.

Proposal Titles:

Proposal titles must begin with **SaTC: Frontiers**. If you submit a proposal as part of a set of collaborative proposals, the title of the proposal should start with **SaTC: Frontiers** followed by a colon, then "Collaborative" followed by a colon, and then the title, i.e., the title of each proposal would be **SaTC: Frontiers: Collaborative: Title**.

Project Description:

Up to 20 pages is allowed for the Project Description.

Supplementary Documents:

In the Supplementary Documents Section, upload the following:

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 organizations 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, Postdoctoral Researchers, 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:

1. Mary Smith; XYZ University; PI
2. John Jones; University of PQR; Senior Personnel
3. Jane Brown; XYZ University; Postdoctoral Researcher
4. Bob Adams; ABC Community College; Paid Consultant
5. Susan White; DEF Corporation; Unpaid Collaborator
6. Tim Green; ZZZ University; Subawardee

2. *Collaboration Plans:*

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, **all Frontiers 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, organizations, and/or disciplines; 3) identification of the specific coordination mechanisms that will enable cross-investigator, cross-organization, 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 SaTC Frontiers 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 uploaded in the "Data Management Plan" section. The Data Management Plan must be substantive and specific to the project and should address all project-relevant aspects of data privacy and security. In addition to addressing how the project will conform to NSF's policy on the dissemination and sharing of research results, the Data Management Plan should address the following topics if they are relevant to the project:

- **Handling of sensitive data:** sensitivity of the data to be collected, ethics of data collection and identification of harms that could arise from its collection or inadvertent dissemination, techniques that will be used to protect the privacy of individuals and organizations associated with the data; and plans to request Institutional Review Board (IRB) approval for data collection, aggregation, and analysis.
- **Data sharing:** methods for providing other researchers with controlled access to datasets and the time period during which data will be available. If the project will develop software or hardware, the Data Management Plan should discuss not only what access other researchers will have to source code or hardware design artifacts (e.g., specific open source licenses) and the physical location of the data repository (e.g., commercial cloud, private server, campus server), but also the method by which other researchers may access these products of the project (e.g., GitHub repository).
- **Authorization for data access and protection of data:** policies for authorizing access to the data and techniques (including security protections) that will be used to prevent the unauthorized dissemination of the data.

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>.

4. *Broadening Participation in Computing (BPC) Plans (required):*

All Frontiers projects must include BPC plans, which specify activities that are meaningful and include concrete metrics for success. These plans must seek to increase the participation of underrepresented groups in computing. Proposals should include descriptions (of one to three pages) of their planned BPC activities under Supplementary Documents in their submissions. More information, including examples of BPC activities and metrics, can be found at:
<https://www.nsf.gov/cise/bpc/>.

No other Supplementary Documents, except as permitted by the NSF Proposal & Award Policies & Procedures Guide, are allowed.

Single Copy Documents:

Collaborators and Other Affiliations Information: Proposers should follow the guidance specified in Chapter II.C.1.e of the 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.

B. Budgetary Information

Cost Sharing:

Inclusion of voluntary committed cost sharing is prohibited.

Budget Preparation Instructions:

Budgets for Frontiers projects must include funding for one or more project representatives (PI/co-PI/Senior Personnel, or NSF-approved replacement) to attend all SaTC PI meetings to be held every other year throughout the duration of the project. The first PI meeting for awards made under this solicitation is expected in 2021. These requirements for PI meeting attendance apply to each set of collaborative proposals as a whole, not to each part of a project.

C. Due Dates

- **Letter of Intent Due Date(s) (required)** (due by 5 p.m. submitter's local time):
July 05, 2019
- **Full Proposal Deadline(s)** (due by 5 p.m. submitter's local time):
September 30, 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 and Research.gov systems. 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 may use Research.gov to verify the status of their submission to NSF. For proposers that submitted via Grants.gov, until an application has been received and validated by NSF, the Authorized Organizational Representative may check the status of an application on Grants.gov. After proposers have received an e-mail notification from NSF, Research.gov should be used to check the status of an application.

VI. NSF PROPOSAL PROCESSING AND REVIEW PROCEDURES

Proposals received by NSF are assigned to the appropriate NSF program for 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

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 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.

Reviewers will be asked to apply the existing Merit Review Criteria for Broader Impacts to the **Broadening Participation in Computing (BPC)** plan:

- What is the potential for the BPC plan to have a measurable impact on underrepresentation?
- Is the BPC plan well-reasoned, well-organized and based on a sound-rationale?
- Is there a well-defined mechanism for assessing its success?
- Does the PI have adequate resources to carry out these activities?
- How well-qualified is the individual, team or organization to implement the BPC plan?

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=papppg.

Special Award Conditions:

It is anticipated that each Frontier project will be merit reviewed in a site visit conducted at the end of Year 2 to assess project progress and to determine if the project warrants continued support in Years 3 through 5. In addition to the site visit at the end of year 2, a Frontier project may be site reviewed in other years as deemed necessary by the CISE directorate.

At least one representative (PI/co-PI/senior personnel or NSF-approved replacement) from each project must attend a SaTC PI meeting to be held every other year, for the duration of the project. The first PI meeting for awards made under this solicitation is expected in 2021.

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:

- Nina Amla, Program Director, CISE/CCF, telephone: (703) 292-7991, email: namla@nsf.gov
- Shannon I. Beck, Associate Program Director/Program Coordinator, CISE/CNS, telephone: (703) 292-2487, email: sbeck@nsf.gov
- Dan R. Cosley, Program Director, CISE/IIS, telephone: (703) 292-8491, email: dcosley@nsf.gov
- Sol Greenspan, Program Director, CISE/CCF, telephone: (703) 292-8910, email: sgreensp@nsf.gov
- Sara Kiesler, Program Director, SBE/SES, telephone: (703) 292 8643, email: skiesler@nsf.gov
- Wei-Shinn Ku, Program Director, CISE/IIS, telephone: (703) 292-8318, email: weiku@nsf.gov
- Sandip Kundu, Program Director, CISE/CNS, telephone: (703) 292-8950, email: skundu@nsf.gov
- Jenshan Lin, Program Director, ENG/ECCS, telephone: (703) 292-7950, email: jenlin@nsf.gov
- Victor P. Piotrowski, Program Director, EHR/DGE, telephone: (703) 292-8670, email: vp Piotrow@nsf.gov
- Andrew D. Pollington, Program Director, MPS/DMS, telephone: (703) 292-4878, email: adpollin@nsf.gov
- Indrajit Ray, Program Director, CISE/CNS, telephone: (703) 292-5387, email: iray@nsf.gov
- Phillip A. Regalia, Program Director, CISE/CCF, telephone: (703) 292-2981, email: pregalia@nsf.gov
- Alexander Sprintson, Program Director, CISE/CNS, telephone: (703) 292-8950, email: asprints@nsf.gov
- Janet P. Striuli, Program Director, MPS/DMS, telephone: (703) 292-2858, email: jstriuli@nsf.gov
- Kevin Thompson, Program Director, CISE/OAC, telephone: (703) 292-4220, email: kthomps@nsf.gov

For questions related to the use of FastLane or Research.gov, contact:

- FastLane and Research.gov Help Desk: 1-800-673-6188
FastLane Help Desk e-mail: fastlane@nsf.gov.

Research.gov Help Desk e-mail: rgov@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.

Facilitation Awards for Scientists and Engineers with Disabilities (FASSED) 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:

Suzanne H. Plimpton
Reports Clearance Officer
Office of the General Counsel
National Science Foundation
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