Algorithms in the Field (AitF)

PROGRAM SOLICITATION
NSF 16-515

REPLACES DOCUMENT(S):
NSF 15-515

National Science Foundation

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

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

    February 18, 2016 - March 03, 2016

IMPORTANT INFORMATION AND REVISION NOTES

This program will pilot a modified review process in which PIs will receive reviews before the panel meeting and will have an opportunity to provide a brief response for the panelists to consider. Details are provided below under "Proposal Preparation and Submission Procedures" and "NSF Proposal Processing and Review Procedures."

The collaboration plan is now limited to three pages (instead of two) and must include plans for evaluating project success.

The previous AitF solicitation distinguished two classes of projects. This solicitation calls for only a single class.

Any proposal submitted in response to this solicitation should be submitted in accordance with the revised NSF *Proposal & Award Policies & Procedures Guide* (PAPPG) (NSF 16-1), which is effective for proposals submitted, or due, on or after January 25, 2016. Please be advised that proposers who opt to submit prior to January 25, 2016, must also follow the guidelines contained in NSF 16-1.

SUMMARY OF PROGRAM REQUIREMENTS

General Information

Program Title:

    Algorithms in the Field (AitF)

Synopsis of Program:

    Algorithms in the Field encourages closer collaboration between two groups of researchers: (i) theoretical computer science researchers, who focus on the design and analysis of provably efficient and provably accurate algorithms for various computational models; and (ii) other computing and information researchers including a combination of systems and domain experts (very broadly construed – including but not limited to researchers in computer architecture, programming languages and systems, computer networks, cyber-physical systems, cyber-human systems, machine learning, artificial intelligence and its applications, database and data analytics, etc.) who focus on the particular design constraints of applications and/or computing devices. Each proposal must have at least one co-PI interested in theoretical computer science and one interested in any of the other areas typically supported by CISE. Proposals are expected to address the dissemination of both the algorithmic contributions and the resulting applications, tools, languages, compilers, libraries, architectures, systems, data, etc.

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.

- Tracy Kimbrel, Program Director, CISE/CCF, telephone: (703) 292-8910, email: tkimbrel@nsf.gov

- Thyagarajan Nandagopal, Program Director, CISE/CNS, telephone: (703) 292-8950, email: tnandago@nsf.gov

- Rahul Shah, Program Director, CISE/CCF, telephone: (703) 292-8910, email: rshah@nsf.gov

- Jack Snoeyink, Program Director, CISE/CCF, telephone: (703) 292-8910, email: jsnoeyin@nsf.gov

- Maria Zemankova, Program Director, CISE/IIS, telephone: (703) 292-8930, email: mzemanko@nsf.gov

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

- 47.070 --- Computer and Information Science and Engineering

Award Information

Anticipated Type of Award: Standard Grant or Continuing Grant

Estimated Number of Awards: 15

Approximately 15 awards of up to $800,000 per award with durations up to 4 years are anticipated, subject to availability of funds.

Anticipated Funding Amount: $9,000,000

Subject to availability of funds.

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:

> Each proposal must have at least one co-PI focusing on theoretical computer science and one focusing on any other area typically supported by CISE such as networking, data mining, human-computer interaction, cyber-physical systems, and so forth. We emphasize that these four "fields" are chosen only to illustrate the wide range of collaborations sought and are in no way intended to limit scope or indicate favored areas.

Limit on Number of Proposals per Organization:

> There are no restrictions or limits.

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

> An investigator may participate as PI, co-PI, or senior personnel in no more than two proposals submitted in response to this solicitation.

> In the event that an individual exceeds this limit, proposals will be accepted based on earliest date and time of proposal submission, i.e., the first two proposals received will be accepted and the remainder will be returned without review. No exceptions will be made.

> Proposals submitted in response to this solicitation may not duplicate or be substantially similar to other proposals concurrently under consideration by NSF.

Proposal Preparation and Submission Instructions

A. Proposal Preparation Instructions

- **Letters of Intent:** Not required

- **Preliminary Proposal Submission:** Not required

- **Full Proposals:**

  - Full Proposals submitted via FastLane: NSF Proposal and Award Policies and Procedures Guide, 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:**

  Not Applicable

C. Due Dates

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

    February 18, 2016 - March 03, 2016

Proposal Review Information Criteria

Merit Review Criteria:

National Science Board approved criteria apply.

Award Administration Information

Award Conditions:

Standard NSF award conditions apply.

Reporting Requirements:

Standard NSF reporting requirements apply.

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I. INTRODUCTION

Numerous and diverse computational and communication challenges permeate all aspects of our daily lives: tasks such as communicating by phone/email, banking, shopping, searching on the World Wide Web, and even driving a vehicle are made possible or easier by suites of computer codes that are transparently executed on a multitude of computing devices. Algorithms, which are at the heart of these computer codes, are expected to solve complex problems that are critical to academic disciplines, as well as the business world and government agencies, with the end goal of making everyday life better. The diversity of these challenges (ranging from large-scale, multi-modal searches, to efficiently populating data structures and databases, to sophisticated numerical computations) and the wide variety of available computing devices (ranging from tiny sensors, cell phones and GPS-based navigational aids to supercomputers and warehouse-scale data centers for cloud computing) place new demands on the theoretical foundations of computing. Traditional models, such as Turing machines and random-access machines, and measures, such as asymptotic time and space complexity and communication complexity, may no longer be sufficient to capture the multiple facets of modern computation. For instance, energy consumption is emerging as a first-class design consideration in platforms ranging from embedded systems to large-scale data farms. On a different axis, "algorithmic accountability" is gaining traction as a measure of algorithm quality.

Solid foundations for algorithms are of paramount importance: understanding fundamental properties of an algorithm, such as the tradeoff between the resource requirements and solution quality, has been at the very heart of computer science since the early days of computing. At the same time, in order to solve applied problems, the proposed algorithms and their analyses must take into account the particular computational and structural constraints imposed by their respective application domains. Such constraints include limited computational time (e.g., a response to an online query has to be computed almost instantaneously); available computational power or energy (e.g., a handheld device has only limited processing power; running computations on an isolated battery-operated device should take into account the battery life); limited amount of communication between available processors (e.g., in supercomputing devices with massive amounts of parallelism, communication between the processors is often the critical bottleneck; in the division of functionality between the cloud and edge devices, communication is a key factor); statistical estimation properties (e.g., estimation accuracy vs. data size); non-stationarity of data; structural limitations on inputs and/or outputs (e.g., when only certain inputs appear; when multiple outputs are possible, yet only certain outputs make sense for the application); or when accountability places constraints on the output. Algorithms may need to simultaneously satisfy criteria along multiple dimensions.

II. PROGRAM DESCRIPTION

Algorithms in the Field posits the need for closer collaboration between two groups of researchers: (i) theoretical computer science researchers who focus on the design and analysis of provably efficient and provably accurate algorithms for various computational models; and (ii) other computing and information researchers including a combination of systems and domain experts (very broadly construed – including researchers in computer architecture, programming languages and systems, computer networks, cyber-physical systems, cyber-human systems, machine learning, data mining, artificial intelligence and its applications, database and data analytics, etc.) who focus on the particular design constraints of applications and/or computing devices. Today, these communities operate largely independently of one another, leading to the design and analysis of algorithms that often manifest a gap between theory and practice. Adapting and applying proven algorithmic solutions to a particular computational challenge necessitates partnerships and collaborations that are often not in place. On the other hand, when existing theory shows intractability, the technology can adapt and lead to new theories and innovations. This again requires a close collaboration between these two communities. The bi-directional cross-fertilization envisioned by the Algorithms in the Field program can lead to new fields as well as broader applicability of cutting-edge applications.

The objective of Algorithms in the Field is to bridge the gap between theory and practice in the design, analysis, implementation, and evaluation of algorithms. The premise is that by working jointly "in the field" researchers from these different communities will continually inform each other, innovate in their respective areas, and forge algorithms that are simultaneously validated by theory, systems, and applications communities. Some specific details of the community needs are as follows:

- In the absence of close collaboration, it can be a long time from emergence of an exciting new application area before a new concrete model and its fundamental problems are identified and appreciated by the theory community. On the other hand, foundational work in theory develops deep and rich techniques for abstract problems, and in many cases the standard algorithmic toolbox already contains the answers to a new application area's problems. In these cases, the value of a theoretical background is the ability to recognize the problems and apply/adapt the known solutions. Most new problems necessitate a more dynamic interaction between theory and other groups.

- An ideal algorithm is simultaneously efficient, intuitive, and easy to implement. Asymptotic analysis provides a good first order approximation of the performance of an algorithm, but it often hides huge constants and may lead to complicated algorithmic steps that shave off small multiplicative factors. On the other hand, simple heuristics are often widely implemented and successfully used. This raises questions regarding what existing theory fails to predict and how to develop new theories that lead to new practical and useful algorithms.

- Closer collaboration between theorists and other researchers will bring new challenges to theorists. Concomitantly, new teaming with the theory community has the potential to significantly advance algorithm development in applied domains that are experiencing an explosion of challenges associated with big data throughput, privacy, real-time response, data heterogeneity, model complexity, computational costs of inference and learning, and data quality – to name but a few. This solicitation aims to provoke radically new approaches to real problems such as optimization, scalability, information in social networks, provable quality of crowd-sourced data, theoretical constructs that advance understanding in neuroscience, and quantification of tradeoffs between resources and precision.

- Collaboration and algorithm development are needed in important areas such as approximate computing, new coding strategies for distributed data storage, large-scale protocol verification with program-semantics-based proofs, energy-efficient sensing and data logging methods, black-box software testing, and the many facets of data privacy, keeping in mind challenges posed by trends such as ever-proliferating heterogeneity and parallelism, novel devices and architectures, and new programming paradigms, languages, and systems.

Bringing researchers with widely varying research interests together with algorithms researchers is expected to lead to fruitful new relationships and unexpected directions of research. This program will consider collaborations between researchers interested in the rigorous design and analysis of algorithms, and researchers interested in any of the other areas typically supported by CISE. AitF seeks to support proposals that make strong advances in both the area of algorithmic design and in the application area to which the algorithms are being deployed; an ideal proposal will integrate both algorithms and "field" components and show potential for lasting impact on both sides. Proposals that make strong advances primarily to one side of this relationship should be submitted to the appropriate program for that side.

We purposely avoid defining "field" or providing an exhaustive list of targeted fields. We encourage a wide variety of areas and will rely on the reviewer community to evaluate projects' suitability for the program in the spirit of the Algorithms in the Field concept as described above.

Project Classes

Unlike the first year of the program, we make no distinction between classes of projects based on size or characteristics. We remind submitters that the budget limit is a maximum only and no minimum is specified. We encourage smaller, exploratory projects as well as larger ones.

AitF PI Meetings

The AitF program is aiming to grow a new research community. In this spirit, the program plans to host PI meetings every year in the U.S., with participation from funded PIs (at least one collaborating PI focusing on algorithmic theory and at least one PI focusing on application per award), along with other representatives from the research community, government and industry.

III. AWARD INFORMATION

Approximately $9 million will be made available in FY 2016 to support approximately 15 awards with durations up to 4 years.

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

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:

Each proposal must have at least one co-PI focusing on theoretical computer science and one focusing on any other area typically supported by CISE such as networking, data mining, human-computer interaction, cyber-physical systems, and so forth. We emphasize that these four "fields" are chosen only to illustrate the wide range of collaborations sought and are in no way intended to limit scope or indicate favored areas.

Limit on Number of Proposals per Organization:

There are no restrictions or limits.

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

An investigator may participate as PI, co-PI, or senior personnel in no more than two proposals submitted in response to this solicitation.

In the event that an individual exceeds this limit, proposals will be accepted based on earliest date and time of proposal submission, i.e., the first two proposals received will be accepted and the remainder will be returned without review. No exceptions will be made.

Proposals submitted in response to this solicitation may not duplicate or be substantially similar to other proposals concurrently under consideration by NSF.

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.5 of the Grant Proposal Guide provides additional information on collaborative proposals.

See Chapter II.C.2 of the GPG 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 GPG instructions.

Additional Proposal Preparation and Submission Guidelines

Proposal titles must indicate the **AitF** program, followed by a colon, followed by the title of the project. For a collaborative proposal (that is, one submitted as separate submissions from multiple organizations), all participating institutions should use the same title, which should also include the phrase **Collaborative Research** followed by a colon. Thus, a single-institution proposal would have a title of the form **AitF: Title**, and a collaborative proposal would use the form **AitF: Collaborative Research: Title**.

Each proposal is required to include a Collaboration Plan as a separate supplementary document (limited to 3 pages). This plan must describe the distinct expertise provided by the PIs as required above under Who May Serve as PI as well as plans for working together to advance knowledge in both algorithms and at least one "field" area. Joint supervision of students and postdoctoral researchers is strongly encouraged. The collaboration plan must also describe clear measures of success for both the algorithmic and "field" aspects of the project and a plan for evaluating success. **Proposals without this document will be returned without review.**

Each proposal is required to include a Data Management Plan as a separate supplementary document (limited to 2 pages). This

plan must address the dissemination of the algorithmic contributions and resulting applications, tools, languages, compilers, libraries, architectures, systems, software, architectures, data, etc. Open source release of these artifacts is strongly encouraged. **Proposals without this document will be returned without review.**

Submission of additional material after initial merit review: PIs will have an opportunity to provide an additional 1000 words of text responding to initial reviews. NSF will collect reviews prior to the panel and will provide these reviews to the PIs. The PIs will have one week to prepare responses and submit them by email to the program directors. This additional material will be considered by the review panel. See NSF Proposal Processing and Review Procedures below for more information. After award and decline decisions are finalized, PIs will be asked to complete a brief, optional survey to assess the effectiveness of this pilot process.

B. Budgetary Information

Cost Sharing:

Inclusion of voluntary committed cost sharing is prohibited.

Budget Preparation Instructions:

Budgets for all projects must include funding for travel for the collaborating PIs (those focusing on algorithmic foundations as well as those focusing on "field" areas) to attend annual AitF PI Meetings during the proposed lifetime of the award. For budget preparation purposes, PIs may assume these meetings will be held in the Washington, DC, area.

C. Due Dates

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

    February 18, 2016 - March 03, 2016

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://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 *Investing in Science, Engineering, and Education for the Nation's Future: NSF Strategic Plan for 2014-2018*. 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. (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, or PI Response Mechanism.

Panelists will submit initial reviews prior to the start of the panel meeting. Panelists will be asked to include clear and constructive statements of weaknesses, and specific questions of clarification or context, with the understanding that PIs will be provided an optional but recommended opportunity to respond. The set of reviews for a proposal will be made available to the PIs. **Each lead PI (of only the lead institution for collaborative proposals) will have approximately one week to prepare a brief (1000-word maximum) response**, which will be considered by the panel before making its final summary and recommendation. For ease of implementation, responses will be collected by email as **plain (ASCII) text – no PDF or other formats will be accepted**. To facilitate planning, **PIs will be notified approximately three weeks before their set of reviews is made available**. Detailed instructions for submitting responses will be provided at that time. Late responses will be considered only under circumstances similar to those that would allow extension of proposal submission deadlines, such as natural disasters and problems caused by NSF systems. After award and decline decisions are finalized, PIs will be asked to complete a brief, optional survey to assess the effectiveness of this pilot process.

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 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.

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

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:

- Tracy Kimbrel, Program Director, CISE/CCF, telephone: (703) 292-8910, email: tkimbrel@nsf.gov

- Thyagarajan Nandagopal, Program Director, CISE/CNS, telephone: (703) 292-8950, email: tnandago@nsf.gov

- Rahul Shah, Program Director, CISE/CCF, telephone: (703) 292-8910, email: rshah@nsf.gov

- Jack Snoeyink, Program Director, CISE/CCF, telephone: (703) 292-8910, email: jsnoeyin@nsf.gov

- Maria Zemankova, Program Director, CISE/IIS, telephone: (703) 292-8930, email: mzemanko@nsf.gov

For questions related to the use of FastLane, contact:

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

For questions relating to Grants.gov contact:

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

IX. OTHER INFORMATION

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

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

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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.

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

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

- **For General Information** (NSF Information Center)**:** (703) 292-5111

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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
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