OPPORTUNITIES IN ENGINEERING HUMAN-CENTERED SERVICE SYSTEMS

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ENG Advisory Committee Meeting

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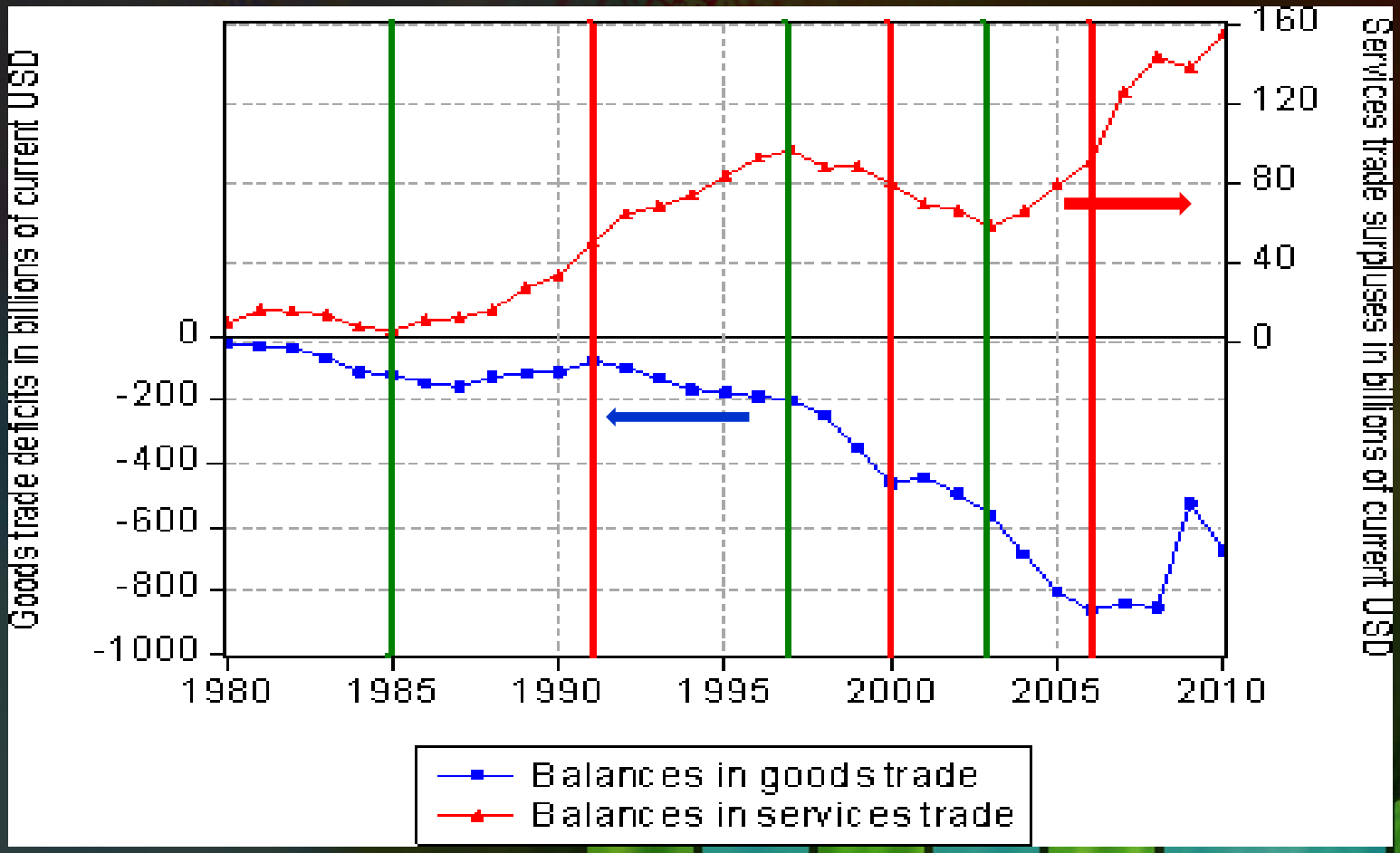
A Service Economy

79.4% (2013 est.) of U.S. GDP are services*

*Source: Field Listing - GDP composition by sector. CIA World Factbook (2010 and 2012)
Sources: Government Accountability Office; Bureau of Labor Statistics; S&P Capital IQ; iSuppli, By AMANDA COX, CHARLES DUHIGG, XAQUÍN G.V., MIKA GRÖNDAHL, HAEYOUN PARK, GRAHAM ROBERTS, KARL RUSSELL

Trade Surpluses in Services



Source: Nath and Uday, U.S. Trade in Information-Intensive Services, 2011

What is “Service”?

Traditional v. Future

What is “Service”?

1. Human centered
2. Interactions between human world and physical/virtual realities
3. Value co-creation

Service is no longer just a term for traditional services

Boundaries between services, manufacturing and agriculture sectors getting blurred

"The first three industrial revolutions came about as a result of mechanization, electricity and IT. ***Now, the introduction of the Internet of Things and Services into the manufacturing environment is ushering in a fourth industrial revolution***."*

*Source: Securing the future of German manufacturing industry, Forschungsunion, April, 2013.

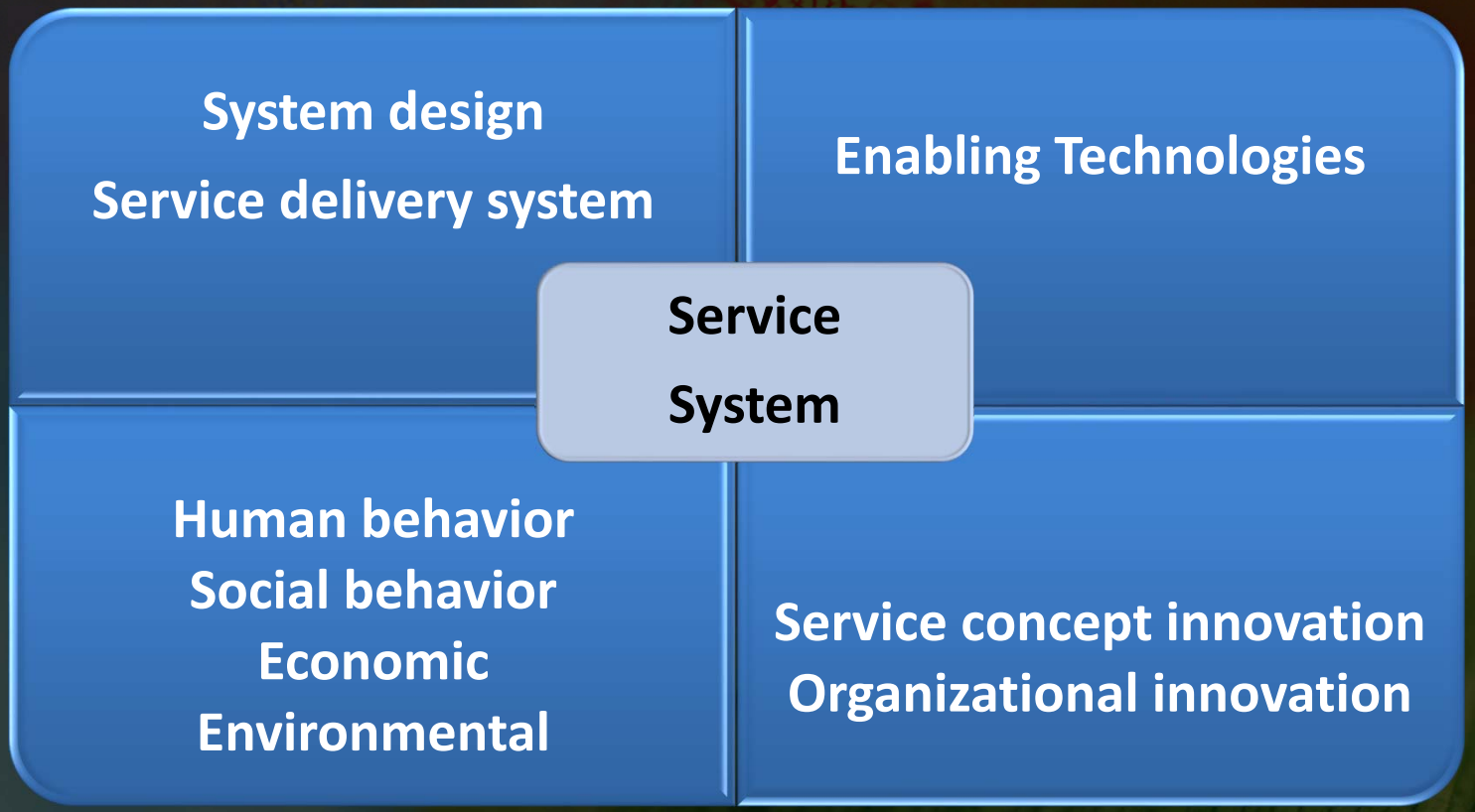
Why Engineering?

- Smart factories connect with
  - Smart mobility
  - Smart logistics
  - Smart grids
  - Smart buildings
  - Smart products
- Together these form an internet of things *and* an internet of services

Many Puzzle Pieces Are Involved….

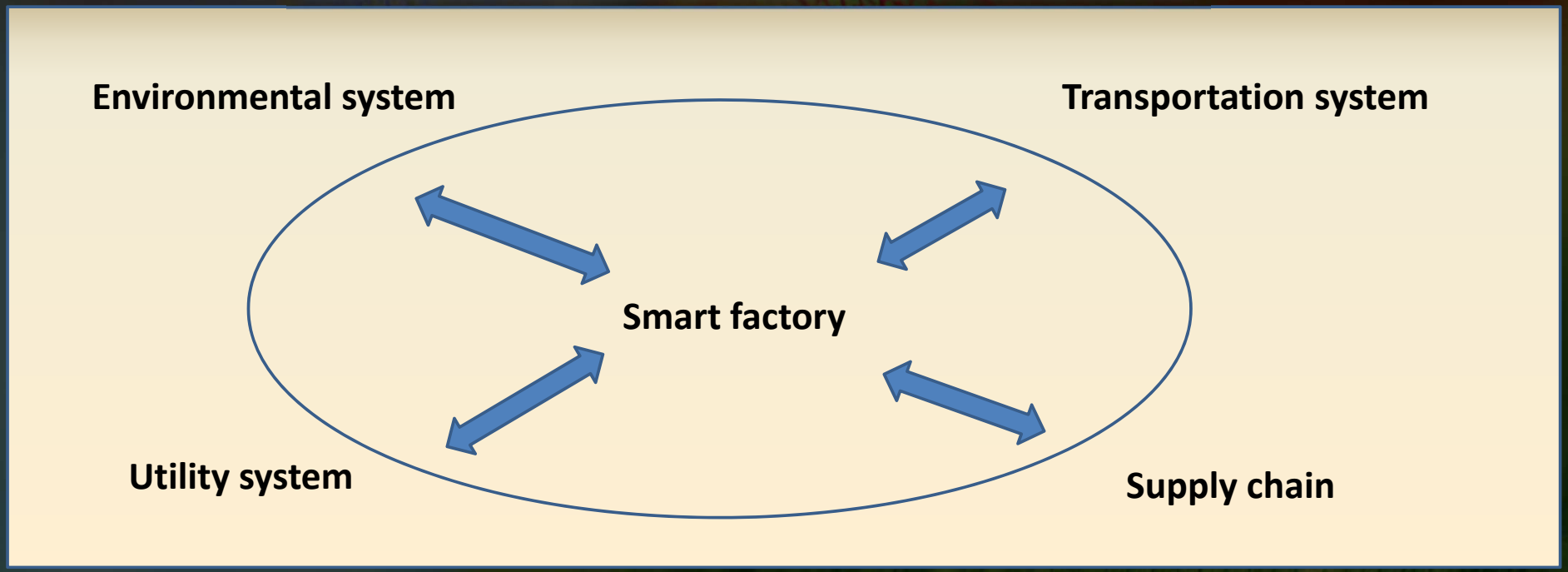
- Behavioral science
- Business
- Computer science
- Engineering

“Human-Centered Service Systems Engineering”



Interdependency and Interoperability of Service Systems

Engineering research challenges



Looking into the Future…

1% increase in healthcare system efficiency means an estimated value of $63 billion over 15 years*

1% increase in railway system efficiency means an estimated value of $27 billion over 15 years*

"If the transition to the industrial age is any guide, most of the jobs and types of careers in the age of smart machines do not exist yet." – Jim Spohrer

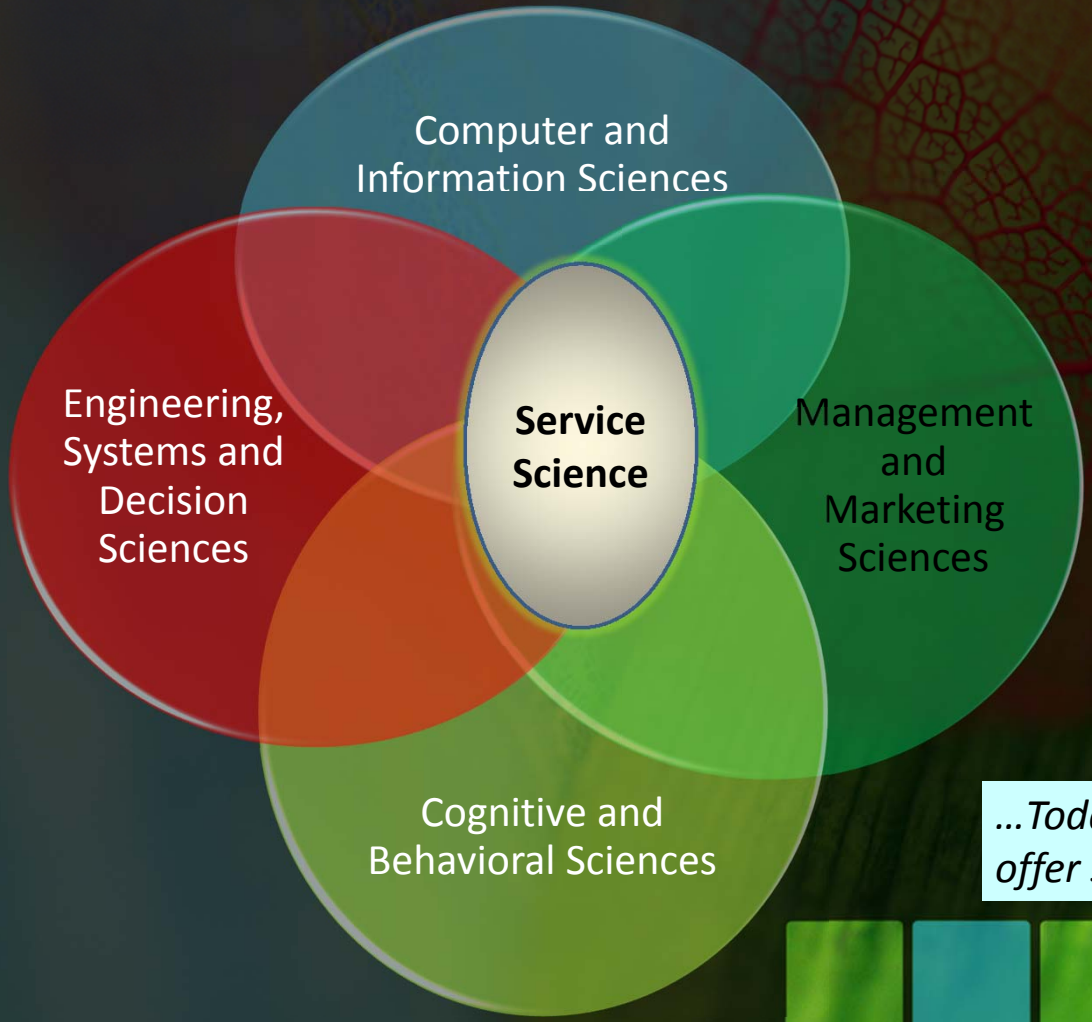
*Source: GE report: Industrial Internet, 2013

Questions

What are the engineering research challenges to enable efficient, quality and economic (cyber-physical-social) service systems?

How can we prepare the next generation of engineers and researchers to enable this prosperous and sustainable future?

The Emergence of "Service Science"



"…We have no choice but to make services more science- and technology-based if we are to improve the value delivered from the services sector. This is true of not just IT services, but especially of other services such as health, education and government."
Robert Morris, vice president for services research at IBM Research, 2008

…Today, more than 450 universities worldwide offer some sort of service science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UNIVERSITY OF CALIFORNIA
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About Service Science
Modern businesses rely on technology, communication, information, automation, and globalization. They operate in a complex web of suppliers, customers, and other stakeholders, creating value by sharing skills and capabilities with others for mutual benefit. Service science is the emerging study of such complex service systems. It involves methods and theories from a range of disciplines, including operations, industrial engineering, marketing, computer science, psychology, information systems, design, and more. Effective understanding of service systems often require combining multiple methods to consider how interactions of people, technology, organizations, and information create value under various conditions.
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OF SERVICE SCIENCE

What Is the Current Research Landscape?

- Fundamental research fostering new technologies (e.g., sensors and actuators, smart materials, etc.)
- Understanding human behavior and how humans interact with technology (e.g., human-computer interaction research, public health research)
- Mathematical modeling and simulation of service systems (e.g., understanding and modeling transportation system)
- Research in cyber-physical systems (e.g., robotics, smart grids, natural language processing), etc.

Human-Centered Service System Engineering

Services

SERVICE SYSTEMS ENGINEERING /SYSTEMS INTEGRATION

Human-Centered Service System Engineering

Fundamental research:

- Understand and model complex and unanticipated human and social behaviors, and their interaction with the virtual and physical realities (individual and collective behaviors)
  - Understand the premise of value co-creation and human interaction affecting engineered systems
  - Design efficient service system with high quality outputs and outcomes

Translational research:

- Foster integration/adaptation of innovative technologies into human-centered service systems design
- Go back to the discovery drawing board inspired by user experiences

Building Innovation Capacity (BIC)

In terms of translational research, how can we:

- Encourage different communities to work together (transdisciplinary research)
- Foster the involvement of industry in early-stage, high-risk, translational academic research
- Develop human innovation capacity

PFI:BIC – Smart Service Systems

- PFI:BIC NSF 13587
- Solicitation: Aug 2013
- CISE, SBE and ENG cognizant program officers
- Proposals due: Jan 2014
- First Awards: Summer 2014
  - 84 Proposals in 7 different general areas of service
  - Wide variety of industrial partners
- Interdisciplinary workshop planned for Fall 2014

Grand Challenges Require Service Systems Engineering Research

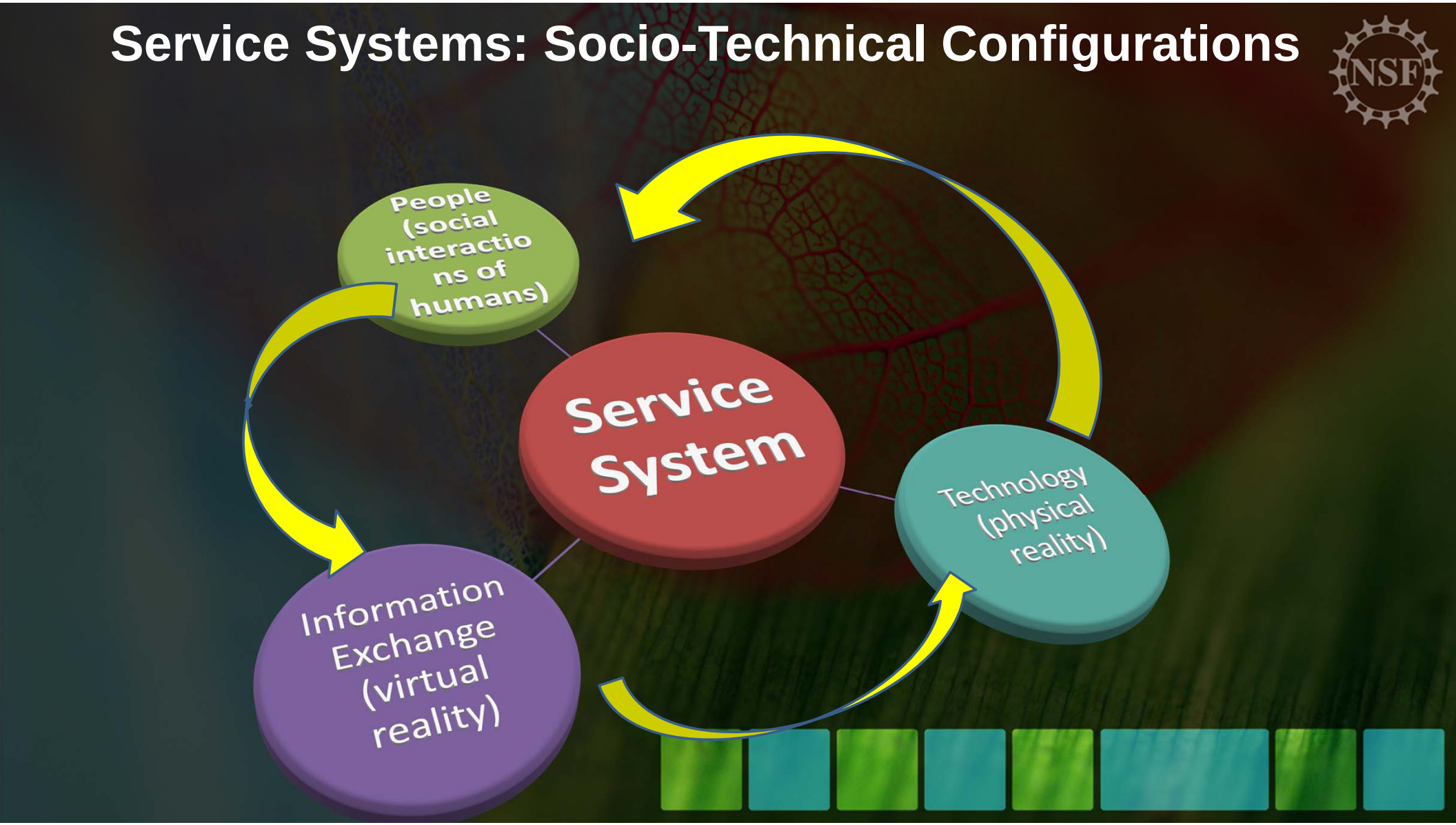
Examples

- Efficient energy network
- Personalized medicine
- Personalized learning
- Access to clean water
- Food security
- Improving urban infrastructure

"…making value requires an integrated system of activities—understanding customers, research, development, design, manufacturing, and services—that are all necessary to deliver value to customers. **Making value requires that a holistic system of these activities be developed and optimized in the national interest**." - Charles M. Vest, 2012

Backup

Service Systems: Socio-Technical Configurations



Personalized E-Health Service

Understand and model how patient behavior (nutrition, fitness, social network, disease management, compliance with device and potential treatment) affects readings and how these affects design of the devices, materials, and software

Health Monitoring

Provider Action and Feedback

Design user interfaces that support clinical decisions by converting data [through analytics] into essential information; understand how providers react to data from WBANs

- Source: Health Informatics Research, IBM Watson Research Center, http://www.research.ibm.com/healthcare/projects_wellness_platform.shtml
- Iboun Taimiya Sylla, **Body Area Networks: A way to improve remote patient monitoring, November 2011, ECN, http://www.ecnmag.com/articles/2011/11/body-area-networks-way-improve-remote-patient-monitoring**
- **Phillips, Clinical Decision Support, http://www.healthcare.philips.com/main/products/hi_pm/products/clinical_support.wpd**