Software Infrastructure for Sustained Innovation - S2I2 (SI2-S2I2)

PROGRAM SOLICITATION
NSF 15-553

REPLACES DOCUMENT(S):
NSF 13-511

National Science Foundation

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

Directorate for Biological Sciences
- Division of Biological Infrastructure

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- Division of Atmospheric and Geospace Sciences
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- Division of Ocean Sciences
- Division of Polar Programs

Directorate for Mathematical & Physical Sciences
- Division of Physics
- Division of Astronomical Sciences
- Division of Mathematical Sciences
- Division of Materials Research
- Division of Chemistry

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

June 03, 2015

Implementation Proposals

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

Proposals Accepted Anytime

Conceptualization Proposals

IMPORTANT INFORMATION AND REVISION NOTES

This revision primarily adds details about Implementation Awards. This solicitation describes the S^2I^2 component of the SI^2 program. Implementation awards in area of topics **1) Chemical and Materials Research** and **2) Science Gateways** may be proposed in response to this solicitation. Future versions of this solicitation focused on additional areas will be published in response to S^2I^2 Conceptualization awards and other community activities. The overarching description, vision, and goals of the S^2I^2 element of the SI^2 program and the high-level description of S^2I^2 Implementation awards is intended to remain unchanged over these solicitations.

This solicitation also offers an opportunity to propose S^2I^2 Conceptualizations.

Important Information

Any proposal submitted in response to this solicitation should be submitted in accordance with the revised NSF Proposal & Award Policies & Procedures Guide (PAPPG) (NSF 15-1), which is effective for proposals submitted, or due, on or after December 26, 2014. The PAPPG is consistent with, and, implements the new Uniform Administrative Requirements, Cost Principles, and Audit Requirements for Federal Awards (Uniform Guidance) (2 CFR § 200).

SUMMARY OF PROGRAM REQUIREMENTS

General Information

Program Title:

Software Infrastructure for Sustained Innovation - S2I2 (SI2-S2I2)

Synopsis of Program:

Software Infrastructure for Sustained Innovation (SI^2) is a long-term investment focused on realizing a portion of the Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21, http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=504730) vision and catalyzing new thinking, paradigms and practices in science and engineering. CIF21 envisions a linked cyberinfrastructure architecture that integrates large-scale computing, high-speed networks, massive data archives, instruments and major facilities, observatories, experiments, and embedded sensors and actuators, across the nation and the world, and that enables research at unprecedented scales, complexity, resolution, and accuracy by integrating computation, data, and experiments in novel ways.

Software is a primary modality through which CIF21 innovation and discovery will be realized. It permeates all aspects and layers of cyberinfrastructure (from application codes and frameworks, programming systems, libraries and system software, to middleware, operating systems, networking and the low-level drivers). The CIF21 software infrastructure must address the complexity of this cyberinfrastructure, accommodating: disruptive hardware trends; ever-increasing data volumes; data integrity, privacy, and confidentiality; security; complex application structures and behaviors; and emerging concerns such as fault-tolerance and energy efficiency. The programs must focus on building robust, reliable and sustainable software that will support and advance sustained scientific innovation and discovery.

The Division of Advanced Cyberinfrastructure in the Computer & Information Science & Engineering Directorate (CISE/ACI) is partnering with Directorates and Offices across the NSF to support SI^2, a long-term comprehensive program focused on realizing a sustained software infrastructure that is an integral part of CIF21. The goal of this program is to catalyze and nurture the interdisciplinary processes required to support the entire software lifecycle, resulting in sustainable community software elements and reusable components at all levels of the software stack. The program addresses software in all aspects of cyberinfrastructure, from embedded sensor systems and instruments, to desktops and high-end data and computing systems, to major instruments and facilities.

The goal of the overall SI^2 program is to create a software ecosystem that scales from individual or small groups of software innovators to large hubs of software excellence. It is envisioned that the SI^2 program will collectively support vibrant partnerships between academia, government laboratories and industry, including international entities, for the development and stewardship of a sustainable software infrastructure that can enhance productivity and accelerate innovation in science and engineering.

The SI^2 program includes three classes of awards:

1. **Scientific Software Elements (SSE):** SSE awards target small groups that will create and deploy robust software elements for which there is a demonstrated need that will advance one or more significant areas of science and engineering.

2. **Scientific Software Integration (SSI):** SSI awards target larger, interdisciplinary teams organized around the development and application of common software infrastructure aimed at solving common research problems faced by NSF researchers in one or more areas of science and engineering. SSI awards will result in a sustainable community software framework serving a diverse community or communities.

3. **Scientific Software Innovation Institutes (S^2I^2):** S^2I^2s are an integral part of the SI^2 software ecosystems and focus on the establishment of long-term hubs of excellence in software infrastructure and technologies, which will serve a research community of substantial size and disciplinary breadth. The outcomes of S^2I^2 go beyond the software itself, including the software development infrastructure and process, successfully responding to science challenges, and enabling transformative new science. These institutes will provide expertise, processes and architectures, resources and implementation mechanisms to transform computational science and engineering innovations and community software into robust and sustained software infrastructure for enabling science and engineering, which in turn will transform research practices and productivity. S^2I^2 proposals will bring together multidisciplinary teams of domain scientists and engineers, computer scientists and software engineers, technologists and educators.

This solicitation is focused on the Scientific Software Innovation Institutes (S^2I^2) class of awards. S^2I^2 includes two subclasses of awards: *Conceptualization Awards*, which are planning awards aimed at organizing an interdisciplinary community and understanding their software requirements and challenges, and *Implementation Awards,* which will be made to implement community activities that support software infrastructure, for example, such as those developed by the conceptualization awards.

Please refer to (i) A Vision and Strategy for Software for Science, Engineering, and Education (NSF 12-113) and (ii) Implementation of NSF Software Vision (http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=504817) for further information about NSF's vision for software as part of cyberinfrastructure and the programs that support this vision.

Conceptualization Proposals:

Successful conceptualization proposals must reflect the quality, commitment, and planning that will be needed to lead to full Implementation awards.

Specific NSF unit interests follow, though these are not meant to limit potential proposals:

- The CISE Division of Advanced Cyberinfrastructure is particularly interested in proposals that address the set of broad issues related to general SI^2 software, including sustainability, software lifecycle/ecosystem, governance, verification & validation, reproducibility, etc.
- The Biological Sciences Directorate is particularly interested in proposals that focus on high priority

research problems and that will significantly leverage existing investments in ways that transform the infrastructure in support of BIO and BIO-related research. For further information about BIO's interests in S^2I^2 see the Dear Colleague Letter of November 22, 2011 (NSF-12-019).
- The Engineering Directorate is not participating in the conceptualization portion of this solicitation.
- The MPS/Astronomy Division will consider supporting proposals that would have a clearly demonstrated impact on a significant portion of the astronomy research community.
- The MPS/Materials Research Division is particularly interested in proposals that advance priorities in the Materials Genome Initiative.
- The MPS/Division of Mathematical Sciences is particularly interested in proposals that include the creation, development, and application of new mathematical and statistical theories and tools.
- The MPS/Physics Division will consider proposals that will significantly advance fundamental research in Physics.

The interests of NSF units participating in this solicitation but not listed above (EHR, GEO, MPS/CHE, etc.) are described on their individual web pages.

Please note that successful conceptualization proposals will demonstrate clear and compelling science-driven goals that are responsive to research priorities identified across and within participating units. It is strongly recommended that prospective PIs contact program officers from the list of Cognizant Program Officers to ascertain that the scientific focus of the proposed work is appropriate for this solicitation.

Conceptualization proposals submitted to NSF in response to this solicitation must have a clear relevance to the overall SI^2 program and should be responsive to this solicitation and its review criteria. Proposals that are not relevant or not responsive to the solicitation will not be considered for funding and will be returned without review.

Conceptualization proposals must also be in areas not covered by current conceptualization awards. For a list of awards, see Implementation of NSF Software Vision (http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=504817). Participants who are interested in areas already covered should contact the relevant current S^2I^2 team(s) to participate in those ongoing conceptualization activities.

Implementation Proposals:

Implementation proposals may only be submitted in the specific topic(s) listed in this solicitation, which define particular areas in which NSF sees a need for an institute as evidenced by prior community activity, for example, an institute conceptualization award, a Research Coordination Network (RCN) award, etc., and has reserved budget resources from the directorates and divisions that would be impacted by such an institute.

Future versions of this solicitation will permit response in different topics, in response to community activities, such as S^2I^2 Conceptualization awards.

The specific institute implementation topics for this solicitation are:

1. Chemical and Materials Research Software Institute (CMRSI)

A CMRSI will be a focal point to facilitate the development of a sustainable software ecosystem to catalyze the application of computation and associated data-centric methods across chemical and materials research. A software ecosystem containing reliable, interoperable, verified, and accessible software tools enables scientists and engineers to innovatively use computation and data to engage challenging and transformational problems of chemical and materials research, thus better addressing societal priorities and contributing toward the development of a quantitative and predictive understanding of materials and chemistry. Relevant problems driving algorithm, method, and software development include but are not limited to: the computational design of chemicals and materials for specific functions starting from atoms, molecules, or other fundamental building blocks; the prediction of new synthesis pathways; advancing understanding of how catalysts work; advancing fundamental understanding of systems far from equilibrium with application to biological systems and the synthesis of soft materials; enabling meaningful simulation of polymeric and other materials across scales of length and time leading to insights for synthesis and performance; advancing understanding of quantum dynamics of complex chemical and condensed phase systems; and understanding macroscopic materials or chemical properties from their atomic or molecular origins, such as controlling self-assembly, microstructure evolution, and microscale transport processes. Activities in support of the Materials Genome Initiative are welcome.

2. Science Gateways Software Institute (SGSI)

An SGSI will be a focal point to facilitate the development of a sustainable software ecosystem for science gateways. Science Gateways (also known as portals and hubs) are themselves synergistic focal points where scientists form growing communities; where digital resources, expensive equipment, and collaboration resources are available to those who would otherwise not have access to them; and where the public can participate in the scientific process, spanning science and engineering research and education. Gateways assemble and integrate some of the most complex components of today's cyberinfrastructure (CI), making them accessible to a wider spectrum of users through easy-to-use interfaces. They provide researchers with unified human and programmable access to facilities: computing resources (e.g., supercomputers, clouds), instruments (e.g., telescopes, sensor networks), data (e.g., data collections, collaborative spaces), software (e.g., simulation, modeling, and analysis capabilities, workflow systems), and more, thus increasing the value of these facilities. They make the interdisciplinary collaborations needed to solve the most complex problems more feasible. They support CI abstractions that allow scalable, dynamic use of diverse CI without demanding detailed and complex technical understanding of CI components, and provide scalable solutions for solving classes of problems, eliminating the need for thousands of individual infrastructure installations.

Proposals that are not relevant or not responsive to the solicitation will not be considered for funding and will be returned without review.

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.

- Daniel S. Katz, Program Director, CISE/ACI, telephone: (703) 292-2254, email: SI2Queries@nsf.gov

- Rajiv Ramnath, Program Director, CISE/ACI, telephone: (703) 292-4776, email: SI2Queries@nsf.gov
- John C. Cherniavsky, Senior Advisor, EHR, telephone: (703) 292-5136, email: SI2Queries@nsf.gov
- Almadena Y. Chtchelkanova, Program Director, CISE/CCF, telephone: (703) 292-8910, email: SI2Queries@nsf.gov
- Evelyn Goldfield, Program Director, MPS/CHE, telephone: (703) 292-2173, email: SI2Queries@nsf.gov
- Sol Greenspan, Program Director, CISE/CCF, telephone: (703) 292-8910, email: SI2Queries@nsf.gov
- Daryl W. Hess, Program Director, MPS/DMR, telephone: (703) 292-4942, email: SI2Queries@nsf.gov
- Peter H. McCartney, Program Director, BIO/DBI, telephone: (703) 292-8470, email: SI2Queries@nsf.gov
- Bogdan Mihaila, Program Director, MPS/PHY, telephone: (703) 292-8235, email: SI2Queries@nsf.gov
- Andrew D. Pollington, Program Director, MPS/DMS, telephone: (703) 292-4878, email: SI2Queries@nsf.gov
- Barbara Ransom, Program Director, GEO/OCE, telephone: (703) 292-7792, email: SI2Queries@nsf.gov
- Nigel A. Sharp, Program Director, MPS/AST, telephone: (703) 292-4905, email: SI2Queries@nsf.gov
- Mary Toney, Program Director, ENG/CMMI, telephone: (703) 292-7008, email: SI2Queries@nsf.gov
- Eva Zanzerkia, Program Director, GEO/EAR, telephone: (703) 292-8556, email: SI2Queries@nsf.gov

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

- 47.041 --- Engineering
- 47.049 --- Mathematical and Physical Sciences
- 47.050 --- Geosciences
- 47.070 --- Computer and Information Science and Engineering
- 47.074 --- Biological Sciences
- 47.076 --- Education and Human Resources

Award Information

Anticipated Type of Award: Standard Grant or Continuing Grant or Cooperative Agreement

Estimated Number of Awards: 3 to 8

Up to 5 Conceptualization awards, 1 SGSI award, and 2 CMRSI awards are anticipated.

Anticipated Funding Amount: $13,500,000

In FY15 up to $2,500,000 will be available for Conceptualization proposals.

In FY15 up to $11,000,000 will be available to fund the first year of five-year Implementation awards submitted in response to this solicitation.

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.
- Non-profit, non-academic organizations: Independent museums, observatories, research labs, professional societies and similar organizations in the U.S. associated with educational or research activities.
- For-profit organizations: U.S. commercial organizations, especially small businesses with strong capabilities in scientific or engineering research or education.
- Other Federal Agencies and Federally Funded Research and Development Centers (FFRDCs): Contact the appropriate program before preparing a proposal for submission.
- Proposals that capitalize upon productive intellectual partnerships involving investigators from academe, industry and/or other types of organizations, including international entities, are encouraged. While NSF will consider supporting SI^2 activities undertaken by SBIR-eligible organizations through subawards, other for-profit entities and international partners must support their participation in SI^2 projects from other funding sources. For those who plan to submit a proposal with international counterparts, please consult NSF's International Science and Engineering (ISE) Section.

Who May Serve as PI:

There are no restrictions or limits.

Limit on Number of Proposals per Organization: 3

Each organization may only submit one proposal of each class (Conceptualization, CMRSI implementation, SGSI Implementation). The limit on Conceptualization proposals per organization is for every 12 months.

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

An individual can participate as PI, co-PI, or Senior Personnel, or Consultant on **no more than one**

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

There is no limit on the number of Conceptualization proposals per PI, though there is a limit of one Conceptualization proposal per institution every 12 months

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

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

  June 03, 2015

  Implementation Proposals

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

  Proposals Accepted Anytime

  Conceptualization Proposals

Proposal Review Information Criteria

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

Award Administration Information

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

Reporting Requirements: Standard NSF reporting requirements apply.

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I. INTRODUCTION

Software Infrastructure for Sustained Innovation (SI^2) is a long-term investment focused on realizing a portion of the Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21) vision and catalyzing new thinking, paradigms and practices in science and engineering. CIF21 envisions a linked cyberinfrastructure architecture that integrates large-scale computing, high-speed networks, massive data archives, instruments and major facilities, observatories, experiments, and embedded sensors and actuators, across the nation and the world, and that enables research at unprecedented scales, complexity, resolution, and accuracy by integrating computation, data and experiments in novel ways.

Software is a primary modality through which CIF21 innovation and discovery will be realized. It permeates all aspects and layers of cyberinfrastructure (from application codes and frameworks, programming systems, libraries and system software, to middleware, operating systems, networking and the low-level drivers). The CIF21 software infrastructure must address the complexity of this cyberinfrastructure, accommodating: disruptive hardware trends; ever-increasing data volumes; data integrity, privacy, and confidentiality; security; complex application structures and behaviors; and emerging concerns such as fault-tolerance and energy efficiency. The programs must focus on building robust, reliable and sustainable software that will support and advance sustained scientific innovation and discovery.

The Division of Advanced Cyberinfrastructure in the Computer & Information Science & Engineering Directorate (CISE/ACI) is partnering with Directorates and Offices across the NSF to support SI^2, a long-term comprehensive program focused on realizing a sustained software infrastructure that is an integral part of CIF21. The goal of this program is to catalyze and nurture the interdisciplinary processes required to support the entire software lifecycle, resulting in sustainable community software elements and reusable components at all levels of the software stack. The program addresses software in all aspects of cyberinfrastructure, from embedded sensor systems and instruments, to desktops and high-end data and computing systems, to major instruments and facilities.

The goal of the overall SI^2 program is to create a software ecosystem that scales from individual or small groups of software innovators to large hubs of software excellence. It is envisioned that the SI^2 program will collectively support vibrant partnerships between academia, government laboratories and industry, including international entities, for the development and stewardship of a sustainable software infrastructure that can enhance productivity and accelerate innovation in science and engineering.

The SI^2 program includes three classes of awards:

1. **Scientific Software Elements (SSE):** SSE awards target small groups that will create and deploy robust software elements for which there is a demonstrated need that will advance one or more significant areas of science and engineering.
2. **Scientific Software Integration (SSI):** SSI awards target larger, interdisciplinary teams organized around the development and application of common software infrastructure aimed at solving common research problems faced by NSF researchers in one or more areas of science and engineering. SSI awards will result in a sustainable community software framework serving a diverse community or communities.
3. **Scientific Software Innovation Institutes (S^2I^2):** S^2I^2s are an integral part of the SI^2 software ecosystems and focus on the establishment of long-term hubs of excellence in software infrastructure and technologies, which will serve a research community of substantial size and disciplinary breadth. The outcomes of S^2I^2 go beyond the software itself, including the software development infrastructure and process, successfully responding to science challenges, and enabling transformative new science. These institutes will provide expertise, processes and architectures, resources and implementation mechanisms to transform computational science and engineering innovations and community software into robust and sustained software infrastructure for enabling science and engineering, which in turn will transform research practices and productivity. S^2I^2 proposals will bring together multidisciplinary teams of domain scientists and engineers, computer scientists and software engineers, technologists and educators.

This solicitation is focused on the Scientific Software Innovation Institutes (S^2I^2) class of awards. Two subclasses of awards are planned for the S^2I^2 part of this program: *Conceptualization Awards*, which are planning awards aimed at organizing an interdisciplinary community and understanding their software requirements and challenges, and *Implementation Awards,* which will be made to implement community activities that support software infrastructure, for example, such as those developed by the conceptualization awards.

Please refer to (i) A Vision and Strategy for Software for Science, Engineering, and Education (NSF 12-113) and (ii) Implementation of NSF Software Vision (http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=504817) for further information about NSF's vision for software as part of cyberinfrastructure and the programs that support this vision.

II. PROGRAM DESCRIPTION

Scientific Software Innovation Institutes (S^2I^2) will focus on the establishment of long-term hubs of excellence in software infrastructure and technologies, which will serve a research community of substantial size and disciplinary breadth. It is expected that outcomes of S^2I^2 go beyond the software itself and also include the infrastructure and process by which software is developed and

sustained in response to, and to successfully enable, transformative new science. These institutes will provide expertise, processes and architectures, resources, and implementation mechanism to transform computational science and engineering innovations and community software into robust and sustained software infrastructure for enabling science and engineering, which in turn will transform research practices and productivity. S^2I^2 proposals are expected to bring together interdisciplinary teams of scientists, engineers, and educators together with software engineers and technologists.

An S^2I^2 proposal must describe the vision and rationale for the proposed institute as a multi-faceted enterprise with credible connections to the community it serves. The proposal must make a compelling case for the institute's need and scope, and state its anticipated impact on the target communities. Furthermore, in addition to innovating in the domain (or domains) and the computational and computer science aspects of the software, the proposals must also focus on the required processes and services necessary to support the community. The institutes will provide necessary structures and mechanisms for support, outreach, and workforce development, with a proactive approach to diversity, and will stimulate interaction between all stakeholders through various means including the definition of joint research directions, community standards and models, and collaborative development activities. The institutes will also provide pathways for community involvement, enabling software elements developed within the community to be transitioned to conform to community software frameworks, standards and processes, and to be made accessible, usable and extendible by the community. Institutes are encouraged to leverage existing infrastructure investments. Where appropriate, involvement with industry and government laboratories, and partnering with international efforts are encouraged. Proposals should identify a clear set of near-, mid-, and long-term goals, and how the project will organize itself to accomplish those goals. Finally, proposals should also include a model for longer-term sustainability of the institute itself.

S^2I^2 awards are subdivided into Conceptualization and Implementation awards which are described below.

(a) Conceptualization Awards: S^2I^2 Conceptualization Awards are planning awards aimed at organizing an interdisciplinary community and understanding their software requirements and challenges. Example activities that may be undertaken as part of this award include focused workshops, special sessions at professional meetings, sandpits, focus groups, etc. These awards will typically be 1 year in duration. The product of a conceptualization award will be a strategic plan for enabling science and education through a sustained software infrastructure that will be freely available to the community, and will address the following elements:

- the science community and the specific grand challenge research questions that the S^2I^2 will support;
- specific software elements and frameworks that are relevant to the community, the sustainability challenges that need to be addressed, and why addressing these challenges will be transformative;
- appropriate software architectures and lifecycle processes, development, testing and deployment methodologies, validation and verification processes, end usability and interface considerations, and required infrastructure and technologies;
- the required organizational, personnel and management structures and operational processes;
- the requirements and necessary mechanisms for human resource development, including integration of education and training, mentoring of students, postdoctoral fellows as well as software professionals, and proactively addressing diversity and broadening participation;
- potential approaches for long-term sustainability of the software institute as well as the software; and
- potential risks including risks associated with establishment and execution, necessary infrastructure and associated technologies, community engagement, and long-term sustainability.

The strategic plan resulting from the conceptualization phase is expected to serve as the conceptual design upon which a subsequent S^2I^2 Implementation proposal could be based.

(b) S^2I^2 Implementation Awards: The S^2I^2 Implementation Awards will be made to implement community strategic plans, such as those outlined in conceptualization phase described above. It is expected that proposals for Implementation Awards will be considered in response to specific areas that are explicitly identified by NSF. The size of these awards as well as the structure of the institute will be based, in part, on the targeted community and its needs. Awards are expected to be cooperative agreements between NSF and the awardee(s), and funds will be released annually subject to agreed-to milestones, annual project reviews (starting 18 months after the project begins), and based on approval by NSF and the availability of funds. New S^2I^2 Implementation awards will be funded for 5 years and will consist of **design** and **execution** phases, described below.

Implementation topics in this solicitation are:

i. Chemical and Materials Research Software Institute (CMRSI)

A CMRSI will be a focal point to facilitate the development of a sustainable software ecosystem to catalyze the application of computation and associated data-centric methods across chemical and materials research. A software ecosystem containing reliable, interoperable, verified, and accessible software tools enables scientists and engineers to innovatively use computation and data to engage challenging and transformational problems of chemical and materials research, thus better addressing societal priorities and contributing toward the development of a quantitative and predictive understanding of materials and chemistry. Relevant problems driving algorithm, method, and software development include but are not limited to: the computational design of chemicals and materials for specific functions starting from atoms, molecules, or other fundamental building blocks; the prediction of new synthesis pathways; advancing understanding of how catalysts work; advancing fundamental understanding of systems far from equilibrium with application to biological systems and the synthesis of soft materials; enabling meaningful simulation of polymeric and other materials across scales of length and time leading to insights for synthesis and performance; advancing understanding of quantum dynamics of complex chemical and condensed phase systems; and understanding macroscopic materials or chemical properties from their atomic or molecular origins, such as controlling self-assembly, microstructure evolution, and microscale transport processes. Activities in support of the Materials Genome Initiative are welcome.

CMRSI activities might include: developing and maintaining algorithms, computational methods, and software tools beyond the scope of SSE, SSI, and other such efforts; enabling the adoption of community standards; promoting methods and strategies to advance the scientific and engineering frontiers through enabling the attack of problems of greater complexity or problems requiring higher resolution, larger simulation size, or additional or more accurate theory; promoting mechanisms and strategies to make codes interoperable to simplify the solution of complex problems; and making the software ecosystem transparent from the user perspective to changes in hardware while extracting high performance and eliminating duplication of effort. To achieve its goals, a CMRSI will likely involve investigators from different disciplines, leverage existing efforts, develop international collaborations and partnerships, and develop collaborative networks of researchers around the world.

A successful CMRSI will provide leadership to: 1) advance computational and relevant data-centric approaches in chemical and materials research and help define grand challenge problems and computational requirements for their solution; 2) educate investigators and the next generation of investigators to effectively use the software ecosystem to solve real research problems and integrate software into the way science and engineering are done; and 3) educate the next generation of researchers to enable them to create the software cyberinfrastructure required to both advance fundamental understanding in the chemical and materials sciences and enable researchers to address the grand challenge problems of the future.

ii. Science Gateways Software Institute (SGSI)

An SGSI will be a focal point to facilitate the development of a sustainable software ecosystem for science gateways. Science Gateways (also known as portals and hubs) are themselves synergistic focal points where scientists form growing communities; where digital resources, expensive equipment, and collaboration resources are available to those who would otherwise not have access to them; and where the public can participate in the scientific process, spanning science and engineering research and education. Gateways assemble and integrate some of the most complex components of today's cyberinfrastructure (CI), making them accessible to a wider spectrum of users through easy-to-use interfaces. They provide researchers with unified human and programmable access to facilities: computing resources (e.g., supercomputers, clouds), instruments (e.g., telescopes, sensor networks), data (e.g., data collections, collaborative spaces), software (e.g., simulation, modeling, and analysis capabilities, workflow systems), and more, thus increasing the value of these facilities. They make the interdisciplinary collaborations needed to solve the most complex problems more feasible. They support CI abstractions that allow scalable, dynamic use of diverse CI without demanding detailed and complex technical understanding of CI components, and provide scalable solutions for solving classes of problems, eliminating the need for thousands of individual infrastructure installations.

SGSI activities might include: developing and maintaining computational- and data-oriented software and tools beyond the scope of SSE, SSI, and other such efforts; enabling the adoption of community standards; promoting methods and strategies to advance the research frontiers; promoting mechanisms and strategies to make codes interoperable to simplify the solution of complex problems; making the software ecosystem transparent from the science gateway developer perspective to changes in cyberinfrastructure systems; and educating researchers and developers. To achieve its goals, an SGSI will likely involve researchers and developers from different disciplines, leverage existing efforts, develop international collaborations and partnerships, and develop collaborative and integrated research, development, and education networks around the world.

A successful SGSI will provide leadership to: 1) bring science gateway developers together with each other and with the developers and operators of existing and potential cyberinfrastructure elements that science gateways integrate and enable the use of, in order to promote the efficient, effective, and sustainable development of scientific web and mobile interfaces to a dynamic set of complex resources in support of research and education across all areas of science and engineering; 2) educate developers and the next generation of investigators to effectively use the gateway software ecosystem to solve real research problems; and 3) educate the next generation of researchers to enable them to create the software cyberinfrastructure required to both advance fundamental understanding of science gateways and enable researchers to address the grand challenge problems of the future.

S^2I^2 *Design Phase:* The goal of the S^2I^2 design phase is to support required institute design and ramp-up activities and to demonstrate readiness for the execution phase. This phase is expected to last up to 2 years. The S^2I^2 design phase will focus on concrete design and implementation activities necessary for the execution of the institute, and will result in a Project Execution Plan to be delivered 18 months after the project begins, that provides the following:

- an explicit description of requirements for structure, processes, infrastructure of the institute derived from the strategic science and education goals;
- the mechanisms established for community integration, and specifically, policies and mechanisms for the "docking" of relevant community software efforts including those funded by SSE and SSI awards;
- a management plan that identifies roles, responsibilities, deliverables, milestones, with appropriate articulation of these elements with the project budget;
- the overall staffing requirements, current state of staffing, and appropriate recruitment and retention strategies moving ahead;
- detailed budget requirements and basis for cost estimates;
- experiences with the specific software elements and frameworks identified, as well as the software architecture and development methodologies and lifecycle processes;
- approaches for long-term sustainability of the software institute;
- the established linkages within and across research communities, including but not limited to, complementary components of community cyberinfrastructure (i.e., software tools, databases, instruments, etc.); concomitant cyberinfrastructure ecosystems, components of which could further the goals of S^2I^2; industry and international links that enhance the software elements or outreach;
- the specific metrics, governance structures, and advisory and oversight mechanisms designed to evaluate whether and how the institute is meeting its stated goals; as well as the required mechanisms for outreach; and
- the identification of the principal risks the institute might encounter during implementation, operations and achievement of its goals, and how each of those risks will be mitigated through contingency plans.

The Project Execution Plan will be reviewed 21 months after the project begins, to assess readiness of the project to move to the execution phase. Review criteria will include:

- Has the institute enabled new science and broader impacts?
- Has the institute demonstrated success in addressing the issues it identified to motivate its formation?
- Has the institute responded to changes in the issues of concern from the community?
- Has the institute achieved a consensus among the software developers in the institute's topic area?
- Are the software products available in the institute's topic area integrated or interoperable, including but not limited to the products from the SSE and SSI teams working in this area?
- Has the institute achieved broad buy-in among the software user community in the institute's topic area?
- Has the institute created and begun to implement a sustainability plan that is realistic and likely to be successful?
- Has the institute succeeded in terms of its success metrics?

S^2I^2 *Execution Phase:* In the S^2I^2 execution phase, the institute is expected to be completely staffed and operational, and fulfilling the proposed mission. The institute will be reviewed every 12 months, starting 6 months after the Execution phase begins, based on the goals of the SI^2 programs as well as specific metrics outlined in the proposal. Depending on the outcome of the review 18 months prior to the end of the award, NSF may choose to implement a phase-down plan for the remaining duration of the award. Successful institutes will continue to receive the planned support through the remainder of the grant period, and may be renewed for an additional 5 years. If so, the review 18 months prior to the end of the renewed award will lead to either a final phase-down or an opportunity for a new implementation proposal.

Annual review criteria will include:

- Has the institute enabled new science and broader impacts?
- Has the institute demonstrated success in addressing the issues it identified to motivate its formation?
- Has the institute responded to changes in the issues of concern from the community?
- Has the institute achieved a consensus among the software developers in the institute's topic area?
- Are the software products available in the institute's topic area integrated or interoperable, including but not limited to the

products from the SSE and SSI teams working in this area?
- Has the institute achieved broad buy-in among the software user community in the institute's topic area?
- Is the institute working to make the broad range of connections that will permit it to be sustainable in the longer term?
- Has the institute succeeded in terms of its success metrics?

Industry and International Participation in SI^2: NSF encourages participation by industry and international collaborators in all classes of SI^2 awards where it clearly strengthens the proposed activity (e.g., involvement of specific and unique expertise or resources or addressing sustainability).

- International participants are encouraged to seek support from their funding organizations. NSF funds may not be used to support the expenses of international researchers at their home institution. However, NSF funds may be used for travel expenses for US scientists and students who are integral to the project, or for international collaborators to participate in activities in the US. For those who plan to submit a proposal with international counterparts, please consult NSF's Office of International Science and Engineering (http://www.nsf.gov/od/iia/ise/index.jsp).
- The SI^2 program recognizes that software is a fundamental infrastructure that cross-cuts academic, government, civic, and commercial organizations. The program encourages proposals to explore novel partnerships beyond academe wherever beneficial and permissible within the guidelines of the NSF GPG.
- Participation of industry helps translate advances in science and engineering into economic gains through the software ecosystem. The SI^2 program encourages proposals to include educational programs and models that develop and sustain an agile professional workforce able to use the software ecosystem creatively and competitively, and to sustain the evolving software ecosystem.

III. AWARD INFORMATION

The actual number of S^{2}I^2 Conceptualization awards may vary based on the quality of proposals, responsiveness to the solicitation, and availability of funds. Note that funded conceptualization awards may lead to full implementation awards in the future, but that the number of full implementation awards will be smaller than the number of conceptualization awards. Up to 5 S^{2}I^2 Conceptualization award (each up to $500,000) may be funded in FY15, totaling $2,500,000.

S^{2}I^2 Implementation awards will only be made based on proposals submitted in response to the topics listed in this solicitation. A CMRSI Implementation award may range from $1,000,000 to $4,000,000 per year, and may initially be planned for five years. An SGSI Implementation award may range from $1,000,000 to $3,000,000 per year, and may initially be planned for five years. One SGSI implementation award and up to two CMRSI implementation awards may be made. Total FY15 funding for S^{2}I^2 Implementation awards may be $11,000,000.

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.
- Non-profit, non-academic organizations: Independent museums, observatories, research labs, professional societies and similar organizations in the U.S. associated with educational or research activities.
- For-profit organizations: U.S. commercial organizations, especially small businesses with strong capabilities in scientific or engineering research or education.
- Other Federal Agencies and Federally Funded Research and Development Centers (FFRDCs): Contact the appropriate program before preparing a proposal for submission.
- Proposals that capitalize upon productive intellectual partnerships involving investigators from academe, industry and/or other types of organizations, including international entities, are encouraged. While NSF will consider supporting SI^2 activities undertaken by SBIR-eligible organizations through subawards, other for-profit entities and international partners must support their participation in SI^2 projects from other funding sources. For those who plan to submit a proposal with international counterparts, please consult NSF's International Science and Engineering (ISE) Section.

Who May Serve as PI:

There are no restrictions or limits.

Limit on Number of Proposals per Organization: 3

Each organization may only submit one proposal of each class (Conceptualization, CMRSI implementation, SGSI Implementation). The limit on Conceptualization proposals per organization is for every 12 months.

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

An individual can participate as PI, co-PI, or Senior Personnel, or Consultant on **no more than one Implementation proposal** submitted in response to this solicitation. **These eligibility constraints will be strictly enforced in order to treat everyone fairly and consistently.** In the event that an individual exceeds the one-proposal limit for this solicitation, the proposal received within the limit will be accepted based on earliest date and time of proposal submission (i.e., the first proposal received will be accepted and the remainder will be returned without review). **No exceptions will be made.**

There is no limit on the number of Conceptualization proposals per PI, though there is a limit of one Conceptualization proposal per institution every 12 months

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.

Note: Separately submitted collaborative proposals are not permitted for Implementation projects. Such projects must be submitted by a single institution, though other institutions may be involved through other means, such as subawards, partnerships, etc.

The following supplements guidance in the GPG:

Cover Sheet: Provide a short informative title for the proposed S^2I^2 project. Conceptualization project titles should start with "S2I2: Cncp:" and Implementation proposal titles should start with "S2I2: Impl:" The system allows one PI and at most four Co-PIs to be designated for each proposal. If your project involves international partners, check the international activities box and list the countries involved. If needed, additional lead personnel should be designated as non co-PI, Senior Personnel on the Budget form.

Project Summary (1-page limit):

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.

The overview includes a description of the S^2I^2 project (including its transformative research and education goals, the innovative software infrastructure being proposed, and the community (communities) that will be impacted) that would result if the proposal were funded and a statement of objectives and methods to be employed. The statement on intellectual merit should describe the potential of the proposed activity to advance knowledge. The statement on broader impacts should describe the potential of the proposed activity to benefit society and contribute to the achievement of specific, desired societal outcomes. The Project Summary should be written in the third person, informative to other persons working in the same or related fields, and, insofar as possible, understandable to a scientifically or technically literate lay reader. It should not be an abstract of the proposal.

Proposals that do not contain the Project Summary, including an overview and separate statements on intellectual merit and broader impacts will not be accepted by FastLane or will be returned without review.

Project Description (15-page limit for S^2I^2 Conceptualization Proposals, 20-page limit for S^2I^2 Implementation Proposals)

For S^2I^2 Conceptualization Proposals, the Project Description should clearly describe:

- The rationale for the envisioned institute, its mission and goals, and its responsiveness to community needs and to programmatic areas of interest to the SI^2 program and associated DCLs.
- The scientific communities and software elements/frameworks targeted, and the specific software sustainability challenges that will be addressed.
- Approaches for reaching out to the relevant communities and engaging them in the conceptual design process.
- The anticipated impact to the scientific communities in terms of research, innovation and productivity.
- The overarching approach as well as specific steps that will be taken towards the conceptual design of the envisioned institute.
- A steering committee composed of leading members of the targeted community that could assume key roles in the leadership and/or management of the envisioned institute. A brief biography of the members of the steering committee and their role in the conceptualization process should be included.

The proposal should also clearly outline what qualifies the PIs to lead the conceptualization effort for the envisioned institute.

For S^2I^2 Implementation Proposals, the Project Description should clearly describe:

- The overall rationale for the envisioned institute, its mission, and its goals.
- A set of software issues and needs and software sustainability challenges faced by a particular, well-defined yet broad community (that is clearly identified in the proposal) that can best be addressed by an institute of the type proposed, a compelling case these are the most important issues faced by the community, and that these issues are truly important.
- A clear and compelling plan of activities that shows how the proposed institute will address these issues and needs by involving (and leveraging) the community, including its software developers, in a way that will benefit the entire community.
- If there are other NSF-funded activities that might appear to overlap the institute's activities, a discussion clarifying how the funding of each activity will be independent and non-overlapping.
- Metrics of how success will be measured, that include at least impact on the developer and user communities.
- Evidence that the people involved in planning and setting up the institute have the organizational, scientific, technical, and sociocultural skills to undertake such a task, and that they are trusted and respected by the community as a whole.
- Evidence of a high degree of community buy in that a) these are the urgent/critical needs and b) this institute is the way to address them.
- A plan for management of the institute, including 1) the specific roles of the PI, co-PIs, other senior personnel and paid consultants at all institutions involved, 2) how the project will be managed across institutions and disciplines, 3) identification of the specific coordination mechanisms that will enable cross-institution and/or cross-discipline scientific integration, and 4) pointers to the budget line items that support these management and coordination mechanisms.
- A steering committee composed of leading members of the targeted community that will assume key roles in the leadership and/or management of the institute. A brief biography of the members of the steering committee and their role in the conceptualization process should be included.
- A plan for how the institute activities will continue and/or the value of the institute's products will be preserved after the award, particularly if it does not receive additional funds from NSF.

The proposal should also clearly outline what qualifies the PIs to lead the envisioned institute.

Required Documents for both Conceptualization and Implementation Proposals

In addition to *Data Management Plan* and the *Postdoctoral Research Mentoring Plan (*if required), the following items are the only items permitted as supplementary documentation, single copy documents, or appendices. Unless otherwise instructed, documentation should be saved and uploaded as a single Portable Document Format (PDF) file.

1. Project Personnel (a text-searchable PDF document uploaded as a Single Copy Document). List all Senior Personnel in the project. For each person, provide the last name, first name, and institution/organization. In the main body of the proposal, a corresponding biographical sketch should be provided for all individuals included on this list, as instructed in Section II.C.2.f of the Grant Proposal Guide.

2. Letters of Collaboration (Optional): Include only official letters of collaboration with specific commitments of resources from participating institutions or organizations anticipated to receive subawards, or from organizations that will provide resources for the project. Scan your signed letters and upload them into the Supplementary Documents section of FastLane or Grants.gov, but do not send originals. Do not submit letters of support, which do not provide specific commitments of resources. For example, letters of endorsement and letters of a laudatory nature for the proposed project are not acceptable.

No other items or appendices are to be included. ***Full proposals containing items other than those required above or by the Grant Proposal Guide (GPG) will not be reviewed.***

B. Budgetary Information

Cost Sharing: Inclusion of voluntary committed cost sharing is prohibited.

Budget Preparation Instructions:

All awardees are expected to participate in an annual SI^2 PI meeting with travel costs supported by the award. These travel costs should be included in the FastLane budget.

C. Due Dates

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

  June 03, 2015

  Implementation Proposals

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

  Proposals Accepted Anytime

  Conceptualization Proposals

D. FastLane / Grants.gov Requirements

For Proposals Submitted Via FastLane:

To prepare and submit a proposal via FastLane, see detailed technical instructions available at: https://www.fastlane.nsf.gov/a1/newstan.htm. For FastLane user support, call the FastLane Help Desk at 1-800-673-6188 or e-mail fastlane@nsf.gov. The FastLane Help Desk answers general technical questions related to the use of the FastLane system. Specific questions related to this program solicitation should be referred to the NSF program staff contact(s) listed in Section VIII of this funding opportunity.

For Proposals Submitted Via Grants.gov:

Before using Grants.gov for the first time, each organization must register to create an institutional profile. Once registered, the applicant's organization can then apply for any federal grant on the Grants.gov website. Comprehensive information about using Grants.gov is available on the Grants.gov Applicant Resources webpage: http://www.grants.gov/web/grants/applicants.html. In addition, the NSF Grants.gov Application Guide (see link in Section V.A) provides instructions regarding the technical preparation of proposals via Grants.gov. For Grants.gov user support, contact the Grants.gov Contact Center at 1-800-518-4726 or by email: support@grants.gov. The Grants.gov Contact Center answers general technical questions related to the use of Grants.gov. Specific questions related to this program solicitation should be referred to the NSF program staff contact(s) listed in Section VIII of this solicitation.

Submitting the Proposal: Once all documents have been completed, the Authorized Organizational Representative (AOR) must submit the application to Grants.gov and verify the desired funding opportunity and agency to which the application is submitted. The AOR must then sign and submit the application to Grants.gov. The completed application will be transferred to the NSF FastLane system for further processing.

Proposers that submitted via FastLane are strongly encouraged to use FastLane to verify the status of their submission to NSF. For proposers that submitted via Grants.gov, until an application has been received and validated by NSF, the Authorized Organizational Representative may check the status of an application on Grants.gov. After proposers have received an e-mail notification from NSF, Research.gov should be used to check the status of an application.

VI. NSF PROPOSAL PROCESSING AND REVIEW PROCEDURES

Proposals received by NSF are assigned to the appropriate NSF program for acknowledgement and, if they meet NSF requirements, for review. All proposals are carefully reviewed by a scientist, engineer, or educator serving as an NSF Program Officer, and usually by three to ten other persons outside NSF either as *ad hoc* reviewers, panelists, or both, who are experts in the particular fields represented by the proposal. These reviewers are selected by Program Officers charged with oversight of the review process. Proposers are invited to suggest names of persons they believe are especially well qualified to review the proposal and/or persons they would prefer not review the proposal. These suggestions may serve as one source in the reviewer selection process at the Program Officer's discretion. Submission of such names, however, is optional. Care is taken to ensure that reviewers have no conflicts of interest with the proposal. In addition, Program Officers may obtain comments from site visits before recommending final action on proposals. Senior NSF staff further review recommendations for awards. A flowchart that depicts the entire NSF proposal and award process (and associated timeline) is included in the GPG as Exhibit III-1.

A comprehensive description of the Foundation's merit review process is available on the NSF website at: http://nsf.gov/bfa/dias/policy/merit_review/.

Proposers should also be aware of core strategies that are essential to the fulfillment of NSF's mission, as articulated in *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

S^2I^2 Conceptualization Awards

- The rationale for the envisioned institute, its mission and goals, and its responsiveness to community needs.
- The appropriateness and readiness of the scientific communities and software elements/frameworks targeted and the specific software sustainability challenges that will be addressed.
- The effectiveness of the approaches for reaching out to the relevant communities and engaging them in the conceptual design process.
- The anticipated impact to the scientific communities in terms of research, innovation, education and productivity.
- The appropriateness of the overarching approach as well as specific steps that will be taken towards the conceptual design of the envisioned institute.
- The qualifications and experience of the PIs.

S^2I^2 Implementation Awards

- The overall rationale for the envisioned institute, its mission and goals.
- The appropriateness of the set of software issues and needs and software sustainability challenges faced by a particular, well-defined yet broad community (that is clearly identified in the proposal) chosen to be addressed by an institute of the type proposed, and the evidence that these are the most important issues faced by the community and that these issues are truly important.
- The clarity and convincingness of the plan for how the proposed institute will address these issues and needs by involving (and leveraging) the community, including its software developers, in a way that will benefit the entire community.
- The suitability of the project management plan for a project of this scope and scale, and the evidence that the proposers will be able carry it out.
- The discussion of risks and risk mitigation.
- The metrics of how success will be measured, including at least impact on the developer and user communities.
- The evidence that the people involved in planning and setting up the institute have the organizational, scientific, technical, and sociocultural skills to undertake such a task, and that they are trusted and respected by the community as a whole.
- The demonstration of a high degree of community buy in that a) these are the urgent/critical needs and b) this institute is the way to address them.
- The steering committee, composed of leading members of the targeted community, that will assume key roles in the leadership and/or management of the institute.
- The plan for how the institute activities will continue and/or the value of the institute's products will be preserved after the award, particularly if it does not receive additional funds from NSF.

B. Review and Selection Process

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

Conceptualization proposals will be reviewed through either panel review and/or ad hoc review, depending on the number of proposals submitted at any one time and their overlaps in subject.

Implementation proposals will be reviewed through panel review and ad hoc review, potentially with a reverse site visit if necessary.

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 be completed and submitted by each reviewer. 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.

Special Award Conditions:

At least one PI from each SI^2 awarded projects is expected to participate in an annual SI^2 PI meeting, with travel costs supported by the award.

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 at least 90 days prior to the end of the current budget period. (Some programs or awards require submission of more frequent project reports). Within 90 days following expiration of a grant, the PI also is required to submit a final project report, and a project outcomes report for the general public.

Failure to provide the required annual or final project reports, or the project outcomes report, will delay NSF review and processing of any future funding increments as well as any pending proposals for all identified PIs and co-PIs on a given award. PIs should

examine the formats of the required reports in advance to assure availability of required data.

PIs are required to use NSF's electronic project-reporting system, available through Research.gov, for preparation and submission of annual and final project reports. Such reports provide information on accomplishments, project participants (individual and organizational), publications, and other specific products and impacts of the project. Submission of the report via Research.gov constitutes certification by the PI that the contents of the report are accurate and complete. The project outcomes report also must be prepared and submitted using Research.gov. This report serves as a brief summary, prepared specifically for the public, of the nature and outcomes of the project. This report will be posted on the NSF website exactly as it is submitted by the PI.

More comprehensive information on NSF Reporting Requirements and other important information on the administration of NSF awards is contained in the NSF *Award & Administration Guide* (AAG) Chapter II, available electronically on the NSF Website at http://www.nsf.gov/publications/pub_summ.jsp?ods_key=aag.

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:

- Daniel S. Katz, Program Director, CISE/ACI, telephone: (703) 292-2254, email: SI2Queries@nsf.gov
- Rajiv Ramnath, Program Director, CISE/ACI, telephone: (703) 292-4776, email: SI2Queries@nsf.gov
- John C. Cherniavsky, Senior Advisor, EHR, telephone: (703) 292-5136, email: SI2Queries@nsf.gov
- Almadena Y. Chtchelkanova, Program Director, CISE/CCF, telephone: (703) 292-8910, email: SI2Queries@nsf.gov
- Evelyn Goldfield, Program Director, MPS/CHE, telephone: (703) 292-2173, email: SI2Queries@nsf.gov
- Sol Greenspan, Program Director, CISE/CCF, telephone: (703) 292-8910, email: SI2Queries@nsf.gov
- Daryl W. Hess, Program Director, MPS/DMR, telephone: (703) 292-4942, email: SI2Queries@nsf.gov
- Peter H. McCartney, Program Director, BIO/DBI, telephone: (703) 292-8470, email: SI2Queries@nsf.gov
- Bogdan Mihaila, Program Director, MPS/PHY, telephone: (703) 292-8235, email: SI2Queries@nsf.gov
- Andrew D. Pollington, Program Director, MPS/DMS, telephone: (703) 292-4878, email: SI2Queries@nsf.gov
- Barbara Ransom, Program Director, GEO/OCE, telephone: (703) 292-7792, email: SI2Queries@nsf.gov
- Nigel A. Sharp, Program Director, MPS/AST, telephone: (703) 292-4905, email: SI2Queries@nsf.gov
- Mary Toney, Program Director, ENG/CMMI, telephone: (703) 292-7008, email: SI2Queries@nsf.gov
- Eva Zanzerkia, Program Director, GEO/EAR, telephone: (703) 292-8556, email: SI2Queries@nsf.gov

For questions related to the use of FastLane, contact:

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

For questions relating to Grants.gov contact:

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

IX. OTHER INFORMATION

The NSF website provides the most comprehensive source of information on NSF Directorates (including contact information), programs and funding opportunities. Use of this website by potential proposers is strongly encouraged. In addition, "NSF Update" is an information-delivery system designed to keep potential proposers and other interested parties apprised of new NSF funding opportunities and publications, important changes in proposal and award policies and procedures, and upcoming NSF Grants Conferences. Subscribers are informed through e-mail or the user's Web browser each time new publications are issued that match their identified interests. "NSF Update" also is available on NSF's website at https://public.govdelivery.com/accounts/USNSF/subscriber/new?topic_id=USNSF_179.

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

Related Programs:

See also:

- A Vision and Strategy for Software for Science, Engineering, and Education -- http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf12113
- Implementation of NSF Software Vision -- http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=504817

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

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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
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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:

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