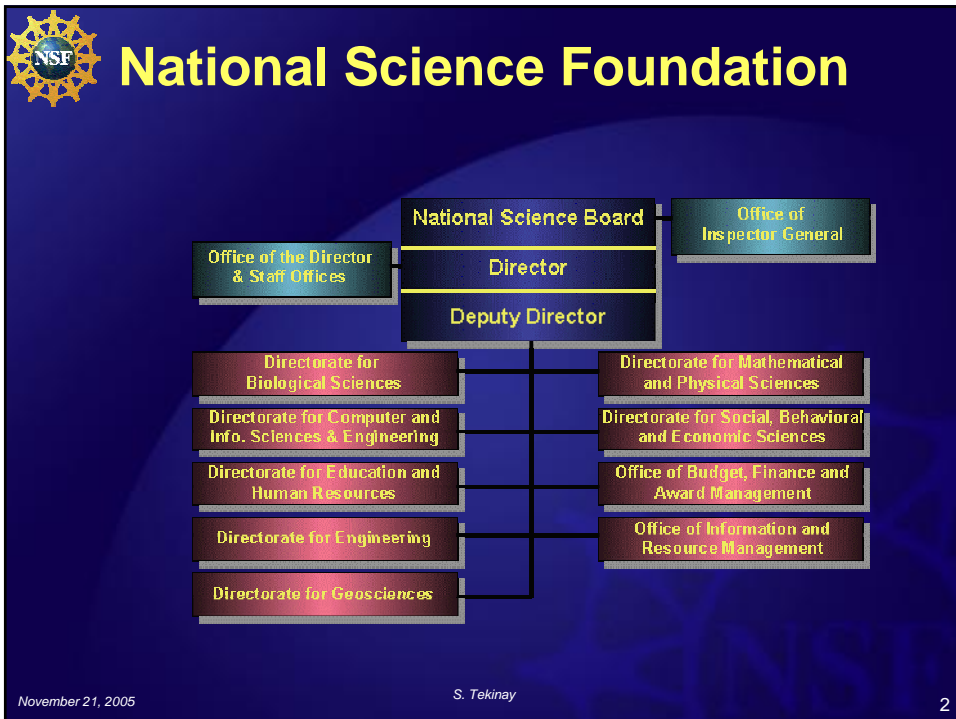


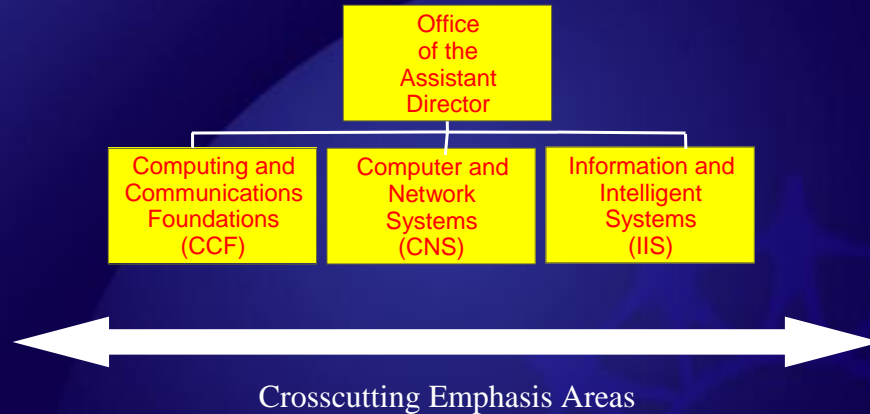
# GENI: A New NSF Initiative and the Role of Cooperative Communications

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## Current CISE Organization



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## Computing and Communication Foundations (CCF)

- Theoretical Foundations
  - Communications, signal processing, and computer science theory
- Foundations of Computing Processes and Artifacts
  - Software engineering; software tools for HPC; programming languages; compilers; computer architecture; graphics and visualization
- Emerging Models for Technology and Computation
  - Computational biology; quantum computing; nano-scale computing; biologically inspired computing

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# GENI Initiative



## GENI Initiative

- Global Environment for Networking Investigations
  - The new new Internet:
  - existing network testbeds
    - PlanetLab, ORBIT, WHYNET, Emulab, X-Bone, DETER and others
- GENI comprises two components:
  - 1) the GENI Research Program and
  - 2) the experimental GENI Facility



## GENI Vision

- The GENI Initiative envisions the creation of new networking and distributed system architectures that, for example:
  - Build in security and robustness;
  - Enable the vision of pervasive computing and bridge the gap between the physical and virtual worlds by including mobile, wireless and sensor networks;
  - Enable control and management of other critical infrastructures;
  - Include ease of operation and usability; and
  - Enable new classes of societal-level services and applications.

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## GENI Design

- The GENI Initiative will support research, design, and development of new networking and distributed systems capabilities by:
- **Creating new core functionality:** Going beyond existing paradigms of datagram, packet and circuit switching; designing new naming, addressing, and overall identity architectures,
  - **Developing enhanced capabilities:** Building security into the architecture; designing for high availability; balancing privacy and accountability
  - **Deploying and validating new architectures:** Designing new architectures that incorporate emerging technologies (e.g., new wireless and optical technologies) and new computing paradigms enabled by pervasive devices;
  - **Building higher-level service abstractions:** Using, for example, information objects, location-based services, and identity frameworks;
  - **Building new services and applications:** Making large-scale distributed applications secure, robust and manageable; developing principles and patterns for distributed applications

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## GENI Experimental Facility

One approach for a GENI Facility would enable:

- Shared use through slicing and virtualization in time and space domains (i.e., where “slice” denotes the subset of resources bound to a particular experiment);
- Access to physical facilities through programmable platforms (e.g., via customized protocol stacks);
- Large-scale user participation by “user opt-in” and IP tunnels;
- Protection and collaboration among researchers by controlled isolation and connection among slices;
- A broad range of investigations using new classes of platforms and networks, a variety of access circuits and technologies, and global control and management software; and
- Interconnection of independent facilities via federated design

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## GENI Research Foundations

In the Theoretical Foundations Research Community, we believe GENI should be based on NEW:

- *Core theory*
- *Fundamental algorithms*
- *Applications*

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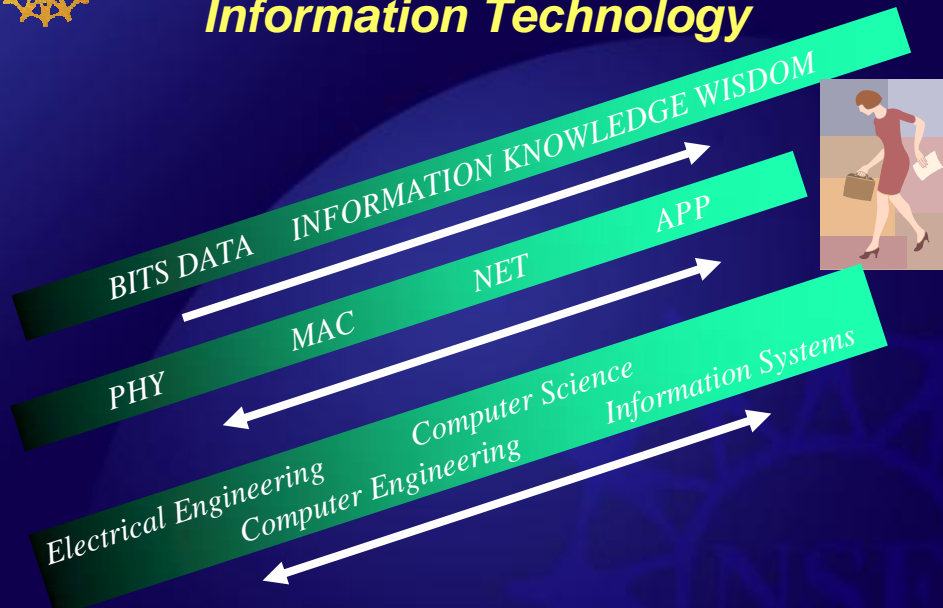


## Core theory and fundamental algorithms

- expanding existing theory and formulating a new communication framework; **link=channel, channel=link ; cross-layer versus re-layer**
- considering the temporal and spatial distribution of information and power; **distribution of RF enabled devices, formation of virtual MIMO clusters, local scalability, power combining...**
- viewing electromagnetic spectrum as a natural resource; **interference avoidance, waveform agility, water-filling ...**
- investigating relationships to theoretical foundations of social computing, microeconomics, and biology; **game theory**
- developing an evolution theory for computing and learning with mobile information sources; **mobile agents, exchange executibles**
- establishing the role of location from spatial behavior of propagation to "place;" **cooperation and association at all layers**



## Engineering versus Information Technology





## Applications and Concepts

- multimedia signal processing, smart displays

### CONTENT and CONTEXT AWARE

#### Signal Processing and Communications

- wireless communications, mobile and sensor devices

### GEOGRAPHY OF RADIO RESOURCES

- ad hoc networks, sensor networks, peer-to-peer communications and information networks

### GEOGRAPHY OF INFORMATION



## Geography of Radio Resources

- Bandwidth
- Interference
- Propagation
  
- Power
- Wireless node distribution
- Mobility



## Geography of Information

- Temporal and spatial
  - Where information items reside
    - Mobility
  - The significance/relevance of information in time and place
    - The endurance of the significance of information
- Social networks
  - Scalability, network hierarchy...

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## CONTENT/CONTEXT AWARE Communications and Signal Processing

- Information at the physical layer
  - QoS
  - Security
- Voice to voicemail, picture to text
- Strongly tied geography of information and geography of radio resources

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## Outreach

- In planning for GENI CISE has supported numerous community workshops
- CISE is supporting on-going planning efforts, including needs assessment and requirements for the GENI Facility and Research.
- CISE will hold town meetings and continue to support future workshops to broaden community participation.
- CISE will work with industry, other US agencies, and international groups to broaden participation in GENI beyond NSF and the US government.

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## BACKUP

CISE Info





## CISE Mission

- CISE has three goals:
  - To uphold a position of world leadership in computing, communications and information science and engineering
  - To promote the understanding of the principles and advance uses of computing, communications and information systems in service to society
  - To contribute to universal, transparent and affordable participation in an information-based society

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## Computer and Network Systems (CNS)

- Computer Systems
  - Distributed systems; embedded and hybrid systems; Next Generation system
- Network Systems
  - General networking; wireless systems; sensor networks
- Computing Research Infrastructure
  - Research infrastructure; minority institutional infrastructure; research resources
- Education and Workforce
  - Curriculum development/educational innovation; IT workforce; special projects; cross-directorate activities (e.g., REU sites)

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## Information and Intelligent Systems (IIS)

- Systems in Context
  - Human computer interaction; educational technology; robotics; computer-supported cooperative work; digital government
- Understanding, Inference, and Data
  - Databases; artificial intelligence; text, image, speech, and video analysis; information retrieval; knowledge systems
- Science & Engineering Informatics/Information Integration
  - Bioinformatics; geoinformatics; cognitive neuroscience; Driven by a computer science agenda and application domains

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## Cross-Foundational Programs

- **IGERT \*** – preliminary proposals by Feb 2005
- **REU Sites** – August 2005, tell students about summer opportunities, post flyer
- **CAREER** – spring 2005, recognized starting place for new faculty
- **ADVANCE** – spring 2005, institutional transformation and leadership
- **GK-12** - May, June, great fellowships and outreach

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## \*Introduction to the IGERT Program

- Integrative Graduate Education and Research Traineeship (IGERT)
- educate U.S. Ph.D. scientists, engineers, and educators with the interdisciplinary backgrounds, deep knowledge in chosen disciplines, and technical, professional, and personal skills to become in their own careers the leaders and creative agents for change
- catalyze a cultural change in graduate education, for students, faculty, and institutions, by establishing innovative new models for graduate education and training in a fertile environment for collaborative research that transcends traditional disciplinary boundaries
- facilitate greater diversity in student participation and preparation, and to contribute to the development of a diverse, globally-engaged science and engineering workforce.

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## Cross-Cutting Emphasis Areas

- Characteristics
  - Cuts across clusters and divisions
  - Addresses scientific or national priority
  - Has a program solicitation and funds
- FY05 Emphasis Areas: Cyber Trust, Science of Design, Information Integration, DDDAS: Dynamic Data Driven Application Systems
- FY 2006 Emphasis Areas
  - Cyber Trust: February 6 2006
  - Science of Design: Waiting for New Solicitation
  - Information Integration: December 2005
  - Broadening Participation: April 06

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# Cyber Trust



## CyberTrust Theme

- Vision: A society in which
  - Computing systems operate securely and reliably
  - Computing systems protect sensitive information
  - Systems are developed and operated by a well-trained and diverse workforce
- Research on foundations, network security, systems software, and information systems
- Integrated education and workforce activities

# Science of Design



## Science of Design

- Considers formal theories and computational methods for the representation, synthesis, and evaluation of designs and requirements;
- Design processes supporting compositionality, maintainability, adaptability and evolution;
- The role of requirements and specifications in design;
- Computer-aided design for software-intensive systems;
- Studies of designs, designers and design methodologies;
- Development of design education and the integration of knowledge about design methodologies into educational curriculum and
- Training for computer scientists, software engineers and systems engineers.

# Broadening Participation in Computing Program



## BPC Program

- The Broadening Participation in Computing (BPC) program aims to significantly increase the number of students who are U.S. citizens and permanent residents receiving post secondary degrees in the computing disciplines.
  - New Program FY05
  - Available Funds: 14 Million
  - Full Proposal: April 5, 2006
  - Check CISE web site concerning which proposals require a Letter of Intent and due dates