

# Networking Technology and Systems (NeTS)

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## Program Solicitation

NSF 08-524

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*Replaces Document(s):*

NSF 07-507

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### 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):

March 25, 2008

## REVISION NOTES

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The following items are major revisions to the previous program solicitation:

- Networking Broadly Defined (NBD), Networking of Sensor Systems (NOSS), and Wireless Networks (WN)— are no longer programmatic areas;
- Networking at the Edges (NEDG), Network Ecosystems (NECO), Aware Networking (ANET), and Exploratory Networking (XPLR), have been added as programmatic areas;
- Future INternet Design (FIND) has been updated; and
- Budget restrictions for projects have been changed.

## SUMMARY OF PROGRAM REQUIREMENTS

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### General Information

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**Program Title:**

Networking Technology and Systems (NeTS)

**Synopsis of Program:**

The Networking Technology and Systems (NeTS) program supports pioneering visions and transformative research agendas that explore the frontiers of networking, provide a better understanding of the dynamics of large-scale networks, expand networking capabilities and use, and help pave the way for the next generation Internet.

Since its inception, the NeTS program has continuously sought to ensure that its mission and scope is at the forefront of research. In previous years, the program identified core networking technologies worthy of further investigation, emphasized the importance of future Internet design, and encouraged groundbreaking research in broadly defined areas of networking. In FY 2008, the NeTS program is organized by research challenges, rather than core technologies, and emphasizes multi-disciplinary, holistic approaches that augment our knowledge about the design and deployment of robust, large-scale, heterogeneous networks.

This solicitation invites innovative, forward-looking research projects in the following five areas:

- Networking at the Edges (NEDG);
- Network Ecosystems (NECO);
- Aware Networking (ANET);
- Exploratory Networking (XPLR); and
- Future Internet Design (FIND)

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).
- Planning grants, workshops and other community building activities: Proposals in this category must be discussed with a NeTS program officer prior to submission. Planning grants will be funded at levels up to \$100K/year for up to two years. Workshops in new or emerging areas in networking research and education will be funded at levels up to \$50K for one year.

**Cognizant Program Officer(s):**

- David Du, POC for NEDG, NECO, XPLR, telephone: (703) 292-8950, email: [ddu@nsf.gov](mailto:ddu@nsf.gov)
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- Jie Wu, POC for NEDG, NECO, XPLR, telephone: (703) 292-8950, email: [jwu@nsf.gov](mailto:jwu@nsf.gov)

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

- 47.070 --- Computer and Information Science and Engineering

**Award Information**

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**Anticipated Type of Award:** Standard Grant or Continuing Grant

**Estimated Number of Awards:**

60 to 80 total.

The NeTS program expects to make the following 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).
- Planning grants, workshops and other community building activities: Proposals in this category must be discussed with a NeTS program officer prior to submission. Planning grants will be funded at levels up to \$100K/year for up to two years. Workshops in new or emerging areas in networking research and education will be funded at levels up to \$50K for one year.

**Anticipated Funding Amount:** \$40,000,000 in FY 2008, pending availability of funds.

**Eligibility Information**

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**Organization Limit:**

None Specified

**PI Limit:**

While the majority of NeTS PIs are faculty at academic institutions, researchers from for-profit organizations may also serve as PIs, co-PIs, Senior Personnel, or sub-contractors in NeTS projects. However, NeTS will not provide salary or related support for individuals from for-profit organizations. NeTS will provide support for graduate students working in collaborative university-industry projects.

**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 Networking Technology and Systems (NeTS). 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: Networking Technology and Systems (NeTS), Cyber Trust (CT) and Computer Systems Research (CSR).

## Proposal Preparation and Submission Instructions

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**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](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):

March 25, 2008

## Proposal Review Information Criteria

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**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

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**Award Conditions:** Standard NSF award conditions apply.

**Reporting Requirements:** Standard NSF reporting requirements apply.

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## I. INTRODUCTION

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Fueled by continuing advances in computing and communication technologies, the Internet has become integral to our lives and vital to the operation of important sectors of our society. It has evolved from a small-scale network of computers to a large-scale, highly-engineered network of networks. Recent advances in networking and communications technologies are further expanding the scope of what it means to be "connected". Future networks are envisioned to be available anywhere, anytime, and accessible from any device. While this vision anticipates unprecedented opportunities for innovative applications and new uses of the Internet, it also demands a re-examination of the way networks are designed to promote and sustain innovation, creativity, economic growth and social prosperity.

The NeTS program supports research projects that create and exploit the possibilities of future networks and services and the applications they enable. The program also seeks to develop the fundamental design principles that can revolutionize the way future networks and their associated architectures, protocols and services are conceived, designed and deployed. To this end, NeTS will support:

- theoretical and systems-oriented networking research projects, in all aspects of networking, including architectures, protocols, algorithms and services, and projects that seek new fundamental understanding of heterogeneous, large-scale networks, including networks that operate in harsh environments and in times of crisis, and network services that primarily support human activities;
- research projects that focus on the design, development and validation of tools, software and hardware for network

- research, network understanding, and network analysis, experimentation and evaluation; and
- innovative and effective ways for creating new research agendas and enhancing community development, including workshops on innovations in networking education, and exploratory activities that may shape long-term research directions for networking research.

The emphasis of the NeTS program is on projects with broad scope and ambitious research and education goals. Of particular interest are cross-cutting research activities and inter-disciplinary collaborations, focused on holistic approaches to networking in large-scale, heterogeneous environments. Although proposals that focus primarily on security and privacy should be submitted to NSF's Cyber Trust program, PIs are strongly encouraged to include relevant security and privacy considerations in NeTS proposals.

## II. PROGRAM DESCRIPTION

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The NeTS program is seeking proposals in one of the following five programmatic areas.

### **Networking at the Edges (NEDG)**

Recent advances in wireless and optical fiber technologies has enabled a variety of access networks, ranging from cellular, wireless and vehicular networks, to Gigabit wired connections and broadband fiber-optic access networks. Various wireless access network technologies, such as ad-hoc, mesh, microwave, and satellite networks, are being deployed to support cost-effective, always-on connectivity to different classes of users. Fiber-to-the-curb/home/node (FTTX) access networks are also emerging as viable alternatives for the delivery of multi-media services and Internet access to enterprises and residential homes. The proliferation of these access methodologies adds considerable flexibility to the network edge, thereby creating unprecedented opportunities for service innovation and the development of new applications.

Wireless technology has been one of the most transforming and empowering technologies in recent years. Recent advances in wireless communications, coupled with the proliferation of a variety of smart wireless devices, have ushered in a new generation of wireless applications, ranging from multimedia streaming and content sharing to inter-vehicular communications, emergency response and disaster recovery. The current Internet architecture and protocols are not well designed to address the unique challenges of wireless networks brought about by mobility, energy limitations, lack of security, and poor manageability.

Optical access networks are widely considered to be the technology of choice for next-generation broadband services to enterprises and residential homes. These emerging networks have particularly unique features in terms of their potential for very high data rate communications and enhanced security, scalability, and flexibility to support broadband applications. Despite these benefits, however, a considerable gap still exists between existing networks and the full potential of optical access networks.

The focus of NEDG is on holistic approaches to address challenging network access problems, such as:

- scalable frameworks, protocols and mechanisms to support adaptive and efficient resource management and control in edge networks and new paradigms to enable applications to adapt to the varying characteristics of the access network, such as physical link property, variability in resource availability, and mobility;
- scalable, cross-layer design methodologies focused on the interactions among protocol layers, cooperative communications, network coding, routing, and media access;
- novel ways to seamlessly integrate access networks with the global Internet;
- new multi-modal, routing technologies and protocols that support broader semantics for location, attributes and coordinates;
- new frameworks and protocols to leverage the full potential of access networks by adapting to and exploiting their intrinsic properties, such as mobility and high-level redundancy in wireless technology, very high bandwidth and availability in optical access networks as well as programmability and broadcast capabilities, as first-class objects for efficient information dissemination, increased reliability, and higher performance predictability; and
- proof-of-concept design and validation of testbeds and performance analysis tools, including benchmarks, traces simulators, and emulators.

Projects that focus on building testbeds or on implementation and support for shared resources are outside the scope of this solicitation and should be submitted to Computing Research Infrastructure (CRI) or Major Research Instrumentation (MRI) programs.

Proposals submitted to NEDG must not be incremental or solely focused on technologies. They must address the broader context of NEDG.

## Network Ecosystems (NECO)

The Internet, a system of systems, comprises radically different technologies and serves a wide variety of applications and users over varying timescales in very different environments. To advance our fundamental understanding of how these systems behave at all scales and how they can be designed to achieve their full potential, NECO focuses on theoretical and system-level research related to large-scale, complex networks and systems. The scope of NECO extends from research focused on examining the complex nature of large-scale networks, to system-level networking research focusing on networking architectures, protocols and mechanisms for robust, easily manageable networks at scale, innovative frameworks and paradigms to support networking in extreme environments, holistic approaches and scalable algorithms for heterogeneous large-scale sensor networks, and new networking paradigms, inspired in some cases by other sciences such as biology, for robust scalable network architectures, protocols and mechanisms.

Of interest are topics such as:

- mathematically rigorous models to study and analyze the dynamics and emergent properties of large-scale networks and understand their behavior at various scaling properties and under different stress conditions;
- new mechanisms, tools and methods for measurements and traffic characterization for a better understanding and a more accurate prediction of the network behavior for a wide range of time-scales, a broad range of network topology structures and technologies, and multiple protocols interacting across the different network layers;
- new simulation models, algorithms, and schemes for large-scale, heterogeneous networks, capable of identifying and extracting meaningful patterns that can be used to guide the network simulation toward accurate understanding of network behaviors;
- development of novel network monitoring, measurement and analysis techniques to understand, characterize and extract topological and logical features of the network infrastructure; and
- multi-disciplinary analysis of complex networks such as economics, game-theoretic, decision or organization science; and understanding communication networks in their social environment.

The exponential growth of the Internet and its emergence as a global platform for information dissemination have placed great stress on its basic protocols and mechanisms and their ability to support system-wide networking functions, such as end-to-end data transport, congestion control, routing within and across autonomous domains, and network management. Addressing the needs of emerging Internet services and applications calls for new network frameworks, protocols and methodologies to deal not only with the need for higher scalability and robustness, but also for the need to deal with the wide range of social values, and economic and legal policies of network users, service providers and application developers. NECO seeks innovative, forward-looking research proposals to address challenges such as:

- novel architectures and algorithms for inter- and intra- routing that strive to achieve scalability, resiliency, and the interplay between routing and manageability. Of particular interest are frameworks which take into consideration economic and business policies;
- new paradigms and protocols that leverage mathematical approaches and frameworks (such as control theory and advances in game theory) for resource allocation and congestion control, with a focus on efficiency, robustness, stability and manageability;
- efficient architectures and protocols for content distribution and information sharing in large-scale, peer-to-peer networks; and
- new paradigms, architectures and protocols for network virtualization, for improved efficiency, increased scalability, ease of service and reduced operational costs.

Network systems operating in challenging environments may require capabilities which go beyond what can be offered by the current Internet. This class of networks may include: infrastructure-less networks composed of mobile and space-based nodes, operating under varying network conditions; networks deployed under stressed conditions, such as in response to infrastructure outages due to natural and human-caused disasters; and networks designed using purpose built technologies such as underwater acoustic networks, pico-satellite networks, and aerial and ground vehicular networks.

The design and deployment of these networks bring about several challenges and require research that might include:

- holistic approaches for new architectures, mechanisms and protocols for adaptive, survivable and resilient networks expected to operate under extreme conditions, where delays can be large and/or highly variable, and outages and signal loss may occur frequently and unpredictably;
- novel mobile network models that capture both time and space in challenging networks
- cross-layer approaches, which demonstrate a high-degree of resiliency across all protocol layers, including the physical layer; and
- novel networking frameworks and service architectures for extreme environments.

Networks composed of large numbers of static and mobile sensors with limited processing and communications capabilities, are increasingly being deployed and used for different purposes, including environmental monitoring, critical infrastructure protection, precision agriculture, disaster management, weather forecasting and healthcare. The huge amount of data generated or collected by these devices need to be stored, processed, and communicated to access points for decision

making and possible actions. An intrinsic property of sensor networks, which sets them apart from traditional wireless networks, is the importance of the collaborative, as opposed to individual, behavior of the sensor nodes, which has a profound impact on the design of sensor networks. Research topics of interest in this programmatic area may include, but are not limited to:

- new paradigms and frameworks to advance our fundamental understanding of the design and development of large-scale networks of heterogeneous, resource-constrained sensing and actuating devices communicating through unreliable channels;
- new programming paradigms and software tools for rapid deployment, failure recovery and ease of management;
- support for the requirements of emerging applications in critical areas like healthcare, environmental monitoring, transportation, emergency response and public safety; and
- new paradigms, frameworks and models focused on exploring the tradeoffs such as those that arise in optimizing data storage, data processing, and data delivery and achieving high-level of data accuracy in large-scale sensor networks.

Significant progress has been achieved toward the design and deployment of reliable networks, capable of adapting to varying network conditions and failures. Nevertheless, existing large-scale networks often exhibit undesirable behaviors in presence of failures. Biological systems, on the other hand, are able to efficiently adapt to environmental changes as they occur and often succeed in carrying out their tasks successfully and reliably, even in the presence of multiple component failures. Models inspired by biological systems and others may provide the basis for new network design approaches for enhanced reliability and robustness. Network reliability and robustness, inspired by other sciences, might focus on:

- new network architectures, algorithms and protocols for evolvable, reliable and easily managed large-scale, adaptive networks;
- novel paradigms and approaches for self-organizing and self-healing large-scale networks; and
- new frameworks, protocols and mechanisms for survivability and fault-tolerance in failure prone networking environments.

### **Aware Networking (ANET)**

There are several social and technical developments that beg for new research involving humans and networked systems. Computer systems and networks are increasingly mobile and intertwined in human life, both personal and economic. The interaction of humans and these systems are enriched by location capabilities; software and hardware immersive environments, sensors and actuators, and the rapid appearance of new devices, features and applications. There are new concepts and theories emerging from other scientific fields, such as from cyber-physical systems and human cognition, that may provide insights into pervasive systems and their interaction with human users. It is evident that there are services and requirements that are not well met by today's networks and systems but if developed would enhance the experience of human users. These requirements include ensuring full access to growing capabilities, creating services that make seamless, reliable and safe environments for humans, and developing networks for pervasive computing for human use.

ANET takes into account the developments described above and takes its name from networks that are human aware, environment aware, and application aware. The ANET area seeks research addressing network challenges that relate to the interaction of humans with the network such as work on services that support application awareness or environment awareness and on services that create the experience of seamlessness for the end users of the network. ANET will ideally focus on network innovations that address what is insecure, risky, inelegant, unscalable, or non-existent in current systems.

Examples of challenges that might be the focus of research submitted to ANET include:

- new paradigms and guiding principles for the design and deployment of reliable and predictable ANET architectures, protocols and services, including in contexts where applications may require proactive and timely action;
- innovative models and sound methodologies for acquiring and seamlessly embedding relevant context information into the network architecture, protocols and services to support applications with, for example, stringent timing and bandwidth requirements or unique characteristics, such as mobility and energy constraints;
- novel approaches to a coherent system of identity and naming, allowing access to diverse applications and data sources;
- frameworks for transparency and control of privacy-sensitive information generated, propagated and stored in the network, including not only personal information privacy, but also network and geographic location privacy, and other types;
- frameworks and protocols for responsive environments, where network services are greatly challenged, not only by the traffic engineering required for sensing and interactive delivery of high definition information delivery, but also by the need to support the involvement of very large numbers of humans, roaming unpredictably, as integral parts of the system; ,
- new paradigms to address the current limitations of networking systems for streaming and interactive multimedia in providing service to heterogeneous endpoints and in sustaining service over periods of poor connectivity, particularly with respect to the limited dynamic range of current multimedia services compared with the service that is required for a sensorily and visually rich future environment; and
- new network service architectures and protocols to support emerging systems and applications, such as "open

social” and “cloud computing”, and “service oriented architecture” (SOA) developed by very large numbers of users, and address issues that arise from their complexity, security and privacy.

The ANET focus is distinct from the Network Ecology (NECO) programmatic area. ANET’s topics may be a part of the large systematic considerations in NECO, but in deciding which programmatic area to submit to, PIs must determine whether the proposed research topic focuses on an overall systems view including the end uses and end systems (NECO) or primarily on humans, the end uses, and end systems (ANET).

### **Exploratory Networking (XPLR)**

XPLR is intended to inspire the networking research community to engage in high-risk, transformational research and explore new and untested ideas, unconstrained by current technology, architectures and protocols, with potential for disruptive innovations in networking and communications. The objective of XPLR is to create new concepts and develop new problem spaces, which result in new research fields, deep understanding, or innovative solutions in areas of networking not within the scope of the other NeTS programmatic areas. **In general, proposals that seek to optimize or improve performance of existing capabilities or services, or proposals that focus on research directly related to other NeTS programmatic areas are not appropriate for XPLR.**

New technical approaches must be presented within a networking context to solve networking problems. Proposals may include proof-of-concept hardware, especially in areas which involve emerging or future technology. Such proposals must show how this hardware will drive a new networking capability and have significant impact. Successful proposals will present an ambitious research plan and discuss how these new ideas have the potential to have an impact.

### **Future Internet Design (FIND)**

#### *a. FIND Program Design*

FIND was designed based on the premise that to meet the needs of the twenty-first century, the research community must ask not how to make the existing Internet better through incremental change, but rather what the desirable network should be and how it should be designed. Accordingly, investigators must begin with a “clean slate” unconstrained by the properties of today’s Internet. FIND supports transformational or radical innovations in networking, leading to the architectures of future-generation Internets that are referred to herein as the “Future Internet”.

FIND is based on a new conceptualization of networking research that alters the nature of the research process - moving away from business as usual within the established research and education communities towards a more collaborative, integrative, and inclusive program of research. FIND is a multi-year, multi-phase program as described below.

- The goal of FIND Phase I is to identify the functional elements of the Future Internet and to understand their interactions. The NeTS program solicited FIND Phase I proposals beginning in FY 2006. It is expected that the last cohort of new FIND Phase I projects will be funded in FY 2008.
- The goal of FIND Phase II is to implement elements of plausible new architectures, building on research insights and outcomes provided by FIND Phase I projects. The NeTS FY 2009 competition will solicit the first cohort of Phase II proposals. The NeTS program anticipates soliciting additional Phase II proposals in FYs 2010 and 2011.
- The goal of FIND Phase III is to reduce select architectures to practice by fleshing out the details of protocols and producing code that runs on state-of-the-art research infrastructure. The NeTS program anticipates soliciting Phase III proposals in FY 2012.

Initial experiments in Phases II and III are likely to lead to iteration in design, so there will be continuing opportunities to propose and integrate new concepts into the most promising future architectures. To facilitate shared learning and the development of consensus, FIND Principal Investigators (PIs) are required to attend FIND PI meetings three times each year.

#### *b. FY 2008 FIND Phase I Proposals*

To serve the purposes of the Future Internet, the protocols and structures that guide its operation require coordinated, coherent design. New approaches require rethinking of network functions and the development of strategies to address a range of challenges and opportunities. These include, but are not limited to:

- exploration of fundamental policy and engineering trade-offs in the design of secured, privacy protecting, and robust networked systems or fundamental new requirements and capabilities in such areas;



- exploration of new paradigms of communication that go beyond packet and circuit switching,
- consideration of new models of information dissemination;
- design of data, control, and management planes;
- further advances in self-evolving networks with virtualized overlays; and
- architectures that promote healthy economic models.

In FY 2008 (the last year of FIND Phase I), the NeTS program is soliciting proposals that: evaluate requirements for a new architecture; reason carefully about architectural responses to these requirements; and, propose, develop and demonstrate ideas that might contribute to a new architecture. All proposals must be relevant to architecture, meaning the basic design principles and structures that will define a Future Internet, rather than a specific technology. (Research on the architecture and design of specific subnet technologies, such as wireless or optics, is not appropriate for FIND unless the primary motivation of the work is to influence architectures at an internetworking level - a level that spans heterogeneous networking technologies and defines the basis on which end-points communicate.)

Proposals must define requirements of a Future Internet, such as: enhanced security, privacy, resilience and availability; openness to incorporation of new technologies; ability to adapt to new computing paradigms; ability to support future complex applications; improved network management; economic viability; harmony with societal values; and, openness to future innovations. Together, such requirements and others mandate a transformed global network that will be a subject of research and development, a benefit to society, and a driver of new investment and innovation. (The NeTS program does not insist that FIND PIs accept the requirements listed herein as a mandate. PIs are free to state their own view of requirements for a Future Internet, but FIND projects must be justified in the context of high-level requirements—these or others.)

In FY 2008, FIND Phase I will support research across a broad range of topics including, but not limited to:

- creating new core functionality;
- design for security;
- design for manageability;
- design for utility and social needs;
- design for real-time and uninterruptible services;
- architectural implications of new technology in the optical, wireless, sensor network and embedded computing spaces;
- creating higher-level service architectures;
- holistic network design; and
- theory of network architecture.

Before submitting a FIND proposal, PIs are encouraged to consider projects already funded by FIND, available at <http://www.nets-find.net>. Proposals submitted to FIND in FY 2008 may be motivated by similar requirements or network functions as those already supported, HOWEVER, they should represent innovative new approaches, not incremental improvements on the projects already funded.

#### *c. FIND Community Phase II Planning Activities in FY 2008*

During FY 2008, NeTS program officers will work with the FIND PI community to plan and facilitate a transition from FIND Phase I to FIND Phase II. The purpose of these activities is to bring together groups of researchers and students to discuss overarching architectures and to begin to create compatible FIND Phase II research teams. PIs interested in participating in these activities must discuss their ideas with the NeTS program officers responsible for FIND.

### **NeTS Relation to other CISE Research Areas**

Network research themes include research and education projects that are related to FIND as well as to other programs within and outside CISE. Proposals that focus on architectures and protocols for a radically new Internet not based on the current Internet should be submitted to the Future Internet Design (FIND) program. Proposals that concentrate on the security of specific technologies/applications – such as security of wireless and sensor networks or the current Internet – should be submitted to the Cyber Trust (CT) program. Applications of sensor technologies without a significant networking component should be submitted to other NSF sensor application programs or discussed with one of the NeTS program officers for referral to other programs. Proposals that break new ground in the theory of particular technologies should be submitted to the Theoretical Foundations (TF) program. Proposals that deal with wireless and optical technologies should be submitted to the relevant programs in the Directorate for Engineering. Investigators who submit proposals that appear to be relevant to more than one program are encouraged to contact the program officers identified in this solicitation for guidance.

### III. AWARD INFORMATION

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The estimated program budget (\$40M) and estimated number of awards (60-80) are subject to the availability of funds. Awards will be made as standard or continuing grants.

Three types of NeTS awards will be made:

- 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).
- Planning grants, workshops and other community building activities: Proposals in this category must be discussed with a NeTS program officer prior to submission. Planning grants will be funded at levels up to \$100K/year for up to two years. Workshops in new or emerging areas in networking research and education will be funded at levels up to \$50K for one year

### IV. ELIGIBILITY INFORMATION

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#### Organization Limit:

None Specified

#### PI Limit:

While the majority of NeTS PIs are faculty at academic institutions, researchers from for-profit organizations may also serve as PIs, co-PIs, Senior Personnel, or sub-contractors in NeTS projects. However, NeTS will not provide salary or related support for individuals from for-profit organizations. NeTS will provide support for graduate students working in collaborative university-industry projects.

#### 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 Networking Technology and Systems (NeTS). 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: Networking Technology and Systems (NeTS), Cyber Trust (CT) and Computer Systems Research (CSR).

### V. PROPOSAL PREPARATION AND SUBMISSION INSTRUCTIONS

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#### A. Proposal Preparation Instructions

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**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](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](mailto: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](mailto: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 the general guidelines in the GPG or NSF Grants.gov Application Guide:**

- To assist NSF staff in sorting proposals for review, proposal titles should begin with an acronym that identifies the programmatic area to which the proposal is being submitted, i.e. Networking at the Edges = NEDG, Network Ecosystems =NECO, Aware Networking = ANET, Exploratory Networking = XPLR, Future Internet Design =FIND. For example, a NeTS proposal might have a title such as "FIND: A Framework for Future Internet Manageability".
- Every NeTS "Team" proposal must include a Management and Collaboration Plan within the 15-page Project Description.
- Every NeTS proposal must include a discussion of broader impacts and should include a substantive education component. Broader impacts include the integration of education and research, promoting diversity in the networking workforce, developing substantial experimental research educational experiences, and developing curriculum in emerging network areas. The following URL contains examples illustrating activities that are likely to demonstrate the broader impacts: <http://www.nsf.gov/pubs/gpg/broaderimpacts.pdf>

Proposers to NEDG, NECO, ANET, and XPLR must provide the following information:

- Upload into FastLane's Additional Single Copy Documents section, text that describes the research infrastructure to be used to validate the proposed work, such as simulation, emulation or demonstration on experimental infrastructure. If appropriate infrastructure exists, describe whether and how it is sufficient to validate the proposed work. If such infrastructure does not exist, describe the characteristics or features you would need to validate your work.

Proposers to FIND should address the following points in their proposals:

- Clearly indicate what Future Internet requirement(s) - such as those discussed earlier in this solicitation - the proposed work will address;
- Discuss how this work will fit into a larger overall architectural framework. Discuss what other problems this work might mitigate or exacerbate.
- Upload into FastLane's Additional Single Copy Documents section, text that describes the infrastructure to be used to validate the proposed work, such as simulation, emulation or demonstration on a networking infrastructure. If the appropriate infrastructure exists, describe whether and how it is sufficient to validate the proposed work. If infrastructure that does not exist is needed, describe the characteristics or features you would require to validate your work.
- Budget for one PI to travel to three FIND PI meetings per year and for one student to attend one FIND PI meeting per year for the duration of the award.

## **B. Budgetary Information**

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

## **C. Due Dates**

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

March 25, 2008

#### D. FastLane/Grants.gov Requirements

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- **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](mailto: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](mailto: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

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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

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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.

**Additional Review Criteria:**

Additional considerations in evaluating NeTS-FIND proposals include:

- How well does the proposed work address one or more architectural requirement(s)?
- How well does the proposed work relate to and enhance a larger overall architectural framework?
- How important is this work to the framing of a new architecture?

**B. Review and Selection Process**

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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

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### A. Notification of the Award

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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

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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](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](mailto: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](http://www.nsf.gov/publications/pub_summ.jsp?ods_key=aag).

### C. Reporting Requirements

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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

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General inquiries regarding this program should be made to:

- David Du, POC for NEDG, NECO, XPLR, telephone: (703) 292-8950, email: [ddu@nsf.gov](mailto:ddu@nsf.gov)
- Darleen Fisher, POC for FIND, NECO, XPLR, telephone: (703) 292-8950, email: [dlfisher@nsf.gov](mailto:dlfisher@nsf.gov)



- Allison Mankin, POC for FIND, ANET, XPLR, telephone: (703) 292-8572, email: [amankin@nsf.gov](mailto:amankin@nsf.gov)
- Jie Wu, POC for NEDG, NECO, XPLR, telephone: (703) 292-8950, email: [jwu@nsf.gov](mailto:jwu@nsf.gov)

For questions related to the use of FastLane, contact:

- FastLane Help Desk, telephone: 1-800-673-6188; e-mail: [fastlane@nsf.gov](mailto: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](mailto:support@grants.gov).

## IX. OTHER INFORMATION

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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>.

## ABOUT THE NATIONAL SCIENCE FOUNDATION

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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](mailto: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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