

Service Systems Engineering

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

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

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







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



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 (= $34\% \times 42\%$).







Manufacturing as a Service





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





SSE Core Concepts







Service Innovation Framework

1. Emerging demand	2. Define the domain	3. Vision and gaps	4. Bridge the gaps	5. Call for actions
<u>Service</u> Innovation	<u>Service</u> Systems	<u>Service</u> <u>Science</u>	<u>Stakeholder</u> Priorities	The white paper offers a starting point to -
Growth in service GDP and jobs Service quality & productivity Environmental friendly & sustainable	Customer-provider interactions that enable value cocreation Dynamic configurations of resources: people, technologies,	To discover the underlying principles of complex service systems Systematically create, scale and improve systems	Education Skills & Mindset Research Knowledge & Tools	Develop programmes & qualifications Encourage an interdisciplinary approach
Urbanisation & aging population Globalisation & technology drivers Opportunities for businesses, governments and individuals	organisations and information Increasing scale, complexity and connectedness of service systems B2B, B2C, C2C, B2G, G2C, G2G service networks	Foundations laid by existing disciplines Progress in academic studies and practical tools Gaps in knowledge and skills	Business Employment & Collaboration Government Policies & Investment	Develop and improve service innovation roadmaps, leading to a doubling of investment in service education and research by 2015

Glossary of definitions, history and outlook of service research, global trends, and ongoing debate







SSE Core Concepts

- 21st century global services economy -Information-driven, Customer centric, Eoriented, 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



- 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







SSE Attributes

- Real-time interaction of service system entities made possible by emerging technologies
- Dynamic Decision making based on <u>predictive analytics</u> 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





SSE Applications







NIST GridWise Architecture for Smart Grid Interoperability

	8: Economic/Regulatory Policy	Political and Economic Objectives as Embodied in Policy and Regulation
Organizational	7: Business Objectives	Strategic and Tactical Objectives Shared between Businesses
	6: Business Procedures	Alignment between Operational Business Processes and Procedures
	5: Business Context	Awareness of the Business Knowledge Related to a Specific Interaction
Informational	4: Semantic Understanding	Understanding of the Concepts Contained in the Message Data Structures
	3: Syntactic Interoperability	Understanding of Data Structure in Messages Exchanged between Systems
Technical	2: Network Interoperability	Mechanism to Exchange Messages between Multiple Systems across a Variety of Networks
	1: Basic Connectivity	Mechanism to Establish Physical and Logical Connections between Systems



NIST Smart Grid Framework





NST National Institute of Standards and Technology • U.S. Department of Commerce

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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)







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Open Forum









Appendix









Courtesy: Dr. Jim Spohrer, Innovation Champion, IBM

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