Value of Service Systems Engineering

Lead Authors: *Ricardo Pineda, Bud Lawson, Richard Turner*

Service systems engineering (SSE) is a multidisciplinary approach to manage and design value co-creation of a service system. It extends the holistic view of a system to a customer-centric, end-to-end view of service system design. Service systems engineers must play the role of an integrator by considering the interface requirements for the interoperability of service system entities, not only for technical integration, but also for the processes and organization required for optimal customer experience during service operations.

Service systems engineering uses disciplined approaches to minimize risk by coordinating/orchestrating social aspects, governance (including security), environmental, human behavior, business, customer care, service management, operations, and technology development processes. Therefore, systems engineers must have a good understanding of cross disciplinary issues to manage, communicate, plan, and organize service systems development and delivery of service. Service systems engineering also brings a customer focus to promote service excellence and to facilitate service innovation through the use of emerging technologies to propose creation of new service systems and value co-creation.

The service design process includes the definition of methods, processes, and procedures necessary to monitor and track service requirements verification and validation, in particular as they relate to the operations, administration, maintenance, and provisioning procedures of the whole service system and its entities. These procedures ensure that failures by any entity are

detected and do not propagate and disturb the operations of the service (Luzeaux and Ruault 2010).

Research on service systems needs to fuse business process management, service innovation, and social networks for the modeling of service system value chain (Carroll et al. 2010). The systems engineering approach helps to better understand and manage conflict, thereby helping both private and public organizations optimize their strategic decision making. The use of a systemic approach reduces rework, overall time to market, and total cost of development.

☐

Contents

Service SE Knowledge & Skills

The world's economies continue to move toward the creation and delivery of more innovative services. To best prepare tomorrow's leaders, new disciplines are needed that include and ingrain different skills and create the knowledge to support such global services. "In this evolving world, a new kind of engineer is needed, one who can think broadly across disciplines and consider the human dimensions that are at the heart of every design challenge" (Grasso and Martinelli 2007).

Service systems engineers fit the T-shaped model of professionals (Maglio and Spohrer 2008) who must have a deeply developed specialty area, as well as a broad set of skills and capabilities (See the Enabling Individuals article). Chang (2010) lists the following twelve service system management and engineering (SSME) skills:

1. Management of Service Systems. These skills include scheduling, budgeting and management of information systems/technologies, and leadership;
2. Operations of Service Systems. Engineers should be

proficient in process evaluation and improvement, quality improvement, customer relationships, and uncertainty management;

3. Service Processes. These skills include performance measurements, flow charting, work task breakdown;

4. Business Management. Business skills include project costing, business planning, and change management;

5. Analytical Skills. These skills include problem solving, economic decision analysis, risk analysis, cost estimating, probability and statistics;

6. Interpersonal Skills. Increasingly, service systems engineers are expected to excel in professional responsibility, verbal skills, technical writing, facilitating, and team building;

7. Knowledge Management. Service systems engineers should be familiar with definition, strategies, success factors, hurdles, and best practices in industry;

8. Creativity and Innovation in Services. These skills include creative thinking methods, success factors, value chain, best practices, and future of innovation;

9. Financial and Cost Analysis and Management. Additional business skills include activity-based costing, cost estimation under uncertainty, T-account, financial statements, ratio analysis, balanced scoreboards, and capital formation;

10. Marketing Management. Market forecast, market segmentation, marketing mix- service, price, communications and distribution- are important marketing tools;

11. Ethics and Integrity. Service Systems Engineers must be held to high ethical standards. These include practicing ethics in workplace and clear guidelines for making tough ethical decisions, corporate ethics programs, affirmation action, and workforce diversity, as well as global issues related to ethics. (See Ethical Behavior); and

12. Global Orientation. Increasingly, engineers must be aware of emerging business trends and challenges with regards to globalization drivers, global opportunities, and global leadership qualities.

Service Architecture, Modeling &

Views

Successful deployment of service value chains is highly dependent on the alignment of the service with the overall enterprise service strategy, customer expectations, and customer's service experience. The importance of service-oriented customer-centric design has been recognized for several years by traditional service providers (telecommunications, information technology (IT), business reengineering, web services, etc.) through the creation of process-driven architecture frameworks.

Architecture frameworks are important for creating a holistic system view. They promote a common understanding of the major building blocks and their interrelation in systems of systems or complex systems (see also Complexity). An architecture is a model of the the system created to describe the entities, the interactions and interoperability among entities, as well as the expected behavior, utilization, and properties of the end-to-end system. The architectures become the main tool to guide stakeholders, developers, third-party providers, operations managers, service managers, and users in the understanding of the end-to-end service system, as well as to enable governance at the service management and the service development levels.

These architecture frameworks have been defined through standards bodies and/or by private enterprises that recognize their advantage—standard processes that integrate the business-strategic processes and operations with the information technology and technology infrastructure (See Systems Engineering Standards). Most architecture frameworks model different scopes and levels of detail of business strategies, product and service offerings, business operations, and organizational aspects. Unfortunately, there are currently no frameworks that cover all the aspects (views) required to model the service systems. Some frameworks focus on business strategies, others in business process management, others in business operations, still others in aligning IT strategy or technology strategy to business strategy. Thus, a combination of architecture frameworks is required to create the enterprise service system model. For instance, an enterprise may use an enterprise business architecture (EBA) model covering strategic goals and objectives, business organization, and business services and processes where driven by market evolution, technology evolution, and customer demands. However,

a reference framework would be needed to model the IT strategy (e.g., Information Technology Infrastructure Library (ITIL) v. 3 (OGC 2009)) and the organizations and processes needed to deliver, maintain, and manage the IT services according to the business strategy.

Service Architecture Frameworks

Prime examples of Service Architecture Frameworks are listed below.

Standards:

- Zachmann Framework (Zachman 2003)
- Business Process Modeling (BPM) (Hantry et al. 2010)
- The Open Group Architecture Framework (TOGAF) (TOGAF 2009)
- Enhanced-Telecomm Operations Map (eTOM) by the TeleManagemnt Forum (eTOM 2009)
- Service Oriented Architecture (SOA) (Erl 2008)
- National Institute of Standards and Technology (NIST) Smart Grid Reference Model (NIST 2010)
- Web services business process execution language (WS-BPEL) (OASIS 2007)
- Department of Defense Architecture Framework (DoDAF) (DoD 2010)
- Others.

Proprietary Enterprise Architecture Frameworks:

- Hewlett - Packard IT Service Management Reference Model (HP ITSMRM 2000)
- International Business Machines Systems Management Solutions Life Cycle, IBM Rational Software.
- Microsoft Operations Framework

This list represents only a sample of the existing service architecture frameworks.

One great example of architecture frameworks applications for service systems, the "High Level Reference Model for the Smart Grid," developed by NIST in 2010 under the "Energy Independence and Security Act of 2007" (EISA), is presented below:

> *EISA designated the development of a*

Smart Grid as a national policy goal, specifying that an interoperability framework should be "flexible, uniform and technology neutral. The law also instructed that the framework should accommodate "traditional, centralized generation and distribution resources" while also facilitating incorporation of new, innovative Smart Grid technologies, such as distributed renewable energy resources and energy storage. (NIST 2010)

The NIST reference model was developed as "a tool for identifying the standards and protocols needed to ensure interoperability and cyber security, and defining and developing architectures for systems and subsystems within the smart grid." Figure 1 illustrates this model and the strategic (organizational), informational (business operations, data structures, and information exchanges required among system entities), and technical needs of the smart grid (data structures, entities specifications, interoperability requirements, etc.).
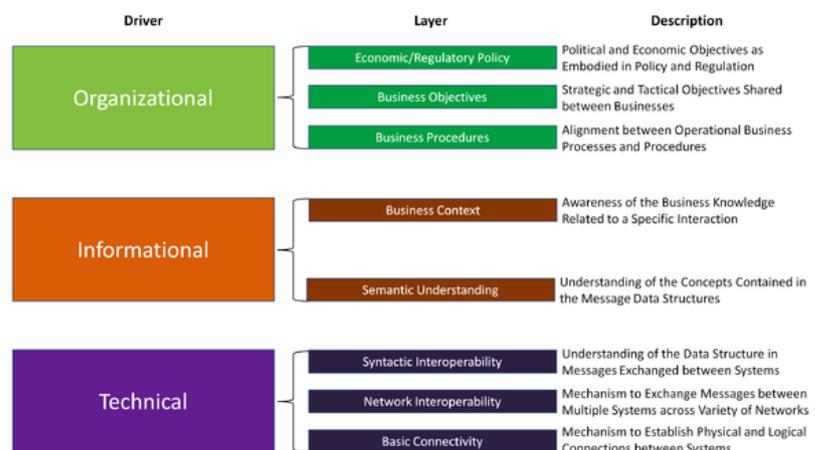

Figure 1. The Grid-Wide Architecture Council's Eight-Layered Stack (NIST and US Dept. of Commerce 2010). Released.

The NIST reference model uses this architecture framework to identify existing standards, identify new standards required for interoperability among interconnected networks, and to enable innovations where smart grid components (energy sources, bulk generation, storage, distribution, transmission, metering, cyber infrastructure, markets, service providers, customers, etc.) are supported by a broad range of interoperable options by well-defined interfaces

useful across industries, including security. Emerging/innovative service development with massively scaled, well-managed, and secured networks will enable a dynamic market driven ecosystem representing new economic growth (NIST 2010).

This architecture framework is being used today by different standards organizations, such as the Smart Grid Interoperability Panel (SGIP), and several smart grid working groups. For details on priorities, working programs, and working group charters, see "High Level Reference Model for the Smart Grid" (NIST 2010).

For service systems, the application of any of these frameworks requires modifications/adaptations to create dynamic frameworks aware of environmental changes due to competitor's offerings, market demands, and customer co-creation. Most frameworks are static in nature; this requires business operations to manage changes through pre-defined (pre-programmed) processes for service configuration and change control. Dynamic frameworks would allow real-time, or near real-time, analysis of impacts of newly discovered service on business processes, organizations, and revenue for run-time environment deployment.

Automatic service configuration and change control are being incorporated into the management process via service oriented architecture (SOA) for service automation (Gu et al. 2010) and service oriented computing (Maglio et al. 2010). In particular, progress has been made over the last ten years on the standards for adaptation, orchestration and creation of web services (WS) for service based applications (SBA). A good summary of existing life cycle approaches for adaptable and evolvable SBA is presented in (Papazoglou et al. 2010). Some examples of this are

- web services development life cycle (SDLC);
- rational unified process (RUP) for SOA;
- service oriented modeling and architecture (SOMA); and
- service oriented analysis and design/decision Modeling (SOAD).

Further research is required to understand the architectural implications of dynamic service configuration, including research on human behavior, social aspects, governance processes, business processes, and implications of dynamic service level agreements (SLA) for an enterprise service system. New

ways are needed to include adaptation requirements for new technologies that will exchange information with the service system entities and may have their own specifications. These technologies include robots, sensors, renewable energy, nanotechnologies, three dimensional printers, and implantable medical devices.

References

Works Cited

Carroll, N., E. Whelan, and I. Richardson. 2010. "Applying Social Network Analysis to Discover Service Innovation within Agile Service Networks." *Service Science*. 2 (4): 225-244.

Chang, C.M. 2010. *Service Systems Management and Engineering: Creating Strategic Differentiation and Operational Excellence*. New York, NY, USA: John Wiley & Sons, Inc.

DoD. 2010. *DoD Architecture Framework (DoDAF)*, version 2.0. Arlington, VA, USA: US Department of Defense (DoD).

Erl, T. 2008. *SOA Principles of Service Design*. Boston, MA, USA: Prentice Hall, Pearson Education.

eTOM. 2009. "Business Process Framework." Morristown, NJ: TeleManagement Forum. Accessed May 30, 2011 at http://www.tmforum.org/BusinessProcessFramework/1647/home.html.

Grasso, D., and D. Martinelli. 2007. "Section B: Holistic Engineering." *The Chronicle Review, The Chronicles of Higher Education*. Vol. 53, Issue 28. Page 8B. March 2007.

Gu. Q., Cuadrado, F., Lago, P. and Duenãs, J.C. 2010. "Architecture views illustrating the service automation aspect of SOA". *Service research challenges and solutions for the future internet*. 339-372.

Hantry, F., M.P. Papazoglou, W. van den Heuvel, R. Haque, E. Whelan, N. Carroll, D. Karastoyanova, F. Leymann, C. Nikolaou, W. Lamersdorf, and M. Hacid. 2010. "Business Process Management," in *Service Research Challenges and Solutions for the Future Internet S-Cube – Towards Engineering, Managing and Adapting Service-Based Systems*, edited by M.

Papazoglou, K. Pohl, M. Parkin, and A. Metzger. Berlin and Heidelberg, Germany: Springer-Verlag. 27-54.

HP ITSMRM. 2000. "HP IT Service Management Reference Model. Technical White Paper." Palo Alto, California, USA: Hewlett – Packard Company. Accessed September 2, 2011. Available: ftp://ftp.hp.com/pub/services/itsm/info/itsm_rmwp.pdf.

Luzeaux, D., and J.R. Ruault (eds.). 2010. *Systems of Systems.* New York, NY, USA: John Wiley & Sons.

Maglio, P., and J. Spohrer. 2008. "Fundamentals of Service Science." *Journal of the Academy of Marketing Science.* 36 (1): 18-20.

National Institute of Standard and Technology (NIST). 2010. *NIST Framework and Roadmap for Smart Grid Interoperability Standards Release 1.0.* Gaithersburg, MD, USA: Office of the National Coordinator for Smart Grid Interoperability, US Department of Commerce. Accessed September 2, 2011. Available: http://www.nist.gov/smartgrid/upload/FinalSGDoc20100 19-corr010411-2.pdf.

OASIS. 2007. "Web Services Business Process Execution Language Version 2.0." Organization for Advancement of Structured Information Standards (OASIS) Standard. Accessed September 2, 2011. Available: http://docs.oasis-open.org/webcgm/v2.0/OS/webcgm-v2.0 .pdf.

OGC (Office of Government Commerce). 2009. *ITIL Lifecycle Publication Suite Books*. London, UK: The Stationery Office.

Papazoglou, M., K. Pohl, M. Parkin, and A. Metzger. 1998. "Service Research Challenges and Solutions for the Future Internet," in *Service Research Challenges and Solutions for the Future Internet S-Cube – Towards Engineering, Managing and Adapting Service-Based Systems*. Berlin and Heidelberg, Germany: Springer-Verlag.

TOGAF. 2009. "The Open Group Architecture Framework," version 9. The Open Architecture Group. Accessed September 2, 2011. Available: http://www.opengroup.org/togaf.

Zachman, J. 2003. "The Zachman Framework for Enterprise Architecture: Primer for Enterprise Engineering and Manufacturing." Accessed September 2, 2011. Available:

http://www.zachmanframeworkassociates.com/index.php/ebook.

Primary References

Chang, C.M. 2010. *Service Systems Management and Engineering: Creating Strategic Differentiation and Operational Excellence.* New York, NY, USA: John Wiley & Sons, Inc.

Erl, T. 2008. *SOA Principles of Service Design.* Boston, MA, USA: Prentice Hall, Pearson Education.

Hantry, F., M.P. Papazoglou, W. van den Heuvel, R. Haque, E. Whelan, N. Carroll, D. Karastoyanova, F. Leymann, C. Nikolaou, W. Lamersdorf, and M. Hacid. 2010. "Business Process Management," in *Service Research Challenges and Solutions for the Future Internet S-Cube – Towards Engineering, Managing and Adapting Service-Based Systems*, edited by M. Papazoglou, K. Pohl, M. Parkin, and A. Metzger. Berlin and Heidelberg, Germany: Springer-Verlag. p. 27-54.

National Institute of Standard and Technology (NIST). 2010. *NIST Framework and Roadmap for Smart Grid Interoperability Standards Release 1.0.* Gaithersburg, MD, USA: Office of the National Coordinator for Smart Grid Interoperability, US Department of Commerce. Accessed September 2, 2011. Available: http://www.nist.gov/smartgrid/upload/FinalSGDoc201001019-corr010411-2.pdf.

Additional References

None.

< Previous Article | Parent Article | Next Article >
SEBoK v. 2.11, released 25 November 2024