Update from NSF Engineering

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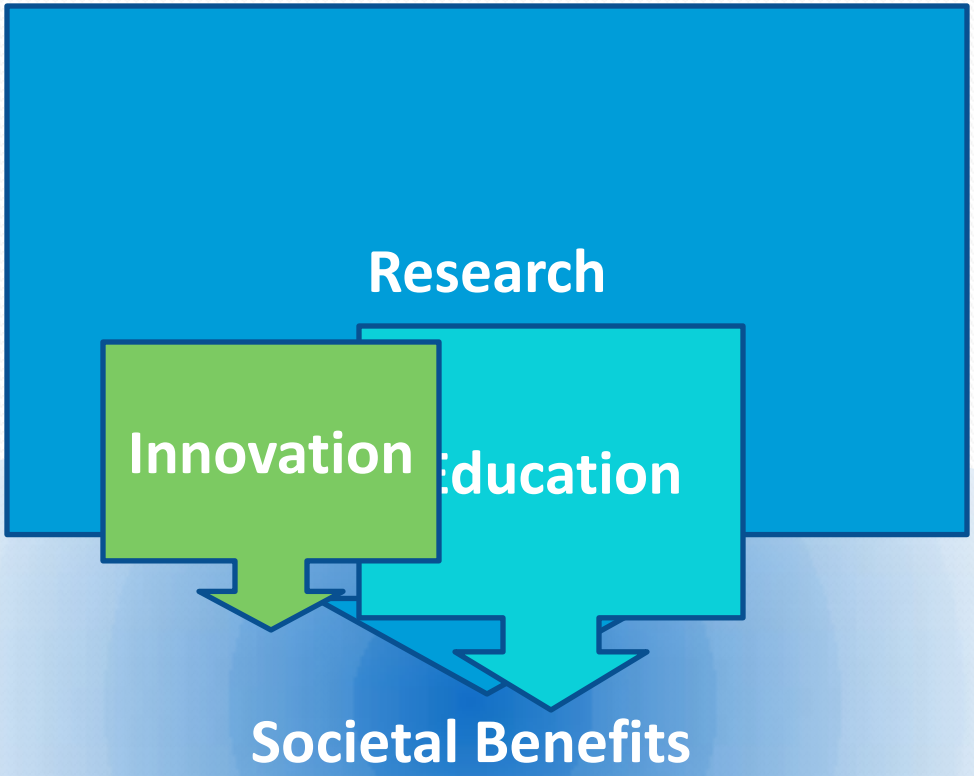
Assistant Director for Engineering
National Science Foundation

Presentation at the EDC PPC Colloquium
February 11, 2014

NSF ENG: *Investing in transformative research and education to foster innovations for benefits to society*



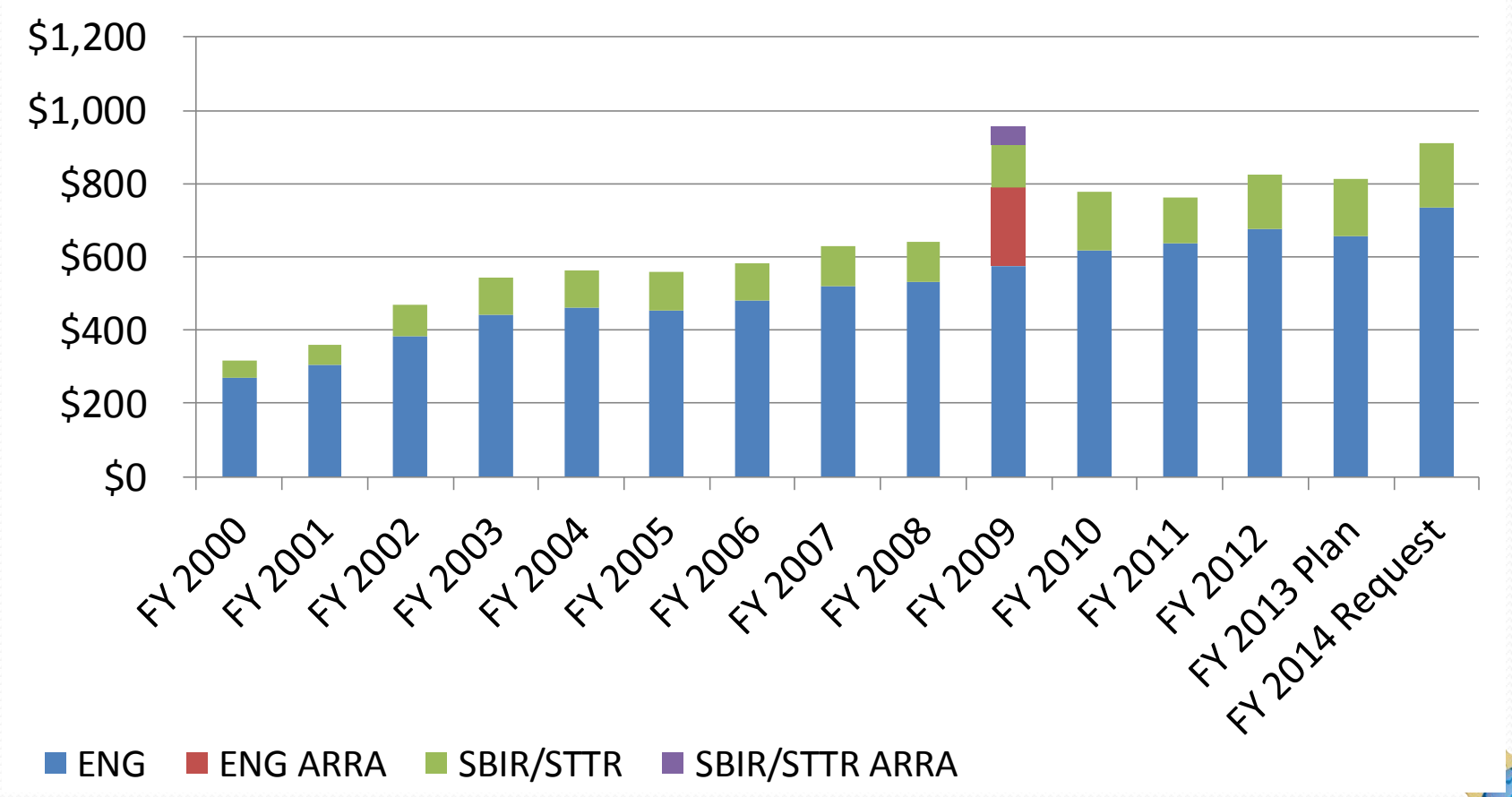
NSF Directorate for Engineering (ENG)

Office of the Assistant Director

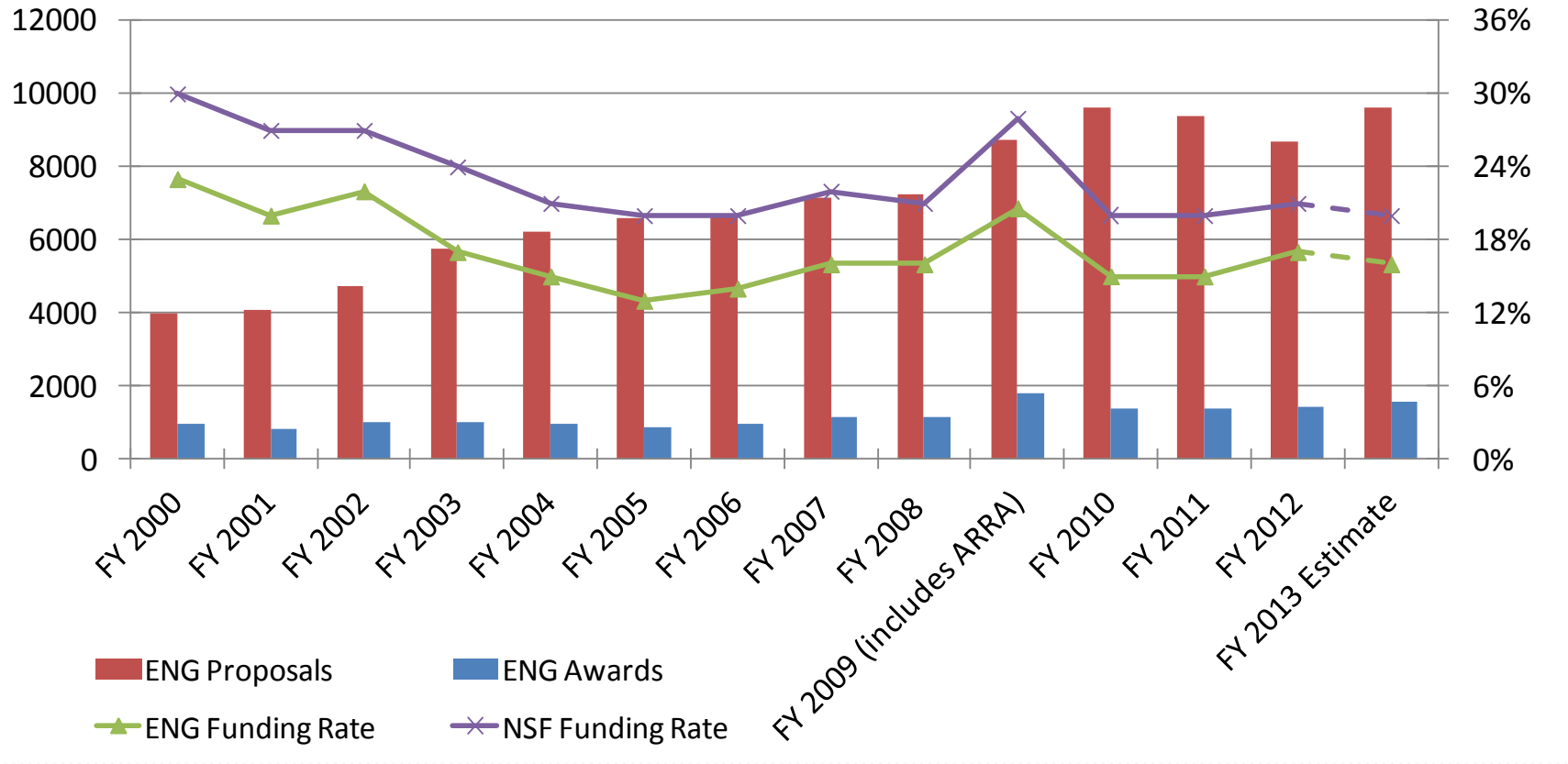
Emerging Frontiers in Research and Innovation (EFRI)

Engineering Education and Centers (EEC)	• Engineering Centers • Engineering Education • Engineering Workforce
Chemical, Bioengineering, Environmental, and Transport Systems (CBET)	• Chemical, Biochemical, and Biotechnology Systems • Biomedical Engineering and Engineering Healthcare • Environmental Engineering and Sustainability • Transport and Thermal Fluids Phenomena
Civil, Mechanical, and Manufacturing Innovation (CMMI)	• Advanced Manufacturing • Mechanics and Engineering Materials • Resilient and Sustainable Infrastructure • Systems Engineering and Design
Electrical, Communications, and Cyber Systems (ECCS)	• Electronics, Photonics, and Magnetic Devices • Communications, Circuits, and Sensing Systems • Energy, Power, and Adaptive Systems
Industrial Innovation and Partnerships (IIP)	• Academic Partnerships (GOALI, I/UCRC, PFI AIR, and PFI BIC) • Small Business Partnerships (SBIR, STTR)

ENG and SBIR/STTR Budgets ($M)



ENG Research Grant Proposals and Awards



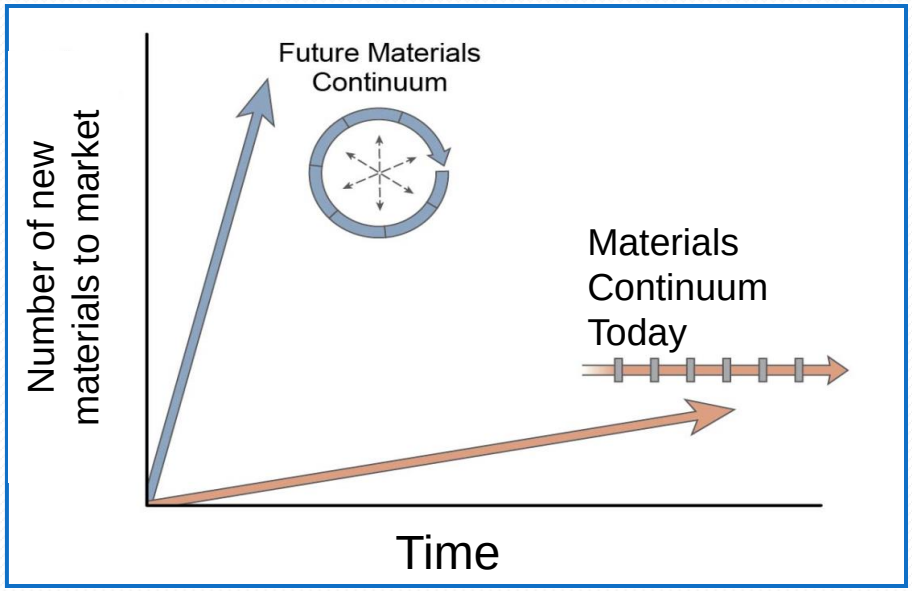
ENG Prioritizes Research Critical to the Nation's Challenges

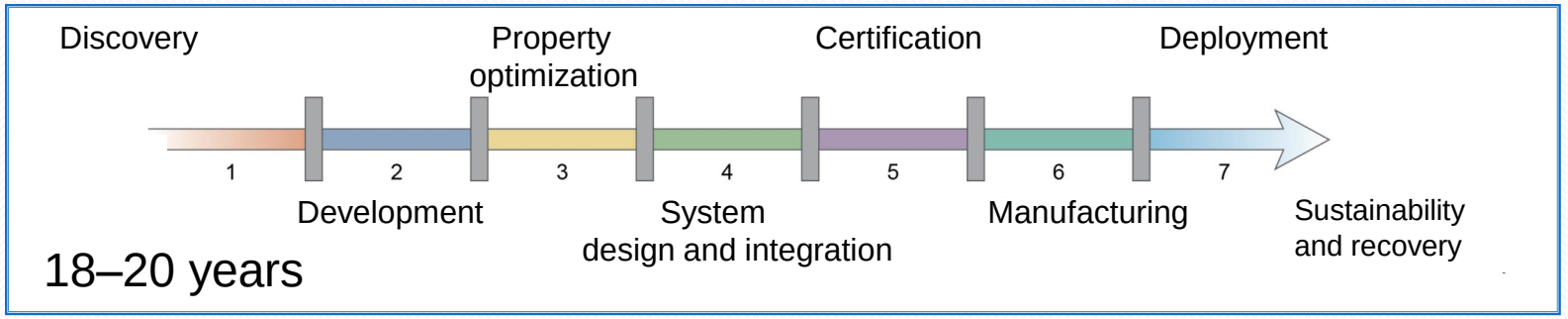
- National Initiatives
  - Advanced Manufacturing
  - Clean Energy
  - National Nanotechnology Initiative
  - National Robotics Initiative
  - BRAIN
- NSF Cross-cutting Priorities
  - Cyber-Enabled Materials, Manufacturing, and Smart Systems
  - Communications and Cyberinfrastructure
  - Science, Engineering, and Education for Sustainability
  - Education and Career Development
  - Interdisciplinary Research
  - Innovation Ecosystem

Advanced Manufacturing

- Historically NSF has supported frontier research that has led to transformational advances in manufacturing
  - Additive manufacturing grew out, in part, from basic research investments in the 70's and 80's
  - MEMS enabled by fundamental research in late 80s (NSF & DARPA)
- Present research extends traditional advances and builds upon convergence of trans-disciplinary advances
  - National Robotics Initiative (NRI): towards autonomous systems
  - Cyber-Physical Systems (CPS): smart manufacturing
  - Digital design and manufacturing methods
  - Scalable Nano-manufacturing – moving forward on NNI discoveries
  - Bio-manufacturing
  - Novel semiconductor design and manufacturing
- Looking forward
  - Internet enabled, distributed, personalized, dynamic, digital, …
  - Energy and materials efficient sustainable manufacturing
  - Integration of services into manufacturing and servitization of products

Materials Genome Initiative



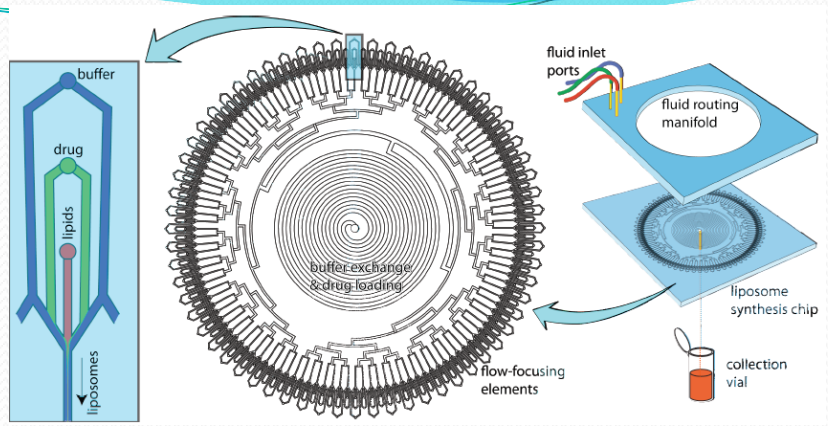


Bio-manufacturing

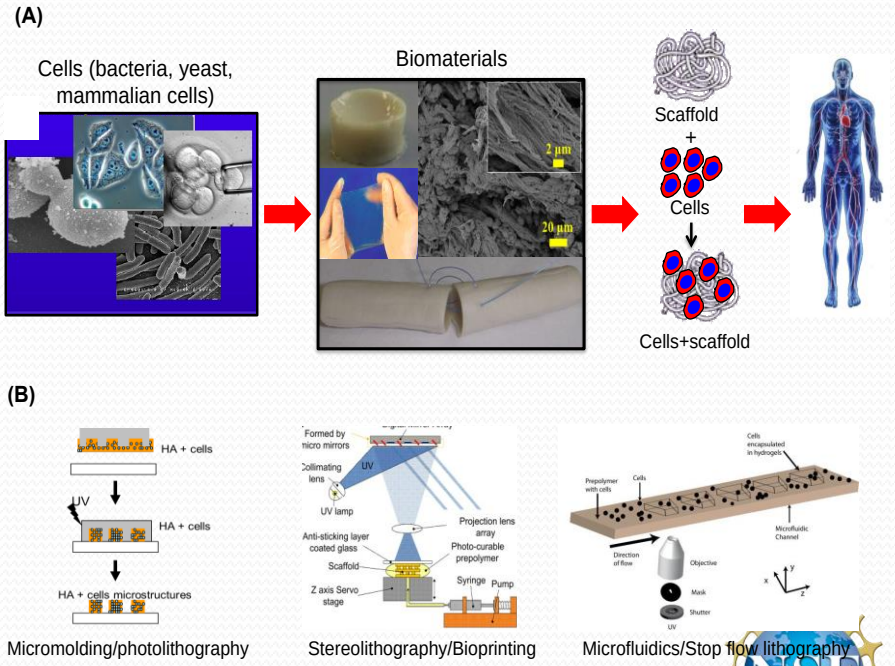
The use of biological systems comprised of biomolecules, cells and biomaterials, or the products of biological systems, to generate new devices and constructs with a view towards scalability and industrialization

Vision: To combine advances in biology with innovative design to engineer the next generation of biologically inspired products

Objective: To advance research in biomanufacturing as an emerging discipline in the academic and industrial communities, as well as a technological opportunity to spur research and industry growth



Production of liposomal pharmaceuticals in a microfluidic system



Fabrication of complex, biologically active, three-dimensional constructs

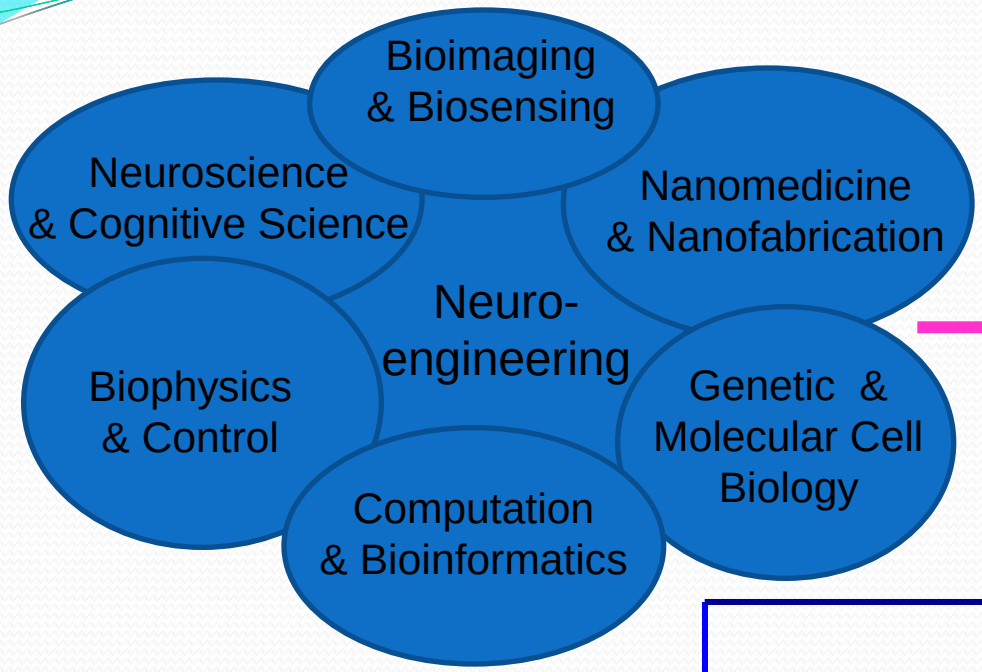
President Obama

WH, April 2, 2013

"BRAIN" Initiative—a bold new research effort to revolutionize our understanding of the human mind and uncover new ways to treat, prevent, and cure brain disorders like Alzheimer's, schizophrenia, autism, epilepsy, and traumatic brain injury.

"… the BRAIN Initiative will change that by giving scientists the tools they need to get a dynamic picture of the brain in action and better understand how we think and how we learn and how we remember."

Mapping and Engineering the Brain



Integration

Noninvasive Brain Activity Mapping

Deciphering

mechanisms underlying the brain adaptation to changing environment, and genetic and epigenetic landscape	neural representations and coding, and principles of brain organization and decision making
mechanisms underlying dynamic decisions and communication within and across scales	neural circuits and signal pathways that regulate the regrowth, repair of nerve tissues and cells

Engineering

- Intelligent Systems
- Brain Circuit Control Network
- Artificial Intelligence
- Intelligent Robotics

Infrastructure Systems

- Fundamental research to enable design of resilient and sustainable infrastructure systems
- Historical approaches and successes
  - Earthquake resistant structures (e.g. base isolation, novel materials, improved building codes)
  - NEES – unique national facilities “at scale”
  - Integration of engineering and social sciences for infrastructure management and hazard mitigation
  - RAPIDs: Learning from real-world examples
- Looking forward
  - Protecting from multi-hazard threats and evolving trends (climate change, demographics, etc.)
  - Design of infrastructure systems as processes and services vs. discrete “things”
  - Interdependency of existing and emerging infrastructure – challenges and opportunities
  - Ubiquity and availability of real-time data

A New Opportunity - RIPS

- Resilient Interdependent Infrastructures Processes and Systems
- Under the Emerging Frontiers in Research and Innovation (EFRI) Program
  - Deadline: March 19, 2014

National Science Foundation
Directorate for Engineering (ENG)

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Emerging Frontiers in Research and Innovation (EFRI)

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Resilient Interdependent Infrastructure Processes and Systems (RIPS)

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PROGRAM GUIDELINES

Solicitation 14-524

DUE DATES

Full Proposal Deadline Date: March 19, 2014
Type I and Type II Proposals

SYNOPSIS

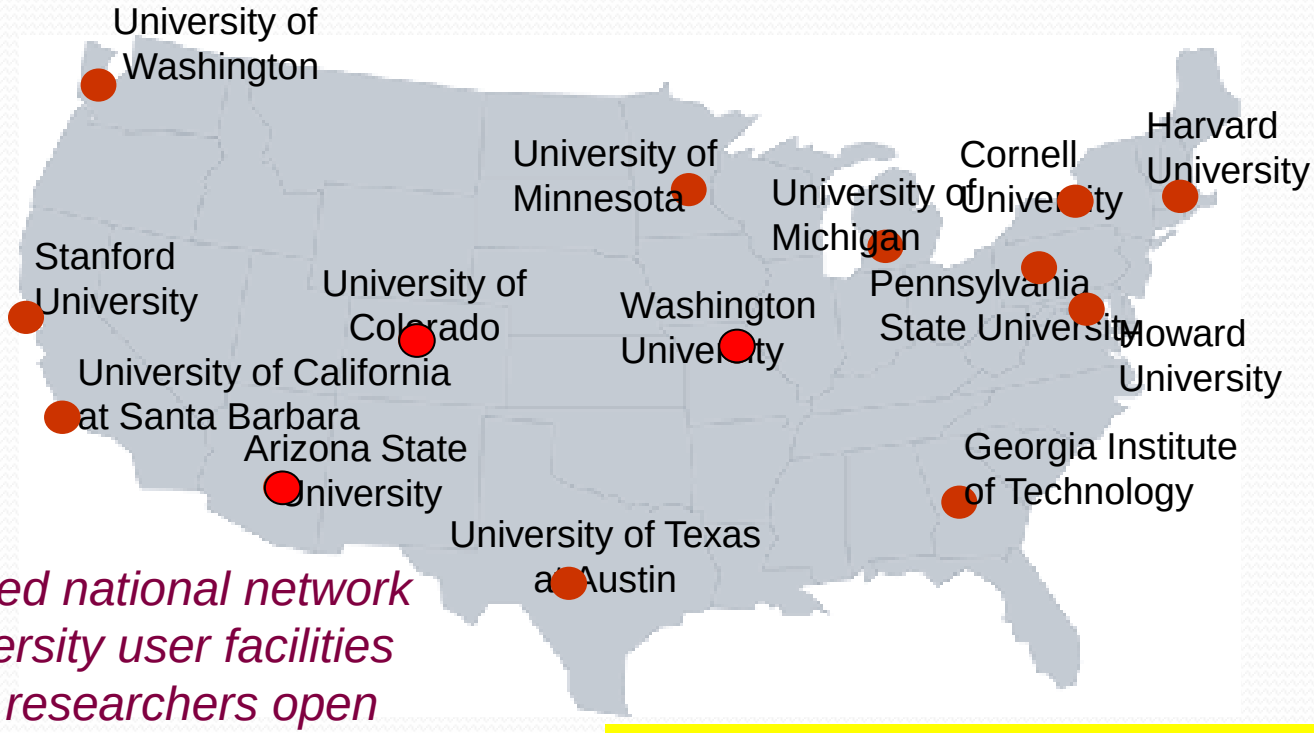
Critical infrastructures are the mainstay of our nation's economy, security and health. These infrastructures are interdependent. For example, the electrical power system depends on the delivery of fuels to power generating stations through transportation services, the production of those fuels depends in turn on the use of electrical power, and those fuels are needed by the transportation services.

The goals of the **Resilient Interdependent Infrastructure Processes and Systems** (RIPS) solicitation are (1) to foster an interdisciplinary research community that discovers new knowledge for the design and operation of infrastructures as processes

Two-Dimensional Atomic-layer Research and Engineering – 2-DARE

- Under our EFRI program
- Three themes:
  - Exploration of Materials Properties and Device Applications
  - Synthesis and Nanomanufacturing
  - Theory and Modeling
- 159 pre-proposals submitted
- 42 full proposals invited

National Nanotechnology Infrastructure Network (NNIN)



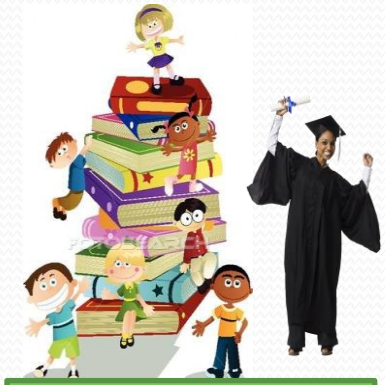
An integrated national network of 14 university user facilities providing researchers open access to resources, instrumentation and expertise in all domains of nanoscale science, engineering and technology

www.NNIN.org

New competition underway

All NSF Directorates participating in funding: $16M/year

New ERC Competition in Underway



Education

Interdisciplinary

Innovation

Enginee

Infrastr

- 188 pre-proposals received
- 18 invited for full proposals
- Deadline ~ June 2014
- Awards in FY15

CAREER: Teacher-Scholar

- "Successful applicants will propose creative, effective, **integrated** research and education plans, and indicate how they will assess these components."

CAREER Project Description:

- a description of the **proposed research project**, including preliminary supporting data where appropriate, specific objectives, methods and procedures to be used, and expected significance of the results;
- a description of the **proposed educational activities**, including plans to evaluate their impact on students and other participants;
- **a description of how the research and educational activities are integrated with one another**

NSF remains fully committed to supporting the junior faculty

Education - NSF IUSE Program
(Improving Undergraduate STEM Education)

- IUSE supports the improvement of the undergraduate STEM education enterprise through funding research on design, development, and wide-spread implementation of effective STEM learning and teaching knowledge and practice, as well as foundational research on student learning.

- Projects that build on available evidence and theory, and that will generate evidence and build knowledge.

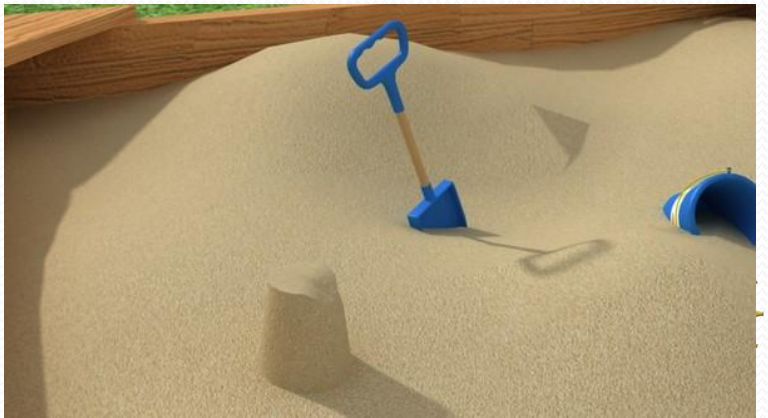
- Led by Education and Human Resources Directorate

NSF IUSE Ideas Labs

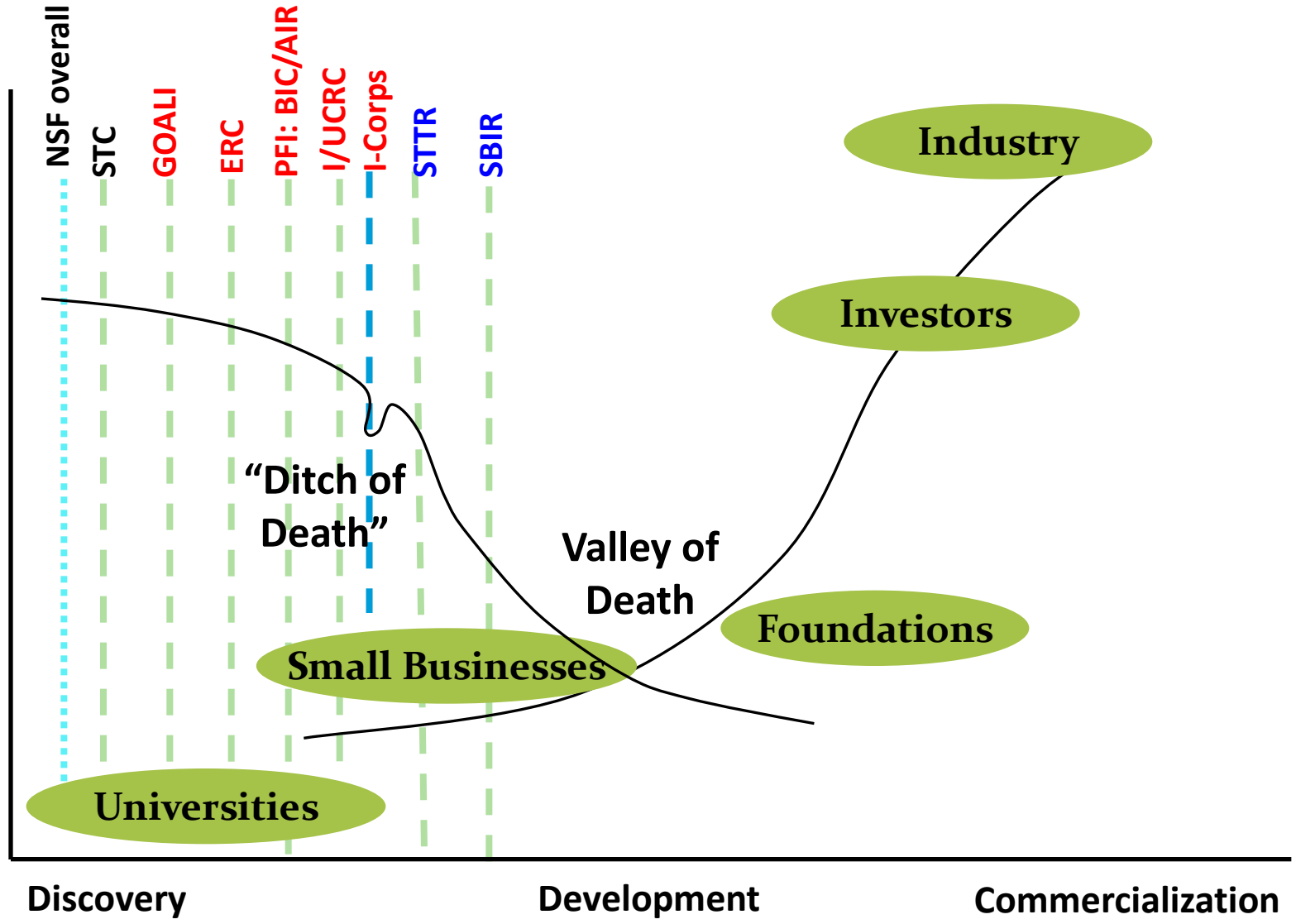
Geosciences – Building capacity in MSIs and community colleges

Engineering – Addressing social inequality in engineering education and practice

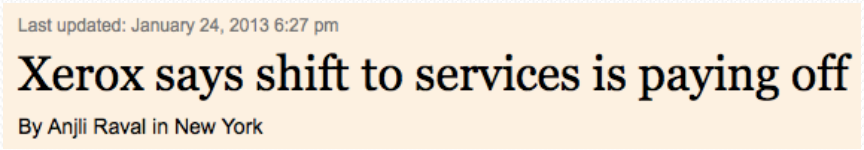
Biology – Integrating mathematics and computing



Research to Innovation



The Service Economy


Last updated: January 24, 2013 6:27 pm

Xerox says shift to services is paying off

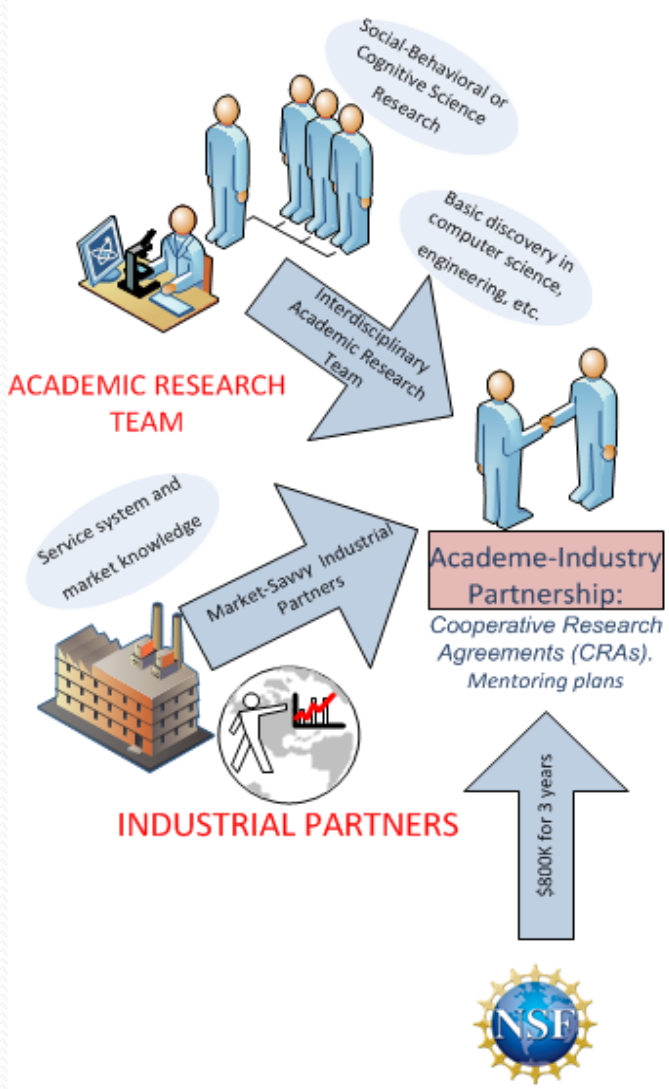
By Anjli Raval in New York

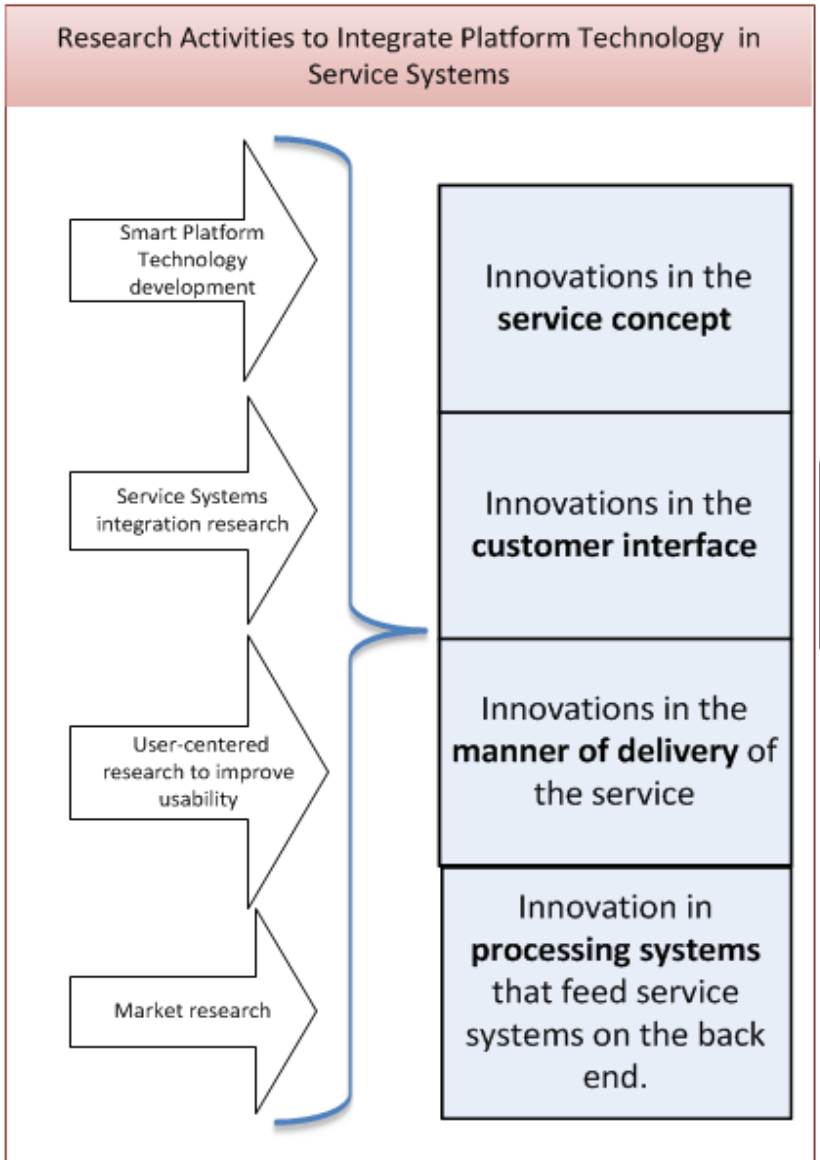

Medtronic's Ishrak outlines health services expansion plans

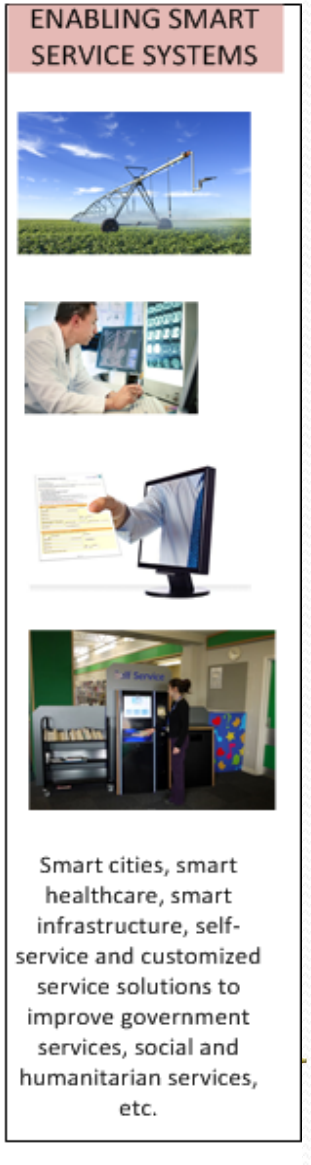
August 21, 2013 | By Mark Hollmer

- The U.S. service sector is responsible for:
  - Employing approximately 80% of workers
  - Creating approximately 80% of GDP
- Manufacturing (product) industries are increasingly incorporating value-added service components.
- The future market will need high-quality, low-cost, and highly personalized solutions in education, healthcare, manufacturing, transportation, and agriculture.

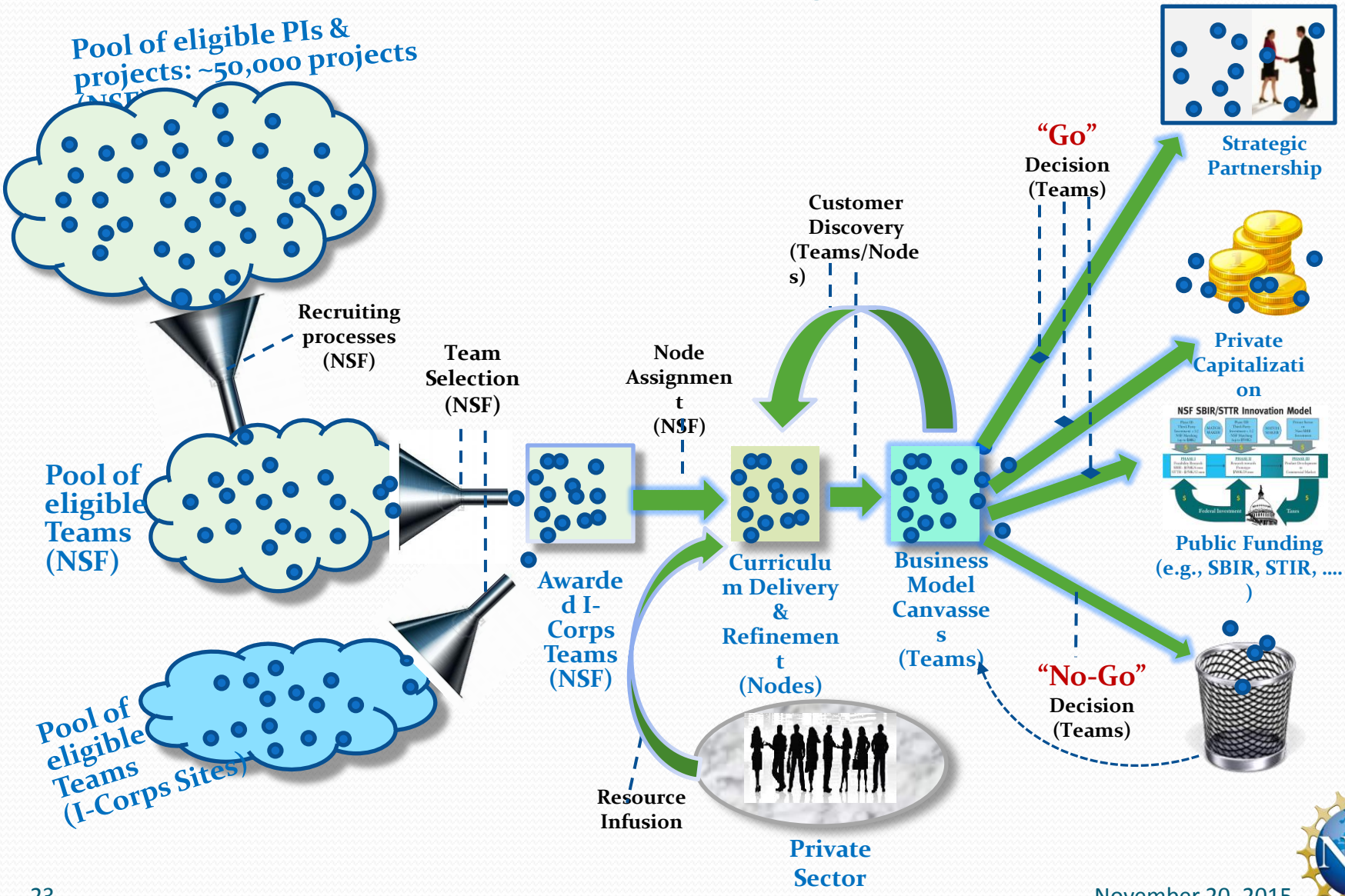
PFI:BIC – Smart Service Systems







NSF I-Corps


Pool of eligible PIs & projects: ~50,000 projects
Recruiting processes (NSF)
Pool of eligible Teams (NSF)
Team Selection (NSF)
Node Assignment (NSF)
Awarded I-Corps Teams (NSF)
Customer Discovery (Teams/Nodes)
Curriculum Delivery & Refinement (Nodes)
Business Model Canvasses (Teams)
"Go" Decision (Teams)
Strategic Partnership
Private Capitalization
NSF SBIR/STTR Innovation Model
Public Funding (e.g., SBIR, STIR, ...)
"No-Go" Decision (Teams)
Pool of eligible Teams (I-Corps Sites)
Resource Infusion
Private Sector

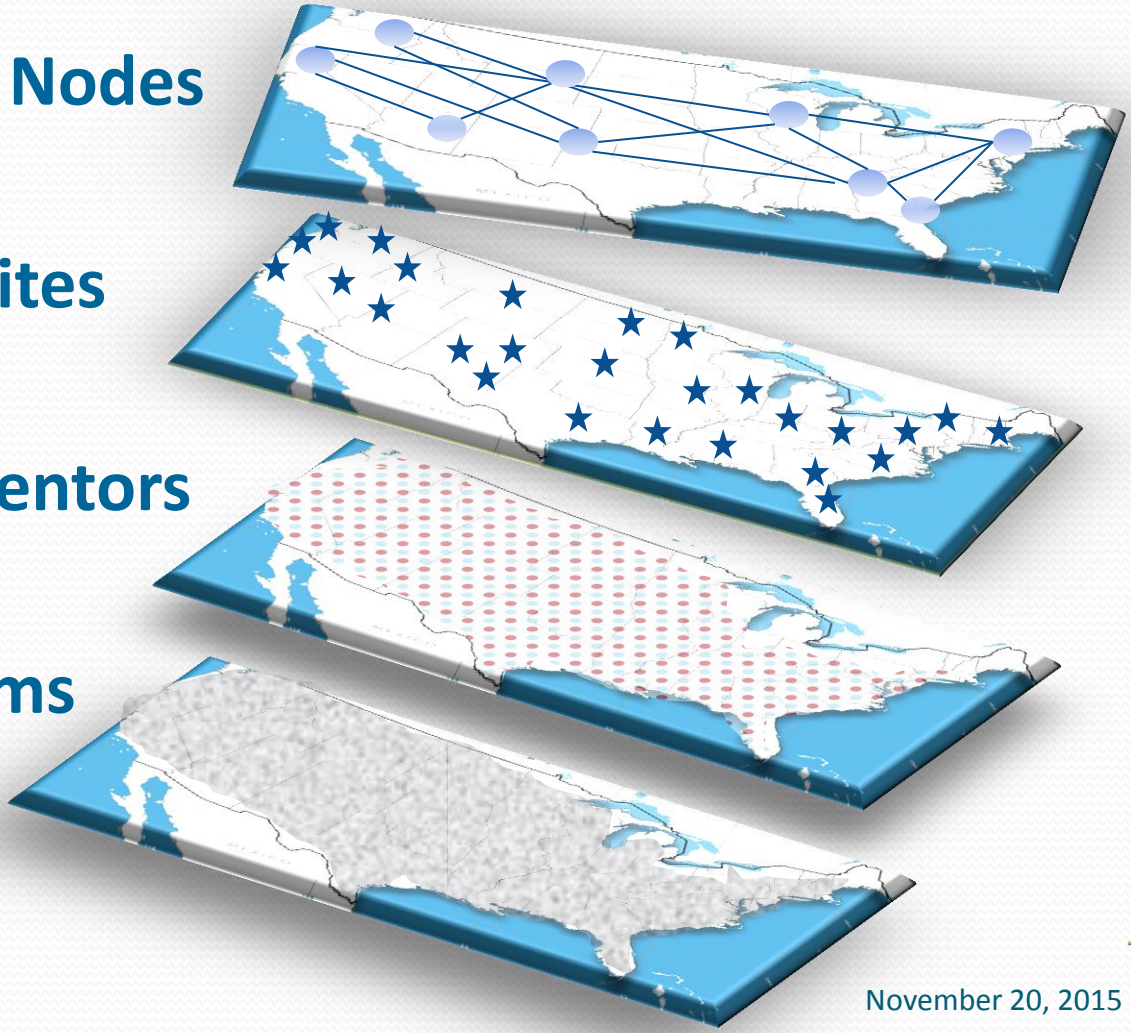
Building the Nation's I-Corps "Fabric"

I-Corps Nodes

I-Corps Sites

I-Corps Mentors

I-Corps Teams



Merit Review Criterion: *Broader Impacts*

- The Broader Impacts criterion encompasses the potential to benefit society and contribute to achieving specific, desired societal outcomes, including:
  - increased participation of women, persons with disabilities, and underrepresented minorities in science, technology, engineering, and mathematics (STEM);
  - improved STEM education at all levels;
  - increased public scientific literacy and public engagement with science and technology; improved well-being of individuals in society;
  - development of a globally competitive STEM workforce;
  - increased partnerships between academia, industry, and others;
  - increased national security;
  - increased economic competitiveness of the United States;
  - and enhanced infrastructure for research and education.

NSB Report MR-11/22 - National Science Foundation's Merit Review Criteria: Review and Revisions

NSB Recommendation

- "Just as institutions play an important role in facilitating research-related activities of their investigators, often in ways that align with strategic departmental and institutional (and possibly state-wide, regional, or national) priorities and investments, such a role can extend to activities directed toward the broader impacts of the project as well."
- "… such efforts might be more effective if coordinated appropriately in ways that leverage particular institutional assets or strategic directions and even link investigators from multiple projects."
- *NSF should encourage institutions to pursue such cooperative possibilities, which have the dual benefit of retaining the contributions of individual investigators while addressing national goals and yielding benefits broader than those within a given project.*
- *How can engineering colleges and departments respond to this opportunity?*

Role of Grand Challenges

- Grand challenges can be very useful in catalyzing major breakthroughs and advances
  - NAE Grand Challenges in Engineering
- Key characteristics:
  - Big impact
  - Ambitious yet achievable
  - Compelling vision
  - Right level of specificity
- How can the engineering research community use the grand challenge vehicle for big research achievements?

Questions?

Ideas, thoughts!

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