Computer and Network Systems (CNS): Core Programs

PROGRAM SOLICITATION
NSF 10-573

REPLACES DOCUMENT(S):
NSF 09-556

National Science Foundation

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

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

September 01, 2010 - September 15, 2010

September 1 - September 15, Annually Thereafter

MEDIUM Projects

November 01, 2010 - November 28, 2010

November 1 - November 28, Annually Thereafter

LARGE Projects

December 01, 2010 - December 17, 2010

December 1 - December 17, Annually Thereafter

SMALL Projects

IMPORTANT INFORMATION AND REVISION NOTES

The following revisions have been made to the Computer and Network Systems: Core Programs solicitation:

- Modest changes have been made to the Computer Systems Research and Networking Technology and Systems program descriptions to fully reflect their scientific scope, and to indicate the Division's continuing interest in supporting cloud/data-intensive computing research supported by the former Data-intensive Computing program (http://nsf.gov/funding/pgm_summ.jsp?pims_id=503324&org=IIS&from=home).
- The submission window for all Medium proposals will now be September 1-15 annually.

Please be advised that the *NSF Proposal & Award Policies & Procedures Guide* (PAPPG) includes revised guidelines to implement the mentoring provisions of the America COMPETES Act (ACA) (Pub. L. No. 110-69, Aug. 9, 2007.) As specified in the ACA, each proposal that requests funding to support postdoctoral researchers must include a description of the mentoring activities that will be provided for such individuals. Proposals that do not comply with this requirement will be returned without review (see the PAPP Guide Part I: *Grant Proposal Guide* Chapter II for further information about the implementation of this new requirement).

SUMMARY OF PROGRAM REQUIREMENTS

General Information

Program Title:

Computer and Network Systems (CNS): Core Programs

Synopsis of Program:

CISE's Division of Computer and Network Systems (CNS) supports research and education projects that develop new knowledge in two core programs:

- The Computer Systems Research (CSR) program; and
- The Networking Technology and Systems (NeTS) 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.

CISE investments in Small, Medium and Large projects complement the directorate's investments in the Expeditions in Computing program, http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=503169&org=CISE&from=home, where projects are funded at levels of up to $10,000,000 total for durations up to 5 years.

Cognizant Program Officer(s):

Please note that the following information is current at the time of publishing. See program website for any updates to the points of contact.

- Darleen L. Fisher, Point of Contact, Networking Technology and Systems, 1175, telephone: (703) 292-8950, email: dlfisher@nsf.gov
- Mohamed Gouda, Point of Contact, Computer Systems Research, 1175, telephone: (703) 292-8458, email: mgouda@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: 80 to 120 - It is anticipated that up to 120 awards will be made each year.

Anticipated Funding Amount: $60,000,000 each year, dependent upon the availability of funds.

Eligibility Information

Organization Limit:

None Specified

PI Limit:

None Specified

Limit on Number of Proposals per Organization:

None Specified

Limit on Number of Proposals per PI: 2

In any contiguous September through December period, an individual may participate as PI, Co-PI or Senior Personnel in **no more than two** proposals submitted in response to the *coordinated solicitation* (where *coordinated solicitation* is defined to include the *Computer and Network Systems (CNS): Core Programs*, the *Information and Intelligent Systems (IIS): Core Programs* and the *Computing and Communication Foundations (CCF): Core Programs* solicitations). For example, between September 2010 and December 2010, 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 Applicable
- **Preliminary Proposal Submission:** Not Applicable
- **Full Proposals:**
  - Full Proposals submitted via FastLane: NSF Proposal and Award Policies and Procedures Guide, Part I: Grant Proposal Guide (GPG) Guidelines apply. The complete text of the GPG is available electronically on the NSF website at: http://www.nsf.gov/publications/pub_summ.jsp?ods_key=gpg.
  - Full Proposals submitted via Grants.gov: NSF Grants.gov Application Guide: A Guide for the Preparation and

Submission of NSF Applications via Grants.gov Guidelines apply (Note: The NSF Grants.gov Application Guide is available on the Grants.gov website and on the NSF website at: http://www.nsf.gov/publications/pub_summ.jsp?ods_key=grantsgovguide)

B. Budgetary Information

- **Cost Sharing Requirements:** Cost Sharing is not required under this solicitation.
- **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 01, 2010 - September 15, 2010

September 1 - September 15, Annually Thereafter

MEDIUM Projects

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December 1 - December 17, 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 Computer and Network Systems (CNS) supports research and education activities that invent new computing and networking technologies and that explore new ways to make use of existing technologies. The Division seeks to develop a better understanding of the fundamental properties of computer and network systems and to create better abstractions and tools for designing, building, analyzing, and measuring future systems.

II. PROGRAM DESCRIPTION

CNS supports two core programs as described below.

- ***Computer Systems Research (CSR)***

  Advances in software and hardware technologies are expanding the frontiers of computing systems and systems programming, paving the way for unparalleled opportunities for innovation and impact on science and society. Recent progress in network-enabled services, coupled with advances in communication, device, and storage technologies, is giving rise to new classes of scalable, customizable and dynamic computing platforms, ushering in a variety of new applications with potential to radically change the way we live, do business and interact with the world. Computing systems and systems programming have become truly ubiquitous, expanding beyond the desktop to sophisticated hand-held devices, and small, inexpensive sensors and actuators on the one hand to massive data centers and peta-scale computers on the other. These platforms allow access to information and services unobtrusively anytime, anywhere. Recent advances in computer architectures have shifted our focus from increasing chip clock speed to increasing the number of cores per chip, paving the way for levels of parallelism never seen before in mainstream computing, with the promise for peta- and exa-scale computing platforms. The Computer Systems Research (CSR) program supports pushing the frontiers of computing systems and systems programming, focusing on transformative research that explores novel ideas and expands the limits of existing paradigms, with potential for significant advances in scientific or technical understanding of the way future applications are designed, operated, managed and used.

  Emerging Web applications and services are highly distributed, with varying levels of coordination, executing over platforms ranging from asymmetric and specialized devices with diverse computing capabilities to large-scale data centers. They often involve seamless integration of multiple functions and require access to potentially large amounts of data often spread over many servers. The increased complexity, scale, heterogeneity and diversity of future computing systems and applications limit the designer's ability to reason about correctness, reliability, availability, performance and security. This is further compounded by the need for energy and power efficiency and for long term sustainability. Addressing these challenges requires fundamentally new programming abstractions, operating systems approaches and runtime system methodologies to advance our understanding of how computation is performed and how resources are managed, at varying levels of granularity and scale. Support for pervasive access to both personal and very large-scale storage and data resources requires new approaches to data management, including support for caching, replication and consistency at scale. Fundamental advances in methods and models to address power, thermal and sustainability issues in the design and operation of computing resources from chips to large scale data centers are essential to reduce the carbon footprint of fast expanding computing technologies, including the study of tradeoffs between energy efficiency, performance and reliability. Frameworks, approaches and methodologies to address these challenges must show potential to improve important system's characteristics, such as manageability, configurability, usability and performance, while reducing vulnerabilities.

  The dynamic and heterogeneous nature of ubiquitous and pervasive computing environments, coupled with the interaction between humans and devices, give rise to unique fundamental and socio-technical challenges. At the core of these challenges is the concept of context, its representation and the underlying principles that underpin how human behavior, activity and interaction with the environment are captured at the appropriate levels of detail. Advances in context-aware, pervasive and ubiquitous computing require new programming models, abstractions and languages. Methodologies and tools are also needed to monitor, evaluate and predict the performance of ubiquitous systems and assess user experience.

  Fully leveraging the opportunities and unprecedented levels of parallelism offered by multi-core architectures poses new challenges which bring into question traditional frameworks, approaches and methodologies for system design. CSR supports transformative research focused on new system design and system programming approaches for multi-core architectures, including new execution and memory models, novel system-level approaches to automatic parallelization of sequential programs, and compiler techniques and dynamic run-time execution paradigms to expose and exploit inherent parallelism and optimize code generation. Understanding highly parallel computing systems also requires innovative methodologies and tools for quantitative and qualitative characterization, evaluation, monitoring and prediction of system behavior at different levels, including the implications of workloads in multi-core system design.

  CSR seeks proposals focused on advances in system computing and system programming that are particular to an application domain or a specific hardware platform as well as generic across domains and platforms. Investigators interested in the CSR program may also wish to consider the Software and Hardware Foundations (SHF) program, which supports foundational software and hardware research essential to enhance the capability of computing systems. CSR PIs should describe credible plans for demonstrating the utility and potential impact of their proposed work.

  For more information on the types of projects supported by the CSR program, please visit our web site at http://www.nsf.gov/cise/cns/csr_pgm_2010.jsp.

- ***Networking Technology and Systems (NeTS)***

  Computer and communication networks of the future must be available anytime and anywhere, and be accessible from any device. They need to evolve over time to incorporate new technologies, support new classes of applications and services, and meet new requirements and challenges; they need to scale and adapt to unforeseen events and uncertainties across multiple dimensions, including types of applications, network size and

topology, mobility patterns, and heterogeneity of devices and networking technologies. They also need to be easily controllable and manageable, resource and energy efficient, secure and resilient to failures and attacks.

The Networking Technology and Systems (NeTS) program supports transformative research on fundamental scientific and technological advances leading to the development of future generation, high performance networks. The scope of the program includes enterprise, core and optical networks, peer-to-peer and application-level networks, and wireless, mobile and sensor networks. The focus is on innovative and possibly radical network architectures, algorithms, protocols, and technologies that are responsive to the evolving requirements of current and yet to be discovered technologies, services and applications operating in wired and wireless environments.

The NeTS program seeks scientific and engineering advances in large-scale network resource allocation and traffic engineering, topology control, context-aware service discovery, naming and addressing, routing and congestion control, opportunistic networking, mobility management at different levels and granularities, virtualization and programmability at-scale and at all levels of the network architecture. NeTS also supports transformative research focused on the development of scalable, non-intrusive mechanisms, tools, and methodologies for network monitoring and diagnosis, measurement and characterization, network simulation and performance modeling and analysis, including the development and distribution of benchmarks to support network research, both for wired and wireless networks. Proposed solutions are expected to bring the network closer to autonomy, where the need for human intervention is minimal.

In the area of wireless networks, NeTS seeks research projects on novel frameworks, architectures, protocols, methodologies and tools for the design and analysis, deployment, operation and management of robust and highly dependable cellular and hybrid, mobile ad-hoc, vehicular, mesh, sensor, and body area networks. Needed are systematic theory and methodologies for cross-layer design of architectures that are better suited for dynamic interactions between network functionalities, that can support adaptability of network operations, and that can exploit system-wide energy tradeoffs and improve long-term network sustainability. Also sought are holistic approaches to support efficient dynamic spectrum allocation, usage and sharing, and to support the coexistence of multiple co-located networks, with possibly different radio technologies and network protocols. NeTS will also support research on new network abstractions, models and algorithms that exploit a deeper understanding of the physical layer fundamental characteristics and recent developments in information theory to harness the potential of emerging technologies, such as multi-antenna and cognitive radios, for enhanced network performance and for more efficient network-wide interference management.

In networked sensor systems, key research challenges, which go beyond access control, routing, monitoring and event detection, include the development of new paradigms, frameworks and methodologies for multi-modal sensing that enhance the quality of sensed information in the presence of uncertainty and exploit context and situation awareness; such research will enable real-time control and actuation, knowledge discovery, and intelligent decision making in personal and social settings and applications. Projects focused on innovative and holistic approaches to address these challenges in large-scale, heterogeneous sensor networks are encouraged.

Networking research and education projects of an inter-disciplinary nature should be directed to the Network Science and Engineering (NetSE) cross-cutting program. For example, projects that take a broad social, technical and economic perspective focusing on how networks and network architectures are designed to meet social, economic or legal challenges should be directed to the NetSE program. For more information on the types of projects supported by the NeTS program, please visit the following web site
http://www.nsf.gov/cise/cns/nets_pgm_2010.jsp

PROJECT CLASSES

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

- **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, 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. The length of and level of detail provided in the Collaboration Plan should be commensurate with the complexity of the proposed project. Please see *Proposal Preparation Instructions* Section V.A for additional submission guidelines.
- **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. 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. The length of and level of detail provided in the Collaboration Plan should be commensurate with the complexity of the proposed project. 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. The Expeditions solicitation can be accessed at http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=503169&org=CISE&from=home .

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 enriching learning experiences will be provided for a diverse population of students,

and may describe the development of innovative curricula or educational materials that advance literacy about and expertise in areas supported by CISE.

Proposals that extend beyond the scope of one CISE core program are welcome. In such cases, PIs should identify the most relevant program(s) in the proposal submission process (see *Proposal Preparation Instructions* later in this document). CISE Program Officers will work with their NSF colleagues to ensure that these proposals are appropriately co-reviewed and considered for funding.

III. AWARD INFORMATION

Approximately $60 million will be available each year to support up to 120 awards, pending the availability of funds.

IV. ELIGIBILITY INFORMATION

Organization Limit:

None Specified

PI Limit:

None Specified

Limit on Number of Proposals per Organization:

None Specified

Limit on Number of Proposals per PI: 2

In any contiguous September through December period, an individual may participate as PI, Co-PI or Senior Personnel in **no more than two** proposals submitted in response to the *coordinated solicitation* (where *coordinated solicitation* is defined to include the *Computer and Network Systems (CNS): Core Programs*, the *Information and Intelligent Systems (IIS): Core Programs* and the *Computing and Communication Foundations (CCF): Core Programs* solicitations). For example, between September 2010 and December 2010, 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.4 of the Grant Proposal Guide provides additional information on collaborative proposals.

The following information SUPPLEMENTS (not replaces) 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:

- Computer Systems Research: CSR
- Networking Technology and Systems: NeTS

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 Small proposal to the Networking Technology and Systems core program, then your title would be **NeTS: Small: 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 for a Medium project to the Computer Systems Research core program, the title of each would be **CSR: Medium: 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 crosscutting program, followed by a colon then the project class, followed by a colon then "RUI", followed by a colon and then the title, for example, **CSR: Medium: 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 crosscutting program, followed by a colon then the project class, followed by a colon then "GOALI", followed by a colon and then the title, for example, **NeTS: Medium: GOALI: Title**.

Proposals that extend beyond the scope of one CISE core program are welcome. In such cases, PIs should identify the acronym for the **most relevant** core program, followed by any other relevant program acronym(s) separated by colons (for example, **CSR: HCC: Large: Title**). CISE Program Officers will work with their NSF colleagues to ensure that these proposals are appropriately co-reviewed and considered for funding.

Project Summary: The Project Summary must include an explicit description of both the Intellectual Merit and Broader Impacts of the activities proposed, preferably in separate paragraphs titled "Intellectual Merit" and "Broader Impacts".

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

Project Description:

All Proposals - Describe the research and education activities to be undertaken in 15 pages or less. Describe curriculum development activities in a separate section titled "Curriculum Development Activities."

Medium and Large Proposals - 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.While the length of the Project Description for Small proposals is limited to 15 pages, for Medium and Large proposals up to 3 additional pages are allowed for Collaboration Plans. Collaboration Plans should be included at the end of the Project Description in a section entitled "Collaboration Plan". 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, that proposal will not be merit reviewed until the proposing organization submits such a Plan to NSF. Failure to respond within 10 business days to NSF's request for a missing Collaboration Plan may result in the proposal being 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, only the lead institution should provide this information),

Provide current, accurate information for all personnel and institutions involved in the project. NSF staff will use this information in the merit review process to manage conflicts of interest. The list 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 Inc.; Paid Consultant
5. Mary White; Welldone Institution; Unpaid Collaborator
6. Tim Green; ZZZ University; Subawardee

(2) Post Doctoral Mentoring Plan (if applicable)

Proposals that include funding to support postdoctoral researchers in any way must include a Post Doctoral Mentoring Plan. Proposals that request funding to support post docs and that do not include Post Doctoral Mentoring Plans will be returned without review.

(3) 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.

B. Budgetary Information

Cost Sharing: Cost sharing is not required under this solicitation.

C. Due Dates

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

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D. FastLane / Grants.gov Requirements

- **For Proposals Submitted Via FastLane:**

  Detailed technical instructions regarding the technical aspects of preparation and submission via FastLane are 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.

  Submission of Electronically Signed Cover Sheets. The Authorized Organizational Representative (AOR) must electronically sign the proposal Cover Sheet to submit the required proposal certifications (see Chapter II, Section C of the Grant Proposal Guide for a listing of the certifications). The AOR must provide the required electronic certifications within five working days following the electronic submission of the proposal. Further instructions regarding this process are available on the FastLane Website at: https://www.fastlane.nsf.gov/fastlane.jsp.

- **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://www07.grants.gov/applicants/app_help_reso.jsp. In addition, the NSF Grants.gov Application Guide provides additional technical guidance regarding 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.

VI. NSF PROPOSAL PROCESSING AND REVIEW PROCEDURES

Proposals received by NSF are assigned to the appropriate NSF program where they will be reviewed if they meet NSF proposal

preparation requirements. 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 who are experts in the particular fields represented by the proposal. These reviewers are selected by Program Officers charged with the 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.

A. NSF Merit Review Criteria

All NSF proposals are evaluated through use of the two National Science Board (NSB)-approved merit review criteria: intellectual merit and the broader impacts of the proposed effort. In some instances, however, NSF will employ additional criteria as required to highlight the specific objectives of certain programs and activities.

The two NSB-approved merit review criteria are listed below. The criteria include considerations that help define them. These considerations are suggestions and not all will apply to any given proposal. While proposers must address both merit review criteria, reviewers will be asked to address only those considerations that are relevant to the proposal being considered and for which the reviewer is qualified to make judgements.

What is the intellectual merit of the proposed activity?
How important is the proposed activity to advancing knowledge and understanding within its own field or across different fields? How well qualified is the proposer (individual or team) to conduct the project? (If appropriate, the reviewer will comment on the quality of the prior work.) To what extent does the proposed activity suggest and explore creative, original, or potentially transformative concepts? How well conceived and organized is the proposed activity? Is there sufficient access to resources?

What are the broader impacts of the proposed activity?
How well does the activity advance discovery and understanding while promoting teaching, training, and learning? How well does the proposed activity broaden the participation of underrepresented groups (e.g., gender, ethnicity, disability, geographic, etc.)? To what extent will it enhance the infrastructure for research and education, such as facilities, instrumentation, networks, and partnerships? Will the results be disseminated broadly to enhance scientific and technological understanding? What may be the benefits of the proposed activity to society?

Examples illustrating activities likely to demonstrate broader impacts are available electronically on the NSF website at: http://www.nsf.gov/pubs/gpg/broaderimpacts.pdf.

Mentoring activities provided to postdoctoral researchers supported on the project, as described in a one-page supplementary document, will be evaluated under the Broader Impacts criterion.

NSF staff also will give careful consideration to the following in making funding decisions:

Integration of Research and Education
One of the principal strategies in support of NSF's goals is to foster integration of research and education through the programs, projects, and activities it supports at academic and research institutions. These institutions provide abundant opportunities where individuals may concurrently assume responsibilities as researchers, educators, and students and where all can engage in joint efforts that infuse education with the excitement of discovery and enrich research through the diversity of learning perspectives.

Integrating Diversity into NSF Programs, Projects, and Activities
Broadening opportunities and enabling the participation of all citizens -- women and men, underrepresented minorities, and persons with disabilities -- 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.

Additional 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.

B. Review and Selection Process

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

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

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 is striving to be able to tell applicants whether their proposals have been declined or recommended for funding within six months. The time interval begins on the deadline or target date, or receipt date, whichever is later. The interval ends when the Division Director accepts the Program Officer's recommendation.

A summary rating and accompanying narrative will be completed and submitted by each reviewer. In all cases, reviews are treated as confidential documents. Verbatim copies of reviews, excluding the names of the reviewers, 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.

In all cases, 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 and 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.

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 letter, 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 letter; (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 letter. 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 before the end of the current budget period. (Some programs or awards require more frequent project reports). Within 90 days after 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 that PI. 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 FastLane, for preparation and submission of annual and final project reports. Such reports provide information on activities and findings, project participants (individual and organizational), publications, and other specific products and contributions. PIs will not be required to re-enter information previously provided, either with a proposal or in earlier updates using the electronic system. Submission of the report via FastLane constitutes certification by the PI that the contents of the report are accurate and complete. The project outcomes report 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.

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:

- Darleen L. Fisher, Point of Contact, Networking Technology and Systems, 1175, telephone: (703) 292-8950, email: dlfisher@nsf.gov
- Mohamed Gouda, Point of Contact, Computer Systems Research, 1175, telephone: (703) 292-8458, email: mgouda@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 CNS Program Officers also support CNS core programs as indicated below:

Computer Systems Research (CSR)

- Helen Gill, (703) 292-8950, hgill@nsf.gov, Room 1175
- Krishna Kant, (703) 292-8950, kkant@nsf.gov, Room 1175

Networking Technology and Systems (NeTS)

- Sajal Das, (703) 292-8950, sdas@nsf.gov, Room 1175
- Victor S. Frost, (703) 292-8950, vsfrost@nsf.gov, Room 1175

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, National Science Foundation Update is a free e-mail subscription service 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 Regional Grants Conferences. Subscribers are informed through e-mail when new publications are issued that match their identified interests. Users can subscribe to this service by clicking the "Get NSF Updates by Email" link on the NSF web site.

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

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

CAREER: Faculty Early Career Development, http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5262

CISE Cross-cutting Programs: FY 2011, http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=13451

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

Community-Based Data Interoperability Networks (Interop) http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=502112&org=CISE

Cyber-enabled Discovery and Innovation (CDI), http://www.nsf.gov/crssprgm/cdi/

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

Engineering Research Centers (ERCs) http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5502&org=NSF&sel_org=NSF&from=fund

Expeditions in Computing, http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf07592

Foundations of Data and Visual Analytics, http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=501081&org=NSF&sel_org=NSF&from=fund

Grant Opportunities for Academic Liaison with Industry (GOALI) http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=13706&org=CISE

High-End Computing University Research Activity (HECURA), http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=13645&org=NSF&sel_org=NSF&from=fund

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

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

Research in Undergraduate Institutions (RUI) http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5518&org=CISE&sel_org=CISE&from=fund

Science of Learning Centers (SLCs) http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5567&org=CISE&sel_org=CISE&from=fund

Science and Technology Centers (STCs) http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5541&org=CISE&sel_org=CISE&from=fund

Sustainable Digital Data Preservation and Access Network Partners (DataNet) http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=503141&org=CISE&sel_org=CISE&from=fund

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&from=fund

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

Broadening Participation in Computing (BPC), http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=13510&org=NSF&sel_org=NSF&from=fund

Computational Science Training for Undergraduates in the Mathematical Sciences (CSUMS), http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=13655&org=EHR&sel_org=EHR&from=fund

Developing Global Scientists and Engineers [International Research Experiences for Students (IRES) and Doctoral Dissertation Enhancement Projects (DDEP)], http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=12831&org=CISE&sel_org=CISE&from=fund

Discovery Research K-12 (DR-K12), http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=500047&org=EHR&sel_org=EHR&from=fund

Federal Cyber Service: Scholarship for Service (SFS) http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5228

Graduate Research Fellowships (GRF), http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=6201&org=DGE&from=home

Integrative Graduate Education and Research Training (IGERT), http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=12759

International Research Fellowship Program (IRFP) http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5179&org=CISE&sel_org=CISE&from=fund

Information Technology Experiences for Students and Teachers (ITEST) http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5467&org=EHR&sel_org=EHR&from=fund

NSF Graduate Teaching Fellows in K-12 Education (GK-12), http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5472&from=fund

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

Research Experiences for Undergraduates (REU) Sites and Supplements, http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5517&from=fund

Science, Technology, Engineering, and Mathematics Talent Expansion Program (STEP) http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5488&org=EHR&sel_org=EHR&from=fund

Transforming Undergraduate Education in Science (TUES), http://www.nsf.gov/pubs/2010/nsf10544/nsf10544.htm

Research Infrastructure Programs

Computing Research Infrastructure (CRI), http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=12810&org=NSF&sel_org=NSF&from=fund

EPSCoR Research Infrastructure Improvement Grant Program http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5672&org=CISE&sel_org=CISE&from=fund

Major Research Infrastructure (MRI), http://www.nsf.gov/od/oia/programs/mri/

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

ABOUT THE NATIONAL SCIENCE FOUNDATION

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

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

NSF receives approximately 40,000 proposals each year for research, education and training projects, of which approximately 11,000 are funded. In addition, the Foundation receives several thousand applications for graduate and postdoctoral fellowships. The agency operates no laboratories itself but does support National Research Centers, user facilities, certain oceanographic vessels and Antarctic research stations. The Foundation also supports cooperative research between universities and industry, US participation in international scientific and engineering efforts, and educational activities at every academic level.

Facilitation Awards for Scientists and Engineers with Disabilities provide funding for special assistance or equipment to enable persons with disabilities to work on NSF-supported projects. See Grant Proposal Guide Chapter II, Section D.2 for instructions regarding preparation of these types of proposals.

The National Science Foundation has Telephonic Device for the Deaf (TDD) and Federal Information Relay Service (FIRS) capabilities that enable individuals with hearing impairments to communicate with the Foundation about NSF programs, employment or general information. TDD may be accessed at (703) 292-5090 and (800) 281-8749, FIRS at (800) 877-8339.

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

The National Science Foundation promotes and advances scientific progress in the United States by competitively awarding grants and cooperative agreements for research and education in the sciences, mathematics, and engineering.

To get the latest information about program deadlines, to download copies of NSF publications, and to access abstracts of awards, visit the NSF Website at http://www.nsf.gov

- **Location:** 4201 Wilson Blvd. Arlington, VA 22230
- **For General Information** (NSF Information Center)**:** (703) 292-5111
- **TDD (for the hearing-impaired):** (703) 292-5090
- **To Order Publications or Forms:**

  Send an e-mail to: nsfpubs@nsf.gov

  or telephone: (703) 292-7827
- **To Locate NSF Employees:** (703) 292-5111

PRIVACY ACT AND PUBLIC BURDEN STATEMENTS

The information requested on proposal forms and project reports is solicited under the authority of the National Science Foundation Act of 1950, as amended. The information on proposal forms will be used in connection with the selection of qualified proposals; and project reports submitted by awardees will be used for program evaluation and reporting within the Executive Branch and to Congress. The information requested may be disclosed to qualified reviewers and staff assistants as part of the proposal review process; to proposer institutions/grantees to provide or obtain data regarding the proposal review process, award decisions, or the administration of awards; to government contractors, experts, volunteers and researchers and educators as necessary to complete assigned work; to other government agencies or other entities needing information regarding applicants or nominees as part of a joint application review process, or in order to coordinate programs or policy; and to another Federal agency, court, or party in a court or Federal administrative proceeding if the government is a party. Information about Principal Investigators may be added to the Reviewer file and used to select potential candidates to serve as peer reviewers or advisory committee members. See Systems of Records, NSF-50, "Principal Investigator/Proposal File and Associated Records," 69 Federal Register 26410 (May 12, 2004), and NSF-51, "Reviewer/Proposal File and Associated Records," 69 Federal Register 26410 (May 12, 2004). Submission of the information is voluntary. Failure to provide full and complete information, however, may reduce the possibility of receiving an award.

An agency may not conduct or sponsor, and a person is not required to respond to, an information collection unless it displays a valid Office of Management and Budget (OMB) control number. The OMB control number for this collection is 3145-0058. Public reporting burden for this collection of information is estimated to average 120 hours per response, including the time for reviewing instructions. Send comments regarding the burden estimate and any other aspect of this collection of information, including suggestions for reducing this burden, to:

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