Computer Systems Research (CSR)

Program Solicitation
NSF 08-538

Replaces Document(s):
NSF 07-504

National Science Foundation

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

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

April 23, 2008

REVISION NOTES

The following revisions have been made to last year's solicitation:

- Previous CSR solicitations included separate thematic topics in System Modeling and Analysis (SMA) and Advanced Execution Systems (AES). These research topics remain of interest within each of the three core areas highlighted in this solicitation, but they are no longer separately identified.
- No new thematic or “seedling” areas are included in this announcement.
- The Cyber Physical Systems thematic topic from the previous solicitation is continued and expanded as a major component of the Embedded, Hybrid, and Critical Systems (EHCS) core area, preparing for possible future expansion.
- The Virtualization for Configuration Management (VCM) thematic area is not continued as a separate thematic topic, although it remains a very suitable subject for research proposals submitted to the CSR program. Leveraging virtualization and understanding its impact on systems' attributes and aspects are broad objectives that cut across all areas of CSR.
- The Cross-System Integration theme is not continued. However, issues of system integration are included implicitly in each of the three CSR core areas described in this solicitation.

SUMMARY OF PROGRAM REQUIREMENTS

General Information

Program Title:

Computer Systems Research (CSR)

Synopsis of Program:

Computer systems are being applied to increasingly demanding applications. The environments in which they function and the resources they manage are increasingly diverse, distributed and dynamic. While the time scales for control decisions are shrinking, the scale and complexity of the systems are increasing. Further, many of the assumptions behind today’s most common computer systems no longer hold. As a

result, these systems often fail in unpredictable ways, become compromised or perform poorly. Accordingly, the frontiers of computer systems research must be moved forward, and new bold research directions must be established to draw upon interdisciplinary research capabilities across science and engineering.

The Computer Systems Research (CSR) Program supports innovative research and education projects that:

- increase our understanding of large-scale and increasingly data-intensive computer systems and applications, through the creation of new knowledge needed to improve their design, use, behavior, and stability;
- capitalize on research opportunities provided by new technologies and new classes of systems;
- expand the capabilities of computer systems by developing highly innovative new ways to exploit existing technologies;
- lead to systems software that is quantifiably more reliable, easier to use, and/or more efficient; and
- produce innovative curricula or educational materials that better prepare future generations of computing professionals.

CSR-funded projects will enable significant progress on challenging high-impact problems, as opposed to incremental progress on familiar problems. Collaborative CSR projects that actively involve industry or other academic communities are particularly welcome. For example, to stimulate breakthroughs in *human-aware* computer and software systems and applications, multi-investigator, multidisciplinary proposals are encouraged. Further, CSR PIs should describe credible plans for demonstrating the utility and potential impact of their proposed work, for example, through empirical prototypes disseminated to and evaluated by the community.

The FY 2008 competition invites innovative, forward-looking research projects in the following three areas:

- Distributed and Mobile Systems and Services (DMSS);
- Parallel Systems, Computing and Execution (PSCE); and
- Embedded, Hybrid, and Critical Systems (EHCS).

Proposals may be submitted in one of the following three categories:

- Small - projects with total budgets up to $450K and durations of up to 3 years (with maximum annual budgets of $150K).
- Team - projects with total budgets up to $2.0M, and durations of up to 4 years (with maximum annual budgets of $500K).
- Other- including planning grants, workshops, Small Grants for Exploratory Research (SGER), and other community building activities. Planning grants and SGER proposals will be funded at levels up to $100K/year for up to two years. Workshops in new or emerging areas in computer and software systems research and education will be funded at levels up to $50K for one year. *Prior to submission of any proposal in the "Other" category, PIs must get permission to submit their proposals from a CSR Program Officer.*

Cognizant Program Officer(s):

- David Du, Program Director, DMSS and PSCE, telephone: (703) 292-8950, email: ddu@nsf.gov
- Helen Gill, Program Director, EHCS, telephone: (703) 292-8950, email: hgill@nsf.gov
- Anita J. LaSalle, Program Director, PSCE and DMSS, telephone: (703) 292-8950, email: alasalle@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:

50 to 60 total. The CSR Program expects to make the following three types of awards:

Small - projects with total budgets up to $450K and durations of up to 3 years (with maximum annual budgets of $150K).

Team - projects with total budgets up to $2.0M, and durations of up to 4 years (with maximum annual budgets of $500K).

Other - including planning grants, workshops, Small Grants for Exploratory Research (SGER), and other community building activities. Planning grants and SGER proposals will be funded at levels up to $100K/year for up to two years. Workshops in new or emerging areas in computer and software systems research and education will be funded at levels up to $50K for one year. Prior to submission of any proposal in the "Other" category, PIs must get permission to submit their proposals from a CSR Program Officer.

Anticipated Funding Amount: $37,000,000 in FY 2008. Approximately $18,000,000 expected for Small Projects, $16,000,000 for Team Projects, and the remainder for awards in the "Other" category. These estimates are subject to the availability of funds and the quality of proposals submitted.

Eligibility Information

Organization Limit:

Proposals may only be submitted by the following:

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

PI Limit:

CSR encourages university-industry collaboration. Accordingly, researchers from for-profit organizations are eligible to participate in proposals submitted by academic institutions, where they may participate as PIs, co-PIs, Senior Personnel, or sub-contractors. However, the CSR program will not provide salary or related financial support for the individuals from for-profit organizations.

PIs submitting proposals to the Cyber-Physical Systems area are encouraged to consider developing collaborative projects with researchers in foreign organizations; however, CSR will not provide support for the foreign participants.

Limit on Number of Proposals per Organization:

None Specified

Limit on Number of Proposals per PI: 2

An individual may appear as PI, co-PI, Senior Personnel, or Consultant on no more than two proposals submitted to the Computer Systems Research (CSR) program. Further, an individual may appear as PI, co-PI, Senior Personnel or Consultant on **no more than three proposals** submitted in total to the following NSF programs in each fiscal year: Computer Systems Research (CSR), Cyber Trust (CT) and Networking Technology and Systems (NeTS). CSR, CT and NeTS proposals that include one or more individuals who exceed this limit will be **collectively** returned without review. This limitation applies only to these three NSF programs and has no impact on other NSF programs.

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/bfa/dias/policy/docs/grantsgovguide.pdf)

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

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

    April 23, 2008

Proposal Review Information Criteria

Merit Review Criteria: National Science Board approved criteria apply.

Award Administration Information

Award Conditions: Standard NSF award conditions apply.

Reporting Requirements: Standard NSF reporting requirements apply.

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I. INTRODUCTION

Revolutionary advances in computer and software systems have created unprecedented opportunities for social innovations and economic prosperity. These systems represent the engine that powers the connected world in which we now live. They cover a wide range of technologies and capabilities, including large-scale, globally distributed heterogeneous systems, LAN-based enterprise systems, workstation clusters, shared-memory multiprocessors, pervasive and ubiquitous systems, special-purpose embedded and real-time systems, processes and supervisory controls, and assemblies of embedded sensor systems. They also support increasingly complex and more dynamic applications and services.

The need to meet the requirements of present and future applications calls for radically new and innovative approaches to the design, implementation, operation and management of next generation computer and software systems. Also needed are new paradigms, frameworks, methods and tools that ensure these complex systems operate effectively, reliably, and securely.

The Computer Systems Research (CSR) Program supports innovative research and education projects that have the potential to:

- increase our understanding of large-scale and increasingly data-intensive computer systems and applications through the creation of new knowledge needed to improve their design, use, behavior, and stability;
- capitalize on research opportunities provided by new technologies and new classes of systems;
- expand the capabilities of computer systems by developing highly innovative new ways to exploit existing technologies;
- lead to systems software that is quantifiably more reliable, easier to use, and/or more efficient; and
- produce innovative curricula or educational materials that better prepare future generations of computing professionals.

CSR-funded projects will enable significant progress on challenging high-impact problems, as opposed to incremental progress on familiar problems. Collaborative CSR projects that actively involve industry or other academic communities are particularly welcome. For example, to stimulate breakthroughs in *human-aware* computer and software systems and applications, multi-investigator, multidisciplinary proposals are encouraged. Further, CSR PIs should describe credible plans for demonstrating the utility and potential impact of their proposed work, for example, through empirical prototypes disseminated to and evaluated by the community.

II. PROGRAM DESCRIPTION

In FY 2008, the CSR Program seeks innovative, forward-looking research and education projects within and across three core areas that pose unique research challenges reflecting the scope, complexity and dynamics of computer and software systems. The three core areas are:

- Distributed and Mobile Systems and Services (DMSS);
- Parallel Systems, Computing and Execution (PSCE); and
- Embedded, Hybrid, and Critical Systems (EHCS)

Research and education opportunities in these core areas are ripe with interdisciplinary potential and promise significant breakthroughs both in the way future computer and software systems are designed, implemented, operated and managed, and in the way humans interact with these systems. The core areas are elaborated below.

A. Distributed and Mobile Systems and Services (DMSS)

Traditionally, distributed systems were built under conditions of gradual, regulated growth, stable ownership, full control of underpinning technology platforms, connected operation, and centralized organizations. However, the environment in which computer and software systems are created and operated today has changed radically. The success of the Internet has impacted the use and scale of distributed systems, ushering in an entirely new class of large-scale, distributed applications. Further, advances in technology for capturing and storing data, coupled with the Internet's capability to retrieve data on a global scale, are giving rise to a number of new data-intensive applications, where very large data sets are stored and retrieved on a regular basis, and where new data, derived from computation over raw information, are frequently updated and saved.

The proliferation of networked and embedded devices is also revolutionizing the field of distributed computing. Advances in wireless networking, mobile computing and sensor technology are creating increasingly powerful but highly variable distributed computing and communications substrates. Digital devices, such as mobile phones for example, are becoming powerful distributed computing platforms. These devices must support both connected and disconnected usage, with each other and with the global Internet, and tolerate mixed modalities and highly variable conditions of the networking environments in which they are expected to operate. As such, they reflect the rapidly changing modalities of information access and sharing and the constantly changing value propositions and markets for components, technology and service provisioning.

The focus of the DMSS area is to support bold research and education projects that advance the state-of-the-art in distributed and mobile systems and applications and further our understanding of the knowledge needed to address the challenges posed by these systems and deliver the functions required by these applications. DMSS encourages research that reexamines the suitability of current operating systems and middleware for emerging computing systems and applications, and focuses on highly original ideas, new approaches and ground-breaking methodologies. Research outcomes will promise transformative impact within the area and on distributed computing practice.

Broad categories of research of interest within DMSS include, but are not restricted to:

- Resource management: scheduling, virtual memory management and protection; management of multiple levels of memory hierarchy and file systems; new approaches to the design and management of file systems architectures for very large-scale, distributed environments; content management and archive strategies for large-scale distributed systems; scalable and robust methods for communication and synchronization; process and data migration and data replication; virtualization of resources and efficient resource utilization; scalable and adaptive approaches for resource management in very large-scale, failure prone computing environments; and resource management across heterogeneous platforms with distinct administrative boundaries.
- System storage: new directions and innovative approaches for the design, implementation, evaluation and analysis of modern computer storage systems; storage virtualization; energy efficient, self-managing storage; novel technology-driven storage systems; scalable, secure, reliable, and easy-manageable storage systems; mobile, access-anywhere and personal storage; and innovative approaches to data and metadata caching, replication and consistency.
- System services: membership, naming, and authorization services; local and remote resource discovery and resource requests services; support for debugging large, widely dispersed distributed systems; checkpoint and recovery services; positioning, tracking, location-aware services in mobile computing environments; mechanisms that enable dynamic coalitions, such as in peer-to-peer or ad-hoc environments; mechanism to support various and mixed interaction and invocation modalities; and customizable and adaptable systems services.
- System architecture: software architectures addressing changing trends, such as sizes or speeds of processors, memory, address spaces, storage and backing store; multi-threaded kernel design and kernel-level management functions for end-to-end provisioning of services; dynamic, customizable kernels; high-level programming abstractions and models for data-intensive applications; system software architectures that scale to handle thousands of components; software architecture to support service composition, particularly in wireless environments; new resource-aware service architectures and programming abstractions for networked embedded computing; context-aware systems architectures; and new paradigms and frameworks to organize systems, such as peer-to-peer networks.
- System properties: balancing security, usability and flexibility; fault-tolerance and reliability; efficiency; scalability; resiliency and adaptability for longevity of continuous service; and ability to cope with unexpected events.
- System management, maintenance, and evolution: new paradigms and frameworks to improve manageability, configurability and accountability while reducing the associated costs and overheads; monitoring software and tools to inspect and determine the system’s state from various levels of abstraction, and monitor various hardware configurations for reliability, operation sustainability and performance; trainable, self-tunable software and tools that learn important system configurations, such as topology, status, interconnection norms, patterns of behavior and parameters; methods to inspect, diagnose and understand problems in the system, anomalies, and

performance impediments in order to improve reliability, reduce vulnerabilities, and ascertain connectivity while improving usability.

- System performance: performance evaluation and predication of large scale systems; system measurement and monitoring for performance tuning or to provide resilience to faults; qualitative and quantitative evaluation of complex systems; verification and validation frameworks and tools; methods and tools to assess the impact of different system components on the overall performance of the system; and advanced simulation tools and techniques.

B. **Parallel Systems, Computing and Execution (PSCE)**

Early high-end parallel computer systems were designed with specialized architectural structure, interconnects, and a variety of memory hierarchies. The computational load, largely high-end scientific computation and industrial design, was primarily supported through reusable libraries of algorithms that had been carefully parallelized for target architectures. The mainstreaming of high-speed multiprocessing, presaged by speed and scale advances in processing technology, novel graphics and other special-purpose computing engines, along with the increasing availability of multiprocessing computing platforms, provided a viable alternative to increase performance, while reducing energy consumption, heat dissipation and design complexity. The trend toward high processing power at a reasonable cost continues with the emergence of multi-core architectures with extremely large numbers of processors, and the growing use of reconfigurable processors such as FPGAs, reconfigurable interconnects, and wireless on-chip networks. These emerging platforms are no longer targeting only high-end computing, but are also aimed for commodity deployment. Traditional computing frameworks, methods and languages for exploiting such resources do not scale to commodity usage. Innovative approaches for the design and implementation of high-performance computing systems are needed to extend the computing frontiers, realize the potential of emerging technology and meet the increasing demands of present and future computation-intensive applications.

The PSCE area seeks innovative and potentially transformative concepts in parallel system design, runtime support for general purpose parallel programming and coordination languages, and middleware and operating systems to manage the requirements of applications they must execute. PSCE supports research to enable coherent provisioning, management, and protection of resources and services across heterogeneous platform architectures and service modalities. Research also is encouraged towards organization of systems technologies to include service architectures and coordination frameworks that enable concurrent execution, manage multi-party interaction, provide integral security, and support a wide variety of distribution patterns running across both computational platforms and networks.

Broad categories of PSCE research include, but are not restricted to:

- Advanced frameworks, programming models and environments for large-scale parallel systems, including system software and operating environments to support complex, resource and data intensive applications; new paradigms for automatic parallelization; middleware for parallel systems; synchronization and concurrency control in large-scale parallel systems; power and energy-aware parallel programming models and abstractions; fault-tolerance and recovery paradigms, mechanisms and tools for dynamic runtime environments; new programming models, compilers and runtime support environments for multi-core systems; multi-core virtualization; and functional debugging and performance tools for multi-core systems.
- New compilation and optimization techniques for runtime parallel systems, including dynamic and adaptive compilation and automatic code generation; computation steering for reliability, scalability and improved performance; innovative approaches for integration of tools, compilers and operating systems; architectural and system support for optimization; dynamic, adaptive and continuous optimization in parallel systems; profiling and feedback-directed optimization methodologies; power and energy aware optimization; transactional memory optimizations; and program characterization and phase analysis techniques for optimized performance.
- Advanced resource management frameworks, methods and tools, including automated resource and application management; integrated resource optimization methods and tools; scalable scheduling algorithms for resource and data intensive large-scale parallel systems; multi-criteria scheduling frameworks and algorithms; tools and environments for workflow scheduling in parallel systems; adaptive and dynamic load balancing algorithms and tools; and application and system level methodologies and tools that exploit the characteristics of the hardware and execution environment to efficiently map parallel computations onto the underlying parallel system.
- Support tools and environments for large-scale parallel systems, including intelligent frameworks and tools that exploit knowledge about program behavior for debugging, monitoring, testing and diagnosis; tools to support system analysis at different levels of granularity across different software layers and heterogeneous hardware platforms; frameworks and methods for instrumentation, measurement and modeling of system behavior; and novel frameworks, methodologies and tools for performance prediction and evaluation of complex parallel systems and large-scale parallel applications.

C. **Embedded, Hybrid, and Critical Systems (EHCS)**

Information technology for embedded and hybrid systems is a key accelerator of progress and innovation in modern engineered systems. Embedded and hybrid systems control devices and systems include cell phones, PDAs, hearing aids, pacemakers, automobiles, electrical power grids, chemical processing plants, and global aviation infrastructure. In fact, the nation's critical infrastructures depend on embedded sensing and hybrid control systems. Many of these are safety- or enterprise-critical systems, with growing interconnectivity and interdependency. However, systems today are often built on top of decades-old technology, as separate, closed, and centralized systems. Future real-time, embedded systems and supervisory and real-time process control systems must become open and interoperable with other systems in widely distributed and highly interactive and uncertain environments.

Research supported under the EHCS area in FY 2008 addresses two component themes in computer systems research: Embedded and Hybrid Systems (EHS) and Cyber-Physical Systems (CPS).

- EHS supports fundamental research needed to develop a deep scientific understanding of real-time embedded computing systems. Research focused on innovative sensing and control concepts in computing for physical and engineered systems is also of interest.
- CPS is an aggressive, forward-looking challenge component that supports transformative research breakthroughs in computational and communication capabilities for future generations of physical and engineered systems, with a strong emphasis on multidisciplinary system development. The CPS challenge is motivated by cyber and physical elements that are deeply integrated into their environments and networked at all scales, and systems that exploit ubiquitous cyber control of physical components. The term "cyber" refers to the integration of computation, communication, storage, and control.

A pervasive subtext in both components of the EHCS area is the creation of high-confidence systems through technologies that can not only support innovative functionality, but also can provide timeliness, dependability, safety, and security guarantees for critical and highly-autonomous systems. Further description of both components of EHCS follows.

1. **Embedded and Hybrid Systems (EHS):**

   EHS supports research and education in the core scientific foundations and systems technology for embedded and hybrid systems. EHS emphasizes hybrid (discrete and continuous) control, and computational modeling of the temporal and dynamic aspects of this class of systems. The goals of this area are to create and unify foundations and to supply technologies needed for building reliable embedded systems. Achieving these goals requires a rethinking of the underpinnings, architectures, and system implementation philosophies for these kinds of systems. The area draws upon control theory, modeling, software generation, real-time and resource-aware scheduling, and formal methods. The span of topics falling within this area includes: real-time systems, hybrid control systems, embedded systems platforms and reconfigurable computing for embedded systems, computational aspects of sensing and actuation networks, and concepts and open assurance technologies for high confidence embedded systems.

   Specific examples of interest include:

   - Embedded systems software and composition technology: innovative concepts and methods for middleware, virtualization strategies, virtual machines, and system services; concepts and methods for high confidence, distributed, real-time operating systems; system services and composition technology to support required properties of complex real-time embedded systems; and programming methods for the integration of embedded system services.
   - Foundations and technology for distributed sensing and control: innovative hybrid control concepts, innovations in supervisory control and data acquisition (SCADA) systems and process control systems (PCS); and scalable support for embedded sensors and sensor nets; managing authority in autonomous and mixed-initiative systems.
   - Assurance methods for modeling, design, development, and certification of high-confidence embedded software and systems: foundations, design, implementation, synthesis, analysis, composition, and certification methods and tools; and innovative approaches for failure modes, mixed criticality, self-test, and recovery and reconstitution.
   - Real-time resource management, partitioning and scheduling and optimization; and platforms for embedded and reconfigurable computing: methods and tools for allocating, scheduling, and managing real-time, power-aware distributed embedded systems; and static and real-time dynamic scheduling technology that addresses

and integrates multiple concerns such as real-time guarantees, power, clock frequency, thermal gain, emission and interference in the electromagnetic spectrum, network bandwidth, task dependence, and criticality level.

2. **Cyber-Physical Systems (CPS)**:

This component of EHCS expands on the CPS thematic area that was initiated in the FY 2007 CSR program. It seeks to open a new frontier of research to address both the growing complexity of physical and engineered systems and the immense capacity for innovation and invention that embedded computation and networked control lend to these systems. It seeks research ideas that organize and simplify this engineering space and advance the understanding, design, and construction of systems that are becoming fundamentally both cyber and physical. The theme seeks exploratory research in two specific focus areas for FY 2008, as described below.

CPS-T. This focus area seeks clean-slate exploratory research to reinvent the real-time systems software technology base. Today's middleware and real-time operating systems are monolithic ("one-size-fits-all"). The boundary between them is a historical technological artifact, rather than a well-designed separation of concerns. Today's virtualization concerns and kernel design strategies generally are focused on single issues (e.g., security, resources, or safety) and service concepts are offered at a very low level of abstraction. They do not scale successfully to very large or very small system requirements, or to open and complex systems. Certification and assurance activities currently are separated from design. The goal of CPS-T research is to discover appropriate new abstractions for open systems and develop open composition capabilities for the precise configuration of high confidence cyber services for CPS at the requisite scale. This research will establish concepts for next-generation systems software architectures and services that can support high-confidence, semantically-grounded CPS execution platforms.

CPS-E. This focus area seeks research in transformative cyber technology for areas such as engineering, materials, transportation, energy, biology, and medicine. Research proposals submitted under this focus will be co-reviewed and considered for co-funding by the NSF Engineering (ENG) directorate. The goal is to enable future multidisciplinary research. Research supported under this focus includes topics such as are listed below. This list is not exhaustive and is intended to illustrate, rather than circumscribe, the potential subjects of investigation. This focus remains highly exploratory; only extremely innovative and potentially transformative concepts should be proposed.

- New concepts for networked control of complex systems, including strategies for coordination and control of loosely coupled and reconfigurable systems, and for reasoning about, and cooperative supervisory control of, composite and highly-coupled systems.
- Novel abstractions and modeling strategies for predicting and controlling the actions and the dynamically evolving status of the physical, mechanical, material, biological, or chemical features of physical systems. The objective is to discover computational models that capture both "cyber" and "physical" aspects of the system and that directly support on-line, real-time interaction with, and computational control of, these phenomena and behaviors under the uncertainties of the natural or engineered environment.
- New systems science concepts for model-based and platform-based system design of CPS, aimed to successfully characterize and integrate the dynamic actions and behavior of cyber elements of a system with the dynamics of physical and engineered components, as well as with the potential cyber and physical actions of the computing and networking substrate. This might include, for example, frameworks for mediating the real-time interaction and interference of cyber and physical elements, and strategies for addressing such combined cyber and physical concerns as the integrated management of energy, power, and thermal effects that may be caused by both cyber and physical elements of the system.
- Transformative computational and physical substrates for deeply embedded networking and computing. This might include, for example, highly innovative computational elements or materials with cyber-mechanical or active structural properties that are fundamentally enabled by, or contribute to, networked computation.

III. AWARD INFORMATION

The estimated program budget in FY 2008 is $37,000,000 and the estimated number of new awards is 50 to 60. Approximately, the amount of $18,000,000 is expected for Small Projects, $16,000,000 for Team Projects, and the remainder for the third type of proposals. These estimates are subject to the availability of funds and the quality of proposals submitted. Awards will be made as standard or continuing grants. The CSR Program expects to make the following three types of awards:

Small - projects with total budgets up to $450K and durations of up to 3 years (with maximum annual budgets of $150K).

Team - projects with total budgets up to $2.0M, and durations of up to 4 years (with maximum annual budgets of $500K).

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IV. ELIGIBILITY INFORMATION

Organization Limit:

Proposals may only be submitted by the following:

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

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Limit on Number of Proposals per Organization:

None Specified

Limit on Number of Proposals per PI: 2

An individual may appear as PI, co-PI, Senior Personnel, or Consultant on no more than two proposals submitted to the Computer Systems Research (CSR) program. Further, an individual may appear as PI, co-PI, Senior Personnel or Consultant on **no more than three proposals** submitted in total to the following NSF programs in each fiscal year: Computer Systems Research (CSR), Cyber Trust (CT) and Networking Technology and Systems (NeTS). CSR, CT and NeTS proposals that include one or more individuals who exceed this limit will be **collectively** returned without review. This limitation applies only to these three NSF programs and has no impact on other NSF programs.

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 information supplements or deviates from the GPG or the NSF Grants.gov Application Guide

To assist NSF staff in sorting proposals for review, proposal titles should begin with “CSR-key1, key2: Project Title” where key1 is an acronym that identifies the core areas, and when relevant the component theme within the core area, and key2 represents the project category. If a proposal addresses topics in more than one core area, it should be directed to whichever one of the areas is most appropriate. Choose from the following key 1 acronyms to identify the appropriate core area:

- DMSS - Distributed and Mobile Systems and Services
- PSCE - Parallel Systems, Computing and Execution.
- EHCS(EHS) - Embedded and Hybrid Systems
- EHCS(CPS) - Cyber Physical Systems

Choose from the following key2 acronyms to identify the category of proposal submitted:

- SM - Small
- TM - Team
- OTH - Other

For example, a proposal might have a title such as “CSR-DMSS, TM: Resource Management in Peer-to-Peer Systems.”

For proposals in the "Other" - OTH category, PIs must contact one of the CSR Program Officers for permission to submit.

CSR proposals should describe how the project will yield significant research and education outcomes (e.g., by validating theories on real systems, by demonstrating the utility of new systems software and making it available to the community, and/or by disseminating and evaluating new educational materials or curricula).

Every proposal must include a discussion of Broader Impacts. Broader Impacts include the integration of education and research, promoting diversity in the computer systems workforce, developing substantial experimental research educational experiences, and developing curriculum and supporting materials in emerging computer systems areas. The following URL contains several examples of broader impacts activities: http://www.nsf.gov/pubs/gpg/broaderimpacts.pdf.

B. Budgetary Information

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

C. Due Dates

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

  April 23, 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/CustomerSupport. 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.

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.

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 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:

- David Du, Program Director, DMSS and PSCE, telephone: (703) 292-8950, email: ddu@nsf.gov
- Helen Gill, Program Director, EHCS, telephone: (703) 292-8950, email: hgill@nsf.gov

- Anita J. LaSalle, Program Director, PSCE and DMSS, telephone: (703) 292-8950, email: alasalle@nsf.gov

For questions related to the use of FastLane, contact:

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

For questions relating to Grants.gov contact:

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

IX. OTHER INFORMATION

The NSF Website provides the most comprehensive source of information on NSF Directorates (including contact information), programs and funding opportunities. Use of this Website by potential proposers is strongly encouraged. In addition, 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:

Systems software exists in the context of applications, and it interacts with other software systems. Consequently, many projects will address topics described in this solicitation as well as topics covered in related programs.

The following NSF programs most closely overlap with the CSR program:

- Networking and Technology (NeTS)
- Cyber Trust (CT)
- Expeditions in Computing
- Cyber-enabled Discovery and Innovation (CDI)
- Software for Real-World Systems (SRS)
- Computing Processes and Artifacts (CPA)

If the major emphasis of the proposal is computer networks, then it should be submitted to the NeTS program. If the major emphasis is to make systems more secure, then the proposal should be submitted to the CT program. A proposal that develops or uses compiler technology for parallel, distributed and heterogeneous systems should be submitted to CSR, but a proposal that addresses theoretical compiler technology should be submitted to the CPA program. Similarly, a project that develops programming languages for programming parallel applications should be submitted to CPA, whereas a project that develops systems software to support parallel computing should be submitted to CSR. As other programs become active, PIs are encouraged to contact the cognizant Program Officers for guidance.

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
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