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Scalable Parallelism in the Extreme (SPX)

PROGRAM SOLICITATION
NSF 16-605

National Science Foundation

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

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

January 10, 2017

IMPORTANT INFORMATION AND REVISION NOTES

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.

SUMMARY OF PROGRAM REQUIREMENTS

General Information

Program Title:

Scalable Parallelism in the Extreme (SPX)

Synopsis of Program:

Computing systems have undergone a fundamental transformation from the single-core processor-devices of the turn of the century to today's ubiquitous and networked devices with multicore/many-core processors along with warehouse-scale computing via the cloud. At the same time, semiconductor technology is facing fundamental physical limits and single-processor performance has plateaued. This means that the ability to achieve performance improvements through improved processor technologies alone has ended. In recognition of this obstacle, the recent National Strategic Computing Initiative (NSCI) encourages collaborative efforts to develop, “over the next 15 years, a viable path forward for future high-performance computing (HPC) systems even after the limits of current semiconductor technology are reached (the 'post-Moore’s Law era').”

Exploiting parallelism is one of the most promising directions to meet these performance demands. While parallelism has already been studied extensively and is a reality in today’s computing technology, the expected scale of future systems is unprecedented. At extreme scales, factors that have small impacts today can become highly significant. For example, even short serial program sections can prove destructive to performance. Heterogeneity of processing elements [Central Processing Units (CPUs), Graphics-Processing Units (GPUs), and accelerators] and their memory hierarchies pose significant management challenges. High system complexity may lead to unacceptable latencies and mean time between failures, even if built with highly reliable components. Furthermore, the interconnectedness of large-scale distributed architectures poses an enormous challenge of understanding and providing guarantees on performance behavior. These are just four of many issues arising in the new era of parallel computing that is upon us.

The Scalable Parallelism in the Extreme (SPX) program aims to support research addressing the challenges of increasing performance in this modern era of parallel computing. This will require a collaborative effort among researchers in multiple areas, from services and applications down to micro-architecture. SPX encompasses all five NSCI Strategic Objectives, including supporting foundational research toward architecture and software approaches that drive performance improvements in the post-Moore’s Law era; development and deployment of programmable, scalable, and reusable platforms in the national HPC and scientific cyberinfrastructure ecosystem; increased coherence of data analytic computing and modeling and simulation; and capable extreme-scale computing. Coordination with industrial efforts that pursue related goals are encouraged.

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.

- Anindya Banerjee, Program Director, CISE/CCF, telephone: (703) 292-7885, email: abanerje@nsf.gov
- Tracy Kimbrel, Program Director, CISE/CCF, telephone: (703) 292-8910, email: tkimbrel@nsf.gov
- Tao Li, Program Director, CISE/CCF, telephone: (703) 292-8238, email: taoli@nsf.gov
- Mimi McClure, Program Director, CISE/CNS, telephone: (703) 292-5197, email: mmcclure@nsf.gov

- Yan Solihin, Program Director, CISE/CNS, telephone: (703) 292-7939, email: ysolihin@nsf.gov
- Rajiv Ramnath, Program Director, CISE/ACI, telephone: (703) 292-4776, email: rramnath@nsf.gov
- Aidong Zhang, Program Director, CISE/IIS, telephone: (703) 292-5311, email: azhang@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

Estimated Number of Awards: 15 to 25

Approximately $10,000,000 will be made available in FY 2017 to support up to 15-25 awards with durations of 2-4 years and up to $1,000,000 per award.

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

Anticipated Funding Amount: $10,000,000

Eligibility Information

Who May Submit Proposals:

Proposals may only be submitted by the following:

- Universities and Colleges - Universities and two- and four-year colleges (including community colleges) accredited in, and having a campus located in, the US acting on behalf of their faculty members. Such organizations also are referred to as academic institutions.

Who May Serve as PI:

Each proposal is required to have two or more PIs providing different and distinct expertise relevant to the program's focus areas.

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 investigator may participate as PI, co-PI, or senior personnel in no more than one proposal 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. **No exceptions will be made.**

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

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:**

  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. submitter's local time):

  January 10, 2017

Proposal Review Information Criteria

Merit Review Criteria:

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

Award Administration Information

Award Conditions:

Standard NSF award conditions apply.

Reporting Requirements:

Standard NSF reporting requirements apply.

TABLE OF CONTENTS

I. INTRODUCTION

Computing systems have undergone a fundamental transformation from the relatively isolated single-processor devices of the turn of the century to today's ubiquitous and networked devices, warehouse-scale computing via the cloud, and extreme-scale high-performance computing (HPC) systems that increasingly are expected to process and continuously analyze large volumes of data subject to updates in real time. Parallelism has become critically important at many levels, from the underlying circuits to the globally shared infrastructure of the Internet. Intermediate levels include cores with pipelining and instruction level parallelism, chips as well as machines with multiple homogeneous and heterogeneous cores and accelerators, racks with multiple machines, and data centers with many racks. Multi- and many-core processors, ever-increasing numbers and variety of edge devices, the data centers servicing them, and the software environments harnessing these resources constitute a new cyberinfrastructure that enables globally-distributed applications with tremendous potential for economic and social impact. These include, but are not limited to, compute- and data-intensive applications, novel cloud computing services running on novel cloud architectures, data and graph analytics, and machine learning and big data applications.

The ever-increasing range of applications has created an insatiable demand for compute power, which comes at a time when a main driver of continued performance improvement is ending: semiconductor technology is facing fundamental physical limits and single-processor performance has plateaued. Recognizing these trends, the National Strategic Computing Initiative outlines the need to establish, "over the next 15 years, a viable path forward for future HPC systems even after the limits of current semiconductor technology are reached (the 'post-Moore's Law era')." Several additional reports ("Future Directions for NSF Advanced Computing Infrastructure to Support U.S. Science and Engineering in 2017-2020"; "21st Century Computer Architecture"; "The Future of Computing Performance: Game Over or Next Level?"; and "Advanced Computing Infrastructure: Vision and Strategic Plan") question

how computational systems can enable emerging, large-scale applications without the benefit of near-perfect performance scaling (Dennard scaling) due to hardware improvements. Although Moore's Law may produce a few more generations of smaller transistors, the end of Dennard scaling means that smaller transistors do not necessarily improve performance or energy efficiency.

Exploiting parallelism is one of the most promising directions to meet these performance demands. While parallelism has already been studied extensively and is a reality in today's computing technology, the expected scale of future systems is unprecedented. At extreme scales, factors that have small impacts today can become highly significant. For example, even short serial program sections can prove destructive to performance. Heterogeneity of processing elements [Central Processing Units (CPUs), Graphics-Processing Units (GPUs), and accelerators] and their memory hierarchies poses significant management challenges. High system complexity may lead to unacceptable latencies and mean time between failures, even if built with highly reliable components. Furthermore, the interconnectedness of large-scale distributed architectures poses an enormous challenge of understanding and providing guarantees on performance behavior. These are just four of many issues arising in the new era of parallel computing that is upon us.

To support the move to parallelism of applications at multiple levels from mobile devices to desktops to extreme-scale systems and the cloud, we need a new era of parallel computing, driven by novel, groundbreaking research in all areas impacting parallel performance and scalability. Sustaining performance improvements as in the past, as well as achieving programmability, reuse, and accuracy of results, will require a collaborative, cross-layer effort among researchers representing all areas from the application layer down to the micro-architecture. Vertical integration, that is, tight linking between research in two or more layers of the hardware-software stack, is critical as abstraction layers evolve in two directions: bottom-up (driven by foundations and principles) and top-down (driven by applications). Moving parallelism to the extreme scale also requires effective use of various types of compute resources [CPUs, GPUs, processors in memory, Field-Programmable Gate Arrays (FPGAs), Application-specific Integrated Circuits (ASICs), etc.], taking into account various forms of memory (hardware-managed caches, software-managed memories, buffers, etc.). Innovations in the hardware/software runtime system, operating system, hypervisor, etc., are needed to manage these resources. Furthermore, given the unprecedented complexity of today's applications (with interactions that traverse a complex pathway of hardware devices, operating systems, networks, distributed protocols, databases, programming languages, and compilers), it is essential that performance be both predictable and portable across architectures. Porting programs to a novel architecture should not lead to a cascading degradation of application performance. Furthermore, applications need predictable performance guarantees, based on accurate tracking of use of resources such as time, memory, and energy.

II. PROGRAM DESCRIPTION

The SPX program aims to support transformative projects to re-evaluate and possibly re-design the traditional computer hardware and software stack for today's heterogeneous, parallel, concurrent, and distributed systems. Thus, SPX seeks collaborations combining, for example, a deep understanding in parallel programming with expertise in software tools; experience in heterogeneous parallel architectures with algorithm design expertise; experience and discovery in emerging substrate technologies with architecture and systems design; knowledge in an application domain with expertise in energy-efficient memory hierarchies; hardware design know-how with human factors expertise; experience in runtime platforms and virtualization tools with knowledge in reliable and distributed computing; and experience in parallel data management with knowledge of parallel linear algebra or statistical algorithms. The program also seeks collaborations that integrate the many different techniques for the analysis and modeling of resources (such as time, memory, and energy) in various areas such as theory, uncertainty quantification, software systems, distributed systems, and programming languages, to create more predictable performance and scalable implementations of software systems, and more efficient ways of distributing workloads over available computing resources. To increase symbiosis between theory and practice, SPX supports research that aims to extract general principles that can be validated on a variety of application domains. In some cases, research may also generate technologies with the potential to be incorporated into innovative applications, tools, products, and cyberinfrastructures that support research in other scientific domains.

A. Research Areas

Within the general focus of cross-layer design, the SPX program is broadly interested in topics pertaining to Algorithms, Programming Languages and Systems, Applications, Architecture and Systems, Extensible Distributed Systems, and Performance Predictability. Illustrative -- but non-exhaustive -- thrusts of these topics are discussed below.

Algorithms: Algorithms research must aim to bridge the gap between theory and concrete systems implementations. Such research must be coordinated with advances in architecture and systems and must be cognizant of cache and memory technologies, of locality and the costs of non-uniform memory access, and of consistency models and coherence protocols. Research is needed to develop scalable algorithms for (a) big data analytics, particularly in the context of extreme-scale HPC systems; (b) graph analytics, for instance in the context of statistical machine learning on graphs, such that algorithms accommodate sparsity and irregularity in graph structure; and (c) approximate and probabilistic computing, such that algorithms can compute sufficiently precise answers while using bounded time, space, communication, and energy. Research is also needed on algorithms for optimizing resource utilization in complex and new architectures. Moreover, more detailed cost models must be considered, because classic cost models such as the random access machine (RAM) model are less accurate when it comes to modeling caches, non-volatile random access memory (NVRAM), parallel execution, and distributed computation.

Programming Languages and Systems: New algorithms, architectures and systems demand corresponding advances in programming models and tools. Diverse hardware platforms complicate the development of large software systems, which are increasingly written in a heterogeneous mix of languages and run-time systems. SPX seeks research in (a) scalable performance and functional correctness of software systems by focusing on programmability, verifiability, modularity, and compositionality; (b) data models, query languages, and query optimization techniques that support large datasets and parallel processing for database, data mining, and machine learning queries; (c) robust compiler analysis and optimization for languages that have not traditionally received such support, including dynamic, scripting, and functional languages; (d) software optimization that crosses program boundaries to consider distributed tasks, for example tasks that make up a data center job; (e) parallel domain-specific languages that provide both high-level programming models for use by domain experts, and high performance across a range of architectures, such as GPUs, FPGAs, and other accelerator-based hardware architectures; and (f) design of new abstractions for both traditional processor cores as well as accelerators to support compilation, synthesis, and software portability across architectures.

Applications: Future applications will be required to analyze massive datasets (for example, streaming from distributed sensors), coupled with advanced modeling and simulation capabilities, to infer broad and significant trends. SPX seeks to develop a coherent platform for modeling, simulation, and data analytics, primarily through the development of a more agile and reusable HPC software portfolio. As data analytics increases in computational intensity, and modeling and simulation encounter increased complexity, scalability barriers arise along with new demands for interoperability, robustness, and reliability of results. Research is thus needed to expose parallelism in applications and consequently produce responsive and timely solutions. To ensure reliability of results,

research is needed to develop fundamental notions of accuracy (possibly based on uncertainty quantification) for these applications; without this, the utility of the applications will be limited. Additionally, SPX supports research in achieving scalability through parallelism in other application domains such as scientific computing, statistical machine learning, and image processing.

Architecture and Systems: Without Dennard scaling to provide smaller, faster, and more efficient transistors, continued advances in computing capability increasingly rely upon innovations in architecture and system design. Research is needed in methodologies that generate new hardware architectures and optimize them in terms of varied metrics -- performance, energy efficiency, chip area, programmability, reliability, security, etc. -- while reducing design effort and suppressing nonrecurring engineering costs. New architectures in the post-Moore's Law era are expected to be increasingly heterogeneous, more application/domain specific, and have higher failure rates. These will pose significant challenges in the software aspects of systems as well, such as in data coherence, system management, resource allocation, and task scheduling. For example, heterogeneous systems increasingly deploy programmable data-parallel accelerators, reconfigurable logic, neuromorphic accelerators, hardware design exploiting approximation, and other specialized capabilities. Research is needed on ways to optimize the composition of heterogeneous systems and steer computation to the best-suited component. Alternatives to silicon and CMOS offer qualitatively new capabilities. For a compelling set of applications, these technologies could revolutionize computing by eliminating today's pressing technology constraints. Research is needed to identify and enable applications that exploit parallelism in these new technologies in memory, communication, and packaging. Nonvolatile memories promise to transform computing by replacing, merging, or hybridizing memory and storage. Biology-based computing and storage architectures, processing in memory, and cryogenic computing (among others) may be applicable to this solicitation if it can be demonstrated that they play a central role in achieving scalable parallelism.

Extensible Distributed Systems: Large-scale heterogeneous distributed systems (e.g., the web, grid, cloud) have become commonplace in both general purpose and scientific contexts. New applications leveraging these systems require a rich environment that enables sensing, data analytics, and advanced computing with diverse distributed data, along with communications among these systems and the elements that comprise them. Data placement and task scheduling that ensures performance despite heterogeneous and non-uniform memory access is critical. Research supporting the science and design of these extensible distributed systems, particularly the components and programming of highly parallel and scalable distributed architectures, will enable the many "smart" technologies of the future. Of significant interest also are fundamental design principles for such distributed systems and the validation of the principles; notions of data consistency, and methodologies, language features, and abstractions that ensure consistency in environments that demand availability in the presence of faults. Proposals on extensible distributed systems that focus on taking advantage of highly parallel environments and scalable architectures are welcome in SPX; those with broader goals for such systems should consider submitting to the Computer Systems Research (CSR) program.

Performance Predictability: The NSCI has set the ambitious goal of achieving capable extreme-scale computing (one billion operations per nanosecond) to ensure that performance increase extends significantly beyond current levels. For complex HPC systems that operate at such extreme scales, predictable performance is of critical importance. In current practice, cloud service providers seek to provide fine-grained service-level agreements to customers; large online services view low, predictable "tail" latencies (i.e., response times) as key to end-user satisfaction. However, predictable performance in complex HPC systems is an open research problem. Such systems exhibit many sources of delays, including failures, garbage collection, cache contention, speed of light, etc., that lead to high latencies. SPX seeks research in end-to-end abstractions that can prevent such delays. Another topic of interest is measures (possibly statistical) to quantify resource/data usage and to provide, based on the measures, performance warranties in the presence of architectural heterogeneity and diverse application-level resource demands. Providing accurate, end-to-end performance guarantees (e.g., for real time, memory, energy, and other resources) is expected to require cross-disciplinary research that spans all layers of the stack, from application-level software to hardware networking and storage devices.

B. Project Classes

SPX makes no distinction between classes of projects based on size or characteristics. Proposers are reminded that the budget limit is a maximum only. SPX encourages smaller, exploratory projects as well as larger ones.

III. AWARD INFORMATION

Anticipated Type of Award: Standard Grant

Estimated Number of Awards: 15 to 25

Approximately $10,000,000 will be made available in FY 2017 to support up to 15-25 awards with durations of 2-4 years and up to $1,000,000 per award.

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

Anticipated Funding Amount: $10,000,000

IV. ELIGIBILITY INFORMATION

Who May Submit Proposals:

Proposals may only be submitted by the following:

- Universities and Colleges - Universities and two- and four-year colleges (including community colleges) accredited in, and having a campus located in, the US acting on behalf of their faculty members. Such organizations also are referred to as academic institutions.

Who May Serve as PI:

Each proposal is required to have two or more PIs providing different and distinct expertise relevant to the program's focus areas.

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 investigator may participate as PI, co-PI, or senior personnel in no more than one proposal 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. **No exceptions will be made.**

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

Additional Eligibility Info:

For U.S. universities and two- and four-year colleges with overseas campuses, this solicitation restricts eligibility to research activities using the facilities, equipment, and other resources of the campus(es) located in the U.S. only. Note: this restriction is directed at institutional eligibility only; it is not intended to restrict international collaborations or research activities by subsequent awardees.

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.

Proposal titles: Proposal titles must indicate the SPX program followed by a colon, then the title of the project. For example, **SPX: Title.** For a collaborative proposal, all participating institutions should use the same title, which should also include the keyword "Collaborative Research:" for example, **SPX: Collaborative Research: Title.** For proposals from PIs in institutions that have RUI (Research in Undergraduate Institutions) eligibility, the title should include the keyword RUI, e.g**. SPX:RUI:Title** or **SPX:RUI:Collaborative Research:Title**.

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

Please provide between 2 and 6 sets of keywords at the end of the overview in the Project Summary. CISE personnel will use this information in implementing the merit review process. The keywords should describe the main scientific/engineering areas explored in the proposal. Keywords should be prefaced with "Keywords" followed by a colon, and keywords should be separated by semi-colons. Keywords should be of the type used to describe research in a journal submission. They should be included at the end of the overview in the project summary and might appear, for example, as **Keywords: energy-aware computing; formal logic; computer graphics; sensor networks; information visualization; privacy.**

Project Description: Length of Project Description - Describe the research and education activities to be undertaken in **up to 15 pages.** Describe curriculum development activities, if any, in a separate section (included in these page limits) titled "Curriculum Development Activities." All proposals should seek to break and re-define traditional or prevailing abstractions. In a clearly-identifiable section in the Project Description, a proposal (a) must explicitly state which abstractions are intended to be broken; (b) provide persuasive arguments in support of the new, re-defined abstractions; and (c) show how the new abstractions will be validated. **Proposals without this clearly-identifiable section will be returned without review.**

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

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

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

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

(2) Collaboration Plans (required):

Achieving the breakthroughs that the SPX program seeks will require a collaborative effort among researchers representing all areas from the application layer down to the micro-architecture. Each proposal is therefore required to have **two or more PIs providing different and distinct expertise** relevant to the program's focus. Proposals must include a collaboration plan as a separate supplementary document (limited to 2 pages). This document must describe the backgrounds and different expertise of the PIs, how these relate to the proposed work, and how the PIs plan to collaborate.

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

(3) Data Management Plan (required)

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

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

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

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

(4) Documentation of Collaborative Arrangements of Significance to the Proposal through Letters of Collaboration:

There are two types of collaboration, one involving individuals/organizations that are included in the budget, and the other involving individuals/organizations that are not included in the budget. Collaborations that are included in the budget should be described in the Project Description. Any substantial collaboration with individuals/organizations not included in the budget should be described in the Facilities, Equipment and Other Resources section of the proposal (see GPG Chapter II.C.2.i). In either case, whether or not the collaborator is included in the budget, **a letter of collaboration from each named participating organization *other than the submitting lead, non-lead, and/or subawardee institutions* must be provided at the time of submission of the proposal. Such letters must explicitly state the nature of the collaboration, appear on the organization's letterhead and be signed by the appropriate organizational representative. These letters must not otherwise deviate from the restrictions and requirements set forth in the GPG (NSF 16-1), Chapter II.C.2.j.**

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

(5) Other Specialized Information

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

No other supplementary documents, except as permitted by the NSF Grant Proposal Guide, are allowed.

Single Copy Documents:

Collaborators and Other Affiliations Information:

For this solicitation, the *Collaborators & Other Affiliations* information specified in the *GPG* should be submitted using the spreadsheet template found at http://www.nsf.gov/cise/collab/. For each proposal, a completed spreadsheet for each PI, co-PI, or senior personnel must be uploaded directly into Fastlane in .xls or .xlsx format as a “Collaborator and Other Affiliations” Single Copy Document. NSF staff use this information in the merit review process to help manage reviewer selection; the spreadsheet will ensure the Collaborator and Other Affiliations information has a common, searchable format.

Note the distinction to (1) above for Supplementary Documents: the listing of all project participants is collected by the project lead and entered as a Supplementary Document, which is then automatically included with all proposals in a project. The Collaborators and Other Affiliations are entered for each participant within each proposal and, as Single Copy Documents, are available only to NSF staff. Collaborators and Other Affiliations due to participants listed on (1) that are not PIs, co-PIs, or senior personnel can be uploaded under Additional Single Copy Documents using Transfer File.

NOTE: The list of collaborators includes all current and past projects (within above timelines) for all participants in the proposal. It is not a list of the collaborators for the given proposal; this should be provided pursuant to item (1) of Supplementary Documents above.

B. Budgetary Information

Cost Sharing:

Inclusion of voluntary committed cost sharing is prohibited.

Other Budgetary Limitations:

Proposal budgets must not exceed $1,000,000.

Budget Preparation Instructions:

PI meetings will be held every two years at locations in the continental United States. The proposal budget should include funds for travel for two PIs to each of these meetings.

C. Due Dates

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

  January 10, 2017

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.

Additional Solicitation Specific Review Criteria

All proposals should seek to break and re-define traditional or prevailing abstractions. Therefore, reviewers will be asked to specifically comment in their reviews on whether the proposal: a) explicitly states which abstractions are intended to be broken; b) provides persuasive arguments in support of the new, re-defined abstractions; and c) shows how the new abstractions will be validated.

B. Review and Selection Process

Proposals submitted in response to this program solicitation will be reviewed by Ad hoc Review and/or Panel Review.

Reviewers will be asked to evaluate proposals using two National Science Board approved merit review criteria and, if applicable, additional program specific criteria. A summary rating and accompanying narrative will generally be completed and submitted by each reviewer and/or panel. The Program Officer assigned to manage the proposal's review will consider the advice of reviewers and will formulate a recommendation.

After scientific, technical and programmatic review and consideration of appropriate factors, the NSF Program Officer recommends to the cognizant Division Director whether the proposal should be declined or recommended for award. NSF strives to be able to tell applicants whether their proposals have been declined or recommended for funding within six months. Large or particularly complex proposals or proposals from new awardees may require additional review and processing time. The time interval begins on the deadline or target date, or receipt date, whichever is later. The interval ends when the Division Director acts upon the Program Officer's recommendation.

After programmatic approval has been obtained, the proposals recommended for funding will be forwarded to the Division of Grants and Agreements for review of business, financial, and policy implications. After an administrative review has occurred, Grants and Agreements Officers perform the processing and issuance of a grant or other agreement. Proposers are cautioned that only a Grants and Agreements Officer may make commitments, obligations or awards on behalf of NSF or authorize the expenditure of funds. No commitment on the part of NSF should be inferred from technical or budgetary discussions with a NSF Program Officer. A Principal Investigator or organization that makes financial or personnel commitments in the absence of a grant or cooperative agreement signed by the NSF Grants and Agreements Officer does so at their own risk.

Once an award or declination decision has been made, Principal Investigators are provided feedback about their proposals. In all cases, reviews are treated as confidential documents. Verbatim copies of reviews, excluding the names of the reviewers or any reviewer-identifying information, are sent to the Principal Investigator/Project Director by the Program Officer. In addition, the proposer will receive an explanation of the decision to award or decline funding.

VII. AWARD ADMINISTRATION INFORMATION

A. Notification of the Award

Notification of the award is made to *the submitting organization* by a Grants Officer in the Division of Grants and Agreements. Organizations whose proposals are declined will be advised as promptly as possible by the cognizant NSF Program administering the program. Verbatim copies of reviews, not including the identity of the reviewer, will be provided automatically to the Principal Investigator. (See Section VI.B. for additional information on the review process).

B. Award Conditions

An NSF award consists of: (1) the award notice, which includes any special provisions applicable to the award and any numbered amendments thereto; (2) the budget, which indicates the amounts, by categories of expense, on which NSF has based its support (or otherwise communicates any specific approvals or disapprovals of proposed expenditures); (3) the proposal referenced in the award notice; (4) the applicable award conditions, such as Grant General Conditions (GC-1)*; or Research Terms and Conditions* and (5) any announcement or other NSF issuance that may be incorporated by reference in the award notice. Cooperative agreements also are administered in accordance with NSF Cooperative Agreement Financial and Administrative Terms and Conditions (CA-FATC) and the applicable Programmatic Terms and Conditions. NSF awards are electronically signed by an NSF Grants and Agreements Officer and transmitted electronically to the organization via e-mail.

*These documents may be accessed electronically on NSF's Website at 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:

- Anindya Banerjee, Program Director, CISE/CCF, telephone: (703) 292-7885, email: abanerje@nsf.gov
- Tracy Kimbrel, Program Director, CISE/CCF, telephone: (703) 292-8910, email: tkimbrel@nsf.gov
- Tao Li, Program Director, CISE/CCF, telephone: (703) 292-8238, email: taoli@nsf.gov
- Mimi McClure, Program Director, CISE/CNS, telephone: (703) 292-5197, email: mmcclure@nsf.gov
- Yan Solihin, Program Director, CISE/CNS, telephone: (703) 292-7939, email: ysolihin@nsf.gov
- Rajiv Ramnath, Program Director, CISE/ACI, telephone: (703) 292-4776, email: rramnath@nsf.gov
- Aidong Zhang, Program Director, CISE/IIS, telephone: (703) 292-5311, email: azhang@nsf.gov

For questions related to the use of FastLane, contact:

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

For questions relating to Grants.gov contact:

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

IX. OTHER INFORMATION

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

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

ABOUT THE NATIONAL SCIENCE FOUNDATION

The National Science Foundation (NSF) is an independent Federal agency created by the National Science Foundation Act of 1950, as amended (42 USC 1861-75). The Act states the purpose of the NSF is "to promote the progress of science; [and] to advance the national health, prosperity, and welfare by supporting research and education in all fields of science and engineering."

NSF funds research and education in most fields of science and engineering. It does this through grants and cooperative agreements to more than 2,000 colleges, universities, K-12 school systems, businesses, informal science organizations and other research organizations throughout the US. The Foundation accounts for about one-fourth of Federal support to academic institutions for basic research.

NSF receives approximately 55,000 proposals each year for research, education and training projects, of which approximately 11,000 are funded. In addition, the Foundation receives several thousand applications for graduate and postdoctoral fellowships. The agency operates no laboratories itself but does support National Research Centers, user facilities, certain oceanographic vessels and Arctic and Antarctic research stations. The Foundation also supports cooperative research between universities and industry, US participation in international scientific and engineering efforts, and educational activities at every academic level.

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
Arlington, VA 22230