Service Systems Engineering

INCOSE Enchantment Chapter Webinar, November 13th, 2013

Amit J. Lopes, Ph.D. ajlopes@utep.edu

Industrial, Manufacturing & Systems Engineering Department
IMSE http://imse.utep.edu

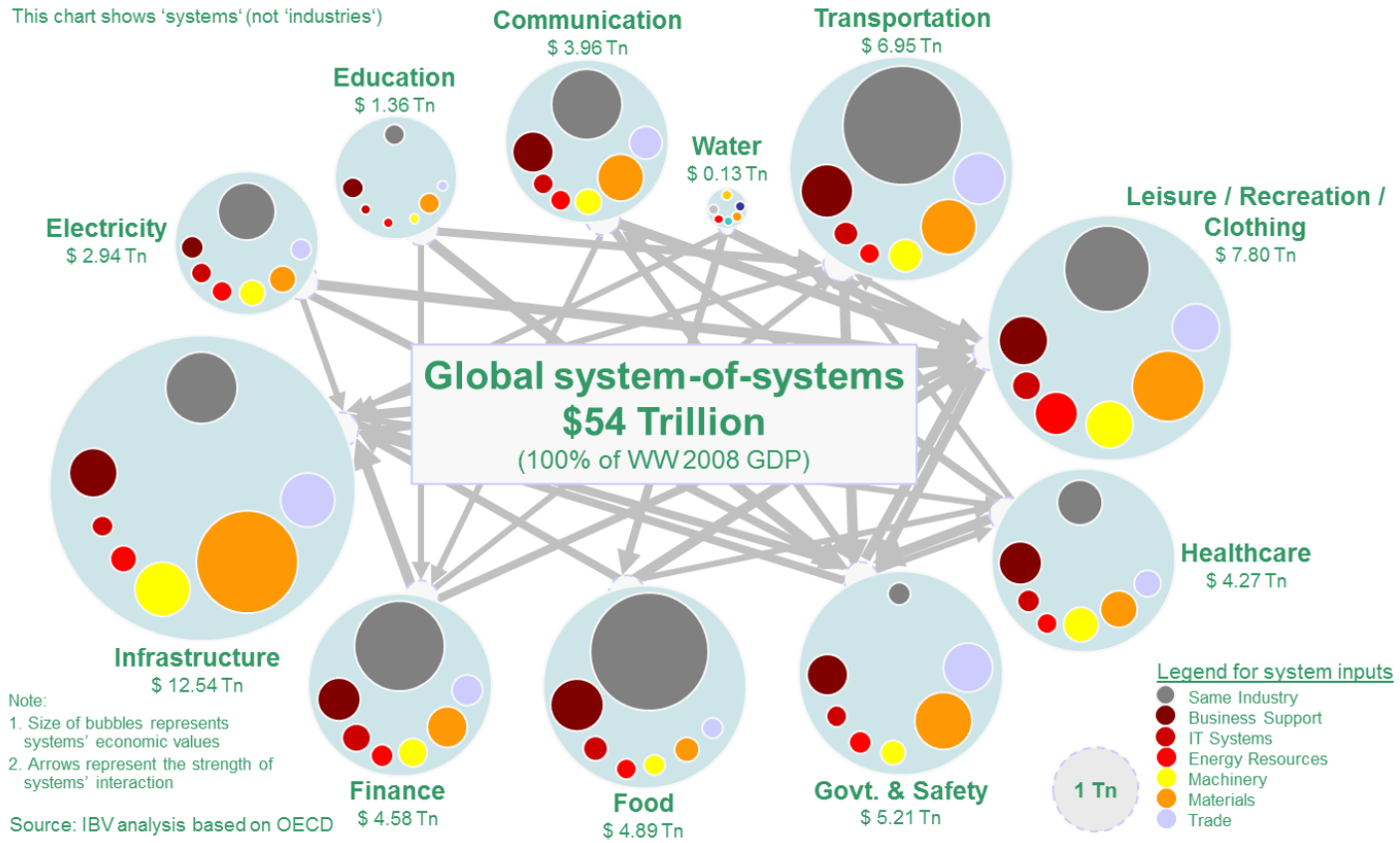
Research Institute for Manufacturing & Engineering Systems
RIMES http://rimes.utep.edu

AGENDA

- **Service Systems (SS) in the Global Economy**
- **SS Engineering (SSE) Core Concepts**
- **SSE Applications**
  - *Smart Grid as a Service (SGaaS)*
- **Challenges**
- **Discussion**
- **Open Forum**

Service System in the Global Economy

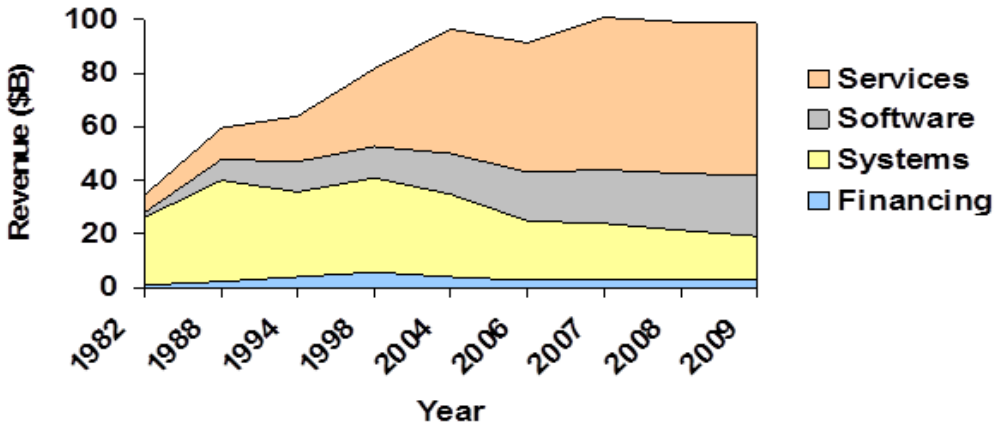
A complex, dynamic, highly interconnected $54 Trillion system-of-systems (OECD-based analysis)



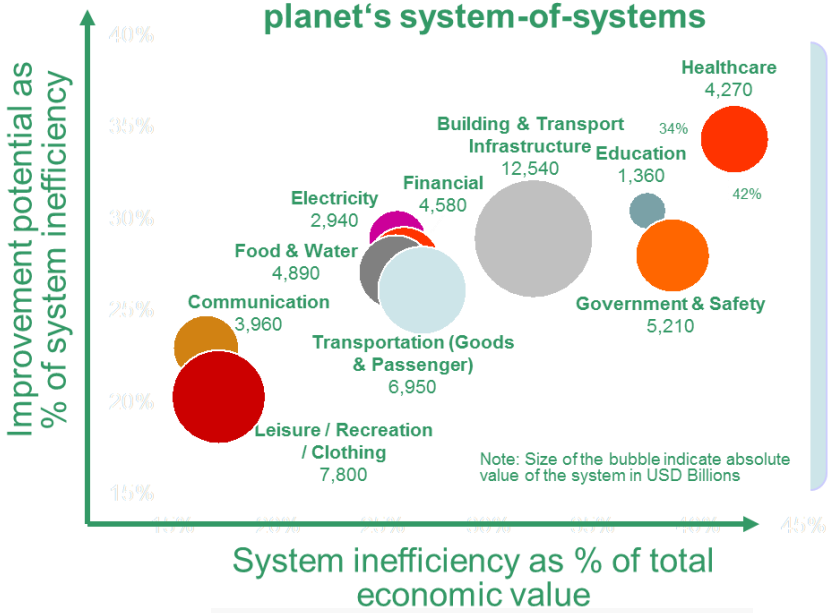
Courtesy: Dr. Jim Spohrer, Innovation Champion, IBM

Service Growth & Inefficiencies

Revenue Growth by Segment



Analysis of inefficiencies in the planet's system-of-systems

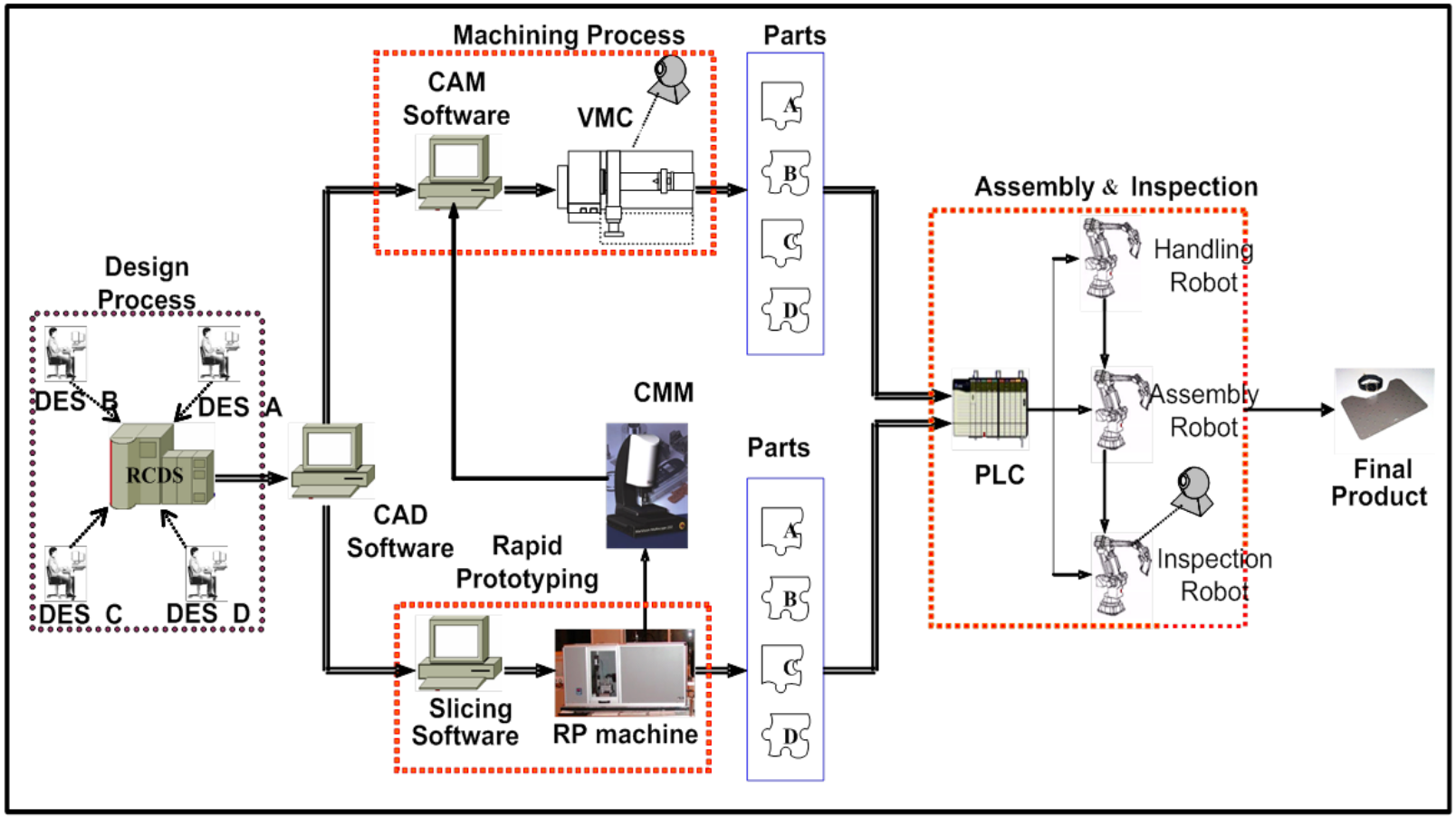


How to read the chart:

For example, the Healthcare system's value is $4,270B. It carries an estimated inefficiency of 42%. From that level of 42% inefficiency, economists estimate that ~34% can be eliminated (= 34% x 42%).

Courtesy: Dr. Jim Spohrer, Innovation Champion, IBM

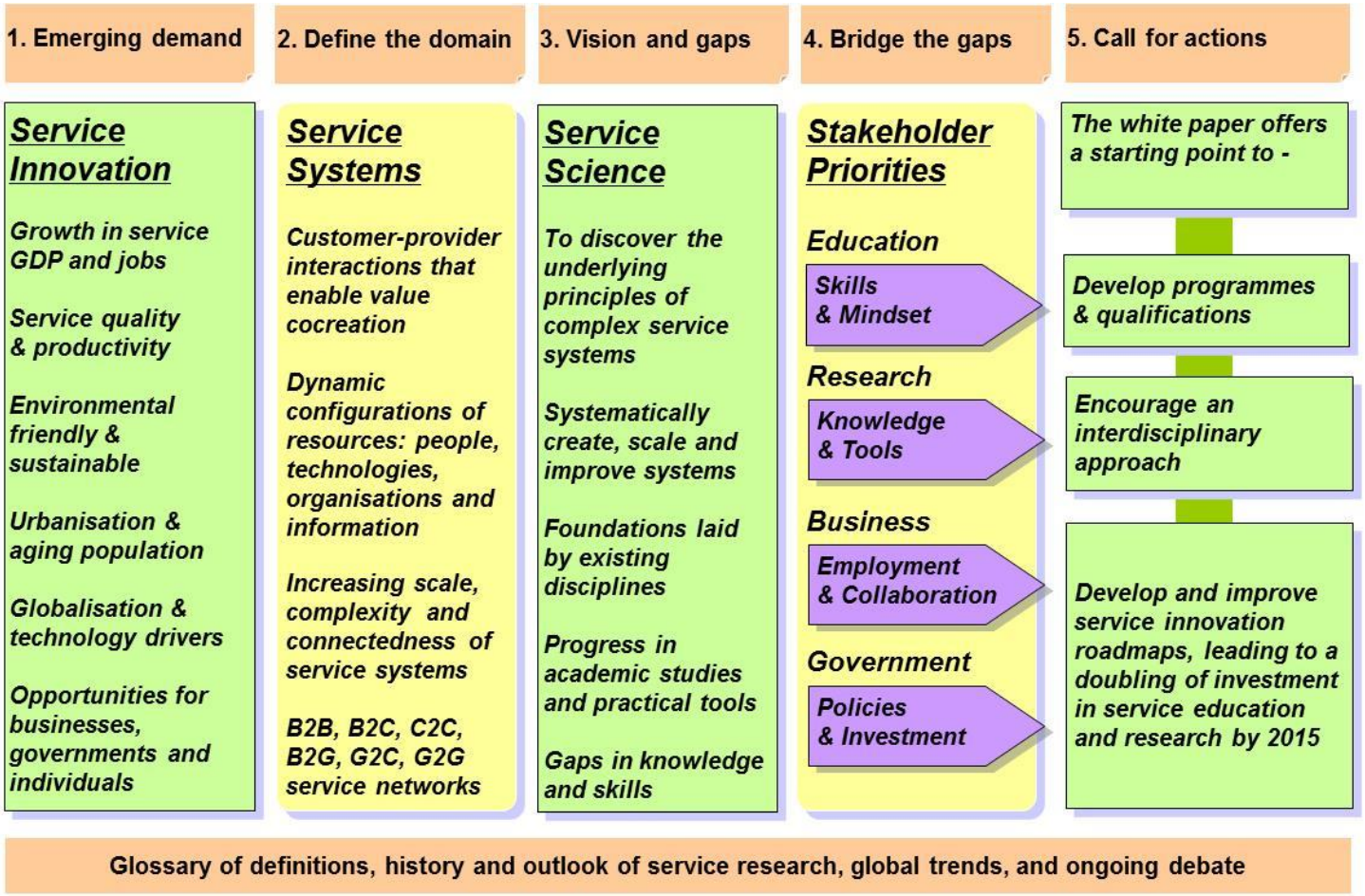
Manufacturing as a Service



Tseng et al., "Enhancement of Internet Based Layer Manufacturing for Engineering Education", ASEE 2010.

SSE Core Concepts

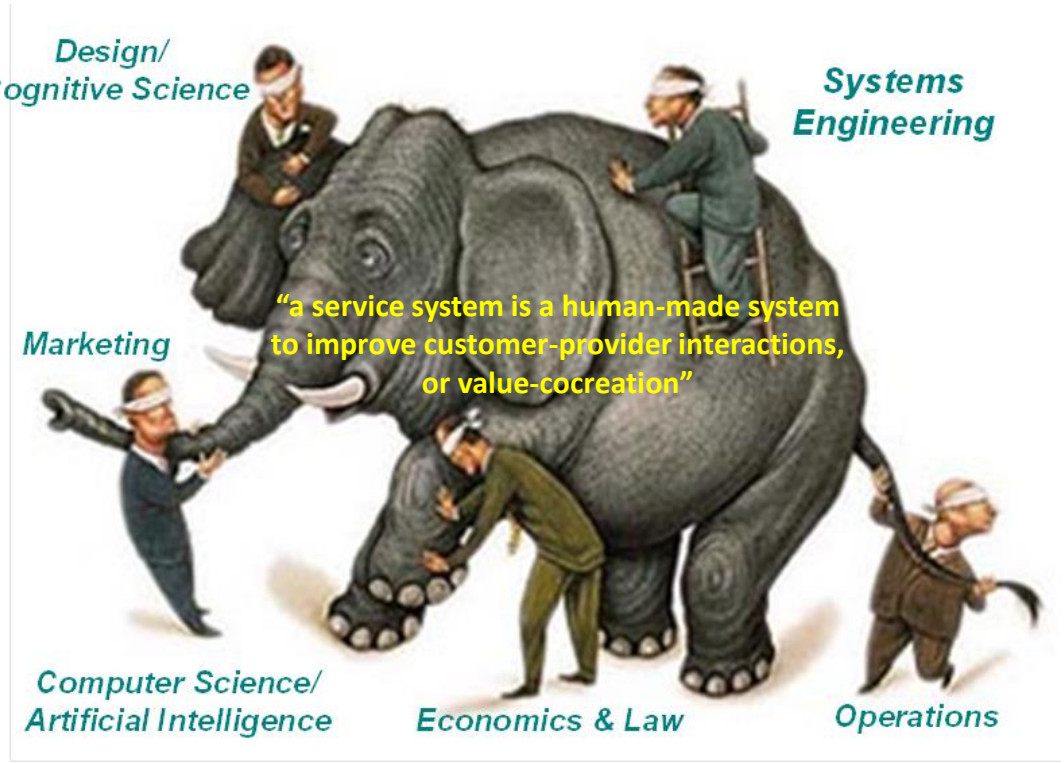
Service Innovation Framework



Courtesy: Dr. Jim Spohrer, Innovation Champion, IBM

SSE Core Concepts

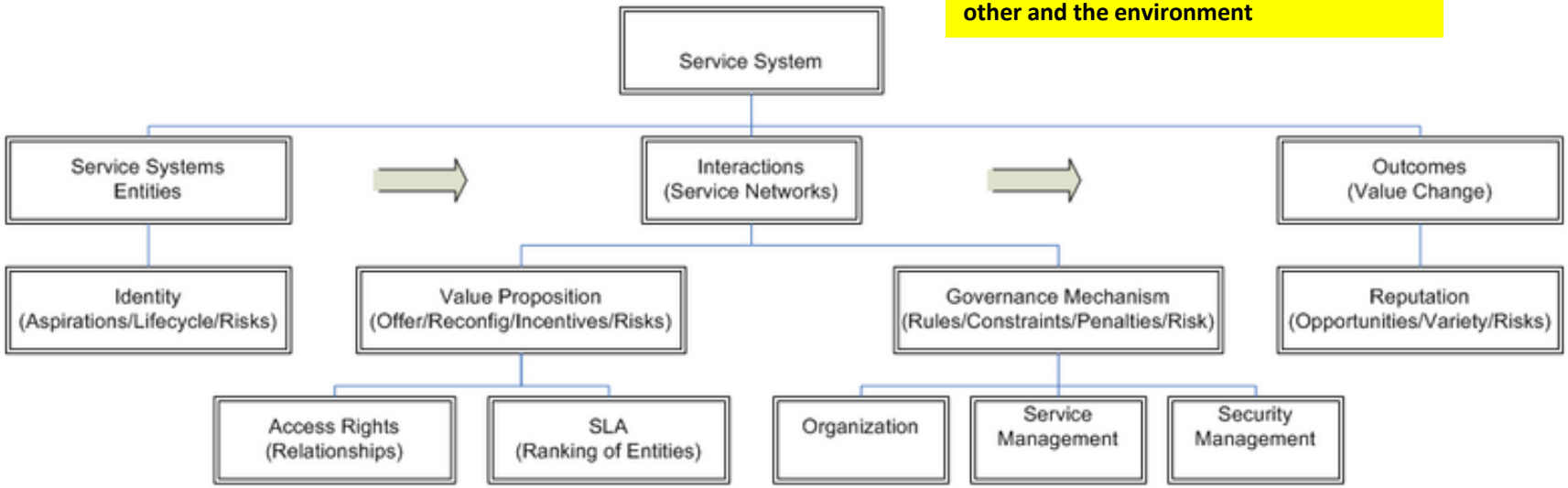
- 21st century global services economy - Information-driven, Customer centric, E-oriented, and Productivity-focused
- Service System: Value co-creation
- Service System Engineering:
  - ❖ Trans-disciplinary collaborations among people, science(s), enterprises, and engineering
  - ❖ Formal methodologies for assessing end-user interactions with enterprises
  - ❖ Socio-economic and technological perspective for value co-creation
  - ❖ **Service value chain: linkages among system entities**



Courtesy: Dr. Jim Spohrer, Innovation Champion, IBM

Service System Conceptual Framework

SS is the study of the populations of entities, and their interactions with each other and the environment



- *Resources:* People, Technology, Information, Organizations
- *Stakeholders:* Customers, Providers, Authorities, Competitors
- *Measures:* Quality, Productivity, Compliance, Sustainable Innovation
- *Access Rights:* Own, Lease, Shared, Privileged

Service Meta-Model

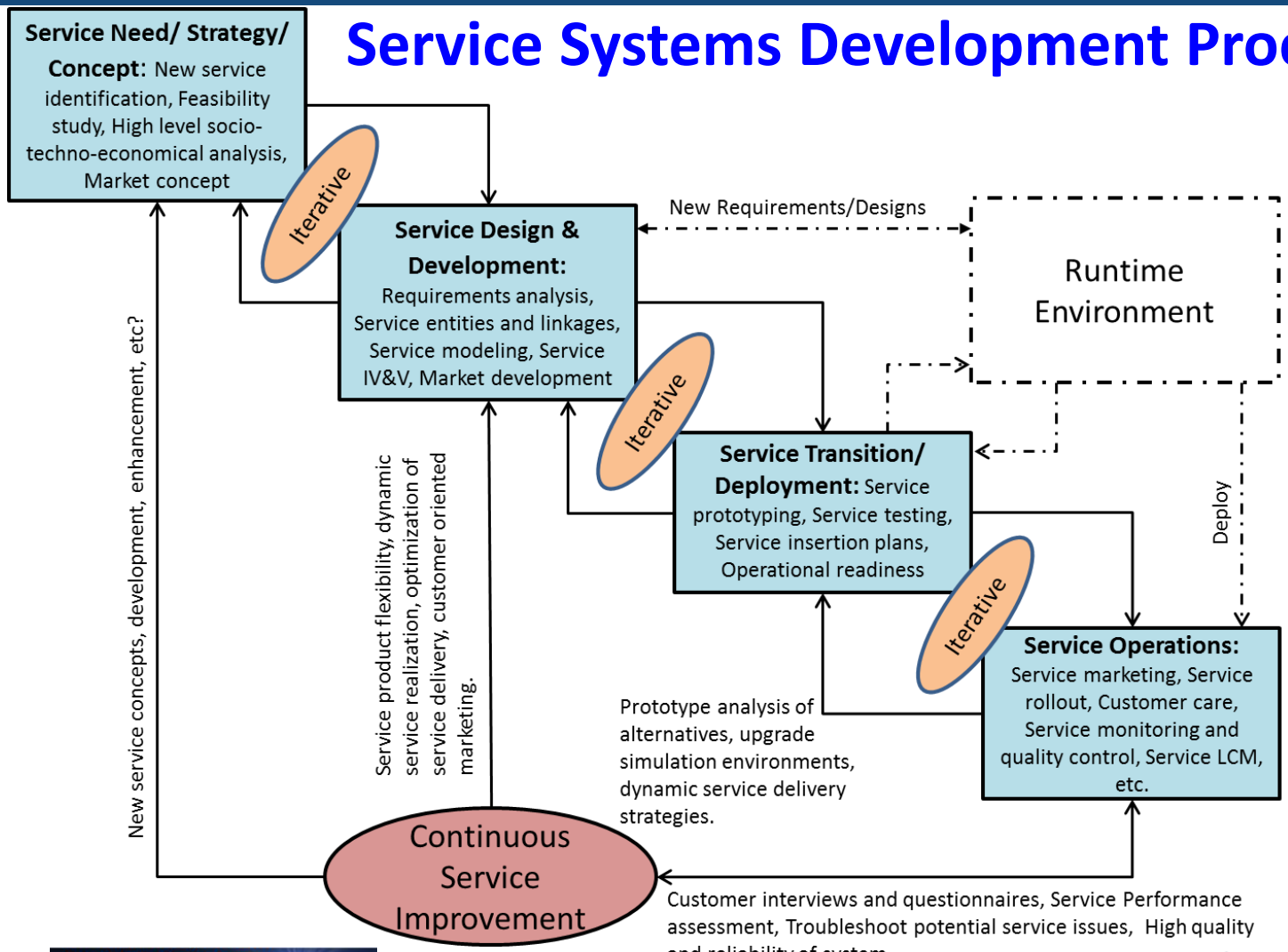
Resources:

People, Technology/Environment, Organization, and Information Sharing

System Entities:

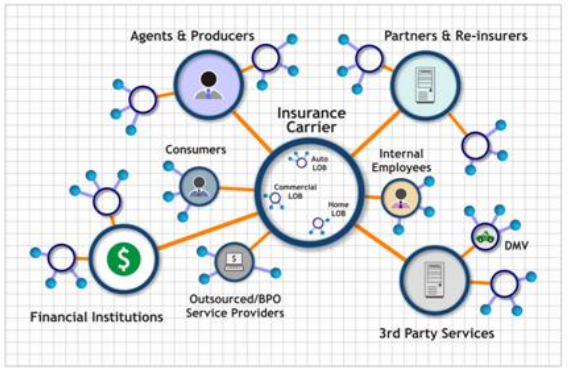
Entity Type	Attributes
Customer	Features, attitudes, preferences, requirements
Goals	Business, service, customer
Inputs	Physical, information, knowledge, constraints
Outputs	Physical, information, knowledge, waste, customer satisfaction
Processes	Service provision, service delivery, service operations, service support, customer relationships, planning and control
Human Enablers	service providers, support providers, management, owner organization, customer
Physical Enablers	Enterprise, buildings, equipment, enabling technologies at Customer premises (desktop 3D printers), furnishings, location, etc.
Informatics Enablers	information, knowledge, methods, processes and tools (MPTs), decision support, skill acquisition
Environment	Political, economic, social, technological, environmental factors

Service Systems Development Process (SSDP)

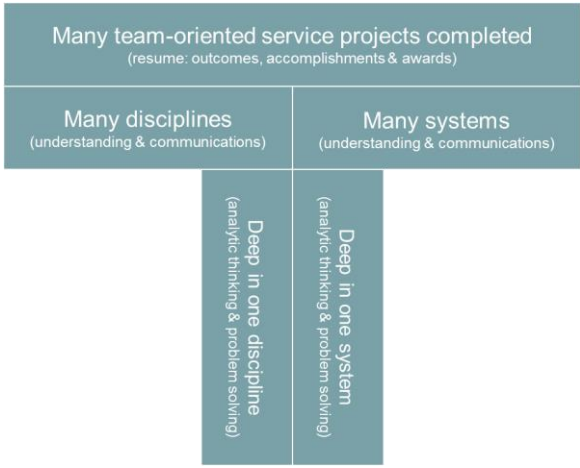


SSE Attributes

- **Real-time interaction of service system entities** made possible by emerging technologies
- **Dynamic Decision** making based on *predictive analytics* and interactions at the operational, tactical, and strategic level
- **Service Level Agreement (SLA) for Service delivery** may be contractual/mandatory or non-contractual and key contracted details of the service are specified through SLAs
- **Net-Centricity** enables comprehensive and reliable surveillance and control of the service during operations
- **Dynamic configuration of resources for service creation** near real-time or real-time
- **Dynamic linkages among the service system entities** (advances in design & modeling, data analytics, control systems, conflict analysis, and decision support systems)
- **New services and associated service systems driven by** strategic directions, policies, and regulations (nation, region, municipality, etc.).
- **Services will become end-user oriented** rather than market segments oriented



Insurance Business Services Ecosystem

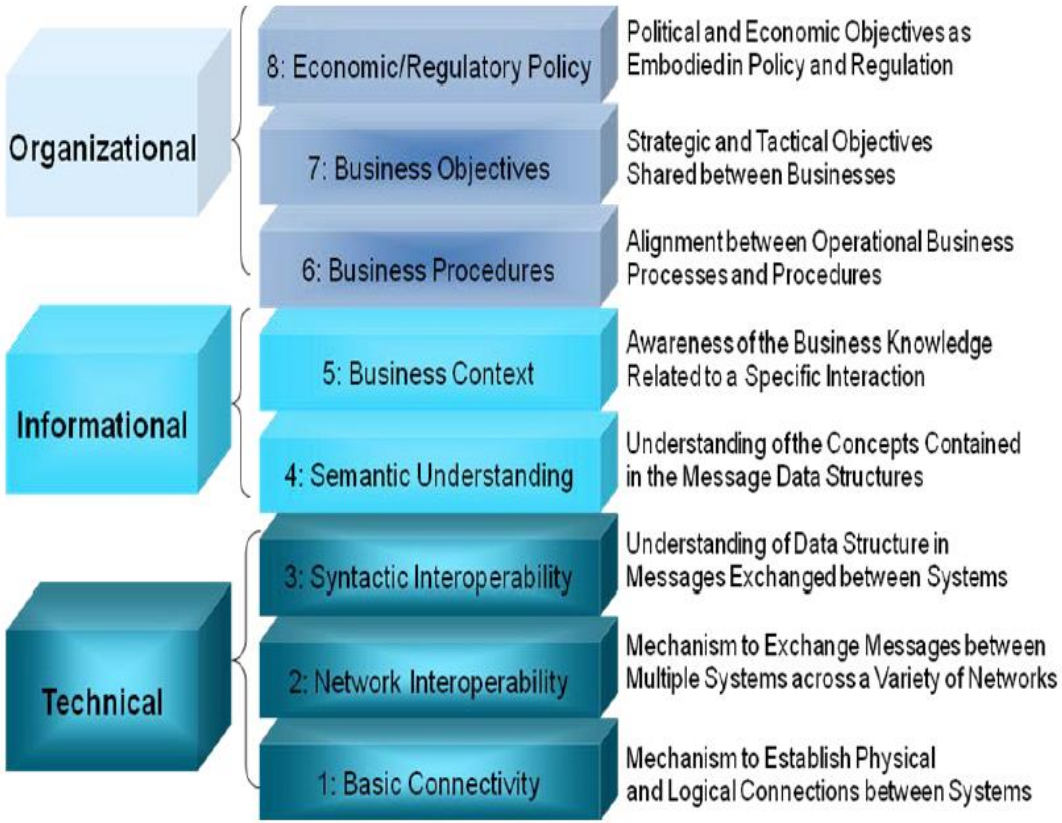


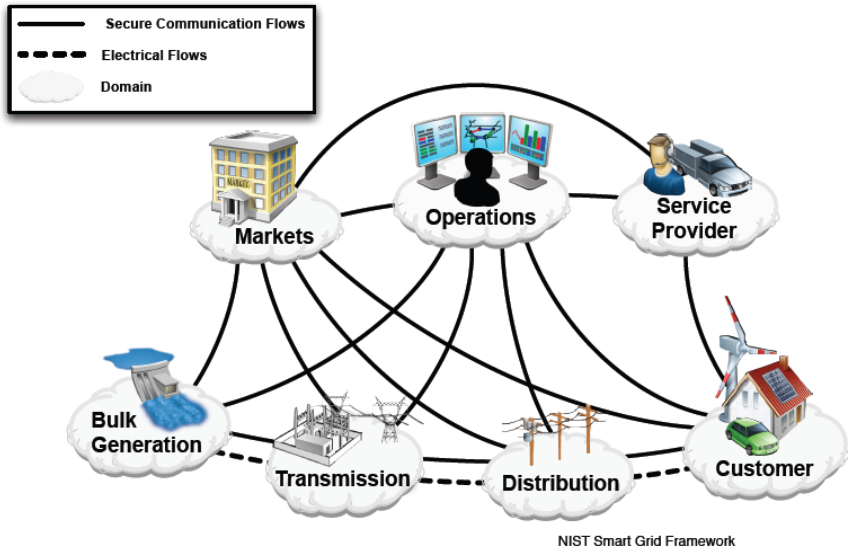
Research Institute for Manufacturing and Engineering Systems

Industrial · Manufacturing · Systems Engineering

SSE Applications

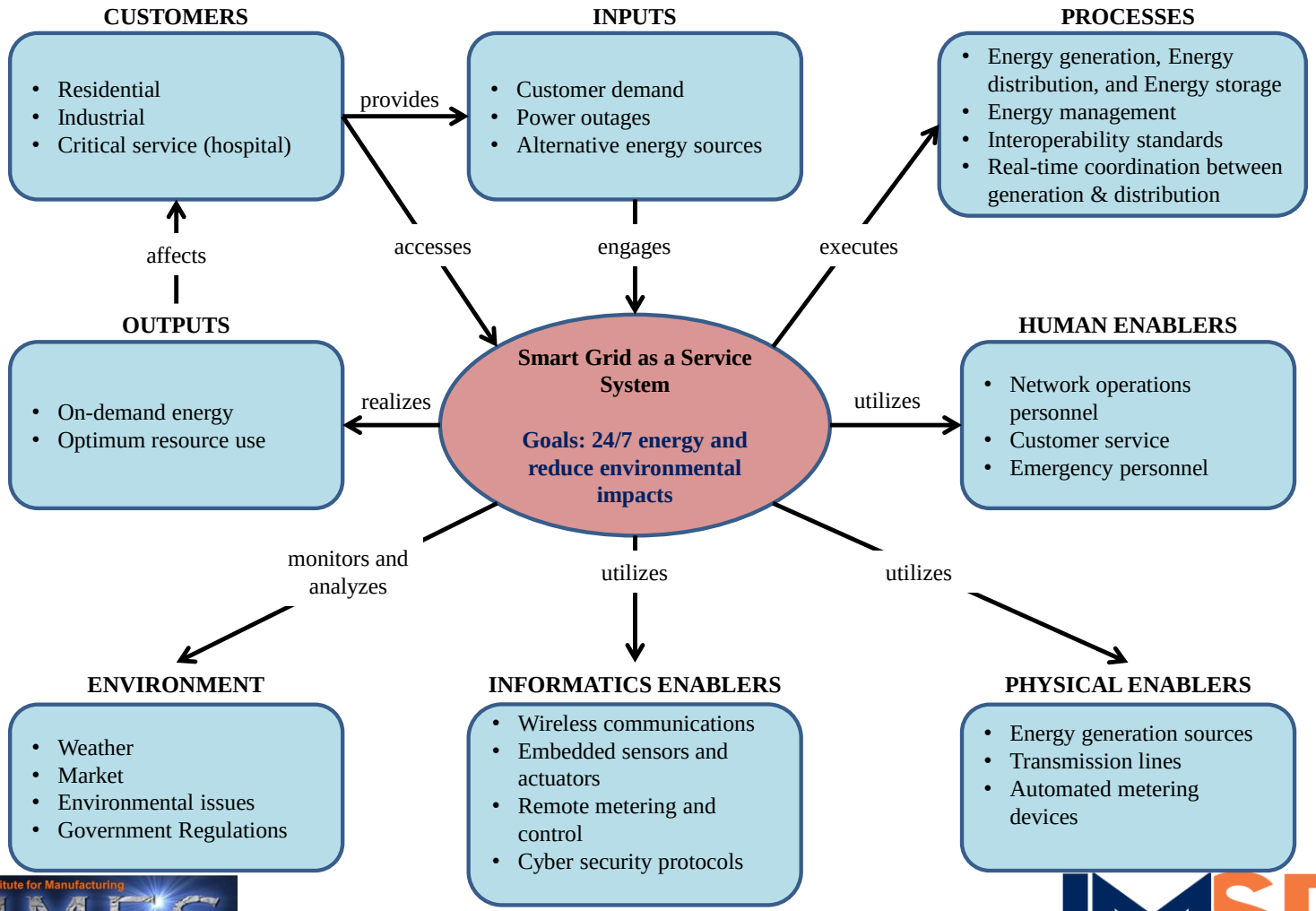
NIST GridWise Architecture for Smart Grid Interoperability



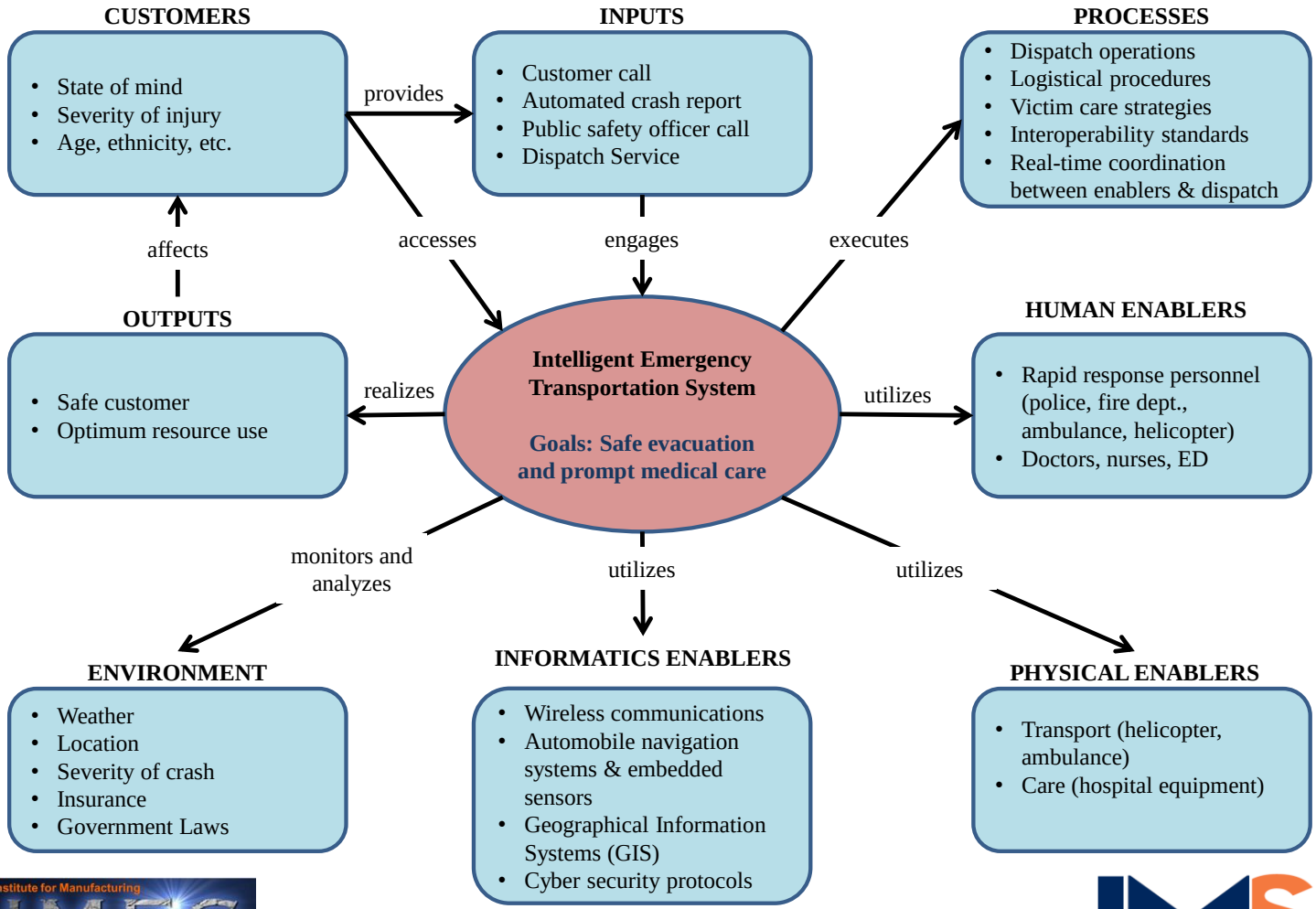


NIST Smart Grid Framework

Smart Grid as a Service (SGaaS)



Intelligent Emergency Transportation System (IETS)



SSE Challenges

SSE Challenges

- Optimization of Service Networks and Value Chains
- Interface Agreements and Interoperability
- Harmonization among Service System entities
- Dynamic Design and Development of Service Systems
  - Rapidly adapting fielded service systems to unforeseeable new threats and opportunities
  - Enabling adaptive service system architecture approaches
  - Agile, assured, efficient, and scalable SE approaches
- A more effective cognitive concept development environment
- Human-in-the-loop implications
- Standards for SOS

Discussion & Future Work

- SSE allows **discovery and definition of required relationships** among service system entities
- SSE methodologies promotes a **systemic understanding of cross disciplinary issues** to deliver on-demand services
- **Human in the Loop** research to better understand dynamic service configuration implications
- Analyze **Service Continuity Plans** in atypical or drastic scenarios (scalability, resilience, DR, etc.)
- **Novel methodologies** are also required to enable faster new technologies insertion

Role of Service Scientists

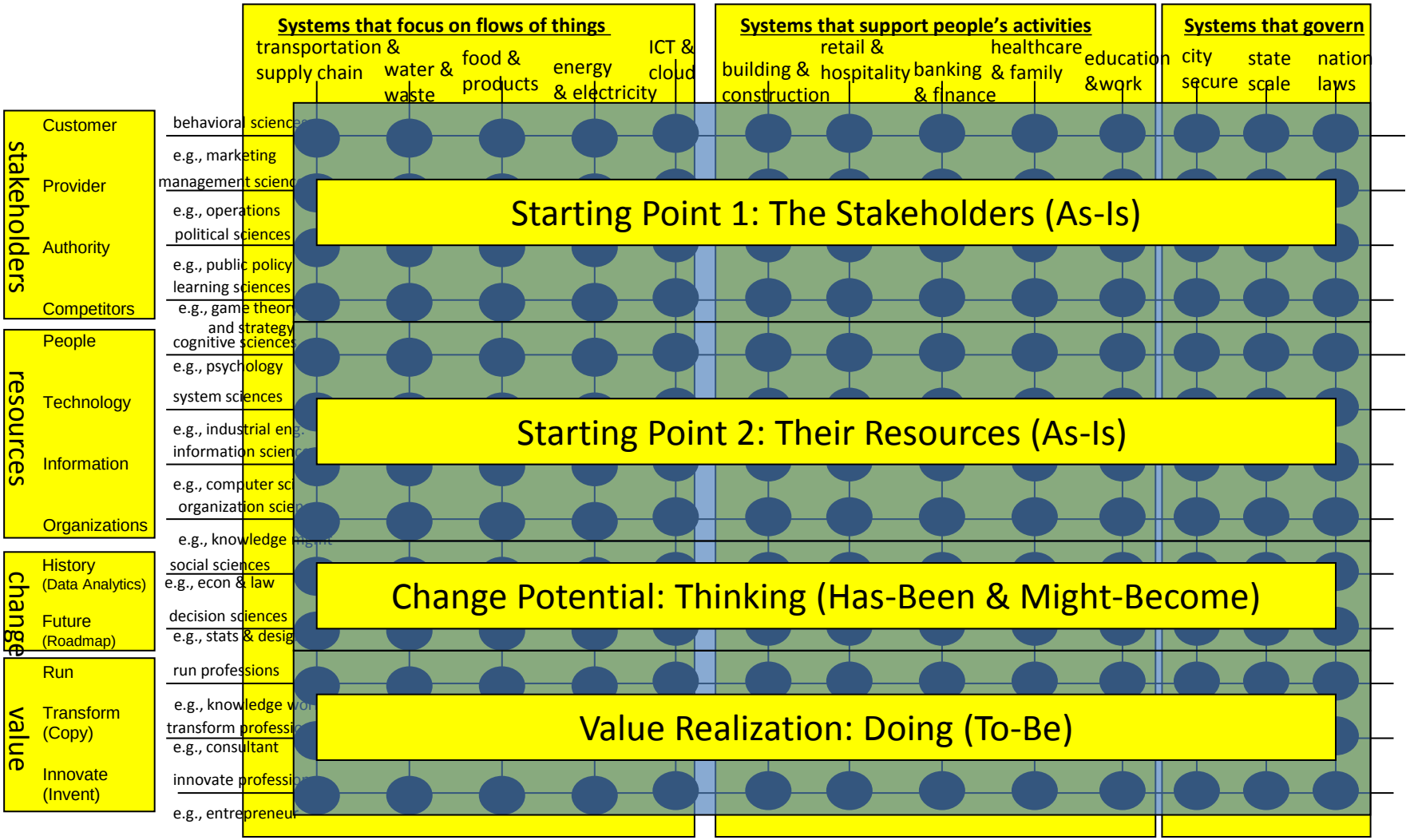
- Service scientists own the body of knowledge around service system problem solving
- Service scientists identify a service system that needs improvement
- Service scientists identify the stakeholders their concerns and perceived opportunities
- Service scientists envision augmentations (additional new service systems) or reconfigurations (of old service systems components) that best address all problems and opportunities
  - Identify year-over-year improvement trajectories
  - Identify incentives to change (ROI, leadership, laws)

References

- Lopes, A. and Pineda, R. 2013. Service Systems Engineering Applications. 2013 Conference on Systems Engineering Research. Procedia Computer Science. Volume 16. pp 678–687
- Pineda, R. Lopes, A., Tseng, B., and Salcedo, O. 2012. Service Systems Engineering: Emerging Skills and Tools. New Challenges in Systems Engineering and Architecting. Procedia Computer Science. Vol. 8, pp 420-427. Conference on Systems Engineering Research (CSER), St. Louis, MO.
- Pyster A. and Olwell, D., Eds. Systems Engineering Book of Knowledge. Service Systems Engineering. Knowledge Area. http://www.bkcasewiki.org/index.php/Service_Systems_Engineering.
- Spohrer, J.C. 2011. Service Science: Progress & Directions. Presented at International Joint Conference on Service Science. Taipei, Taiwan.
- Tseng, B., Wicker, R. Pan, R. and Awalt, C. 2010. Enhancement of Internet Based Layer Manufacturing for Engineering Education. Proceedings of the American Society for Engineering Education 2010 Conference. Louisville, KY.

Open Forum

Appendix



Service Systems Classification

Courtesy: Dr. Jim Spohrer, Innovation Champion, IBM