Funding Opportunities at Electrical & Communications Systems (ECS) Division

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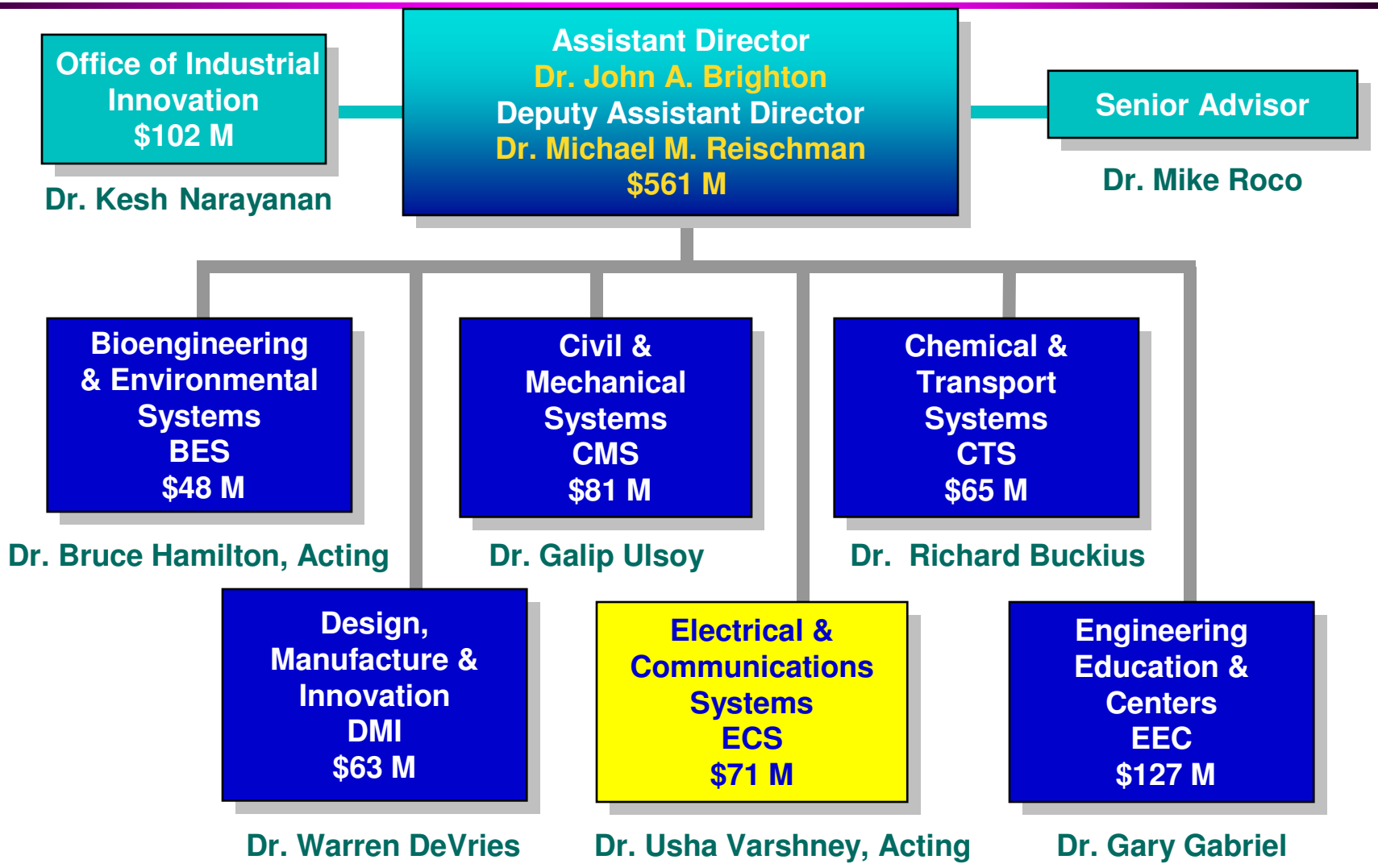
Outline of Presentation

- ECS Programs
- Integrative Systems
- Autonomic Communication Networks
- Cyberengineering/ Cyberinfrastructure
- International Opportunities
- Engineering Education and Centers (EEC) Programs
- Conclusions

Directorate for Engineering



ECS Programs

Electronics, Photonics, and Device Technologies
EPDT

- ✓ Microelectronics
- ✓ Nanoelectronics
- ✓ Molecular Electronics
- ✓ Silicon Nanoelectronics and Beyond
- ✓ Organic Electronics
- ✓ Spin Electronics
- ✓ Bioelectronics
- ✓ Micromagnetics
- ✓ Photonics and Optoelectronics
- ✓ Quantum Optics
- ✓ Ultrafast Sources
- ✓ Sensors and Actuators
- ✓ MEMS/NEMS
- ✓ Power Electronics
- ✓ Nonsilicon Electronics
- ✓ RF/Microwave and Mixed Signals
- ✓ Electromagnetics

Control, Networks, and Computational Intelligence
CNCI

- ✓ Hybrid and Distributed Control
- ✓ Power and Energy Networks
- ✓ Computational Intelligence
- ✓ Sensor Networks
- ✓ Multi-scale Modeling
- ✓ Biologically Inspired Computation
- ✓ Computational Video and Imaging

Integrative Systems
IS

Nanosystems, Microsystems, Macrosystems, Hybrid and Complex Systems

ECS Future Technologies

Key Technologies

- Integrative and Complex Systems
- Communications and Network Systems

Priority Technologies

- Nanoelectronics, Nanophotonics and Nanomagnetics
- Cyberengineering and Cybersecurity Systems
- Critical Infrastructure Technologies and Systems
- Flexible Electronics

Other Focus Areas

- Quantum Engineering
- Diagnostic and Implantable Devices
- Hydrogen Economy
- Neuro-dynamic Control and Learning for Complexity

Unsolicited Proposals

- **Submission Windows**
  - September 7 - October 7
  - January 7 - February 7
- **Review Process**
  - Panel
  - Mail
- **Reviewers**
  - Encourages reviewers from university, industry and government
  - Emphasize diversity and new faculty

Merit Review Criteria

I. What is the Intellectual Merit of the Proposed Activity?

- Importance of the proposed activity in advancing knowledge and understanding
- Qualifications of the proposer (individual or team)
- Intent to explore creative and original concepts
- How well conceived and organized is the proposed activity ?

II. What are the Broader Impacts of the Proposed Activity?

- Advance discovery and understanding while promoting teaching, training, and learning
- Broaden participation of underrepresented groups
- Enhance the infrastructure for research and education
- Disseminate broadly to enhance scientific and technological understanding
- Provide benefit to society

ECS Investments for FY 2005

NSF Priority Areas

- Biocomplexity in the Environment
- Human and Social Dynamics
- Mathematical Sciences
- Nanoscale Science and Engineering

NSF Programs

- CAREER: Faculty Early Career Development
  PECASE: Presidential Early Career Award
- SGER: Small Grants for Exploratory Research
- RET: Research Experiences for Teachers
- REU: Research Experiences for Undergraduates
- ADVANCE: Increasing the Participation and Advancement of Women in Academic Science and Engineering Careers
- MRI: Major Research Instrumentation
- GOALI: Grant Opportunities for Academic Liaison with Industry

ENG Initiatives

- ✓ Collaborative Large-scale Engineering Analysis Network for Environmental Research (CLEANER)
- ✓ Grants for Department-Level Reform of Undergraduate Engineering Education (DLR)
- ✓ Sensors and Sensor Networks ENG, GEO, OPP ($23M), ECS ($4 M)

ECS Initiatives

2002

- Integrated Sensing, Computation, & Networked Systems for Decision & Action (NSF 02-039)
- Spin Electronics for the 21st Century (NSF 02-036) with ENG (CMS, CTS, BES) and ONR
- Electric Power Network Security & Efficiency I (NSF 02-41) with ENG (BES), SBE (INT), EHR (DUE), ONR and EPRI
- Enabling Technologies for Space Solar Power (NSF 02-98) with ENG (BES, DMII), CISE (DIIS), EPRI and NASA

2003

- National Nanotechnology Infrastructure Network (NSF 03-519)
- Sensors and Sensor Networks I (NSF 03-512) with other ENG Divisions, NSF(OPP) and NSF(GEO)
- NSF/ONR Partnership in Electric Power Networks Efficiency and Security II (NSF 02-188) with ENG (BES), SBE (INT), EHR (DUE), ONR and EPRI
- Ultra-High Capacity Optical Communications: Challenges in Broadband Optical Access, Materials Processing, and ManufacturingII (NSF 03-537) with ENG (CTS, DMII), MPS (DMS) and DARPA

2004

- Silicon Nanoelectronics and Challenges to Current CMOS Technology (NSF 03-043) with SRC
- Technological Challenges in Organic Electronics, Photonics and Magnetics (NSF 04-554) with ENG (CMS, CTS, BES, DMII), DARPA and AFOSR
- Sensors and Sensor Networks II (NSF 04-522) with other ENG Divisions, NSF(OPP) and NSF(GEO)

2005

- Sensors and Sensor Networks III, (NSF 05-526) with other ENG Divisions, NSF(OPP) and NSF(GEO)
- Nanoscale Science and Engineering, (NSF 04-043, NSF 05-543) NSF-wide Yearly Solicitation, Centers, Interdisciplinary teams, Exploratory Research, Undergraduate Education
- Graduate Research Supplements (GRS) for Women and Underrepresented Minorities, with BES

Center Activities

Lead Management Oversight:

- **ERC: Computer Integrated Surgical Systems Technology**
  Johns Hopkins U., Rajinder Khosla
- **ERC: Extreme Ultraviolet Engineering Research Center**
  Colorado State U., Filbert Bartoli
- **STC: Nanobiotechnology,** Cornell U., Lawrence Goldberg
- **NSEC: Center for Nanomechanical Systems,** U. of California-Berkeley, Rajinder Khosla
- **SLC: Center of Excellence for Learning in Education, Science, and Technology,** Boston U., Vittal Rao, Radhakisan Baheti

Technical Support:

- **ERC: Center for Power Electronic Systems**
  Virginia Polytechnic Institute and State U., Usha Varshney
- **ERC: Collaborative Adaptive Sensing of the Atmosphere**
  U. of Massachusetts-Amherst, Vittal Rao

Workshop

Macro to Nano: Challenges and Opportunities in Integrative Complex Systems Engineering

March 7-8, 2005, Arlington, Virginia

Scope: **Integrative Complex Systems (ICS) are groups of interacting, interrelated elements that possess**

- **distributed sensing, actuation, computation, and communication functions**
- **heterogeneous components**
  - **Multi-discipline (investigators from different disciplines)**
  - **Multi-domain (chemical, thermal, electrical, mechanical, optical, magnetic…)**
  - **Multi-function (sensing, actuation, computation, and communication)**
  - **Multi-scale (from nano to micro to macro)**

Research Grand Challenges

- **21st Century electrical power infrastructure systems**
  - Fully distributed sensing networks with built-in intelligence having self-regulation, load-balancing, load-shedding having auto-recovery
- **Electronic chips that integrate a collection of components on a single substrate to provide:**
  - Automatic self-correction in the presence of process variations, aging, failures, changes in input load and environmental conditions leading to 100% yield on a wafer while meeting constraints on power and performance
- **Systems for health care and biology**
  - Instrumentation for the systems biology revolution
  - Wearable and implantable micro- and nano-systems for diagnostic and therapeutic/prosthetic applications
  - Feedback and control of closed-loop prosthetic devices
- **Environment and homeland security**
  - Multi-scale sensing, surveillance, and integrated diagnostics in natural and engineered systems
  - Massive wireless arrays of scalable aquatic and aerial sensing networks integrated with communications
  - High-performance networks of microsystems for weather forecasting, surveillance, seismic and ocean wave monitoring

Sensor Networks Grantee's Workshop Recommendations

http://www.cens.ucla.edu/Events/nsf/index.html

- Decentralized and Collaborative Detection
- Sensor Device Technology for Wireless Networked, Systems
- ECS Challenges in Energy Aware Networked Sensor Systems
- Distributed, Scalable, Control in Wireless Sensor Networks
- Actuation in Sensor Networks
- Civil and Environmental Engineering Applications of Wireless Sensor Networks

What CyberInfrastructure Means?

- Infrastructure that enables reliable, distributed, real-time collaboration and analysis requiring ubiquitous access to cyber-resources and large-scale, dynamic information storage
- Cyber-services: security, scheduling, user services, application management, autonomy and monitoring, composition, messaging, collaboration, decision-making, knowledge discovery, workflow, universal access
- Examples of cyber-resources and components to be integrated:
  - Major computational processing capabilities
  - Unique experimental and other physical facilities
  - High-speed networks
  - Tele-participation and tele-operation tools
  - Distributed Sensor/Actuator Networks
  - Data/metadata storage and curation
  - Data analysis and information extraction tools

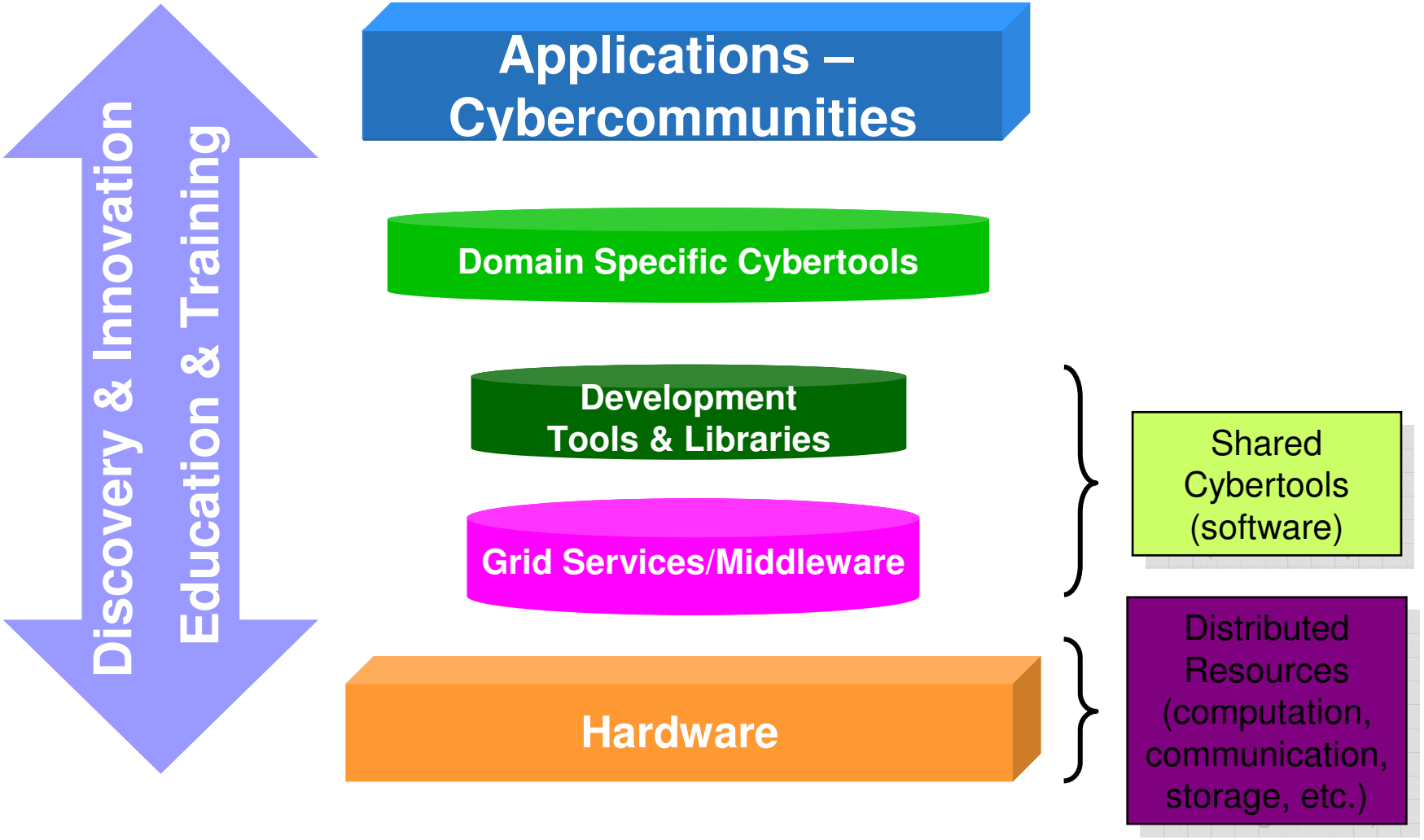
What IS CyberInfrastructure?

- ***Not*** just supercomputers
- What does CyberInfrastructure include?
  - » Cyberresources
    - – Computational engines, grid computing
    - – Mass storage, digital libraries/data bases
    - – communications, networking
  - » Cyberservices
  - » Cybertools (including data mining, visualization…)
  - » Domain tools
    - – Sensors and distributed sensor systems
    - – Community models

All *integrated* to permit the effective and efficient building of domain applications.

Integrated Cyberinfrastructure…

Meeting the Needs of a Community of Communities



Brain-Storming Session on the Role of ECS in Cyberengineering/ Cyberinfrastructure

April 13, 2004 at NSF

The Problem

Virtually every crucial economic and social function depends on the secure, reliable operation of energy, information and telecommunications, transportation, financial, and other infrastructures. From a strategic S&T viewpoint, the *agility*, *robustness, survivability* and resilience of large-scale interdependent dynamic networks that face *new* and *unanticipated* conditions is a grand challenge.

To know what is or will be happening and develop distributed sensing, measurement, communications and control systems for visualizing, analyzing and reconfiguring large-scale emergent behavior to enable highly reliable and self-healing infrastructures.

More specifically, several cyberinfrastructure grand challenges persist, indicated below for the communication and electrical systems: CI poses unique research and engineering challenges as multi-scale multi-level coupled systems, ranging from devices to systems-level dynamics of coupled communication, control and computation networks and associated emergent phenomena (Figure 1). Foundations span Communication, Control Systems and Dynamics, Embedded Computing, Sensor technologies, with nearly 98% of processors are embedded and can actuate as well as sense.

The Research Approach

The Physical Layer – Devices and Networks:

- National Nanofabrication Users Network (NNUN)
- Nanofabrication and Nanoengineering
- Ultra-High-Capacity Optical Communications and Networking
- Electric Power Sources, Distributed Generation and Grids
- Reconfigurable Micro/Nano Sensor Arrays

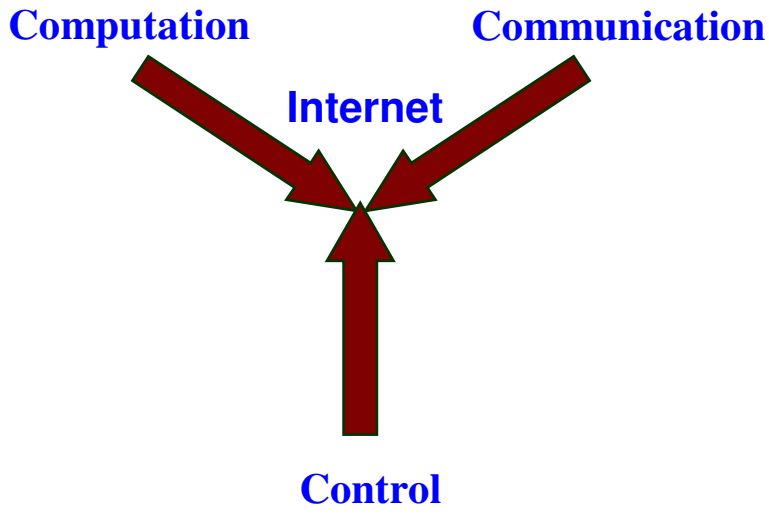


Figure 1: The convergence of communication and computation gave us the Internet; possible next phase of IT revolution is in the interaction with the physical world through sensing and actuation and the convergence of sensing/actuation (Control) with Communication and Computation.

The Research Approach (cont)

- ***Information Layer – Algorithms, Information and Design***

- General tools for distributed, robust, adaptive, hybrid control & related tools for modeling, system identification, estimation
- General tools for sensors-to-information & to decision/control
- Generality via computational intelligence, machine learning, neural networks & related pattern recognition, data mining etc.

- ***Integration of Physical Layer and Information Layer***

- Wireless Communication Systems
- Self-Organizing Sensor and Actuator Networks
- System on Chip for Information and Decision Systems
- Efficient and Secure Grids and Test beds for Power Systems

ECS Cyber Infrastructure Investments

- **The Physical Layer – Devices and Networks**
  - –National Nanofabrication Users Network (NNUN)
  - –Nanofabrication and Nanoengineering
  - –Ultra-High-Capacity Optical Communications and Networking
  - –Electric Power Sources, Distributed Generation and Grids
  - –Reconfigurable Micro/Nano Sensor Arrays
- **Information Layer – Algorithms, Information and Design**
  - –General tools for distributed, robust, adaptive, hybrid control & related tools for modeling, system identification, estimation
  - –General tools for sensors-to-information & to decision/control
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- **Integration of Physical Layer and Information Layer**
  - –Wireless Communication Systems
  - –Self-Organizing Sensor and Actuator Networks
  - –System on Chip for Information and Decision Systems
  - –Efficient and Secure Grids and Testbeds for Power Systems

Types of International (INT) Programs

- Planning Visits
- Cooperative Research Projects
- Workshops
- Postdoctoral Fellowships
- Dissertation Enhancement Research
- Supplemental Awards
- Summer Institutes

Collaborative Projects

- Country or region specific
- Initiate international partnerships
- Mutual benefits are important
- Student involvement is strongly encouraged
- Fund international costs of collaboration

INT Supplements to Research Awards

- International activity of mutual benefit
- Support for junior faculty & students
- Must be related to the research award
- PI should consult NSF program director
- Internal review within NSF
- May be for cooperative research, workshops, & other INT programs

Engineering Education and Centers (EEC) Funding Opportunities

- Engineering Research Centers (ERC) Program
- Industry/University Cooperative Research Centers (IUCRC)
- Grants for the Department-Level Reform of Undergraduate Engineering Education
- Bridges for Engineering Education
- Research Experiences for Undergraduates (REU)
- Research Experiences for Teachers (RET)
- Partnerships For Innovation (PFI)

Additional NSF Funding Opportunities

- **Grant Opportunities for Academic Liaison with Industry (GOALI)**
- **Small Business Innovation Research Program (SBIR)**
- **Small Business Technology Transfer Program (STTR)**

Conclusions

- Integrative Systems
- Convergence of Sensing/Actuation, Control, Computation and Communications
- Focus on Cyberengineering/ Cybersecurity
- Development of Test beds

Thanks for your attention!!!!