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Integrated Sensing, Computation, and Networked Systems for Decision and Action

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Program Solicitation

NSF-02-039

DIRECTORATE FOR ENGINEERING
DIVISION OF ELECTRICAL AND COMMUNICATIONS SYSTEMS

FULL PROPOSAL DEADLINE(S): April 2, 2002

NATIONAL SCIENCE FOUNDATION

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SUMMARY OF PROGRAM REQUIREMENTS

GENERAL INFORMATION

Program Title: Integrated Sensing, Computation, and Networked Systems for Decision and Action

Synopsis of Program: This solicitation focuses on the challenges in future multimode and distributed sensor/actuator systems with emphasis on networking or applications which involve large scale computations. Among the advances sought are: (a) multiple sensors with different functionalities, computation, storage, communication and network interface on prototype chips, (b) imaging and computational video with multilevel and adaptive decision systems, and (c) networking methods for large arrays of geographically distributed sensor/actuator systems.

Cognizant Program Officer(s):

- Vijay Jain, CNCI, Program Director, Engineering, ECS, telephone: (703) 292-8339, e-mail: vjain@nsf.gov.
- Rajinder Khosla, Acting Division Director, Engineering, ECS, telephone: (703) 292-8339, e-mail: rkhosla@nsf.gov.
- Kishan Baheti, CNCI, Program Director, Engineering, ECS, telephone: (703) 292-8339, e-mail: rbaheti@nsf.gov.
- James Mink, EPDT, Program Director, Engineering, ECS, telephone: (703) 292-8339, e-mail: jmink@nsf.gov.
- Paul Werbos, CNCI, Program Director, Engineering, ECS, telephone: (703) 292-8339, e-mail: pwerbos@nsf.gov.

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

- 47.041 --- Engineering

ELIGIBILITY INFORMATION

- **Organization Limit:** Proposals may be submitted by U.S. academic institutions and nonprofit research institutions in support of individual investigators or small groups. Synergistic collaboration among researchers and collaboration or partnerships with industry or government laboratories are encouraged when appropriate; however, NSF awards will be made to U.S. academic institutions and nonprofit research institutions.
- **PI Eligibility Limit:** Only one proposal may be submitted by a Principal Investigator. However, a Principal Investigator for one proposal may be a co-Principal Investigator on one other proposal. Group and collaborative proposals involving more than one institution must be submitted as a single administrative package from one of the institutions involved. Due to the limited availability of funds, prospective applicants are encouraged to contact one of the program officers listed at the end of this document for guidance.
- **Limit on Number of Proposals:** None

AWARD INFORMATION

- **Anticipated Type of Award:** Standard or Continuing Grant
- **Estimated Number of Awards:** 8-10
- **Anticipated Funding Amount:** $3.0 million in FY 2002. Awards up to $300,000 for a single investigator and up to $500,000 for a small interdisciplinary group for a duration of three years are anticipated, subject to availability of funds.

PROPOSAL PREPARATION AND SUBMISSION INSTRUCTIONS

A. Proposal Preparation Instructions

- **Full Proposals:** Supplemental Preparation Guidelines
    - The program announcement/solicitation contains supplements to the standard Grant Proposal Guide (GPG) proposal preparation guidelines. Please see the full program announcement/solicitation for further information.

B. Budgetary Information

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

C. Deadline/Target Dates

- **Letters of Intent (*optional*):** None
- **Preliminary Proposals (*optional*):** None
- **Full Proposal Deadline Date(s):** April 2, 2002

D. FastLane Requirements

- **FastLane Submission:** Required
- **FastLane Contact(s):**
    - Gwen Owens, Administrative Officer, Engineering, ECS, Room 675, telephone: (703) 292-8339, e-mail: gowens@nsf.gov.
    - Fastlane Help Desk, telephone: (800) 673-6188, e-mail: fastlane@nsf.gov.

PROPOSAL REVIEW INFORMATION

- **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.

I. INTRODUCTION

Convergence of communications and computing has in the recent years been recognized as a major revolution. Indeed, the Internet and all other forms of communications and networking have facilitated rapid access to information and computing, overcoming the barriers of distance and time. In a new revolution, sensor and actuator systems, such as microaccelerometers, microgyroscopes, thermal probes at nanometer scales, and microsystems for biochemical analysis are beginning to have a significant impact on industry and our daily lives. However, in future years, sensing, along with communications and computing, will play an even greater role. They promise to be of enormous value in biomedicine, transportation, automotive and consumer electronics, and the security of the nation's civil and engineering infrastructures.

The combination of ultra low-power wireless nodes together with emerging ad hoc networks will give rise to sensing networks that could be assembled and disassembled according to the need. Thereby, very rapid and cost-effective deployment would be achieved over small regions. On the other hand, on a much larger scale, the national backbone networks should incorporate fast-switched priority-based-routing protocols with sensor networks that would provide much faster transfer of data from sensors to the processing centers for intelligent information and decision systems. Integrated sensor networks that include computing and communication are expected to enable (a) accurate distributed sensing, (b) multimode data fusion, (c) transformation of data from one domain to another, (d) extraction of key information, and (e) detection and circumvention of faulty sensors in ultra large arrays.

In some applications, smart sensor systems with 'sensors, processors and storage, and communication and network interface' on a chip would enable new opportunities for design and prototyping of smart devices. The sensors may include mechanical, chemical, biological, fluidic, optical, and/or ultrasonic devices. The communications and networking interface on the chip would enable exchange of sensor data or critical information with the outside world.

Furthermore, imaging and computational video are becoming increasingly important for the observation of nanoscale to macroscale phenomena, and for cataloging atmospheric, undersea, and astronomical events. At the core of imaging and video systems is intensive computing, whereby the raw images from several cameras, strategically placed over a region, must be processed for enhancement, compression, or information extraction; or where autostereoscopic 3D multiview display would be made possible at one or more receiving sites. The information extraction may include detection of events or objects of interest, together with the estimation of key parameters, and may be followed by closed-loop adaptive feedback.

II. PROGRAM DESCRIPTION

Proposals are sought under this announcement that seek to obtain major advances in the area of integrated sensing, computation, and networking. It is envisioned that the research will be carried out by single investigators, or multi-disciplinary groups, with the objective of generating new concepts, approaches, test beds, and prototype chips that are stimulated by the synergistic interaction of diverse disciplines. The goal of the initiative is to encourage collaboration between researchers from electronics, photonics, and device technologies and researchers from control, networks, computations, and systems engineering. Research advances that integrate multiple sensors on a chip and novel networking methods for distributed sensor/actuator arrays are encouraged. In addition, proposers are encouraged to develop innovative curriculum and test beds with broader impact on education of graduate and undergraduate students. It is important that the research programs on sensing, computing, and networking identify and address target applications. Research will be funded based in part on the proposer's explanation of how the research will further benefit the society and the nation. A specific intent of this initiative is to develop science and technologies that focus on systems and networks to accelerate progress in the area of sensors, computing, and networking.

TOPICAL AREAS

This initiative will provide research support under the following topical areas. Each of these areas is intended to be broadly defined. Examples are provided to enhance the definition of each topic, but are not intended to be all-inclusive.

• Smart Sensor Systems on a Chip

The smart sensor systems may include a combination of mechanical, chemical, biological, fluidic, optical, and/or ultrasonic sensing capabilities. Architectural innovations, novel modeling and simulation tools, and implementation of sensors, computational elements, and networking interface on a prototype chip are of interest. The application examples include, but are not limited to, biometric measurements, identity-authentication, detection and analysis of biochemical agents, detection of moving objects, and sensing of turbulent flows.

• Imaging and Computational Video Systems

Array of cameras for 2D and 3D video reconstruction of large-area activities, and test beds for high-resolution ‘autostereoscopic 3D multiview system’ are of interest. The application examples include, but are not limited to, surveillance, telemedicine, advanced manufacturing, distance education and video conferencing. The proposed research may develop novel modeling tools, high fidelity compression methods, and techniques for survivable layered digital video with adaptive feedback loops.

• Networking Methods for Distributed Sensor/Actuator Arrays

Modeling and simulation tools dealing with networked sensing/actuation of large-scale structures or systems, and test beds of ad hoc sensing networks are of interest. In addition, integration of fast-switched priority-based-routing protocols for sensor networks, hierarchical and reconfigurable schemes for distributed control over heterogeneous networks, are encouraged. Also of interest are reconfigurable interconnection networks for arrays of sensors, e.g., microelectromechnical systems/nanoelectromechnical systems (MEMS/NEMS), and processors, both for overcoming faulty units and mapping of multiple applications.

III. ELIGIBILITY INFORMATION

The categories of proposers identified in the Grant Proposal Guide are eligible to submit proposals under this program announcement/solicitation.

IV. AWARD INFORMATION

The awards made under this solicitation will be up to $300,000 for a single investigator and up to $500,000 for a small multidisciplinary group, for a duration of up to three years. Small multidisciplinary groups may be from the same institution or from different institutions, and should demonstrate substantial program enhancement resulting from the interaction of diverse disciplines. It is anticipated that the total funds available from NSF in FY 2002 for this initiative will be approximately $3 million. Estimated program budget, number of awards and average award size/duration are subject to the availability of funds and the quality of proposals.

V. PROPOSAL PREPARATION AND SUBMISSION INSTRUCTIONS

A. Proposal Preparation Instructions

Full Proposal:

Proposals submitted in response to this program announcement/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 Web Site at: http://www.nsf.gov/cgi-bin/getpub?gpg. Paper copies of the GPG may be obtained from the NSF Publications Clearinghouse, telephone (301) 947-2722 or by e-mail from pubs@nsf.gov.

Proposers are reminded to identify the program solicitation number (NSF-02-039) in the program announcement/solicitation block on the proposal Cover Sheet. Compliance with this requirement is critical to determining the relevant proposal processing guidelines. Failure to submit this information may delay processing.

B. Budgetary Information

Cost sharing is not required in proposals submitted under this Program Solicitation.

C. Deadline/Target Dates

Proposals must be submitted by the following date(s):

Full Proposals *by 5:00 PM local time*: April 2, 2002

D. FastLane Requirements

Proposers are required to prepare and submit all proposals for this Program Solicitation through the FastLane system. Detailed instructions for proposal preparation and submission via FastLane are available at: http://www.fastlane.nsf.gov/a1/newstan.htm. For FastLane user support, call 1-800-673-6188 or e-mail fastlane@nsf.gov.

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 certifications within five working days following the electronic submission of the proposal. Further instructions regarding this process are available on the FastLane website at: http://www.fastlane.nsf.gov.

VI. PROPOSAL REVIEW INFORMATION

A. NSF Proposal Review Process

Reviews of proposals submitted to NSF are solicited from peers with expertise in the substantive area of the proposed research or education project. These reviewers are selected by Program Officers charged with the oversight of the review process. NSF invites the proposer to suggest, at the time of submission, the names of appropriate or inappropriate reviewers. Care is taken to ensure that reviewers have no conflicts with the proposer. Special efforts are made to recruit reviewers from non-academic institutions, minority-serving institutions, or adjacent disciplines to that principally addressed in the proposal.

The two 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 he/she is qualified to make judgements.

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

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

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

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

Integrating Diversity into NSF Programs, Projects, and Activities
Broadening opportunities and enabling the participation of all citizens -- women and men, underrepresented minorities, and persons with disabilities -- is essential to the health and vitality of science and engineering. NSF is committed to this principle of diversity and deems it central to the programs, projects, and activities it considers and supports.

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 Director. In addition, the proposer will receive an explanation of the decision to award or decline funding.

B. Review Protocol and Associated Customer Service Standard

All proposals are carefully reviewed by at least three other persons outside NSF who are experts in the particular field represented by the proposal. Proposals submitted in response to this announcement/solicitation will be reviewed by Panel Review.

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

NSF is striving to be able to tell applicants whether their proposals have been declined or recommended for funding within six months for 70 percent of proposals. The time interval begins on the date of receipt. The interval ends when the Division Director accepts the Program Officer's recommendation.

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 its 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 Division 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.A. 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 (NSF-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 agreement awards also are administered in accordance with NSF Cooperative Agreement Terms and Conditions (CA-1). Electronic mail notification is the preferred way to transmit NSF awards to organizations that have electronic mail capabilities and have requested such notification from the Division of Grants and Agreements.

*These documents may be accessed electronically on NSF's Web site at http://www.nsf.gov/home/grants/grants_gac.htm. Paper copies may be obtained from the NSF Publications Clearinghouse, telephone (301) 947-2722 or by e-mail from pubs@nsf.gov.

More comprehensive information on NSF Award Conditions is contained in the NSF *Grant Policy Manual* (GPM) Chapter II, available electronically on the NSF Web site at http://www.nsf.gov/cgi-bin/getpub?gpm. The GPM is also for sale through the Superintendent of Documents, Government Printing Office (GPO), Washington, DC 20402. The telephone number at GPO for subscription information is (202) 512-1800. The GPM may be ordered through the GPO Web site at http://www.gpo.gov.

C. Reporting Requirements

For all multi-year grants (including both standard and continuing grants), the PI must submit an annual project report to the cognizant Program Officer at least 90 days before the end of the current budget period.

Within 90 days after the expiration of an award, the PI also is required to submit a final project report. Approximately 30 days before expiration, NSF will send a notice to remind the PI of the requirement to file the final project report. Failure to provide final technical reports delays NSF review and processing of pending proposals for that PI. PIs should examine the formats of the required reports in advance to assure availability of required data.

NSF has implemented an electronic project reporting system, available through FastLane. This system permits electronic submission and updating of project reports, including information on project participants (individual and organizational), activities and findings, 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.

VIII. CONTACTS FOR ADDITIONAL INFORMATION

General inquiries regarding Integrated Sensing, Computation, and Networked Systems for Decision and Action should be made to:

- Vijay Jain, CNCI, Program Director, Engineering, ECS, telephone: (703) 292-8339, e-mail: vjain@nsf.gov.
- Rajinder Khosla, Acting Division Director, Engineering, ECS, telephone: (703) 292-8339, e-mail: rkhosla@nsf.gov.
- Kishan Baheti, CNCI, Program Director, Engineering, ECS, telephone: (703) 292-8339, e-mail: rbaheti@nsf.gov.
- James Mink, EPDT, Program Director, Engineering, ECS, telephone: (703) 292-8339, e-mail: jmink@nsf.gov.

- Paul Werbos, CNCI, Program Director, Engineering, ECS, telephone: (703) 292-8339, e-mail: pwerbos@nsf.gov.

For questions related to the use of FastLane, contact:

- Gwen Owens, Administrative Officer, Engineering, ECS, Room 675, telephone: (703) 292-8339, e-mail: gowens@nsf.gov.

- Fastlane Help Desk, telephone: (800) 673-6188, e-mail: fastlane@nsf.gov.

IX. OTHER PROGRAMS OF INTEREST

The NSF *Guide to Programs* is a compilation of funding for research and education in science, mathematics, and engineering. The NSF *Guide to Programs* is available electronically at http://www.nsf.gov/cgi-bin/getpub?gp. General descriptions of NSF programs, research areas, and eligibility information for proposal submission are provided in each chapter.

Many NSF programs offer announcements or solicitations concerning specific proposal requirements. To obtain additional information about these requirements, contact the appropriate NSF program offices. Any changes in NSF's fiscal year programs occurring after press time for the *Guide to Programs* will be announced in the NSF E-Bulletin, which is updated daily on the NSF web site at http://www.nsf.gov/home/ebulletin, and in individual program announcements/solicitations. Subscribers can also sign up for NSF's Custom News Service (http://www.nsf.gov/home/cns/start.htm) to be notified of new funding opportunities that become available.

ABOUT THE NATIONAL SCIENCE FOUNDATION

The National Science Foundation (NSF) funds research and education in most fields of science and engineering. Awardees are wholly responsible for conducting their project activities and preparing the results for publication. Thus, the Foundation does not assume responsibility for such findings or their interpretation.

NSF welcomes proposals from all qualified scientists, engineers and educators. The Foundation strongly encourages women, minorities and persons with disabilities to compete fully in its programs. In accordance with Federal statutes, regulations and NSF policies, no person on grounds of race, color, age, sex, national origin or disability shall be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving financial assistance from NSF (unless otherwise specified in the eligibility requirements for a particular program).

Facilitation Awards for Scientists and Engineers with Disabilities (FASED) provide funding for special assistance or equipment to enable persons with disabilities (investigators and other staff, including student research assistants) to work on NSF-supported projects. See the program announcement/solicitation for further information.

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, FIRS at 1-800-877-8339.

The National Science Foundation is committed to making all of the information we publish easy to understand. If you have a suggestion about how to improve the clarity of this document or other NSF-published materials, please contact us at plainlanguage@nsf.gov.

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; 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 applicant 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 needing information as part of the review process or in order to coordinate programs; 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," 63 Federal Register 267 (January 5, 1998), and NSF-51, "Reviewer/Proposal File and Associated Records," 63 Federal Register 268 (January 5, 1998). Submission of the information is voluntary. Failure to provide full and complete information, however, may reduce the possibility of receiving an award.

Pursuant to 5 CFR 1320.5(b), an agency may not conduct or sponsor, and a person is not required to respond to an information collection unless it displays a valid 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 this burden estimate and any other aspect of this collection of information, including suggestions for reducing this burden, to: Suzanne Plimpton, Reports Clearance Officer, Information Dissemination Branch, Division of Administrative Services, National Science Foundation, Arlington, VA 22230, or to Office of Information and Regulatory Affairs of OMB, Attention: Desk Officer for National Science Foundation (3145-0058), 725 17th Street, N.W. Room 10235, Washington, D.C. 20503.

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