



# Funding Opportunities in NSF's CISE Directorate

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# NSF's Target Audience\*

- U.S. Universities and Colleges
- U.S. Nonprofit, Nonacademic Organizations
- U.S. For-Profit Organizations
- State/Local Educational Organizations
- Unaffiliated U.S. Scientists, Engineers, Educators, & Citizens
  - NSF Rarely Supports Foreign Organizations or Other Federal Agencies

\* Program Solicitations may establish more restrictive eligibility





# CISE Organization

Office of the Director

Office of the Assistant Director for CISE

**CCF**  
Computing and Communications Foundations

Clusters

- **EMT**
- **CPA**
- **TF**

**CNS**  
Computer and Network Systems

Clusters

- **NeTS**
- **CSR**
- **CRI**

**IIS**  
Information and Intelligent Systems

Clusters

- **HCC**
- **III**
- **RI**

**OCI**  
Office of Cyberinfrastructure

*(formerly SCI, now an NSF-wide mission, reporting to Director of NSF since 2006)*

Cross-Divisional Programs and CISE/NSF Emphasis Areas

- **CT**
- **CDI**
- **BPC**
- **SRS**
- **Expeditions**
- **CPATH**

# Computing and Communication Foundations Division (CCF)

- **Emerging Models and Technologies for Computation (EMT)**
  - Computational biology; quantum computing; nano-scale computing; biologically-inspired computing
- **Foundations of Computing Processes and Artifacts (CPA)**
  - Advanced computation research; compilers; computer architecture; design automation (micro/nano); graphics & visualization; software engineering & languages
- **Theoretical Foundations (TF)**
  - Computer science and communication theory; numeric symbolic/graphic computation; theory of computing; computational algebra and geometry; signal processing



# Computer and Network Systems Division (CNS)

- **Computer Systems Research (CSR)**
  - Distributed systems; embedded and hybrid systems; next-generation software; parallel systems
- **Networking Technology and Systems (NeTS)**
  - Programmable wireless networks; networking of sensor systems; networking broadly defined; future internet design (GENI)
- **Computing Research Infrastructure (CRI)**
  - Equipment and infrastructure to advance computing research
- **Cross-Directorate Emphasis Areas & Activities**
  - Cybertrust (CT); Science of Design (SoD); Broadening Participation in Computing (BPC); IT workforce and special projects: REU sites, IGERT, ADVANCE, CPATH



# Information and Intelligent Systems Division (IIS)

- **Human-Centered Computing (HCC)**
  - Digital society & technologies; human computer interaction; universal access; intelligent spaces (active displays, sensory devices, immersive experiences) and personal agents (feature-rich gadgets and appliances)
- **Information Integration and Informatics (III)**
  - Digital government; digital libraries & archives; information, data, and knowledge management; science & engineering information integration and informatics
- **Robust Intelligence (RI)**
  - Artificial intelligence & cognitive science; computational neuroscience; computer vision; human language & communication; robotics



# NSF & CISE Budget in \$M FY'06 to FY'08 (*Requested*)

<i>CISE Divisions</i>	<i>FY'05</i>	<i>FY'06</i>	<i>FY'07</i>
<b>CNS</b>	<b>\$141.53</b>	<b>\$162.98 (+15%)</b>	<b>\$191.98 (+18%)</b>
<b>CCF</b>	<b>\$105.46</b>	<b>\$122.82 (+16%)</b>	<b>\$149.15 (+21%)</b>
<b>IIS</b>	<b>\$103.62</b>	<b>\$119.30 (+15%)</b>	<b>\$154.63 (+30%)</b>
<b>ITR (across divisions)</b>	<b>\$145.80</b>	<b>\$121.59 (-16%)</b>	<b>\$78.24 (-36%)</b>
<b><i>CISE Total * (Research)</i></b>	<b>\$496.41</b>	<b>\$526.69 (+6%)</b>	<b>\$574.00 (+9%)</b>
<b>NSF Total</b>	<b>\$5,605</b>	<b>\$6,020 (+7.4%)</b>	<b>\$6,430 (+6.8%)</b>

\* Major Research Equipment and Facilities Construction (MREFC) since '05: \$165.6M add'l



# Foundations of Computing Processes and Artifacts (CPA)

The CPA Cluster supports basic research and education projects aimed at advancing formalisms and methods pertaining to processes and artifacts for designing and building computing and communication systems

- Processes and artifacts range from formalisms, models, algorithms, theories, design principles and languages to hardware/software architectures, technology components, and a variety of physical manifestations and implementations
- The CPA cluster funds a diverse portfolio of high-quality, high-payoff *foundational research* to meet the needs of the scientific and engineering community as well as society at large
- There are *six focus areas* having topics of specific interest, but *clustering* promotes research across sub-fields that may transcend individual focus area boundaries





# Foundations of Computing Processes and Artifacts (CPA)

## Six focus areas comprising the CPA cluster:

- **Advanced Computation:** parallel algorithms, data management, storage, I/O, high-performance computing, simulation, benchmarking
- **Compilers:** parallelization, code transformation, thread management
- **Computer System Architecture:** processor microarchitecture, memory, interconnection networks, reconfigurable computing, tools
- **Design Automation:** VLSI design, test & verification, system-on-chip
- **Graphics and Visualization:** mathematical modeling of data, graphical simulation and animation techniques, graphics processing
- **Software Engineering and Languages:** formalization of software development, correctness, reliability, programming models



# Foundations of Computing Processes and Artifacts (CPA)

- Focus areas and Program Directors of the CPA Cluster

<b>ACR</b>	<b>Advanced Computation Research (Algorithms, Storage, I/O, HPC)</b>	<b>Almadena Chtchelkanova (since 2005)</b>
<b>CHS</b>	<b>Compilers and High-performance Software</b>	<b>Almadena Chtchelkanova (since 2005)</b>
<b>CSA</b>	<b>Computer System Architecture</b>	<b>Timothy M. Pinkston (since 2006)</b>
<b>DA</b>	<b>Design Automation for Micro &amp; Nano Systems (VLSI)</b>	<b>Sankar Basu (since 2003)</b>
<b>GV</b>	<b>Graphics &amp; Visualization</b>	<b>Lawrence Rosenblum (since 2005)</b>
<b>SEL</b>	<b>Software Engineering &amp; Languages</b>	<b>Sol Greenspan (since 2003) Joseph Urban (since 2006) Al Hevner (since 2006)</b>

- Each focus area can have topics of specific interest, but clustering promotes cross-disciplinary research that may transcend focus area boundaries

# Advanced Computation Research (ACR)

Hardware/software research and enabling technologies for advancing the state-of-the-art in computational science and engineering, developing efficient computational parallel algorithms, high throughput input/output (I/O) capabilities, large data storage capacities, and tools for efficiently organizing, locating, and moving data produced by different applications in numerous locations and in various formats

Topics of interest include:

- Design of multi-level (hierarchical, layered) parallel algorithms and libraries
- Scalable and latency tolerant computational/numeric algorithms
- Performance modeling of scalable algorithms
- Management of large-scale distributed file systems and data
- Novel storage devices, architectures, and middleware for high-throughput I/O
- Software and hardware processes and artifacts for design, simulation, benchmarking, tracing, performance measurement, and tuning of I/O, file, and storage systems in high-performance computing environments



# Compilers & HP Software (CHS)

Foundations in compilers research and education for enabling automatic algorithm mapping, code and data transformation, translation to hardware description language (for reconfigurable architectures), advanced analysis to verify program correctness and improve programmer productivity, compiler support for automating the exploitation of parallelism (i.e., parallelizing compilers for single-threaded and multi-threaded programs for multicore & multiprocessor systems)

Topics of interest include:

- Parallelizing compilers and infrastructure for optimizing compilers for multiple platforms, including reconfigurable architectures
- Parallelization techniques for exploiting parallelism at multiple levels applicable to multiple programming models
- Software and compiler support for mapping and scheduling multiple threads on (possibly heterogeneous) multicore and multiprocessor systems
- Software and compiler techniques for managing on-chip communication, power consumption, temperature, and fault tolerance
- Compiler techniques to guarantee safety from potential deadlocks, memory leaks, race conditions, and other forms of correctness in parallel programs



# Computer System Architecture (CSA)

Foundations in computer system architecture research and education for facilitating and enabling scalable performance, power and thermal management, reliability (soft and hard error detection and recovery), dynamic adaptation, real-time computation, security, reduced design complexity, programmability, and other enhanced functionalities

Topics of interest include:

- Processor microarchitecture, memory, and interconnection networks: multithreaded, multicore, and multiprocessor architectures; distributed register and cache architectures; on-chip networks
- Novel architectures and hardware primitives that facilitate concurrency and exploit parallelism at multiple levels and in multiple forms: fine-grained, instruction, data, thread, stream, task, and coarse-grained
- Architectural techniques for managing on-chip communication, power consumption, temperature, operational variability, error/fault tolerance
- Application-to-hardware mapping: application-specific processors, programmable accelerators, and reconfigurable computing
- Design and analysis of computer systems: tools and methods for design space exploration; modeling, benchmarking, simulation, synthesis, and performance evaluation



# Design Automation for Micro and Nano Systems (DA)

Foundations in VLSI design automation in both CMOS silicon technology and future computing media (i.e., MEMs, 3-D, optical, molecular, and nano-scale technologies) to meet the needs of deep submicron VLSI computing and communication chips

Topics of interest include:

- Physical design: routing & layout, power optimization, logic synthesis, on-chip communication, modeling & device simulation
- System-level design: systems-on-a-chip, multicore, embedded, and application-specific processor design; hardware/software co-design
- Test and verification: analog and digital mixed-signal systems, built-in self-test, design for testability, formal proof of correctness
- Nano-scale design related to the circuits/architecture interface: novel approaches to parallelism suitable to nano-scale electronics, systems integration of nano-scale devices, design of reliable systems from unreliable components, defect/fault models, fundamental limits to such designs

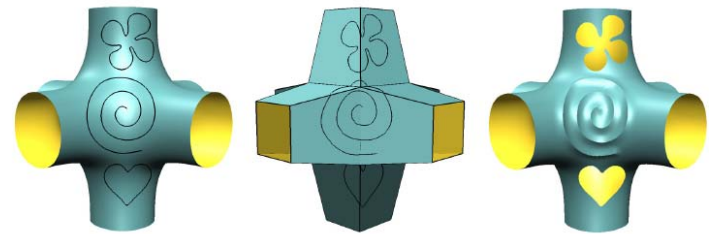


# Graphics & Visualization (GV)

- Integrated research and education projects to advance the scientific foundations and engineering practices/education that underlie the ability to perform visual information transfer, address models of physical events, develop mechanisms for image production, and utilize visualization to represent and explore information
- Focus is on the ability to model, render, and display data and to understand the forms of visualization that can best transfer particular types of information
- Seek *fundamental* advances that will enhance the numerous activities that utilize computer graphics and visualization, including science, engineering, medicine, entertainment, education, commerce, and homeland security



Computer-generated lighting effects using flash photography [Durand, MIT]

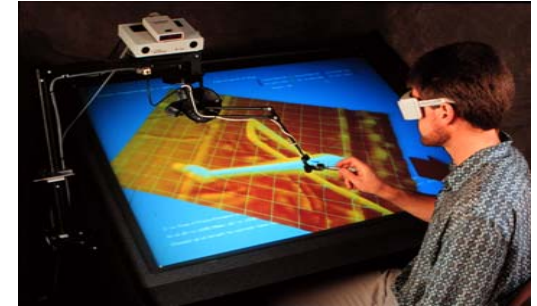


Multiresolution Subdivision Surfaces simplify the addition of sharp surface features onto surfaces [Zorin, NYU]

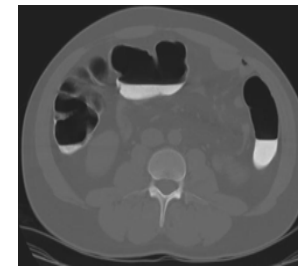
# Graphics & Visualization (GV)

## Topics of interest include:

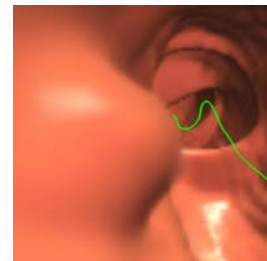
- Mathematical models for representing geometric and non-geometric data
- Algorithms for the photorealistic and non-photorealistic rendering of geometry, lighting, and materials
- Physical-based modeling and graphical simulation
- Animation techniques
- Multi-resolution algorithms for graphics modeling and applications
- Visibility algorithms
- Scientific visualization algorithms and systems
- Visualization aspects of visual analytics
- Visualization aspects of location-aware computing
- Virtual and augmented reality
- Novel hardware for graphics processing
- Graphics issues in computational photography and video
- Innovative multidisciplinary proposals that join visualization with other computer-science domains



The **nanoManipulator** system enables scientists to directly see and touch nanometer-scale objects [Taylor et al., UNC]



The steps of the **Virtual Colonoscopy**: CT scan of patient's abdomen; automatic segmentation and reconstruction; real-time volume rendering [Arie Kaufman, SUNYSB]





# Foundations of Computing Processes and Artifacts (CPA)

- Current CPA focus areas and Program Directors

<b>ACR</b>	<b>Advanced Computation Research (Algorithms, Storage, I/O, HPC)</b>	<b>Almadena Chtchelkanova (since 2005)</b>
<b>CHS</b>	<b>Compilers and High-performance Software</b>	<b>Almadena Chtchelkanova (since 2005)</b>
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- Each focus area can have topics of specific interest, but clustering promotes cross-disciplinary research that may transcend focus area boundaries

# Software Engineering and Languages (SEL)

## Topics of interests include:

- **Programming language principles, design and implementation**
  - PL semantics to elucidate new features, e.g., aspects
  - Advancing type theory to full theorem proving
- **Software analysis and testing**
  - Test-case generation, fault localization
  - Static and dynamic checking, model checking
  - Monitoring and continuous testing of distributed systems
- **Formal methods for program development – components and composition**
  - Assembling components to meet a specification, trusted components, behavioral interfaces
- **Software development methodology**
  - Informal methods, integrated environments, processes, requirements, architectures, dependability, scaling up

# CPA Proposal Solicitation

- 2006 CPA Competition (NSF 06-585)
  - approx. 105 awards from 525 proposals (~20% success rate)
  - ~ \$38,000,000 total funds, ave. of ~ \$125,000/yr (all awards)
- 2007 CPA Solicitation (NSF 07-587)
  - Proposal due date: **December 7, 2007, 5pm local time**
  - Anticipated funding, number, and size of awards:
    - max. of \$42,000,000 anticipated funds (could be much less)
    - 70 to 95 awards of \$100K/year to \$125K/year for 3 years
    - 5 to 7 “team” awards of up to \$500,000/yr for 3 years
    - up to 2 “major team” awards of up to \$900K/yr for 3 or 4 yrs for well-integrated projects of larger scope, possibly cross-area
  - Submission limitations:
    - Investigators may participate as PI, co-PI, or Senior Personnel on at most two proposals; one having multiple PIs
    - PIs must come from US universities or colleges
  - See <http://nsf.gov/pubs/2007/nsf07587/nsf07587.htm>

# Computing Research Infrastructure (CRI)

- **Program Objectives (\$18M total funds):**
  - Supports infrastructure in all areas in which CISE supports research (CRI “complements” research funding)
  - *Infrastructure Acquisition and Development track:* to support research and education of proposers; install and maintenance--\$50K to \$2M awards
  - *Community Resource Development track:* to create resources that support research (and education) for a national community of researchers (e.g., testbed to evaluating research results)--\$300K to \$2M awards
  - *Planning grants:* up to \$50K awards to plan for above
  - Approximately 230 proposals/yr with~ 30% success rate
- **Proposal deadline: 1<sup>st</sup> Tuesday in August 2008**
- **Coordinating Program Directors:**
  - *Tanya Korelsky, Anita LaSalle, Rita Rodriguez, Joseph Urban*



# Cyber-Enabled Discovery and Innovation

- **CDI Objective:** *Enhance American competitiveness by enabling innovation through the use of computational thinking, i.e., computational...*
  - ... Concepts
  - ... Methods
  - ... Models
  - ... Algorithms
  - ... Tools
- **Multi-disciplinary research contributing to more than one area of science or engineering, by innovation in, or innovative use of computational thinking**
  - three types of awards categorized by scale of effort
- **Scope encompasses three general themes:**
  - *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
  - *Building Virtual Organizations:* enhancing discovery and innovation by bringing people and resources together across institutional, geographical and cultural boundaries
- **Anticipated Funding Amount: \$26,000,000 for ~ 30 awards**
  - Letter of Intent due **November 30, 2007** (required)
  - Preliminary proposal due January 8, 2008
  - Full proposal due April 29, 2008 (by invitation only)
- See <http://www.nsf.gov/pubs/2007/nsf07603/nsf07603.htm>

# Foundations of Data and Visual Analytics

- **Problem:** Those involved with science, engineering, commerce, health, and national security all increasingly face the challenge of synthesizing information and deriving insight from massive, dynamic, ambiguous and possibly conflicting digital data
- **This program** seeks the creation of the mathematical and computational sciences foundations required to transform data in ways that permit visual-based understanding
- **Research topics:**
  - Synergistic combinations of data transformation techniques to create more meaningful representations with semantic richness and validity
  - Approaches that will tightly couple novel data transformations with visualization systems, including methods to capture and represent information quality and uncertainty
  - Novel transformations to facilitate dynamic identification of new or unanticipated events which may also include measures of usefulness
  - Computational and mathematical algorithms that will enable the unified representation of dynamic data of multiple types and sources
  - Fundamentally new approaches to identifying changes in massive data sets
- **Awards:** 5 to 7 - This will consist of 1 five-year FODAVA-Lead award totaling \$3,000,000 and 4 to 6 two to three year FODAVA-Partner awards totaling \$300,000 to \$500,000 each
- **Full Proposals due Nov. 20, 2007**
- See <http://nsf.gov/pubs/2007/nsf07583/nsf07583.htm>



# Software for Real-World Systems (SRS)

- *Motivation:* Software is a critical element of real-world systems, yet the science and engineering remain elusive and poorly understood for designing and building the software that will govern the essential behaviors and properties of real-world systems
- Program Goals: Support research on developing new scientific principles, engineering processes and methods, and educational pedagogy for the challenges inherent in real-world systems
  - *Design and evolution of large-scale, real-world systems with scalable, computational methods of composition*
  - *Monitoring, orchestration, and control of real-world system behaviors and interactions in dynamic, ever-changing conditions and operational environments*
  - *Amplification of human participation in the design and use of real-world systems*
- Consideration of emerging technologies (e.g., multicore systems) and innovative applications (e.g., pervasive health care computing) are encouraged, as are industrial partnerships with clearly stated research benefits
- Anticipated Funding Amount: \$10,000,000 for 12 to 20 awards
- Proposals due **January 17, 2008**
- See <http://www.nsf.gov/pubs/2007/nsf07599/nsf07599.htm>

# Expeditions in Computing

Created to inspire bold, transformational research that explores new scientific frontiers that promise disruptive innovations in computing

- **Program Goals:**

- Catalyze far-reaching research in the computing and information fields motivated by hard, emerging problems and/or compelling applications
- Inspire current & future generations to pursue CISE careers
- Stimulate significant research and education outcomes that benefit society through effective knowledge transfer

- **Scope: Research that cuts vertically or horizontally across CISE**

- **Awards: 3 anticipated, w/ budgets of \$2,000,000/yr for five years**

- **Submission Requirements and Deadlines:**

- Letter of Intent (required) due **November 5, 2007**
- Preliminary Proposal (required) due **December 30, 2007**
- Full Proposal (by invitation only) due **April 1, 2008**

- **See <http://www.nsf.gov/pubs/2007/nsf07592/nsf07592.htm>**



# Industry University Cooperative Research Program (I/UCRC)

- **Partnering Industries and Universities to Innovate.**
- **I/UCRCs stimulate highly leveraged industry/university cooperation by focusing on fundamental research recommended by Industrial Advisory Boards.**
- **I/UCRC develops long-term partnerships among industry, academic institutions, and government.**
- **The centers are catalyzed by a small investment from the National Science Foundation (NSF) and are primarily supported by center members, with NSF taking a supporting role in their development and evolution.**

# Contact Information

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