Computing and Communication Foundations (CCF): Core Programs

PROGRAM SOLICITATION
NSF 15-573

REPLACES DOCUMENT(S):
NSF 14-598

National Science Foundation

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

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

September 10, 2015 - September 16, 2015

September 10 - September 16, Annually Thereafter

MEDIUM Projects

September 18, 2015 - September 24, 2015

September 18 - September 24, Annually Thereafter

LARGE Projects

November 04, 2015 - November 18, 2015

November 4 - November 18, Annually Thereafter

SMALL Projects

IMPORTANT INFORMATION AND REVISION NOTES

This is a revision of NSF 14-598, the solicitation for the CISE/CCF Core Programs. The revisions include: Revisions to the submission deadline windows and Revisions of the Proposal Preparation Instructions, including (a) a requirement for a section titled “Broader Impacts of the Proposed Work” within the Project Description section of a proposal, (b) clarification of what must be included as part of “Results from Prior NSF Support” within the Project Description section, and (c) clarification of what may be submitted as a Letter of Collaboration and/or Commitment in the Supplementary Documents section.

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:

Computing and Communication Foundations (CCF): Core Programs

Synopsis of Program:

CISE’s Division of Computing and Communication Foundations (CCF) supports research and education projects that develop new knowledge in three core programs:

- The Algorithmic Foundations (AF) program;
- The Communications and Information Foundations (CIF) program; and
- The Software and Hardware Foundations (SHF) program.

Proposers are invited to submit proposals in three project classes, which are defined as follows:

- Small Projects - up to $500,000 total budget with durations up to three years;
- Medium Projects - $500,001 to $1,200,000 total budget with durations up to four years; and
- Large Projects - $1,200,001 to $3,000,000 total budget with durations up to five years.

A more complete description of the three project classes can be found in section *II. Program Description* of this document.

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.

- John H. Cozzens, Point of Contact, Communications and Information Foundations (CIF), 1115, telephone: (703) 292-8910, email: jcozzens@nsf.gov
- Almadena Y. Chtchelkanova, Point of Contact, Software and Hardware Foundations (SHF), telephone: (703) 292-8910, email: achtchel@nsf.gov
- Tracy Kimbrel, Point of Contact, Algorithmic Foundations (AF), telephone: (703) 292-8910, email: tkimbrel@nsf.gov

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

- 47.070 --- Computer and Information Science and Engineering

Award Information

Anticipated Type of Award: Standard Grant or Continuing Grant

Estimated Number of Awards: 170 to 200

awards will be made each year.

Anticipated Funding Amount: $100,000,000

each year, dependent on the availability of funds.

Eligibility Information

Who May Submit Proposals:

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

Who May Serve as PI:

There are no restrictions or limits.

Limit on Number of Proposals per Organization:

There are no restrictions or limits.

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

In any contiguous September through November period, an individual may participate as PI, Co-PI or Senior Personnel in **no more than two Small, Medium, or Large** proposals submitted in response to the *coordinated solicitation* (where *coordinated solicitation* is defined to include the *Computing and Communication Foundations (CCF): Core Programs* solicitations, *Information and Intelligent Systems (IIS): Core Programs*, and the *Computer and Network Systems (CNS): Core Programs*). For example, between September 2015 and November 2015, an individual may participate as PI, co-PI or Senior Personnel in one proposal submitted to a core program in CCF and in a second proposal submitted to a core program in CNS, or an individual may participate as PI, co-PI or Senior Personnel in two proposals submitted to an IIS core program, etc.

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

The limit on the number of proposals per PI, co-PI or Senior Personnel applies only to the *coordinated 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:** Not Applicable

C. Due Dates

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

  September 10, 2015 - September 16, 2015

  September 10 - September 16, Annually Thereafter

  MEDIUM Projects

  September 18, 2015 - September 24, 2015

  September 18 - September 24, Annually Thereafter

  LARGE Projects

  November 04, 2015 - November 18, 2015

  November 4 - November 18, Annually Thereafter

  SMALL Projects

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.

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I. INTRODUCTION

The Division of Computing and Communication Foundations (CCF) supports transformative research and education projects that explore the foundations of computing and communication. The Division seeks advances in computing and communication theory, algorithm design and analysis, and the architecture and design of computers and software. CCF-supported projects also investigate revolutionary computing models and technologies based on emerging scientific ideas and integrate research and education activities to

prepare future generations of computer science and engineering workers.

II. PROGRAM DESCRIPTION

CCF supports three core programs as described below - Algorithmic Foundations (AF), Communications and Information Foundations (CIF), and Software and Hardware Foundations (SHF).

Algorithmic Foundations (AF)

The Algorithmic Foundations (AF) program supports potentially transformative research and education projects advancing design and analysis of algorithms and characterized by algorithmic thinking accompanied by rigorous analysis. Research on algorithms for problems that are central to computer science and engineering as well as new techniques for the rigorous analysis of algorithms are of interest. AF supports theoretical research that bounds the intrinsic difficulty of problems to determine the measures of complexity in formal models of computation, classical or new. The goal is to understand the fundamental limits of resource-bounded computation and to obtain efficient solutions within those limits. Specifically, the time and space complexity of finding exact and approximate solutions in deterministic and randomized models of computation is a central concern of the program. Research on resources other than time and space, such as communication and energy, is also encouraged. In addition to the traditional, sequential computing paradigm, AF supports research on the design and analysis of novel algorithms in parallel and distributed models, in particular, in heterogeneous multi-core and many-core machines; the computational models and algorithms that capture essential aspects of computing over massive data sets; game theory and social networks; and alternative forms of computation and information processing, including quantum computing and biological models of computation.

The program supports research in algorithms needed in all areas, both within and outside computer science. Algorithmic research with applications in databases, machine learning, data mining, networks, communications, operating systems, languages, compilers, and machine abstractions is supported. New techniques for the design and analysis of algorithms in areas such as cryptography, computational geometry, computational biology, game theory, social networks and numerical, symbolic, and algebraic computing are appropriate for this program. Relevance to application areas is important and collaborations with researchers in those areas are encouraged. However, research funded by this program must advance the study of algorithms.

Research on parallelism and scalability that promises to lead to a new era of parallel computing is now supported through a separate program, eXploiting Parallelism and Scalability (XPS; see *http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=504842).* XPS is particularly interested in “clean-slate” approaches that re-evaluate and possibly re-design the traditional hardware and software stack.

Research that incorporates significant activity in both theory and practice is now supported through a separate program, Algorithms in the Field (AitF): see *http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=505125*). AitF is particularly interested in developing and supporting collaboration between theory researchers and those in more applied areas.

More information on topics appropriate for the Algorithmic Foundations program is available at:

http://www.nsf.gov/cise/ccf/af_pgm12.jsp

Communications and Information Foundations (CIF)

The Communications and Information Foundations (CIF) program supports potentially transformative research that addresses the theoretical underpinnings and current and future enabling technologies for information acquisition, transmission, and processing in communications and information processing systems. As a result, CIF research and education projects strengthen the intellectual foundations of communications and information theory and signal processing in a variety of types of networks such as sensor networks, wireless and multimedia networks, biological networks, and networks of quantum devices. Research outcomes are expected to lead to more secure and reliable communications and advanced mathematical capabilities that are applicable throughout science and engineering.

The program supports basic research in wireless communications, information theory and coding. Included in the CIF program is the reliable transmission of information, in both analog and digital form, in the presence of a variety of channel impairments (noise, multipath, eavesdroppers, interference, etc.). A number of channel architectures are of interest, including multiple-input multiple-output (MIMO) channels, feedback channels, optical channels, quantum channels, and biological channels. CIF has a strong interest in the theoretical performance limits for various communication systems architectures and in the presence of various channel impairments. Also of interest are performance metrics and tradeoffs. An important example is the tradeoff between error probability and latency resulting from coding/decoding algorithms, diversity techniques, interference management, and other types of signal processing.

The CIF program also supports fundamental research in networking including network information theory, network coding, and cross-layer research at the lower layers. The CIF research program in networking focuses on the MAC layer and below and emphasizes research in which the physical-layer attributes play an important role in overall network design and performance such as the impact of physical-layer characteristics on higher network layers. CIF supports research at the intersection of communications and information theory, signal processing, and networking. Examples include sensor networks with applications to environmental monitoring, civil infrastructure monitoring, data communications system monitoring, and power grid monitoring. A further example is network tomography, which involves detecting and classifying spatially distributed anomalies within complex large-scale systems from multiple monitoring (sensor) sites.

In addition to the contemporary signal processing topics that have enabled the IT revolution, there is growing interest within the CIF program in new paradigms that enlarge the scope of signal and information processing from the domain of the linear to the realm of the nonlinear - from linear algebra to algebra, from Euclidean to curved spaces, from uniform to highly non-uniform time and space sampling, to signal processing on graphs. Research that will develop efficient power aware and hardware-friendly algorithms and research on signal/information processing algorithms for the new network science of distributed, decentralized, and cooperative algorithms that avoid global communications is encouraged. The exploration of new approaches to manage massive datasets, such as

compressive sampling/sensing, also promises advances in the field.

The CIF program is particularly interested in the application of signal/information processing in complex systems. Some examples of exciting applications are monitoring the Nation's critical infrastructures, signal processing in biological systems, and biomedical signal and image processing. These and other emerging application domains pose new constraints and challenges, leading to the reexamination of old questions and assumptions.

More information on topics appropriate for this program is available at:

http://www.nsf.gov/cise/ccf/cif_pgm12.jsp

Software and Hardware Foundations (SHF)

All fields of science and engineering - and society at large - depend on fundamental advances in scientific foundations and engineering methods for computer hardware and software. The SHF program supports research and education projects on the design, verification, operation, utilization, and evaluation of computer hardware and software through novel approaches, robust theories, high-leverage tools, and lasting principles. Such advances may offer formal methods, languages, logics, novel software and/or hardware artifacts, or algorithms to enable new or enhanced functionality, verification, usability, and scale. Proposals should clearly describe a plan for evaluating the research.

The SHF program supports all aspects of the science and engineering of software, seeking transformative ideas that reformulate the relationships between requirements, design and evolution of software, and software-intensive systems. SHF supports research projects focusing on program analysis and synthesis, compositionality, verifiability and adaptability of software, as well as research on software analysis and testing techniques for all stages of the software life cycle. SHF also seeks research to increase the automation of software engineering capabilities to attain significant advances in quality and sustainability of software, which may require new representations and processes. Empirical research that increases understanding of software and software creation is also in scope.

SHF supports fundamental research on formal and semi-formal methods for the specification, development and verification of software and hardware systems. This includes, but is not limited to, abstraction, compositional, refinement-based, and probabilistic methods for the modeling and validation of systems involving discrete and continuous behavior. SHF seeks proposals that enhance the applicability, usability, and efficiency of techniques such as abstract interpretation, model checking, theorem proving, automated decision procedures, and constraint solving. Research topics involving the semantics, logics, verification, and analysis of concurrent systems are in scope. SHF supports foundations, algorithms, and tools for software and hardware synthesis.

SHF supports the entire range of programming languages research, from foundations to design to implementation. Fundamental research in both science and engineering of programming languages is highly encouraged. Topics of interest include, but are not limited to, language semantics and type theory, design and implementation of advanced languages and language features, compilers and runtime systems for advanced languages, program analysis and optimization, design and implementation of domain-specific languages, and implementation issues related to locality, synchronization and communication. Research in programming languages and models that go beyond mainstream practice, such as concurrent, functional, logic programming and probabilistic languages, are particularly encouraged. Foundational research that exposes novel synergies between programming languages and other areas of computing is also encouraged.

SHF seeks proposals that address foundational issues in computer architecture and the key challenges in computer hardware and systems design, including, but not limited to, performance, energy efficiency, reliability, scalability, concurrency, and heterogeneity. The program supports fundamental and transformative research in processors, interconnects, memory and storage architectures. SHF seeks research that takes holistic and cross-layer approaches to fully harness the promises and address the challenges of new and emerging substrate technologies and materials as well as considering emerging trends in application environments including computation-intensive, data-intensive, and I/O-intensive applications.

SHF supports foundational research in high-performance computing that is aware of, driven by, and inspired by applications, as well as heterogeneity-aware and architecture-aware. SHF does not support research in domain applications. SHF seeks novel research on enabling technologies and tools to balance and optimize performance goals including scalability, power, productivity, repeatability, reliability, and validity.

SHF supports all topics in design automation including, but not limited to logical, physical, behavioral, and high level synthesis methods, interplay between synthesis and verification, design methodologies for scalable, low power and energy efficient circuits, and physical design in silicon technologies. Also of interest is pre- and post-silicon validation, possibly by using a blend of techniques from testing and verification. SHF seeks research in emerging technologies, including optical interconnects, quantum computing, optical computing, bio-computing, bio-inspired devices, nanotubes and nanophotonics, which have the potential to take computation beyond Moore's Law.

Proposals on parallelism and scalability that promises to lead to a new era of parallel computing are now supported through a separate program, eXploiting Parallelism and Scalability (XPS; see *http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=504842*). XPS is particularly interested in “clean-slate” approaches that re-evaluate and possibly re-design the traditional hardware and software stack.

Proposals that address hardware and/or software security and thus provide the basis for designing, building, and operating a cyberinfrastructure with improved resistance to malicious behavior may be in scope for the Secure and Trustworthy Cyberspace (SaTC) program; see http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=504709.

Investigators interested in the SHF program may also wish to consider the CSR program in the CNS division, which focuses on advances in system computing and system programming that are particular to an application domain or a specific hardware platform.

More information on topics appropriate for the Software and Hardware Foundations program is available at: http://www.nsf.gov/cise/ccf/shf_pgm12.jsp

PROJECT CLASSES

Proposals submitted to this solicitation must be consistent with one of three project classes defined below. Proposals will be considered for funding within their project classes.

SMALL Projects:

Small Projects, with total budgets up to $500,000 for durations of up to three years, are well suited to one or two investigators (PI and one co-PI or other Senior Personnel) and at least one student and/or postdoc.

- **MEDIUM Projects**:

Medium Projects, with total budgets ranging from $500,001 to $1,200,000 for durations up to four years, are well-suited to one or more investigators (PI, co-PI and/or other Senior Personnel) and several students and/or postdocs. Medium project descriptions must be comprehensive and well-integrated, and should make a convincing case that the collaborative contributions of the project team will be greater than the sum of each of their individual contributions. Rationale must be provided to explain why a budget of this size is required to carry out the proposed work. Since the success of collaborative research efforts are known to depend on thoughtful coordination mechanisms that regularly bring together the various participants of the project, **a Collaboration Plan is required for all Medium proposals with more than one investigator**. Up to 2 pages are allowed for Collaboration Plans and they must be submitted as a document under Supplementary Documentation. The length of and level of detail provided in the Collaboration Plan should be commensurate with the complexity of the proposed project. **If a Medium proposal with more than one investigator does not include a Collaboration Plan, that proposal will be returned without review.** Please see *Proposal Preparation Instructions* Section V.A for additional submission guidelines.

- **LARGE Projects**:

Large Projects, with total budgets ranging from $1,200,001 to $3,000,000 for durations of up to five years, are well-suited to two or more investigators (PI, co-PI(s), or other Senior Personnel), and a team of students and/or postdocs. Large project descriptions must be comprehensive and well-integrated, and should make a convincing case that the collaborative contributions of the project team will be greater than the sum of each of their individual contributions. Large projects will typically integrate research from various areas, either within a cluster or across clusters, or tackle ambitious goals not feasible with smaller projects. Rationale must be provided to explain why a budget of this size is required to carry out the proposed work. Since the success of collaborative research efforts are known to depend on thoughtful coordination mechanisms that regularly bring together the various participants of the project, **a Collaboration Plan is required for all Large proposals**. Up to 2 pages are allowed for Collaboration Plans and they must be submitted as a document under Supplementary Documentation. The length of and degree of detail provided in the Collaboration Plan should be commensurate with the complexity of the proposed project. **If a Large proposal does not include a Collaboration Plan, that proposal will be returned without review**. Please see *Proposal Preparation Instructions* Section V.A for additional submission guidelines.

CISE investments in Small, Medium and Large projects complement the Directorate's investments in the Expeditions in Computing program, where projects are funded at levels of up to $10,000,000 total for durations of up to 5 years. Additional information on the Expeditions program can be accessed at:

http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=503169

BREAKTHROUGH PROPOSALS:

CISE encourages proposals that promise extraordinary outcomes, with a possibly corresponding increase in uncertainty in the research plan and overall risk of success relative to traditional submissions, such as: revolutionizing disciplines or sub-disciplines, creating new fields or subfields, disrupting accepted theories and perspectives, and solving widely recognized challenging problems. In order to encourage the submission of proposals possessing one or more of these characteristics, we are offering the opportunity to submit and identify such projects as ***"Breakthrough Proposals."***

Breakthrough proposals may be submitted to all CISE (CCF/CNS/IIS) core programs and may be Small, Medium, or Large. They must be submitted in accordance with the deadlines for Small, Medium, and Large proposals. Submission of a *breakthrough proposal* will count as one against the limit of two proposals per PI as described in the previous sections. The proposal preparation instructions, budgetary limits, and requirements for these proposals are identical to other proposals submitted to CISE (CCF/CNS/IIS) core programs under each of three size c***lasses with the following exceptions:***

1. The word "breakthrough" must be listed as the first keyword in the submitted list of keywords in the Project Summary.
2. A statement, of **up to two pages**, explaining why the proposed research can be described as "breakthrough" and how any associated uncertainty and risk will be managed, **must be submitted as a document under Supplementary Documentation.** A breakthrough proposal must include this statement in order to be considered as a breakthrough proposal. **If it does not include this statement, that proposal will be considered as a regular proposal.**

PROPOSALS FOR CONSIDERATION BY MULTIPLE CISE PROGRAMS

Proposals that intersect more than one CISE research program are welcome. In such cases, PIs must identify the most relevant programs in the proposal submission process (for information about submission and how to identify such proposals, see *Proposal Preparation Instructions* later in this document). CISE Program Officers will ensure that these proposals are co-reviewed as appropriate.

IMPORTANT PROJECT CHARACTERISTICS

The submission of far-reaching, creative research and education projects is encouraged. Funds will be used to support potentially transformative research with high-impact potential. In this way, CISE will catalyze exciting new research activities with the potential to make significant advances in the state-of-the-art.

Interdisciplinary, international and/or academic-industry collaborations that promise to result in major science or engineering advances are welcome. The directorate hopes to attract proposals from faculty at a broad range of academic institutions, including faculty at minority-serving and predominantly undergraduate institutions.

Proposals submitted should demonstrate that rich learning experiences will be provided for a diverse population of students and may propose the development of innovative curricula or educational materials that advance literacy about and expertise in areas supported by CISE.

EMBEDDED REU SUPPLEMENTS

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

count against the budget limitations described in this solicitation for the Small, Medium, and Large project classes.

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

CISE expects to provide up to $8,000 per student per year through the REU supplemental support mechanism. As described in the REU program solicitation (NSF 13-542), indirect costs (F&A) are not allowed on Participant Support Costs in REU Site or REU Supplement budgets.

REU stipend support is one way to retain talented students in undergraduate education, while providing meaningful research experiences. The participation of students from groups underrepresented in computing -underrepresented minorities, women and persons with disabilities -is strongly encouraged. In addition, CISE encourages REU supplements that specifically afford US veterans an opportunity to engage in meaningful research experiences.

CISE REU supplemental funding requests must describe results of any previous such support, including students supported, papers published, etc. Other factors influencing supplemental funding decisions include the number of REU requests submitted by any one principal investigator across all of her/his CISE grants.

Investigators are encouraged to refer to the current REU program solicitation (NSF 13-542) for detailed information concerning submission requirements. Grantees with questions may also contact one of the Cognizant Program Officers listed in this solicitation.

III. AWARD INFORMATION

Up to $100 million each year will support up to 200 awards, pending the availability of funds.

IV. ELIGIBILITY INFORMATION

Who May Submit Proposals:

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

Who May Serve as PI:

There are no restrictions or limits.

Limit on Number of Proposals per Organization:

There are no restrictions or limits.

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

In any contiguous September through November period, an individual may participate as PI, Co-PI or Senior Personnel in **no more than two Small, Medium, or Large** proposals submitted in response to the *coordinated solicitation* (where *coordinated solicitation* is defined to include the *Computing and Communication Foundations (CCF): Core Programs* solicitations, *Information and Intelligent Systems (IIS): Core Programs*, and the *Computer and Network Systems (CNS): Core Programs*). For example, between September 2015 and November 2015, an individual may participate as PI, co-PI or Senior Personnel in one proposal submitted to a core program in CCF and in a second proposal submitted to a core program in CNS, or an individual may participate as PI, co-PI or Senior Personnel in two proposals submitted to an IIS core program, etc.

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

The limit on the number of proposals per PI, co-PI or Senior Personnel applies only to the *coordinated solicitation.*

V. PROPOSAL PREPARATION AND SUBMISSION INSTRUCTIONS

A. Proposal Preparation Instructions

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

- Full proposals submitted via FastLane: Proposals submitted in response to this program solicitation should be prepared and submitted in accordance with the general guidelines contained in the NSF Grant Proposal Guide (GPG). The complete text of the GPG is available electronically on the NSF website at: http://www.nsf.gov/publications/pub_summ.jsp?ods_key=gpg. Paper copies of the GPG may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-7827 or by e-mail from nsfpubs@nsf.gov. Proposers are reminded to identify this program solicitation number in the program solicitation block on the NSF Cover Sheet For Proposal to the National Science Foundation. Compliance with this requirement is critical to

determining the relevant proposal processing guidelines. Failure to submit this information may delay processing.

- Full proposals submitted via Grants.gov: Proposals submitted in response to this program solicitation via Grants.gov should be prepared and submitted in accordance with the NSF Grants.gov Application Guide: A Guide for the Preparation and Submission of NSF Applications via Grants.gov. The complete text of the NSF Grants.gov Application Guide is available on the Grants.gov website and on the NSF website at: (http://www.nsf.gov/publications/pub_summ.jsp?ods_key=grantsgovguide). To obtain copies of the Application Guide and Application Forms Package, click on the Apply tab on the Grants.gov site, then click on the Apply Step 1: Download a Grant Application Package and Application Instructions link and enter the funding opportunity number, (the program solicitation number without the NSF prefix) and press the Download Package button. Paper copies of the Grants.gov Application Guide also may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-7827 or by e-mail from nsfpubs@nsf.gov.

In determining which method to utilize in the electronic preparation and submission of the proposal, please note the following:

Collaborative Proposals. All collaborative proposals submitted as separate submissions from multiple organizations must be submitted via the NSF FastLane system. Chapter II, Section D.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.

The following information SUPPLEMENTS (note that it does not replace) the guidelines provided in the NSF Grant Proposal Guide (GPG).

Proposal Titles: Proposal titles must begin with an acronym that indicates the most relevant core program. Select an acronym from the following list:

- Algorithmic Foundations - AF
- Communications and Information Foundations - CIF
- Software and Hardware Foundations - SHF

The acronym should be followed with a colon, then the project class followed by a colon, then the title of your project. For example, if you are submitting a medium proposal to the Communications and Information Foundations core program, then your title would be **CIF:Medium:Title**. If you submit a proposal as part of a set of collaborative proposals, the title of the proposal should begin with the acronym that indicates the most relevant core program followed by a colon, then the project class followed by a colon, then "Collaborative Research" followed by a colon, and the title. For example, if you are submitting a collaborative set of proposals to the Software and Hardware Foundations core program for a Large project, the title of each would be **SHF:Large:Collaborative Research:Title.**

Proposals from PIs in institutions that have RUI (Research in Undergraduate Institutions) eligibility should have a proposal title that begins with the acronym that indicates the most relevant program acronym, followed by a colon, then the project class, followed by a colon, then "RUI", followed by a colon and then the title, for example, **AF:Small:RUI:Title.**

PIs submitting Grant Opportunities for Academic Liaison with Industry (GOALI) proposals should have a proposal title that begins with the acronym that indicates the most relevant program acronym, followed by a colon, then the project class, followed by a colon, then "GOALI", followed by a colon and then the title, for example, **SHF:Small:GOALI:Title**.

Proposals that extend beyond the scope of one CISE core program or area are welcome. Proposals should be submitted in response to the solicitation for the CISE division (CCF, CNS or IIS) that includes the most relevant core program. In such cases, PIs should identify the acronym for the **most relevant** core program or area, followed by any other relevant program acronym(s) separated by colons, for example, **III:AF:Medium:Title.** In this case, the proposal would be submitted to the Division of Information and Intelligent Systems solicitation but would be considered by IIS/III and CCF/AF. CISE Program Officers will work with their NSF and CISE colleagues to ensure that these proposals are appropriately reviewed and considered for funding. Please see the coordinated CNS and IIS solicitations for information on other CISE core programs and the corresponding acronyms.

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 each keyword set 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. "Breakthrough proposals" should have the word "breakthrough" as the first keyword in the submitted list of keywords.**

Project Description:

Length of Project Description - Describe the research and education activities to be undertaken in **up to 15 pages for Small and Medium proposals and in up to 20 pages for Large proposals.** Describe curriculum development activities, if any, in a separate section (included in these page limits) titled "Curriculum Development Activities."

Proposers are reminded that, as specified in GPG Chapter II.C.2.d.(iii)

- The Project Description must contain, as a separate section within the narrative, a section labeled “Broader Impacts of the Proposed Work.” This section should include a discussion of the broader impacts of the proposed activities.
- Results from Prior NSF Support: If any PI or co-PI identified on the project has received NSF funding (including any current funding) in the past five years, the Project Description must contain information on the award(s), irrespective of whether the support was directly related to the proposal or not. In cases where the PI or co-PI has received more than one award (excluding amendments), they need only report on the one award most closely related to the proposal. Funding includes not just salary support, but any funding awarded by NSF. Please refer to the GPG for details about the information that must be provided. **Note that these results from prior NSF support must be separately described under two distinct headings, “Intellectual Merit” and “Broader Impacts.”**

Proposals without these two distinct sections (including the heading “Broader Impacts of the Proposed Work”) within the Project Description may 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. *A list of past and present Collaborators not related to this proposal (Note: In collaborative proposals, the lead institution should provide this information for all participants):*

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

   1. Collaborators for Mary Smith; XYZ University; PI
      a. Helen Gupta; ABC University
      b. John Jones; University of PQR
      c. Fred Gonzales; DEF Corporation
      d. Susan White; Welldone Institution
   2. Collaborators for John Jones; University of PQR; Senior Personnel
      a. Tim Green; ZZZ University
      b. Ping Chang; ZZZ University
      c. Mary Smith; XYZ University
   3. Collaborators for Jane Brown; XYZ University; Postdoc
      a. Fred Gonzales; DEF Corporation
   4. Collaborators for Bob Adams; ABC Community College; Paid Consultant
      a. a. None
   5. Collaborators for Susan White; Welldone Institution; Unpaid Collaborator
      a. Mary Smith; XYZ University
      b. Harry Nguyen; DEF Corporation
   6. Collaborators for Tim Green; ZZZ University; Subawardee
      a. John Jones; University of PQR

   NOTE: The list of collaborators includes all current and past (see above timelines) projects 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.

3. *Collaboration Plans for Medium and Large Proposals (if applicable)*

   Since the success of collaborative research efforts are known to depend on thoughtful coordination mechanisms that regularly bring together the various participants of the project, **all Medium proposals that include more than one investigator and all Large proposals must include a Collaboration Plan of up to 2 pages**. The length of and degree of detail provided in the Collaboration Plan should be commensurate with the complexity of the proposed project. Where appropriate, the Collaboration Plan might include: 1) the specific roles of the project participants in all organizations involved; 2) information on how the project will be managed across all the investigators, 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 Large proposal, or a Medium proposal with more than one investigator, does not include a Collaboration Plan of up to 2 pages, that proposal will be returned without review.**

4. *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 see: http://www.nsf.gov/bfa/dias/policy/dmp.jsp.

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

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

5. *Breakthrough Description (if applicable)*

   A statement, of **up to two pages**, explaining why the proposed research can be described as "breakthrough," and how any associated uncertainty and risk will be managed, **must be submitted as a document under Supplementary Documentation.** A breakthrough proposal must include this statement in order to be considered as a breakthrough proposal. **If it does not include this statement, that proposal will be considered as a regular proposal.**

6. *Documentation of Collaborative Arrangements of Significance to the Proposal through Letters of Collaboration and/or Commitment:*

   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 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.**

   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.**

7. *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.

GOALI proposals: PIs submitting GOALI proposals should include industry-university agreement letters on intellectual property in this section.

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

B. Budgetary Information

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

C. Due Dates

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

  September 10, 2015 - September 16, 2015

  September 10 - September 16, Annually Thereafter

  MEDIUM Projects

  September 18, 2015 - September 24, 2015

  September 18 - September 24, Annually Thereafter

  LARGE Projects

  November 04, 2015 - November 18, 2015

  November 4 - November 18, Annually Thereafter

  SMALL Projects

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

For Large and relevant Medium proposals, reviewers will be asked to:

- Comment on the extent to which the project scope justifies the level of investment requested, and the degree to which the Collaboration Plan (if required) adequately demonstrates that the participating investigators will work synergistically to accomplish the project objectives.

For Breakthrough proposals, reviewers will be asked to:

- Comment on the extent to which the project satisfies the "breakthrough qualities" as described above in Section II, including an assessment of uncertainty and risk associated with the proposed work.

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 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.

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:

- John H. Cozzens, Point of Contact, Communications and Information Foundations (CIF), 1115, telephone: (703) 292-8910, email: jcozzens@nsf.gov
- Almadena Y. Chtchelkanova, Point of Contact, Software and Hardware Foundations (SHF), telephone: (703) 292-8910, email: achtchel@nsf.gov
- Tracy Kimbrel, Point of Contact, Algorithmic Foundations (AF), telephone: (703) 292-8910, email: tkimbrel@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.

In addition to the Program Officers identified as program points of contact above, the following CCF Program Officers also support CCF core programs as indicated below:

Algorithmic Foundations (AF)

- Mitra Basu, (703) 292-8910, mbasu@nsf.gov, Room 1115
- Dmitry Maslov, (703) 292-8910, dmaslov@nsf.gov, Room 1115
- Jack Snoeyink, (703) 292-7178, jsnoeyin@nsf.gov, Room 1115

Communications and Information Foundations (CIF)

- Phillip Regalia, (703) 292-8910, pregalia@nsf.gov, Room 1115

Software and Hardware Foundations (SHF)

- Anindya Banerjee, (703) 292-7885, abanerje@nsf.gov, Room 1160

- Sankar Basu, (703) 292-8910, sabasu@nsf.gov, Room 1114
- Nina Amla, (703) 292-7991, namla@nsf.gov, Room 1110
- Sol Greenspan, (703) 292-8910, sgreensp@nsf.gov, Room 1108
- Tao Li, (703) 292-8910, taoli@nsf.gov, Room 1115

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.

In addition to the *coordinated solicitation* discussed in this document, NSF provides funding opportunities for the computing community via the following programs and their solicitations:

Discovery Research Programs

CISE-MPS Interdisciplinary Faculty Program in Quantum Information Science,
http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=504743&org=CISE

Collaborative Research in Computational Neuroscience (CRCNS),
http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5147&org=CISE

Critical Resilient Interdependent Infrastructure Systems and Processes (CRISP),
http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=504971&org=CISE

Critical Techniques and Technologies for Advancing Foundations and Applications of Big Data Science and Engineering (BIGDATA), *http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=504767&org=CISE*

Cultivating Cultures for Ethical STEM (CCE STEM), *http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=505027&org=CISE*

Cyber-Innovation for Sustainability Science and Engineering (CyberSEES),
http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=504829&org=CISE

Cyber-Physical Systems (CPS), *http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=503286&org=CISE*

Engineering Research Centers (ERCs), *http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5502&org=CISE*

Enhancing Access to the Radio Spectrum (EARS), *http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=503480&org=CISE*

Expeditions in Computing, *http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=503169&org=CISE*

Exploiting Parallelism and Scalability (XPS), *http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=504842&org=CISE*

Facilitating Research at Primarily Undergraduate Institutions,*http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5518&org=CISE*

Faculty Early Career Development (CAREER), *http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=503214&org=CISE*

Grant Opportunities for Academic Liaison with Industry (GOALI),
http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=504699&org=CISE

Industry/University Cooperative Research Centers Program (I/UCRC),
http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5501&org=CISE

Innovation Corps Teams Program (I-Corps), *http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=504672&org=CISE*

National Robotics Initiative (NRI), *http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=503641&org=CISE*

Partnerships for International Research and Education (PIRE),
http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=12819&org=CISE

Science and Technology Centers: Integrative Partnerships (STC),
http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5541&org=CISE

Science of Learning Collaborative Networks (SL-CN), http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=505176

Secure and Trustworthy Cyberspace (SaTC), *http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=504709&org=CISE*

Smart and Connected Health (SCH), *http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=504739&org=CISE*

United States-Israel Collaboration in Computer Science (USICCS), *http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=504828&org=CISE*

Education and Workforce Development Programs

ADVANCE: Increasing the Participation and Advancement of Women in Academic Science and Engineering Careers, *http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5383&org=CISE*

Advanced Technological Education (ATE), *http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5464&org=CISE*

CyberCorps(R): Scholarship for Service (SFS), *http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=504991&org=CISE*

Cyberlearning and Future Learning Technologies, *http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=504984&org=CISE*

Discovery Research K-12 (DRK-12), *http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=500047&org=CISE*

East Asia and Pacific Summer Institutes for US Graduate Students (EAPSI), *http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5284&org=CISE*

Graduate Research Fellowship Program (GRFP), *http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=6201&org=CISE*

Improving Undergraduate STEM Education (IUSE: EHR), *http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=504976&org=CISE*

Information Technology Experiences for Students and Teachers (ITEST), *http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5467&org=CISE*

International Research Experiences for Students (IRES), *http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=12831&org=CISE*

NSF Research Traineeships Program (NRT), *http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=505015&org=CISE*

NSF Scholarships in Science, Technology, Engineering, and Mathematics (S-STEM), *http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5257&org=CISE*

Research Experiences for Teachers (RET) in Engineering and Computer Science, *http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=505170&org=CISE*

Research Experiences for Undergraduates (REU), *http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5517&org=CISE*

STEM + Computing Partnerships (STEM+C), *http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=503582&org=CISE*

Research Infrastructure Programs

Campus Cyberinfrastructure – Data, Networking, and Innovation Program (CC*DNI), *http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=504748&org=CISE*

CISE Research Infrastructure (CRI), *http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=12810&org=CISE*

Major Research Instrumentation (MRI), *http://www.nsf.gov/od/iia/programs/mri/*

Software Infrastructure for Sustained Innovation - SSE&SSI (SI^2-SSE&SSI), *http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=504865&org=CISE*

For more information on these programs, please consult the NSF web site.

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Office of the General Counsel
National Science Foundation
Arlington, VA 22230