Scope of Service Systems Engineering

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Service systems engineering (SSE) involves all aspects of the enterprise. This topic discusses different aspects of the scope of SSE, from organizational strategy, to interoperability, to the life cycle of services, and then to their design.

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SSE and the Enterprise

Enterprises plan, develop, and manage the enhancements of their infrastructure, products, and services, including marketing strategies for product and service offerings. These plans propose new products or service offerings based on new, unexplored, or unforeseen customer needs with clearly differentiated value propositions. Service strategies are the internal business processes required to design, operate, and

deliver services. The mission of service strategies is to develop the capacity to achieve and maintain a strategic advantage (OGC 2009).

Taking the systems engineering (SE) approach to service systems, or (SSE), is imperative for the service-oriented, customer-centric holistic view to select and combine service system entities. The SSE approach can then define and discover relationships among service system entities to plan, design, adapt, or self-adapt to co-create value. The SSE approach should identify linkages, relationships, constraints, challenges/problems, new technologies, interoperability standards, interface agreements, or process development requirements among service entities required for the planned service or for potential future services (Lefever 2005).

SSE mandates participation not only from engineering, business operations, and customers, but also from various different domains, such as management science, behavioral science, social science, systems science, network science, computer science, decision informatics, etc.

Hipel et al. (2007) have presented a table for service science in terms of the domains and methods, including not only service systems, but also infrastructure and transportation systems, environmental and energy systems, and defense and space systems. The collaboration domains in Figure 1 below are a first approximation to the collaboration required from different disciplines for the SSE paradigm.

Table 1. Service Systems Engineering Domain Collaboration. (Hipel et al. 2007) Reprinted with permission of © Copyright IEEE - All rights reserved.

SEE	Collaboration Domains
SSE Management	• Management Science • Business Process Management • Cognitive Science • Decision Science
Service Realization Process (SRP)	• All engineering fields • Business Operations • Infrastructure Operations • Social Science • Computer Science • Management Science • Behavioral Science • Network Science • Computational Science • Systems Science • Decision Science

Methodologies, Processes, and Tools (MPT)	• Natural Science • Business Science (BPMN) • Mathematical • All engineering fields

Major challenges faced by SSE include the dynamic nature of service systems evolving and adapting to constantly changing operations and/or business environments, and the need to overcome silos of knowledge. Interoperability of service system entities through interface agreements must be at the forefront of the SSE design process for the harmonization of operations, administration, maintenance, and provisioning procedures of the individual service system entities (Pineda 2010).

In addition, service systems require open collaboration among all stakeholders, but recent research on mental models of multidisciplinary teams shows integration and collaboration into cohesive teams has proven to be a major challenge (Carpenter et al. 2010) (See also Team Dynamics). Thus, the emphasis on multidisciplinary (e.g., scientific, engineering, management, and social) education and training programs required to foster systems thinking helps bridge the gaps created by these silos of knowledge.

In the SSE approach, the social, governance, business, service, operations, and management activities are linked together through the service life cycle; service systems are by themselves a type of system of systems (SoS) where traditional systems engineering (TSE) practices need to be extended to include service systems entities' relationships (e.g., interface agreements among people, organizations, processes, and technologies) through information flows, technical interoperability, governance, and access rights within a system of systems.

Interoperability of Services

Interoperability among the different service system entities becomes highly relevant in SSE since the constituent entities are designed according to stakeholder needs; the entity is usually managed and operated to satisfy its own objectives independently of other system entities. The objectives of individual service system entities may not necessarily converge with the overall objectives of the service system. Thus, the need to include the following in the definition of a service system: analysis and design of the service system, governance frameworks to align political objectives,

service strategies, business objectives, information and communications technologies (ICT) objectives, technology objectives and end-to-end operations, administration and maintenance procedures, and allocation of these procedures to individual entities (Luzeaux and Ruault 2010).

The previous discussion relates to a new service system development. There may be instances where a service is planned for delivery in phases of deployment (transition/deployment phase), or as presented earlier, if there is already a service system defined and deployed, then it's possible that the new request is for a service based application (SBA), in which case, the process is more focused on the adaptations needed to deploy the new application. For SBA, instances of advances in computer engineering, computer science, and software development already permit the adaptation and creation of SBA in a run-time environment for the discovery, development, and publishing of applications (Maglio et al. 2010).

The service design process (SDP) for new services is triggered by the market concept of the intended service and considers the stakeholder(s), service value chain(s), target market(s), target customer(s), proposed SLA, demand forecast, pricing strategy, and customer access privileges, which together comprise the service strategy. The SDP process then adapts the TSE as a life cycle approach (concept/definition, design/development, deployment/transition, operations, life cycle management/utilization/CSI, and retirement) as discussed in Life Cycle Models. A more detailed list of the SSE process activities is described in Value of Service Systems Engineering and Service Systems Engineering Stages.

Service Lifecycle Stages

The SDP stages and notation are depicted in Table 2 below; due to the complexity of service systems (see also Complexity) the documents generated are becoming more model-based electronic documents than written binders depending on the methodologies and tools used.

Table 2. Service Realization Process: Life Cycle Stages.
(SEBoK Original)

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Life Cycle Changes	Purpose	Decision Gates

Service Strategy/Concept	New Service identification	*Elicit enterprise needs* *Explore service concepts* *Identify service system entities* *Propose viable HL black box solutions* ***Output: Service Description***	Decision Options - Go, No-GO - Continue this stage - Go to preceding stage - Hold project activity - Terminate project - Test - Deploy
	Feasibility Phase		
	HL Analysis		

Service Design/Development	Service Requirement Analysis and Engineering	*Refine service system requirements* ***Output: Service Requirement Document*** *Create solution description Identify Interfaces among entities* ***Output: Preliminary Design*** *Develop service system detailed architecture and specs* ***Output: Service Specification Document*** *Verify and Validate system requirements* ***Output: service JV & V Plans***
	Service Development	
	Service Integration, Verification, and Validation	

Service Transition/Deployment	*Service Insertion Plans Deploy service system Manage deployment activities Inspect and test (verify)* ***Output: Service Operation Plans, Operations Technical Plans, Operational Readiness Plans***
Service Operations and / Continuous Service Improvement	*Operate a reliable service system to satisfy customer needs Monitor, Measure, & Assess Provide sustained system capability Troubleshoot potential issues Store, archive, or dispose of the service system*

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All the life cycle stages are included for completeness, but very often during the concept analysis phase it may be determined that not all of the stages are needed. In these cases, a recommendation should be made regarding which stages are specifically required for the realization of the service in question.

Service Design Management

Another important role of SSE is the management of the service design process. SSE utilizes TSE practices to manage the resource and asset allocation to perform the activities required to realize the service through the value chain for both the customer and the service provider. The main focus of the service design process management is to provide for the planning, organizational structure, collaboration environment, and program controls to ensure that stakeholder's needs are met from an end-to-end customer perspective.

The service design process management process aligns business objectives and business operational plans with end-to-end service objectives, including customer management plans, service management and operations plans, and operations technical plans. The main SSE management activities are

- planning;
- assessment and control;
- decision management;
- risk management;
- configuration management; and
- information management.

SSE plays a critical role in describing the needs of the intended service in terms of the service's day-to-day operations, including customer care center requirements, interface among service system entities, such as: manufacturing plant, smart grid, hospital, network infrastructure provider(s), content provider(s) and service provider(s), service based application provider(s), applications providers, and the customer management process for the service.

Current research in computer engineering and software systems engineering is looking at the development of run-time platforms to allow real time or near real time customer service discovery and publishing (Spark 2009). The service-centric systems engineering (SeCSE) consortium has a well-defined service design process that is being applied to SBA. In this approach, there are design time and run-time sub-processes for the composition, provisioning, orchestration, and testing for service publishing (Lefever 2005). There is particular interest from the research community to include human-computer interactions (HCI) and behavioral science to address current social networking services (Facebook, Twitter, Linkedin, Google+, etc.) used to share unverified information via audio, messaging, video, chats, etc.

This research is gaining relevance because of the thin line between the customer (consumer, enterprise) and content providers in regards to security, privacy, information authentication, and possible misuse of the user-generated content. Even as the research progresses, these networking services are examples of business models organizing communities of interest for innovation. Hsu says, “If we understand this networking, then we may be able to see through the business

strategies and systems design laws that optimize connected value co-creation" (2009).

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Additional References

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