

Cyber-Enabled Discovery and Innovation (CDI) **NSF**

Letter of Intent Due Date(s) (required):

October 30, 2007 - November 30, 2007

Preliminary Proposal Due Date(s) (required):

Each preliminary proposal must uniquely correspond to a Letter of Intent - see instructions.
December 07, 2007 - January 08, 2008

Full Proposal Submission Window Date(s):

By invitation only, based on review of preliminary proposal - see instructions.
March 28, 2008 - April 29, 2008

Synopsis of Program:

Cyber-Enabled Discovery and Innovation (CDI) is NSF's bold five-year initiative to create *revolutionary* science and engineering research outcomes made possible by innovations and advances in computational thinking. Computational thinking is defined comprehensively to encompass computational concepts, methods, models, algorithms, and tools. Applied in challenging science and engineering research and education contexts, computational thinking promises a profound impact on the Nation's ability to generate and apply new knowledge. Collectively, CDI research outcomes are expected to produce paradigm shifts in our understanding of a wide range of science and engineering phenomena and socio-technical innovations that create new wealth and enhance the national quality of life. CDI seeks ambitious, transformative, multidisciplinary research proposals within or across the following three thematic areas:

- **From Data to Knowledge:** *enhancing human cognition and generating new knowledge from a wealth of heterogeneous digital data;*
- **Understanding Complexity in Natural, Built, and Social Systems:** *deriving fundamental insights on systems comprising multiple interacting elements; and*
- **Building Virtual Organizations:** *enhancing discovery and innovation by bringing people and resources together across institutional, geographical and cultural boundaries.*

With an emphasis on bold multidisciplinary activities that, through computational thinking, promise radical, paradigm-changing research findings, CDI is unique within NSF. Accordingly, investigators are encouraged to come together in the development of far-reaching, high-risk science and engineering research and education agendas that capitalize on innovations in, and/or innovative use of, computational thinking. CDI projects are expected to build upon productive intellectual partnerships involving investigators from academe, industry and/or other types of organizations, including international entities. Congruent with the three thematic areas, CDI projects will enable transformative discovery to identify patterns and structures in massive datasets; exploit computation as a means of achieving deeper understanding in the natural and social sciences and engineering; simulate and predict complex stochastic or chaotic systems; explore and model nature's interactions, connections, complex relations, and interdependencies, scaling from sub-particles to galactic, from subcellular to biosphere, and from the individual to the societal; train future generations of scientists and engineers to enhance and use cyber

resources; and facilitate creative, cyber-enabled boundary-crossing collaborations, including those with industry and international dimensions, to advance the frontiers of science and engineering and broaden participation in STEM fields.

Two types of CDI awards will be supported as a result of the first (FY 2008) CDI competition:

- Type I awards will require efforts up to a level roughly comparable to: summer support for two investigators with complementary expertise; two graduate students; and their collective research needs (e.g. materials, supplies, travel) for three years.
- Type II awards will require larger (than Type I) efforts up to a level roughly comparable to: summer support for three investigators with complementary expertise; three graduate students; one or two senior personnel (including post-doctoral researchers and staff); and their collective research needs (e.g. materials, supplies, travel) for four years. The integrative contributions of the Type II team should clearly be greater than the sum of the contributions of each individual member of the team. In subsequent years, subject to availability of funds, funding opportunities will be provided for three classes of awards, Types I and II as defined above, and Type III as defined below:
- Type III awards will require the engagement of larger (than Type II) multidisciplinary teams, roughly comparable to multiple senior investigators with complementary expertise, multiple graduate students, several senior personnel, and their collective research needs (e.g. materials, supplies, travel) for up to five years. As for Type II awards, the integrative contributions of the Type III team should be clearly greater than the sum of the contributions of each individual member of the team.

Proposals may only be submitted by the following:

- Universities and colleges: U.S. universities and two- and four-year colleges (including community colleges)
- Non-profit, non-academic organizations: Independent museums, observatories, research labs, professional societies and similar organizations in the U.S. associated with educational or research activities, subject to Grant Proposal Guide (GPG) guidelines.

Proposals that capitalize upon productive intellectual partnerships involving investigators from academe, industry and/or other types of organizations, including international entities, are encouraged. Partnerships between academe and other types of organizations, both foreign and domestic, promise the identification of compelling research challenges, and the more effective transformation of discoveries into innovations that create wealth and other societal impacts. While NSF will consider supporting CDI activities undertaken by SBIR-eligible organizations through subawards, other for-profit entities and international partners must support their participation in CDI projects from other funding sources.

I. INTRODUCTION

Our everyday lives have been transformed by the impact of computation and communication. This impact can be observed in the national economy where information technology has contributed in significant and numerous ways to growth in productivity, and to a plethora of new products and services. For example, advances in computing have led to improvements in healthcare diagnoses, access and delivery, in education where learning is increasingly mediated by information technologies, and in science and engineering where the conduct of research is being revolutionized by an increasingly pervasive and sophisticated cyberinfrastructure. There

has also been an impact at a conceptual level. Applying computing to problem-solving has led to, and continues to engender, the development of new ways of conceptualizing, analyzing and solving problems, particularly problems related to complex systems where more traditional research tools afford only limited progress.

Motivated by compelling research challenges across the science and engineering frontier, NSF has been making investments in computational science and engineering research, education, and infrastructure for many years. The potential of an increasingly powerful and functionally-complete cyberinfrastructure to advance science and engineering discovery and learning recently culminated in the creation and initial implementation of the agency's *Cyberinfrastructure Vision for 21st Century Discovery*.

Recognizing that contemporary advances in computational capabilities – most notably algorithms, architectures, data storage, languages, manipulation and visualization, networking, processing power, software systems, and a growing community of experienced computational scientists and engineers – place us on the threshold of a transformation in our understanding of the world around us, NSF has formulated a bold new initiative called Cyber-Enabled Discovery and Innovation (CDI). All NSF directorates and programmatic offices are participating.

II. PROGRAM DESCRIPTION

The Cyber-Enabled Discovery and Innovation (CDI) initiative has been designed to yield *revolutionary* science and engineering research outcomes made possible by innovations and advances in computational thinking. Computational thinking is defined comprehensively to encompass computational concepts, methods, models, algorithms, and tools. Applied in challenging and compelling science and engineering research and education contexts, computational thinking promises a profound impact on the Nation's ability to generate and apply new knowledge. In addition, the challenge of applying computational thinking to very difficult problems in science and engineering will stimulate further advances in computational thinking. Collectively, CDI research outcomes will produce paradigm shifts in our understanding of a wide range of science and engineering phenomena and socio-technical innovations that create new wealth and enhance the national quality of life. CDI investigators are expected to generate groundbreaking multidisciplinary research and education outcomes across biological sciences, computer and information sciences, education, engineering, geosciences, mathematical sciences, physical sciences, and social, behavioral, and economic sciences. The development and creative use of computational thinking to enable discovery and innovation on all fronts of science and engineering is likely to stimulate advances that collectively accelerate development of an increasingly powerful cyberinfrastructure.

With an emphasis on bold, multidisciplinary activities that, through computational thinking, promise radical, paradigm changing science and engineering outcomes, CDI is unique within NSF. Accordingly, investigators are encouraged to come together in the development of far-reaching, high-risk research and education agendas that capitalize on innovations in, and/or innovative use of, computational thinking to create new knowledge and societal impact far beyond today's capabilities. CDI projects will build upon productive intellectual partnerships involving investigators from academe, industry and/or other types of organizations, including international entities.

A **competitive** CDI proposal will:

- Describe an ambitious research and/or education agenda that, through computational thinking, promises paradigm shifting advances in more than one field of science or engineering;
- Provide a compelling rationale for how innovations in, and/or innovative use of, computational thinking will yield the desired project outcomes; and,
- Draw on productive intellectual partnerships that capitalize upon knowledge and expertise synergies in multiple fields or sub-fields of science or engineering, and/or in multiple types of organizations, including academic, for-profit, and not-for-profit entities, both foreign and domestic.

Projects that make straightforward use of existing computational concepts, methods, models, algorithms, and tools to significantly advance only one field of science or engineering should be submitted to an appropriate NSF program in that field instead of to CDI.

Letters of Intent (required):

Submission of a Letter of Intent (LoI) is required. LoIs must be submitted via FastLane consistent with the general guidelines described in NSF's Grant Proposal Guide. The receipt of LoIs assists NSF in planning for the review process, including the timely identification and recruitment of appropriate reviewers. Accordingly, investigators are strongly encouraged to provide information that is as accurate as possible.

Only ONE LoI should be submitted for each proposed project. If a collaborative project is being developed, the corresponding investigators should decide which member of the proposing team will submit the LoI. LoIs need not be submitted by Sponsored Project Offices.

To submit an LoI, enter FastLane and click on "Proposals, Awards and Status". Click on "Proposal Functions" and then "Letters of Intent". Search for and select the CDI program solicitation. Then click on "Create" under "LOI Action" to prepare and submit your LoI. A CDI LoI must include text in each of three sections as indicated below.

- Please include a project title that begins with "CDI-Type I:" or "CDI-Type II:", dependent on the type of project being proposed.
- In the Synopsis section (not to exceed 2500 characters), include a summary of the activities being proposed; a list of the PI(s), co-PI(s) and Senior Personnel, and their organizational affiliations; and, provide an estimate of the total project budget.
- In Other Comments, identify the CDI theme (the most relevant, even if the proposed work cuts across more than one), and up to 3 key words from the following list that best describe the major disciplines of the multidisciplinary research and education being proposed: Biology; Education; Computer Science/Information Science; Engineering; Environmental Sciences; Geosciences; Mathematical Sciences; Physical Sciences; Polar Sciences; Social, Behavioral and Economic Sciences, plus, at the project team's discretion, one key word of the project team's choosing.

On receipt of the LoI, NSF will respond by providing an LoI ID number. ***Please save this number; you must refer to it when submitting a preliminary proposal.***