Secure and Trustworthy Cyberspace: Secure, Trustworthy, Assured and Resilient Semiconductors and Systems (SaTC: STARSS)

PROGRAM SOLICITATION
NSF 14-528

National Science Foundation

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

Directorate for Engineering
Division of Electrical, Communications and Cyber Systems

Semiconductor Research Corporation

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

March 26, 2014

SUMMARY OF PROGRAM REQUIREMENTS

General Information

Program Title:

Secure and Trustworthy Cyberspace: Secure, Trustworthy, Assured and Resilient Semiconductors and Systems (SaTC: STARSS)

Synopsis of Program:

Cyberspace has transformed the daily lives of people for the better. However, our increasing dependence upon cyberspace has exposed its fragility and vulnerabilities: corporations, agencies, national infrastructure and individuals have been victims of cyber-attacks. In December 2011, the National Science and Technology Council (NSTC) with the cooperation of the National Science Foundation (NSF) issued a broad, coordinated federal strategic plan for cybersecurity research and development (Trustworthy Cyberspace: Strategic Plan for the Federal Cybersecurity Research and Development Program) to “change the game,” by calling for establishing a science of cybersecurity, transitioning promising cybersecurity research into practice, and bolstering education and training in cybersecurity.

The NSF's Secure and Trustworthy Cyberspace (SaTC) program is supportive of this strategic plan. SaTC recognizes that cyberspace will continue to grow and evolve, and that advances in science and engineering will create new “leap-ahead” opportunities expanding cyberspace. It further recognizes that cybersecurity must also grow and co-evolve, and that a secure and trustworthy cyberspace will ensure continued economic growth and future technological innovation.

Through this solicitation -- a track within the NSF SaTC program -- NSF and the Semiconductor Research Corporation (SRC) are announcing a joint partnership in the area of Secure, Trustworthy, Assured and Resilient Semiconductors and Systems (SaTC: STARSS) focused on research on Design for Assurance. Specifically, NSF and SRC will support research on new strategies for architecture, specification and verification, especially at the stages of design in which formal methods are currently weak or absent, with the aim of decreasing the likelihood of unintended behavior or access, increasing resistance and resilience to tampering, and improving the ability to provide authentication throughout the supply chain and in the field.

The SaTC:STARSS solicitation will support proposals of up to $500,000 in total budget, with durations of up to three 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) 292-8910, email: namla@nsf.gov
- Celia Merzbacher, telephone: (919) 941-9413, email: celia.merzbacher@src.org
- Ralph Wachter, Program Director, CISE/CNS, telephone: (703) 292-8950, email: rwachter@nsf.gov
- Paul Werbos, Program Director, ENG/ECCS, telephone: (703) 292-8339, email: pwerbos@nsf.gov

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

- 47.041 --- Engineering
- 47.070 --- Computer and Information Science and Engineering

Award Information

Anticipated Type of Award: Standard Grant or Continuing Grant

Estimated Number of Awards: 6

Anticipated Funding Amount: $3,000,000

Eligibility Information

Who May Submit Proposals:

The categories of proposers eligible to submit proposals to the National Science Foundation are identified in the Grant Proposal Guide, Chapter I, Section E.

Who May Serve as PI:

There are no restrictions or limits.

Limit on Number of Proposals per Organization:

There are no restrictions or limits.

Limit on Number of Proposals per PI or Co-PI: 1

An individual can participate as a PI, co-PI or Senior Personnel on no more than one proposal to the SaTC:STARSS program.

These eligibility constraints will be strictly enforced in order to treat everyone fairly and consistently. In the event that an individual exceeds this limit, the proposal received within the limit will be accepted based on the 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.

This limit on the number of proposals per PI, co-PI or Senior Personnel applies only to this SaTC:STARSS solicitation.

Proposal Preparation and Submission Instructions

A. Proposal Preparation Instructions

- Letters of Intent: Not Applicable
- Preliminary Proposal Submission: Not Applicable
- Full Proposals:
  - Full Proposals submitted via FastLane: NSF Proposal and Award Policies and Procedures Guide, Part I: Grant Proposal Guide (GPG) Guidelines apply. The complete text of the GPG is available electronically on the NSF website at: http://www.nsf.gov/publications/pub_summ.jsp?ods_key=gpg.
  - 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: http://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

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

  March 26, 2014

Proposal Review Information Criteria

Merit Review Criteria: National Science Board approved criteria apply.

Award Administration Information

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

Reporting Requirements: Additional reporting requirements apply. Please see the full text of this solicitation for further information.

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I. INTRODUCTION

Semiconductor-based hardware is integral to today's interconnected and intelligent systems -- from personal computers and mobile phones to transportation, financial, energy, and other critical infrastructure systems. As we increasingly depend upon these systems -- individually and collectively -- their trustworthiness, security, and reliability are more important than ever. At the same time, as semiconductors become more pervasive and more networked, their exposure to attack -- whatever the source or motivation -- also is growing.

Processes and tools for design and manufacture of semiconductors ensure that the resulting product does what it is supposed to do. However, they generally do not answer the question, "Does it do anything else?" To provide assurance and confidence in the trustworthiness, reliability, and security of electronic systems, strategies and techniques that incorporate security in all stages and levels of design and manufacture are needed. In addition, strategies and techniques to make semiconductors more difficult to counterfeit are needed. Incorporating such strategies and techniques will decrease the likelihood of unintended behavior or access, increase resistance to tampering and counterfeiting, and improve the ability to provide authentication throughout the supply chain and in the field.

This solicitation -- a track within the SaTC program -- is a joint effort of the National Science Foundation (NSF) and the Semiconductor Research Corporation (SRC). SaTC:STARSS will support proposals of up to $500,000 in total budget, with durations of up to three years.

II. PROGRAM DESCRIPTION

Design and manufacture of today's complex semiconductor circuits and systems requires many steps and involves the work of hundreds of engineers, typically distributed across multiple locations and organizations worldwide. Moreover, today's semiconductor chip is likely to include design modules or blocks (also referred to as intellectual property, or IP, blocks) from multiple sources. Detailed specifications are converted into schematic and then physical designs that may include billions of transistors. Many processes have been developed, and considerable resources are invested along the design and manufacture path to verify, test and validate that the product performs as intended. However, to date, these processes do not provide confidence about whether the chip is altered such that it provides unauthorized access or control. Such undesirable behavior can be due to a weakness in the design that results in an unintentional side channel or due to maliciously inserted Trojan hardware.

Today, semiconductor circuits and systems are designed so as to make it feasible or easier to verify, manufacture and test during subsequent steps. What is needed is an understanding of Design for Assurance, with the objective of decreasing the likelihood of unintended behavior or access, increasing resistance and resilience to tampering and counterfeiting, and improving the ability to provide authentication in the field. Design for Assurance requires new strategies for architecture, specification and verification, especially at the stages of design in which formal methods are currently weak or absent.

Threats and challenges to assurance include, but are not limited to, those listed below. Note that, under Design for Assurance, the goal is not merely to detect threats, but to develop techniques that mitigate vulnerabilities and make systems that are resistant to attack or tampering.

- Unwanted functionality in specification, design or implementation at the behavioral, register-transfer level (RTL), logical or physical level. Unwanted functionality may be malicious or inadvertent. This includes incomplete and ambiguous specifications or implementations.
- Dependencies at interfaces that lead to leakage of sensitive information or weakness to attack. This includes time-dependent behavior or improper reliance of timeouts on external signals.
- Unauthorized access to sensitive data or control functions. This includes access to keys or sensitive internal data.
- Maliciously inserted hardware Trojans and other forms of tampering with a design at any stage of the design cycle, including during manufacturing.
- Tampering with an electronic circuit while in operation, e.g., via a side channel.
- Identification of poor resistance to tampering, whether at a functional, logical or electrical level. In particular, resistance to known tampering methods, such as power, thermal or irradiation attack.
- Hardware authentication.
- Provenance of circuitry, including verification and tracking of IP blocks and of lack of tampering.
- Dependence on external components that are not verifiable and hence vulnerable to attack.

With this solicitation, NSF and SRC seek to support research on Secured, Assured and Resilient Semiconductors and Systems (STARSS), with a focus on Design for Assurance. The following topics are representative of relevant research areas:

- Architecture & Design: Architectural and design approaches, models and frameworks for both reasoning about, as well as specifying, hardware-specific security properties for first-order security architecture elements as well as second and third-order functionality -- i.e., ensuring that the security-specific IP block is not only secure, but that there are no security-related vulnerabilities resulting from side effects related to any other IP blocks or semiconductor pervasive logic. Research on novel design or specification languages is also of interest.
- Properties, Principles & Metrics: Going beyond high-level security properties such as confidentiality, integrity and availability of security-sensitive assets and access mechanisms to derive a set of hardware security design principles and semiconductor-specific properties, along with the development of a knowledge base of concrete examples, scenarios, and other empirical evidence. Ultimately, it is desirable to have not only principles, but also metrics that provide a measure of the security of a particular design.
- Current and Future Threat Assessment: The semiconductor community needs to be able to identify, classify, analyze and share information about security threats in hardware, including both those arising from unintended vulnerabilities and those included as part of a malicious design or fabrication. Given the constantly evolving threat landscape, this information base must be dynamic. Research is needed into taxonomies and representations and taxonomies of hardware-related security threats.
- Security Verification & Analysis: Tools, techniques, and methodologies for verifying hardware-specific security properties and enforcing the security design principles described above. These tools and techniques should ensure coverage and equivalency between various design, implementation, integration, and manufacturing phases and can be extensions and/or enhancements to existing tools and methodologies, intersecting existing design and verification process flows, as well regression and other testing methodologies.
- Tools & Frameworks: In order to utilize the Design for Assurance techniques that emerge, there is need for the semiconductor design and manufacturing equivalent of leading software security engineering models, such as Microsoft's Security Development Lifecycle, IBM's Secure Engineering Framework, and the Building Security In Maturity Model (BSIMM). Such a semiconductor security development model would be targeted at guiding the semiconductor workforce of today as well as of tomorrow -- e.g., academic and industrial curricula targeted at instructing architects, designers, and engineers, responding to vulnerabilities (internally and externally discovered), measuring organizational maturity and product/IP block assurance over time, etc. (Note that development of such models will likely be best facilitated by providing researchers access to current industry processes.)
- Authentication & Attestation: Models are needed for the insertion of artifacts and/or design elements that are verifiable during design and implementation, but also during manufacture and finally support in-field dynamic verification and non-destructive authentication, with the latter establishing a basis for dynamic/on-demand supply chain assurance at the component level. This research would focus on a semiconductor provenance model and related design artifacts, including but not limited to hardware fingerprinting and third party design element model checking. Supporting issues, such as the generation, protection and establishment of trust models for hardware-implemented keys, are also of interest.

Ultimately, concepts addressing the research areas described above must be capable of being implemented in a cost-effective manner.

SaTC and STARSS PI MEETINGS

The SaTC program aims to advance the knowledge base as well as expand the research community. In this spirit, the program plans to host PI meetings every other year with participation from all funded projects and other representatives from the research community, government and industry. Principal investigators from all perspectives are expected to participate in these meetings.

For SaTC:STARSS awards, one or more project representatives (PI, co-PI, senior researcher or NSF-approved replacement) must attend the first PI meeting held after the beginning of the award.

n years in which no SaTC PI meeting is held, SRC will hold a review of all SaTC:STARSS projects.

EMBEDDED REU SUPPLEMENTS

The Research Experiences for Undergraduates (REU) solicitation (NSF 13-542) gives instructions for embedding a request for a REU Supplement in a proposal. Proposers are invited to embed a request for a REU Supplement in the typical amount for one year only according to normal CISE guidelines (detailed below). The amounts of the REU Supplements do not count against the budget limitations described in this solicitation.

For single investigator projects, CISE REU supplemental funding requests should typically be for no more than two students for one year. Research teams funded through multi-investigator projects may request support for a larger number of students, commensurate with the size and nature of their projects. For example, for projects involving four principal investigators, REU supplemental funding is typically requested for about four undergraduates for one year.

As a guide for budget development, CISE REU supplement support averages about $8,000 per student per year; this guideline is neither a floor nor a ceiling. As described in the solicitation, indirect costs (F&A) are not allowed on Participant Support Costs in REU Site or REU Supplement budgets. Note that the REU solicitation's longstanding "administrative allowance" of 25% of the participant support stipend amount in lieu of indirect costs has been discontinued.

REU stipend support is one way to retain talented students in undergraduate education, while providing meaningful research experiences. The participation of students from groups underrepresented in computing -- underrepresented minorities, women and persons with disabilities -- is strongly encouraged. Other factors influencing the funding decision regarding the supplement include

the number of REU requests submitted by any one principal investigator across all of her/his CISE grants.

Investigators are encouraged to refer to the program solicitation *Research Experiences for Undergraduates (REU): Sites and Supplements* (NSF 13-542) for more information concerning submission requirements. For questions, contact one of the Cognizant Program Officers listed in this solicitation.

III. AWARD INFORMATION

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

Projects selected for joint funding by NSF and SRC will be funded through separate NSF and SRC funding instruments. For each such project, NSF support will be provided via an NSF grant and SRC support will be provided via an SRC contract. (Please note: The budget submitted with the proposal should include all necessary project funds without regard to the two funding organizations; NSF and SRC will inform selected PIs of the breakdown in funding between the two organizations, and will request revised budgets at that point.)

IV. ELIGIBILITY INFORMATION

Who May Submit Proposals:

The categories of proposers eligible to submit proposals to the National Science Foundation are identified in the Grant Proposal Guide, Chapter I, Section E.

Who May Serve as PI:

There are no restrictions or limits.

Limit on Number of Proposals per Organization:

There are no restrictions or limits.

Limit on Number of Proposals per PI or Co-PI: 1

An individual can participate as a PI, co-PI or Senior Personnel on no more than one proposal to the SaTC:STARSS program.

These eligibility constraints will be strictly enforced in order to treat everyone fairly and consistently. In the event that an individual exceeds this limit, the proposal received within the limit will be accepted based on the 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.

This limit on the number of proposals per PI, co-PI or Senior Personnel applies only to this SaTC:STARSS 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 Grant Proposal Guide (GPG). The complete text of the GPG is available electronically on the NSF website at: http://www.nsf.gov/publications/pub_summ.jsp?ods_key=gpg. Paper copies of the GPG 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: (http://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. Chapter II, Section D.4 of the Grant Proposal Guide provides additional information on collaborative proposals.

Important Proposal Preparation Information: FastLane will check for required sections of the full proposal, in accordance with *Grant Proposal Guide* (GPG) instructions described in Chapter II.C.2. The GPG requires submission of: Project Summary; Project Description; References Cited; Biographical Sketch(es); Budget; Budget Justification; Current and Pending Support; Facilities, Equipment & Other Resources; Data Management Plan; and Postdoctoral Mentoring Plan, if applicable. If a required section is missing, FastLane will not accept the proposal.

Please note that the proposal preparation instructions provided in this program solicitation may deviate from the GPG instructions. If the solicitation instructions do not require a GPG-required section to be included in the proposal, insert text or upload a document in that section of the proposal that states, "Not Applicable for this Program Solicitation." Doing so will enable FastLane to accept your proposal.

Please note that per guidance in the GPG, the Project Description must contain, as a separate section within the narrative, a discussion of the broader impacts of the proposed activities. Unless otherwise specified in this solicitation, you can decide where to include this section within the Project Description.

Proposal Titles: Proposal titles must begin with the "SaTC:STARSS" acronym, i.e., SaTC:STARSS: Title.

Supplementary Documents: In the Supplementary Documents Section, upload the following:

(1) A statement of consent:

Proposals must include a statement of consent that indicates NSF may share with SRC the proposal, reviews, and any related information. ***Proposals that do not contain this statement will be returned without review.***

(2) A list of Project Personnel and Partner Institutions (Note: In collaborative proposals, only the lead institution should provide this information):

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 conflicts of interest. The list must include all PIs, Co-PIs, Senior Personnel, paid/unpaid Consultants or Collaborators, Subawardees, Postdocs, project-level advisory committee members, and writers of letters of support. 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 Inc.; Paid Consultant
- Mary White; Welldone Institution; Unpaid Collaborator
- Tim Green; ZZZ University; Subawardee

(3) A list of Collaborators (Note: In collaborative proposals, only the lead institution should provide this information):

Provide current, accurate information for all active or recent collaborators of personnel and institutions involved in the project. NSF staff will use this information in the merit review process to manage conflicts of interest. This list -- distinct from (1) above -- must include all active or recent Collaborators of all personnel involved with the proposed project. Collaborators include any individual with whom any member of the project team -- including PIs, Co-PIs, Senior Personnel, paid/unpaid Consultants or Collaborators, Subawardees, Postdocs, and project-level advisory committee members -- has collaborated on a project, book, article, report, or paper within the preceding 48 months; or co-edited a journal, compendium, or conference proceedings within the preceding 24 months. This list should be numbered and include (in this order) Full name and Organization(s), with each item separated by a semi-colon. Each person listed should start a new numbered line.

- Mary Smith; XYZ University
- John Jones; University of PQR
- Jane Brown; XYZ University
- Bob Adams; ABC Inc.
- Mary White; Welldone Institution
- Tim Green; ZZZ University

(4) Postdoctoral Researcher Mentoring Plan (if applicable):

Each proposal that requests funding to support postdoctoral researchers must include, as a supplementary document, a description of the mentoring activities that will be provided for such individuals. In no more than one page, the mentoring plan must describe the mentoring that will be provided to all postdoctoral researchers supported by the project, irrespective of whether they reside at the submitting organization, any subawardee organization, or at any organization participating in a simultaneously submitted collaborative project. Please be advised that if required, FastLane will not permit submission of a proposal that is missing a Postdoctoral Researcher Mentoring Plan.

See Chapter II.C.2.j (http://www.nsf.gov/pubs/policydocs/pappguide/nsf14001/gpg_2.jsp#IIC2j) of the GPG for further information about the implementation of this requirement.

Proposals that include Postdoctoral Mentoring Plans exceeding one page in length will be returned without review.

(5) 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 Grant Proposal Guide (GPG) Chapter II.C.2.j for full policy implementation.

For additional information see:http://www.nsf.gov/bfa/dias/policy/dmp.jsp.

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

Proposals that include Data Management Plans exceeding two pages in length will be returned without review.

Relationship to SaTC Solicitation: PIs may not submit the same or similar proposal to the SaTC Small and SaTC:STARSS competitions. As noted in the Grant Proposal Guide (GPG) Chapter IV.B, a proposal may not be accepted or may be returned

without review if it is a duplicate of, or substantially similar to, a proposal already under consideration by NSF from the same submitter.

B. Budgetary Information

Cost Sharing: Inclusion of voluntary committed cost sharing is prohibited

Other Budgetary Limitations: Budgets for SaTC:STARSS projects must include funding for one or more project representatives (PI, co-PI, senior researcher or NSF-approved replacement) to attend the first biennial SaTC Principal Investigators' (PI) meeting organized by NSF following the award start date. The first PI meeting for awards made under this solicitation is expected in 2014. Budgets must also include costs to attend SRC annual review meetings in the years in which there is not a SaTC PI meeting.

C. Due Dates

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

  March 26, 2014

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 the GPG as Exhibit III-1.

A comprehensive description of the Foundation's merit review process is available on the NSF website at: http://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 *Empowering the Nation Through Discovery and Innovation: NSF Strategic Plan for Fiscal Years (FY) 2011-2016*. 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 core strategies 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 provide abundant opportunities where individuals may concurrently assume responsibilities as researchers, educators, and students, and where all can engage in joint efforts that infuse education with the excitement of discovery and enrich research through the variety of learning perspectives.

Another core strategy in support of NSF's mission is broadening 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. (GPG 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 GPG 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.

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 formulate a recommendation to either support or decline each proposal. The Program Officer assigned to manage the proposal's review will consider the advice of reviewers and will formulate a recommendation.

NSF will manage and conduct the review process of proposals submitted in accordance with NSF standards and procedures. The review and award recommendations will be coordinated by a Joint NSF and SRC Working Group (JWG) of program officers from both NSF and SRC. Relevant information about proposals and reviews of proposals will be shared between the participating organizations as appropriate. The JWG will recommend meritorious proposals for award at appropriate funding levels.

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 http://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 *Award & Administration Guide* (AAG) Chapter II, available electronically on the NSF Website at http://www.nsf.gov/publications/pub_summ.jsp?ods_key=aag.

Special Award Conditions:

Individual awards selected for joint funding by NSF and SRC will be funded through separate NSF and SRC funding instruments. For each such project, NSF support will be provided via an NSF grant and SRC support will be provided via an SRC contract. Either organization may supplement a project without requiring the other party to provide any additional funds.

(Please note: The budget submitted with the proposal should include all necessary project funds without regard to the two funding organizations; NSF and SRC will inform selected PIs of the breakdown in funding between the two organizations, and will request revised budgets at that point.)

All joint or separate awards involving SRC funds must also include an executed agreement on intellectual property signed by the representatives of the awardee organization and SRC. SRC contracts provide for non-exclusive, royalty-free rights to all SRC members for any intellectual property generated as a result of the SRC-funded research.

C. Reporting Requirements

For all NSF multi-year grants (including both standard and continuing grants), the Principal Investigator must submit an annual project report to the cognizant Program Officer at least 90 days prior to the end of the current budget period. (Some programs or awards require submission of more frequent project reports). Within 90 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 *Award & Administration Guide* (AAG) Chapter II, available electronically on the NSF Website at http://www.nsf.gov/publications/pub_summ.jsp?ods_key=aag.

NSF and SRC will manage their respective awards and contracts in accordance with their own guidelines. Awardees will submit annual project reports to NSF via FastLane, subject to NSF procedures, as described above. Awardees will also submit annual reports to SRC, subject to SRC procedures, describing research progress, students participating in the research, and other agreed upon deliverables.

Please see the full text of this solicitation for further information, particularly the discussion about SaTC and STARSS PI Meetings under II. Program Description.

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) 292-8910, email: namla@nsf.gov
- Celia Merzbacher, telephone: (919) 941-9413, email: celia.merzbacher@src.org
- Ralph Wachter, Program Director, CISE/CNS, telephone: (703) 292-8950, email: rwachter@nsf.gov
- Paul Werbos, Program Director, ENG/ECCS, telephone: (703) 292-8339, email: pwerbos@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 at https://public.govdelivery.com/accounts/USNSF/subscriber/new?topic_id=USNSF_179.

Grants.gov provides an additional electronic capability to search for Federal government-wide grant opportunities. NSF funding opportunities may be accessed via this new 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 provide funding for special assistance or equipment to enable persons with disabilities to work on NSF-supported projects. See Grant Proposal Guide Chapter II, Section D.2 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 http://www.nsf.gov

- Location: 4201 Wilson Blvd. Arlington, VA 22230
- 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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