

Software for Real-World Systems (SRS)

Program Solicitation

NSF 07-599



National Science Foundation

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

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

January 17, 2008

REVISION NOTES

In furtherance of the President's Management Agenda, NSF has identified programs that will offer proposers the option to utilize Grants.gov to prepare and submit proposals, or will require that proposers utilize Grants.gov to prepare and submit proposals. Grants.gov provides a single Government-wide portal for finding and applying for Federal grants online.

In response to this program solicitation, proposers may opt to submit proposals via Grants.gov or via the [NSF FastLane](#) system. 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.3 of the Grant Proposal Guide provides additional information on collaborative proposals.

SUMMARY OF PROGRAM REQUIREMENTS

General Information

Program Title:

Software for Real-World Systems (SRS)

Synopsis of Program:

Software is a critical element in a broad range of real-world systems ranging from micro- and nano-scale embedded devices in highways, household appliances, and medical devices to continental- and global-scale critical infrastructures, such as communications and electrical power grids and transportation, health care, and enterprise systems. While software's role in governing overall system behavior can ultimately determine success or failure, the science and engineering of designing and building software for real-world systems remain elusive and poorly understood.

The Directorate for Computer and Information Science and Engineering (CISE) is calling for researchers to discover, define, and apply new scientific principles, engineering processes and methods, and educational pedagogy to the design, development, and use of software for real-world systems. The Software for Real-World Systems (SRS) Program specifically intends to bridge and transcend CISE disciplines by encouraging collaborations that might include any of the sub-disciplines of computer and information science and engineering (e.g., a new logic for reasoning about software systems complexity) to answer the question: **How can software for real-world systems be designed, built, and analyzed in elegant and powerful new ways?** Collaborative activities that include researchers from both the foundations of software (including for example, programming languages, formal methods, and software engineering) community and the computer and network systems community are encouraged.

Bold rethinking of the science and engineering of software for real-world systems – from the basic concepts of design, evolution, and adaptation to the integration of human capabilities – is needed. Emerging technologies, such as multicore processors and pervasive computing, heighten the urgency for new thinking as we build software for future systems. SRS is looking for multi-investigator teams or single investigators who will integrate diverse ideas and novel approaches in the design, development, and use of software for real-world systems.

Cognizant Program Officer(s):

- Alan R. Hevner, Program Director, 1115 N, telephone: (703) 292-8649, email: ahevner@nsf.gov
- Helen Gill, Program Director, 1175 N, telephone: (703) 292-8950, email: hgill@nsf.gov
- Wayne G. Lutters, Program Director, 1125 S, telephone: (703) 292-8930, email: wlutters@nsf.gov
- Joseph Urban, Program Director, 1115 N, telephone: (703) 292-8910, email: jurban@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: 12 to 20

Anticipated Funding Amount: \$10,000,000 pending 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

An investigator may participate as a PI, co-PI, or Senior Personnel in at most **two SRS proposals**, but may participate in no more than one proposal as a single investigator. In other words, if an investigator participates in more than one proposal, at least one of the proposals must be a multi-investigator team project. Proposals that do not comply with this condition will be returned without review; it is therefore strongly advised that all project personnel check with their colleagues to ensure that all participants are in compliance.

Proposal Preparation and Submission Instructions

A. Proposal Preparation Instructions

- **Letters of Intent:** Not Applicable
- **Full Proposals:**
 - Full Proposals submitted via FastLane: 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=jpg.
 - 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/bfa/dias/policy/docs/grantsgovguide.pdf>)

B. Budgetary Information

- **Cost Sharing Requirements:** Cost Sharing is not required by NSF.
- **Indirect Cost (F&A) Limitations:** Not Applicable
- **Other Budgetary Limitations:** Not Applicable

C. Due Dates

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

January 17, 2008

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

Software plays a critical role in a broad range of real-world systems that are pervasive and integral to our lives, ranging from the smallest micro- and nano-scale embedded devices to continental- and global-scale critical infrastructures, such as communications and electric power grids and transportation, health care, and enterprise systems. The types of real-world systems that are the focus of this solicitation include cyber-physical systems (e.g., clinical medical devices, sensors embedded in cars, highways, and bridges), networked systems (e.g., the Internet, banking and financial systems), mobile and ubiquitous systems (e.g., wireless systems, networks of “things that think”), along with other software-intensive systems. Future real-world systems will incorporate emerging technologies, such as multicore processors, which introduce new and different fundamental challenges for software development. While software may be only one component in such systems, it plays a critical role in system stability (or cascading failures), technological innovation (or stagnation), and system success (or failure). Yet, the science and engineering of designing and building the software that will govern the essential behaviors and properties of real-world systems remain elusive and poorly understood.

As real-world systems grow in number, size, complexity, and importance, it becomes increasingly clear that researchers in the sub-disciplines of computer and information science and engineering need to collaborate to rethink the scientific principles, engineering processes and methods, and educational pedagogy that underlie these systems.

II. PROGRAM DESCRIPTION

Software systems and technologies have become a cornerstone of the world economy, fueling organizational productivity and industrial growth. Yet we know that current software technologies have limited security, reliability, and functionality, and that they are not always dependable, which can introduce risks in critical life or death situations. As software-intensive systems become increasingly ubiquitous in our lives, they also become more heterogeneous, decentralized, indeterminate, dynamic, and participatory, demanding increasingly sophisticated control mechanisms and sufficient intelligence to adapt, learn, and reason about the unstructured and uncertain environments in which they operate.

The engineering of software for real-world systems needs new processes and methods based on new scientific principles. This solicitation seeks answers to the question: **How can software for real-world systems be designed, built, and analyzed in elegant and powerful new ways?** A bold rethinking of the fundamentals of software design and evolution as well as new approaches to system adaptation in uncertain human, natural, and man-made environments is needed.

A. Real-World Challenges

The Software for Real-World Systems (SRS) Program calls on researchers to develop new scientific principles, engineering processes and methods, and educational pedagogy for the challenges inherent in such systems. SRS encourages multi-investigator and/or single investigator projects that integrate diverse ideas and novel approaches to produce new knowledge and technologies that address the challenges outlined below. Collaborative activities that include researchers from both the foundations of software (including for example, programming languages, formal methods, and software engineering) community and the computer and network systems community are encouraged.

Recognizing that the challenges described below are interdependent and have overlapping dimensions, successful projects will promise innovations and paradigm shifts in at least two of the following three areas.

1. *Design and evolution of large-scale, real-world systems with scalable, computational methods of composition.*

SRS encourages research projects that develop new scientific principles and engineering processes in support of the design and evolution of real-world systems that can expand to arbitrary size and complexity and that support human intellectual control during development and operation. Considerations of scale, control, and modularity demand that systems be assembled out of components, services, and coordination mechanisms as structured by overarching system architectures. Emerging technologies add new layers of design complexity. For example, the use of multicore processors will require new principles and methods for analyzing, designing, and coordinating parallel processing threads and information streams in a system architecture. **What scientific principles are needed to support engineering processes and methods for scalable, computational composition of human, software, and platform components in order to understand and analyze resulting behaviors and dynamic properties?**

As disparate components are composed into systems, notions of behavioral correctness among the components must be reconciled and the resulting correctness of the composed system's behavior calculated. **What scientific principles are needed to move the field beyond current conceptions and calculations of correctness?**

New principles and methods for designing software to acquire, organize, analyze, and distribute information in real-world systems are desired. The development of sophisticated interfaces, powerful data manipulation languages, and innovative data analytic methods will provide the capability to build effective real-world systems that can manage large information requirements. **How can software for data-intensive systems be designed to cope with enormous amounts of data and to transform that data into useful, actionable information and knowledge?**

2. *Monitoring, orchestration, and control of real-world system behaviors and interactions in dynamic, ever-changing conditions and operational environments.*

The second challenge focuses on the dynamic properties of software components, such as performance, reliability, security, and usability, and how they are represented and analyzed as computable features of composed systems, particularly during operation. **How can real-world systems be designed to identify, understand, manage, and potentially optimize their emergent behaviors and dynamic properties during operation?** Since it is impossible to specify or predict a priori all of the behaviors or dynamic properties of a real-world system while it is operating, unknown, emergent behaviors and properties may result. Thus, methods and principles for dynamic adaptability must be discovered and applied to manage the adaptation of the system as it responds to its environment and transaction load. The flexible nature of software and its inherent malleability provide the potential for systems to adapt autonomically (e.g., self-diagnosing, self-configuring, or self-repairing) to environmental conditions. **What scientific principles and engineering processes and methods are needed to support the autonomic performance of a real-world system in response to its dynamic, ever-changing conditions and operational environment?**

This challenge requires system-level orchestration and control that spans many potential interfaces and interactions with hardware platforms, data, other software components, and people. **How can critical interactions within and among real-world systems and**

between systems and humans be 1) detected and limited or 2) enabled and controlled, as the situation requires?

Systems software that provides principled services and architectures is needed to enable and provide a suitable basis for certifiably dependable systems. Traditional fixed points such as the boundaries that divide operating systems and middleware may need to be reexamined for varied, dynamic, and interacting systems. Future applications will place extreme demands on systems that are time-critical or require dynamic resource allocation, low latency, or low jitter. Service architectures will need to support higher-level abstractions (e.g., for sensing, communication, coordination, prediction, and control) and varied and perhaps changing aggregations of interacting systems. **What scientific principles and engineering methods of analysis and certification are required to achieve system architectures and mechanisms whose composite properties and behaviors are certifiably dependable?**

3. *Amplification of human participation in the design and use of real-world systems.*

The third challenge includes people and human factors in the design of software for real-world systems. People are key participants in most real-world systems, serving as users, software developers, and maintainers. Despite their importance, human-centered design of real-world systems is not routine. **How can software for real-world systems be designed where interactions with people are at the core of the systems design?** We live in a world increasingly defined by software. SRS seeks projects that will produce new knowledge about how to guide the evolution of this software-defined world so that human values are embedded in it, optimal experiences are achieved, and all of society benefits. **What knowledge and tools are needed for people to participate fully in the design, development, and use of real-world systems as end-users, programmers, and stakeholders?**

Another important component of this challenge is how best to harness collective intelligence and human ingenuity in the design and development of software for real-world systems. Participatory computing and open source software (OSS) development provide rich opportunities for user-centered innovations in future systems. **What scientific principles and engineering processes methods are needed to support effective software design collaborations among many, widely distributed contributors? Can the principles and engineering methods of OSS be discovered and extended to a fuller range of participatory computing approaches?**

B. Innovations and Paradigm Shifts in Fundamental Principles, Engineering Processes, and Education Pedagogy

In responding to the challenges of designing and building software for real-world systems outlined in (A) above, projects must pay attention to innovations and paradigm shifts in the scientific principles, engineering processes and methods, and/or educational pedagogy of software for real-world systems. Each project should innovate in at least two of the following areas:

- *Scientific Principles:* SRS calls for a fresh look at the question: **What are the scientific principles for creating and analyzing software for real-world systems?** The Program seeks to uncover fundamental concepts and principles for the development of software as have been found in other sciences such as physics and chemistry. Transformative theories, models, logics, languages, and algorithms are sought. For example, the use of current software development principles of modularity and abstraction levels provide clear benefits for software understandability, reuse, and modifiability. **In a world of dynamic operational environments and real-time adaptability, do we need new understandings of long-proven software development principles or do we need new principles altogether?**
- *Engineering Processes and Methods:* **What are the most effective engineering processes and methods for designing, building, and analyzing software for real-world systems?** The SRS Program calls for innovative methods, techniques, processes, architectures, tools, and testbeds. For example, engineering methods of incremental development and rapid prototyping have been shown to be effective for the development of many existing software systems. **Will such methods still be effective in development environments that are dynamic, decentralized, and where system components are heterogeneous and under the control of other parties? What new engineering methods of system certification are needed in such environments?**

- *Educational Pedagogy*: Regardless of their complex functionality and dynamic properties, software systems must still be easy to understand, use, maintain, and modify. An important goal of the SRS Program is to support innovative pedagogy for educating students and training the U.S. workforce on the new ideas produced by the funded research projects. **What new educational ideas and activities are needed to support the learning and application of scientific principles and engineering methods for the design, construction, and analysis of software for real-world systems?**

Relation to Other Programs

Research on software for real-world systems is an active concern in other NSF programs. Submissions to the SRS Program must have a clear focus on basic research to advance the *science and engineering of software for real-world systems*. Projects outside of this focus can be submitted to related NSF programs, including the following programs.

- The Computing Processes and Artifacts (CPA) cluster within the CCF Division supports research projects where the focus is on particular core software engineering topics such as programming languages and software testing.
- The Computer Systems Research (CSR) program within the CNS Division supports a range of computer systems research topics including cyber-physical systems, dynamic data driven applications systems, and cross systems integration.
- The Information and Intelligent Systems (IIS) Division supports research that: addresses systems in which humans, whether as individuals, teams, organizations, or societies, assume participatory and integral roles throughout all stages of systems development and use; and, develops new knowledge about computational understanding and modeling of the many human and animal capabilities that demonstrate intelligence and adaptability in unstructured and uncertain environments.
- The CISE Pathways to Revitalized Undergraduate Computing Education (CPATH) program supports projects to transform undergraduate computing education on a national scale to meet the challenges and opportunities of a world where computing is essential to U.S. leadership and economic competitiveness across all sectors of society.
- The Engineering (ENG) Directorate has programs in the areas of engineered systems and engineering design.
- The Cyber-enabled Discovery and Innovation (CDI) Program will fund research to support the mutual invention and discovery of new computational concepts, methods, models, algorithms and tools that bridge computer science and other fields of science and engineering.

Proposals involving the development of software systems and/or software tools for a particular application domain specific to another NSF division such as physics, chemistry, or earth sciences should be sent to a program in that division.

Potential investigators should contact the cognizant Program Officers if they have any questions about where their research ideas best fit. Proposals appropriate for consideration in the SRS program may include topics from one or more of the programs described above.

III. AWARD INFORMATION

\$10,000,000 is available in FY 2008, pending availability of funds. Estimated program budget, number of awards and average award size/duration are subject to the availability of funds. SRS encourages multi-investigator team or single investigator research projects formed across multiple disciplines or sub-areas of computer and information science and engineering. Collaborative activities that include investigators from both the foundations of software (including for example, programming languages, formal methods, and software engineering) community and the computer and network systems community are encouraged. Projects will be funded for durations and at levels commensurate with the size of the team and the scope of the research. Larger projects typically will be funded for up to 3 years at levels of up to \$300,000 per year.

Investigators who wish to submit proposals that exceed these parameters must receive prior permission to do so from a cognizant SRS Program Officer.

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

An investigator may participate as a PI, co-PI, or Senior Personnel in at most **two SRS proposals**, but may participate in no more than one proposal as a single investigator. In other words, if an investigator participates in more than one proposal, at least one of the proposals must be a multi-investigator team project. Proposals that do not comply with this condition will be returned without review; it is therefore strongly advised that all project personnel check with their colleagues to ensure that all participants are in compliance.

Additional Eligibility Info:

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 pubs@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/bfa/dias/policy/docs/grantsgovguide.pdf>). 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 pubs@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.3 of the Grant Proposal Guide provides additional information on collaborative proposals.

The following instructions supplement guidance in the GPG or NSF Grants.gov Application Guide.

Research Innovations and Paradigm Shifts – SRS proposals must describe how the project will provide innovations and paradigm shifts in **at least** two of the three areas of *scientific principles, engineering processes and methods, and educational pedagogy* to address the challenges of designing, building, and analyzing software for real-world systems. The “Project Summary” and “Project Description” sections of the proposal must explicitly articulate the expected research contributions to be made in two (or three) of these areas.

Collaboration Plan – For proposals involving multiple investigators, up to three additional pages are required as a supplemental document titled, “Collaboration Plan.” This plan should be included in the “Special Information and Supplemental Documentation” section of the proposal and does not count toward the 15-page limit of the Project Description. The purpose of this Plan is to provide detailed information about the roles of key project personnel and the plans for coordinating project tasks among multiple individuals, institutions and disciplines, as applicable. The Collaboration Plan will be reviewed for clarity of task definitions, effectiveness of task assignments, and achievability of project objectives.

B. Budgetary Information

Cost Sharing: Cost sharing is not required by NSF in proposals submitted to the National Science Foundation.

C. Due Dates

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

January 17, 2008

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. The Grants.gov's Grant Community User Guide is a comprehensive reference document that provides technical information about Grants.gov. Proposers can download the User Guide as a Microsoft Word document or as a PDF document. The Grants.gov User Guide is available at: <http://www.grants.gov/CustomersSupport>. 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 and, if they meet NSF proposal preparation 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 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 with the proposer.

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 and original 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?

NSF staff 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:

Research Innovations and Paradigm Shifts – SRS proposals must describe how the project will provide innovations and paradigm shifts in **at least** two of the three areas of *scientific principles*, *engineering processes and methods*, and *educational pedagogy* to address the challenges of designing, building, and analyzing software for real-world systems. The “Project Summary” and “Project Description” sections of the proposal must explicitly articulate the expected research contributions to be made in two (or three) of these areas.

Collaboration Plan – For multi-investigator projects, a “Collaboration Plan” is required and should provide detailed information about the roles of key project personnel and the plans for coordinating project tasks among multiple individuals, institutions and disciplines, as applicable. The Collaboration Plan will be reviewed for clarity of task definitions, effectiveness of task assignments, and achievability of project objectives.

B. Review and Selection Process

Proposals submitted in response to this program solicitation will be reviewed by 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 date of receipt. 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 Federal Demonstration Partnership (FDP) 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/>

[general_conditions.jsp?org=NSF](#). Paper copies may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-7827 or by e-mail from pubs@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.

Failure to provide the required annual or final project reports 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.

VIII. AGENCY CONTACTS

General inquiries regarding this program should be made to:

- Alan R. Hevner, Program Director, 1115 N, telephone: (703) 292-8649, email: ahevner@nsf.gov
- Helen Gill, Program Director, 1175 N, telephone: (703) 292-8950, email: hgill@nsf.gov
- Wayne G. Lutters, Program Director, 1125 S, telephone: (703) 292-8930, email: wlutters@nsf.gov
- Joseph Urban, Program Director, 1115 N, telephone: (703) 292-8910, email: jurban@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.

Administrative support contact persons:

- Ms. Dawn Patterson, Program Analyst, dpatters@nsf.gov, (703) 292-8910, fax: (703) 292-9059

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, MyNSF (formerly the Custom News Service) 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 Regional 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. MyNSF also is available on NSF's Website at <http://www.nsf.gov/mynsf/>.

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>.

Related Programs:

Please refer to the list of related programs in the Program Description section.

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: pubs@nsf.gov
 - or telephone: (703) 292-7827
- **To Locate NSF Employees:** (703) 292-5111

PRIVACY ACT AND PUBLIC BURDEN STATEMENTS

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

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

Suzanne H. Plimpton
Reports Clearance Officer
Division of Administrative Services
National Science Foundation
Arlington, VA 22230

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