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Service-oriented technology and management: Perspectives on research and practice for the coming decade

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A B S T R A C T

Service-oriented technologies and management have gained attention in the past few years, promising a way to create the basis for agility so that companies can deliver new, more flexible business processes that harness the value of the *services approach* from a customer's perspective. Service-oriented approaches are used for developing software applications and software-as-a-service that can be sourced as virtual hardware resources, including on-demand and utility computing. The driving forces come from the software engineering community and the e-business community. *Service-oriented architecture* promotes the loose coupling of software components so that interoperability across programming languages and platforms, and dynamic choreography of business processes can be achieved. Nevertheless, one of today's most pervasive and perplexing challenges for senior managers deals with how and when to make a commitment to the new practices. The purpose of this article is to shed light on multiple issues associated with service-oriented technologies and management by examining several interrelated questions: why is it appropriate now to study the related business problems from the point of view of services research? What new conceptual frameworks and theoretical perspectives are appropriate for studying service-oriented technologies and management? What value will a service science and business process modeling offer to the firms that adopt them? And, how can these approaches be implemented so as to address the major challenges that organizations face with technology, information and strategy? We contribute new knowledge in this area by tying the economics and information technology strategy perspectives to the semantic and design science perspectives for a broader audience. Usually the more technical perspective is offered on a standalone basis, and confined to the systems space – even when the discussion is about business processes. This article also offers insights on these issues from the multiple perspectives of industry and academic thought leaders.

1. Introduction

The recent convergence of information and communication technology (ICT) design, execution, storage, transmission and reusable knowledge is creating new opportunities. They include redeploying people, reconfiguring organizations, sharing information (e.g., language, processes, metrics, prices, policies and laws), and investing in technologies. The investments are intended to yield technical solutions that adjust to a changing business environment, and effectively leverage the value of knowledge in service relationships that produce high business value (Arsanjani et al., 2004). These are what we call *services* and *service-oriented thinking.*

The *service orientation* is emerging at multiple organizational levels in business, and it leverages technology in response to the growing need for greater business integration, flexibility, and agility. A branch of the computer science literature related to IT infrastructure of Web Services views *service-oriented architecture* (SOA) as "... a technical architecture, a business modeling concept, a piece of infrastructure, an integration source, and a new way of viewing units of automation within the enterprise" (Keith et al., 2006). For greater clarity though, we recommend a definition of service-oriented architecture from the Organization for the Advancement of Structured Information Standards (OASIS) (OASIS, 2006, p. 6), : "A paradigm for organizing and utilizing distributed capabilities that may be under the control of different ownership domains. It provides a uniform means to offer, discover, interact

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with and use capabilities to produce desired effects consistent with measurable preconditions and expectations." Thus, service-oriented architecture is not limited to just Web services, or technology or technical infrastructure either (Brittenham et al., 2007). Instead, it reflects a new way of thinking about processes that reinforces the value of commoditization, reuse, semantics and information, and creates business value (Bieberstein et al., 2005).

In several branches of information systems (IS) research, the issue of service-oriented technologies (Brown et al., 2006; Demirkan and Goul, 2006), especially service-oriented architectures (Arsanjani et al., 2004; Spohrer et al., 2007), and service science (Bitner and Brown, 2006; Chesbrough and Spohrer, 2006; Maglio et al., 2006) are currently being intensively studied and discussed by many researchers and practitioners. Despite the multitudes of publications that can be found on these topics from practitioners (e.g., Horn et al., 2005; Spohrer, 2005) and academics (e.g., Bitner et al., 2008; Lusch and Vargo, 2006; Martin-Flatin et al., 2006), several questions are still left open. They include, for example, the relationship between the business view on services and the underlying technical elements that are required for implementing it. Are services in this regard a new concept and is there a demand from the side of business to study services? What is driving service innovation and how can the concepts that are developed on the technical level be used as a means of support in the organization that creates high business value? What are the current challenges for enterprises and how can they be met by using service-oriented concepts and technology?

In an attempt to shed light on some of these questions, a panel of leading experts from different areas of IT services and service science, representing research in academia and industry, came together to discuss these issues. This occurred in a session entitled "Service-Oriented Technology and Management" at the 2007 International Conference on Electronic Commerce on August 21, 2007, which was held at the Carlson School of Management, University of Minnesota in Minneapolis. The session discussion focused on four key questions:

- **Question 1**: *Why is it appropriate to study leading business problems in IS and technology-related to processes, infrastructures, architectures, and information capabilities from the point of view of services research?*

It is sometimes argued that the current discussion on services is just a revival of discussions that have been occurring for quite a while. On the technical side the encapsulation of functionality in software and its adaptation for other components has been used for several years (e.g., Booch et al., 2007; Lusch and Vargo, 2006). Also, from the viewpoint of economics, a turn toward a service economy cannot be regarded as a new concept; there has been work going on for years that has adopted this general perspective (e.g., Andersen et al., 2000; Baily, 1986; Bosworth and Triplett, 2004). However, it is not clear how the increased amount of services that are now present in the global economy and the current IT architectures which support them should be understood together. Even more important is how service innovations will be carried out in the future and what will be the necessary support structure to make them successful, to maximize business value, and to create high social welfare.

- **Question 2:** *What new conceptual frameworks and theoretical perspectives are appropriate for studying service-oriented technologies and management?*

To provide guidelines to business people and IT leaders and staff members, frameworks that evaluate a range of issues related to service-oriented technologies and management should be beneficial (Maglio et al., 2006; Spohrer et al., 2007). They can provide insights for day-to-day operations conducted under the service paradigm, as well as address longer-term strategic perspectives (Demirkan et al., 2002). They can also effectively harmonize the overall technical considerations and interdependencies with the managerial and strategy challenges that a firm faces.

- **Question 3:** *What value will a science of services and business process modeling offer to the firms that adopt them?*

The representation of business processes and their transformation into executable workflows are issues that are being addressed by new state-of-the-art approaches, including the Unified Modeling Language (UML) (Management Group, 2008; White, 2004) and Business Process Modeling Notation (BPMN) (e.g., Management Group, 2008). Questions remain though: how should these modeling relationships and representation formalisms change in the light of a service-oriented economy on one side and emerging service-oriented architectures on the other side (Arsanjani et al., 2004; Zhang et al., 2006)? And how should changes in the business side influence the composition of information systems, and vice versa? Research into these questions will establish a foundation for the creation of a new discipline, as well as for the creation of new and effective technical and managerial practices (Allen et al., 2006).

- **Question 4:** *How can these approaches be implemented so as to address the major challenges that the enterprise faces with technology, information and strategy?*

For the implementation of service-oriented architectures, some standards and frameworks are available. The choice for specific solutions does not only have to be based on IT constraints though. It may hinge on the strategic implications of a given choice. Thus, these relationships should be viewed as being of high importance, and it is also critical to view them from different perspectives that integrate business and technology-related opportunities and implementation (Marks and Bell, 2006).

The remainder of this article is laid out as follows. Section 2 provides a brief narrative on the motivation in the business economy for the service-oriented approach. It also briefly discusses services, service systems and service science. And it provides some background on IBM Corporation's "Services Science Management and Engineering" (SSME) initiative and its related research agenda (Chesbrough and Spohrer, 2006; Maglio et al., 2006). Section 3 discusses the challenges that enterprises face when they confront the complexity and brittleness of their current infrastructures and business models. The suggested solution for the enterprise emphasizes loose coupling, agility, business and technology semantics, meta-modeling of process relationships within organizations and the reuse of a variety of business process and systems artifacts that are viewed as forming a firm's service-oriented architecture. Section 4 delves more deeply into the nature of services, discusses their shared characteristics, and the related requirements for success. Section 5 discusses economic perspectives on service-oriented technologies and management approaches, and provides some thoughts on how to approach a range of issues and problems that can be evaluated using the related theory. Section 6 offers a number of managerial recommendations, the related research directions, and some final thoughts. Overall, we contribute new knowledge by tying the economics and IT strategy perspectives to the semantic and design science perspectives for a broader audience. Usually the more technical perspective is offered on a standalone basis, and confined to the systems space – even when the discussion is about business processes.

2. Growth of services economy and services research

The world economy is currently transitioning from a goods-based economy to an economy in which value creation, employment, and economic wealth depend on the service sector (Spohrer and Maglio, 2008). Services account for 75% of the US gross domestic product (GDP) (Pal and Zimmerie, 2005) and 80% of private sector employment in the US Karmakar, 2004. They also play a similarly important role in all of the Organization for Economic Cooperation and Development (OECD) countries. Moreover, industries that deliver consulting, experience, information, or other intellectual content now account for more than 70% of total value added in these countries (Spohrer, 2005). Market-based services, excluding those provided by the public sector (e.g., education, health care, and government) account for 50% of the total, and have become the main driver of productivity and economic growth, especially as the use of IT services has grown (Spohrer, 2005). According to Babaie et al., 2006, worldwide end-user spending on IT services will grow at a 6.4% compound annual growth rate through 2010 to reach US$855.6 billion, with positive growth in nearly all market segments.

Service-oriented thinking is one of the fastest growing paradigms in IT, with relevance to accounting, finance, supply chain management and operations, strategy and marketing. According to Forrester Research, companies that implement a service-oriented architecture are able to reduce costs for the integration of projects and maintenance by at least 30% (Wall, 2007). As a future trend, Gartner predicts that at least one-third of business application software spending will be on software-as-a-service, instead of on product licenses by 2012. Also 40% of capital expenditures will be made for infrastructure-as-a-service by 2011 Plummer et al., 2008. IDC estimates that spending on service-oriented architecture-based services alone will grow to US$8.6 billion, experiencing a 138% increase from US$3.6 billion in 2005. They further estimate that spending will grow to more than US$33.8 billion by 2010 Grid Today. IDC: SOA, 2006.

There is a long history of academic and industrial interest in the service sector that continues up to the present day. Yet most of the interest in services has focused narrowly on marketing or management as well as service sector economics. With the rise of technology-enabled services though, many traditional companies have begun to see more and more revenue generated by their service operations. So in industry, there has been a growing recognition in the past decade that service innovations now are as important as technology innovations. Yet, service innovations and their impacts are generally unknown, save for a few economists (e.g., Gadrey and Gallouj, 2002) and some others (e.g., Cherbakov et al., 2005) who have studied investments and innovation in the service industries.

Spohrer et al., 2007 defines a *service* as the application of competence and knowledge to create value between providers and receivers. The value that accrues is derived from the interactions of entities that are known as *service systems* (Vargo and Lusch, 2004). Service systems are configurations of systems that permit *dynamic value co-creation*. Typically they involve people, technology, organizations, and shared information. They also include such things as language, laws, measures, models, and so on. They are connected internally and externally by *value propositions*, with *governance mechanisms* that support and adjudicate the resolution of disputes. The goal of *service science* is to catalog and understand service systems, and to apply that understanding to advancing our ability to design, improve, and scale service systems for practical business and societal purposes. The growth of service economies has broad implications for the operation of businesses, the creation of academic knowledge, the delivery of education, the implementation of government policies, and the pursuit of humanitarian causes (Bitner et al., 2008).

IBM Corporation, a leader in the technology and information services sector of the global economy, generated about 41% of its 2003 pre-tax income of US$9.4 billion, and 37% of its 2007 pre-tax income of US$14.5 billion from the services industry (IBM Corporation, 2007). IBM is a globally integrated enterprise operating in more than 170 countries with more than forty time zones, 370,000 employees and seven business units (Palmisano, 2006). Like many other global enterprises, it has been transforming itself to become an on-demand service business. As a result, it has become increasingly important for IBM to understand how to achieve effective service innovations as a basis for maintaining sustainable growth in its equity value. The company has been doing this in two ways: improving its service business by devoting more resources to innovation, and expanding the scope of its service business to a global scale. This includes: acquisitions and investments for global IT services provided through India; applying the service orientation in the design and transformation of business processes; and the redefinition of what it means to be a provider of hardware and software support. [1]

One of IBM's business goals is to address the problem that most businesses and government organizations face: their processes are run in silos, which constrain effectiveness in providing integrated and cost-effective services to customers. By breaking the siloed business processes into reusable services, and executing them with innovative service-oriented technical architecture and infrastructure services, IBM has been opening up new pathways to future service business revenue and profitability success.

Some of IBM's research agenda relates to service-oriented technology and management service systems and the services they provide, service system improvements, and service system scale and scope:

- *Service systems and the services they provide.* Defining and mapping out the basis for new services and new service systems is an important area of research. For example, understanding what a service system is (and is not) is a basic consideration that requires technical acumen and managerial judgment to be brought together. Another requirement is to define what services are to be produced and to be consumed by the different classes and specific instances of services systems. Related to this is the *locus of service production*: centralized vs. decentralized (Yildiz and Godart, 2007), and internal, external or a hybrid mix of both (Parasuraman et al., 1985). Another interesting set of issues that come up in this context is the role of people, technology, shared information, and customer participation in production processes. So a key consideration in the proposed research is to develop a clear understanding of how all of these different aspects of service system individually create value, and also how they create value in association with one another.
- *Service system improvements.* Another important task for research is to understand the ways a service system improves or can be improved over time through investments. Some of the related goals include: improving efficiency through improved plans, methods, and techniques for service system operations (Au et al., 2008); enhancing effectiveness by making

[1] For additional details, the interested reader should see www.ibm.com/university/ssme. Also the November 2007 special issue of *IBM Systems Journal* is on IT-enabled business transformation, and it is especially relevant (IBM Corporation, 2005; IBM Corporation, 2007b). There are two articles that discuss the details of how IBM has been using service-oriented architecture methods in its own transformation (Vayghan et al., 2007; Walker, 2007). Two additional special issues on the topics of service-oriented architecture (Horn et al., 2005) and IT service management (IBM Corporation, 2007a) are also useful to develop a deeper understanding of what this company has been doing.

appropriate adjustments to organizational processes as a means to address key business problems like successful software development (Grady, 1997); and developing and implementing meaningful performance indicators for a service system, similar to what we have seen in the past with software metrics (e.g., Grady and Caswell, 1987), and hardware performance indicators (Brown, 2000; IBM Corporation, 2007a). Another related goal is to achieve sustainable value propositions for customers that deliver improved results and performance, and provide greater agility, versatility and robustness in the face of changes in the marketplace and organization's strategy (Gurbaxani and Whang, 1991; Schelp and Winter, 2007). Old and new service systems will need to work together without undue costs or performance losses.

- *Service system scale and scope*. Current research also seeks to understand the ways that improvements and new competencies in one service system can achieve scale and build size, as well as develop scope and build cross-implementation opportunities for different kinds of service systems (Swanson, 1994). Practically speaking, what is at stake is the development of an in-depth understanding how to best develop service system scale and scope, so it is possible to grow a firm's profitability at an increasing rate as its revenues grow. This creates substantial managerial incentives to invest in service system scale and scope.

The key to service science is its interdisciplinary qualities. It does not focus only on one aspect of service. Instead, it focuses on *service as a system of interacting parts* that include people, technology, and business. Service science draws on ideas from a number of existing disciplines. They include computer science, cognitive science, economics, organizational behavior, human resources management, marketing, operations research, and IS. The aim is to integrate the variety of perspectives that these different fields offer into one coherent whole. To highlight the interdisciplinary nature of the effort, IBM started an initiative in this area that it has called "Service Science, Management and Engineering" (SSME), as we mentioned earlier.

3. Rethinking systems architecture from a service perspective

Enterprises, including government organizations and other public and private companies, face a difficult set of challenges to improve their strategic and technological agility and reduce the complexities of their operating environments (Desouza, 2006; Patten et al., 2005). (See Fig. 1 for an illustration of the various complexities that organizations face today with their applications and business processes.)

Most enterprises do not have a complete view of their processes and business and technology policies (Zairi, 1997). They are not documented well and tend not to be followed properly. Also, inconsistent information scattered throughout the organization makes decision-makers' tasks harder. They also do not have business strategies that are tightly linked with their IT operations (Zhao et al., 2007). Moreover, inconsistent data, and data and information security have increased dramatically due to globalization, disaggregation, increased external and internal regulations, and compliance requirements (e.g., Sarbanes-Oxley, and the Health Information Protection and Privacy Act) (Luftman et al., 1993; Soper et al., 2007).

In response to these challenges, organizations need to make structural, operational and cultural changes to become more service-oriented. They also need to transform their traditional siloed and tightly coupled business processes into more loosely coupled services, and align them vertically with IT services that are sourced by virtual resources (Brown et al., 2006; Liftman et al., 2006). Although they need to be able to sense environmental change and respond (Overby et al., 2006), they also need to be able to reallocate their resources dynamically as priorities and demand change (Fowler et al., 2000; Pavlou and El Sawy, 2005). When organizations find a way to sense and capture their customers' chang-

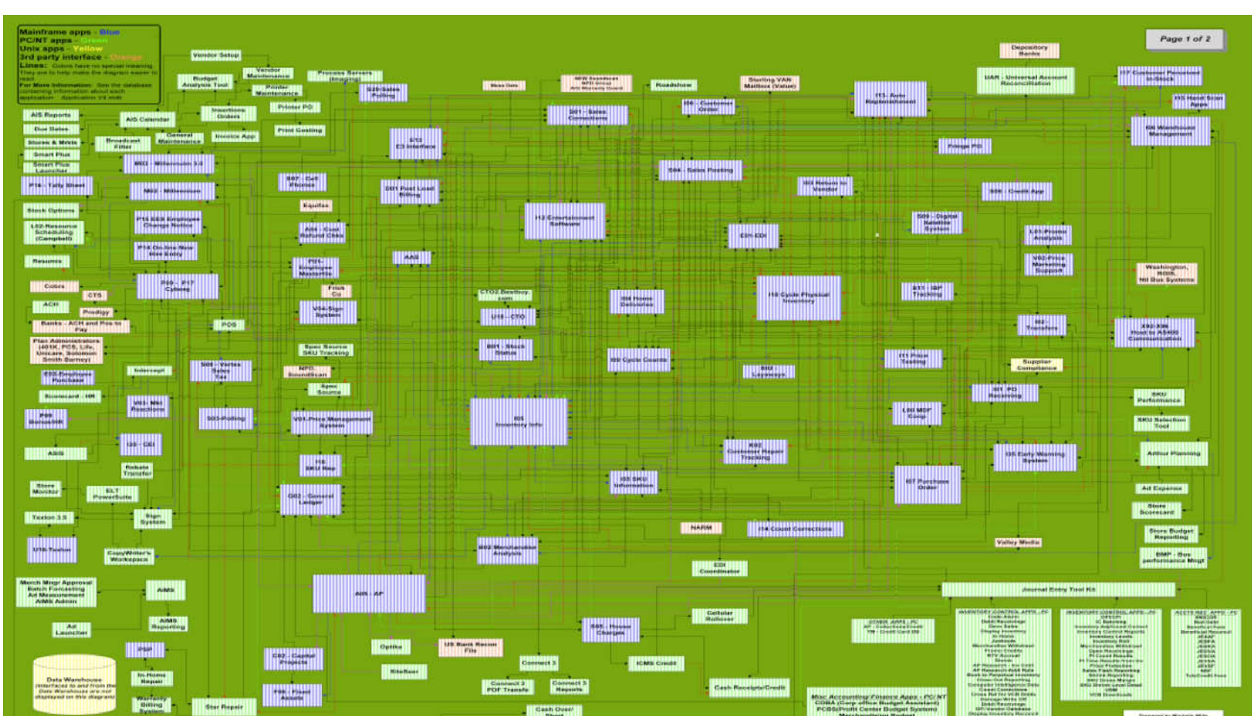

Fig. 1. Sample diagram of complexity in an organization's business and IT landscape.

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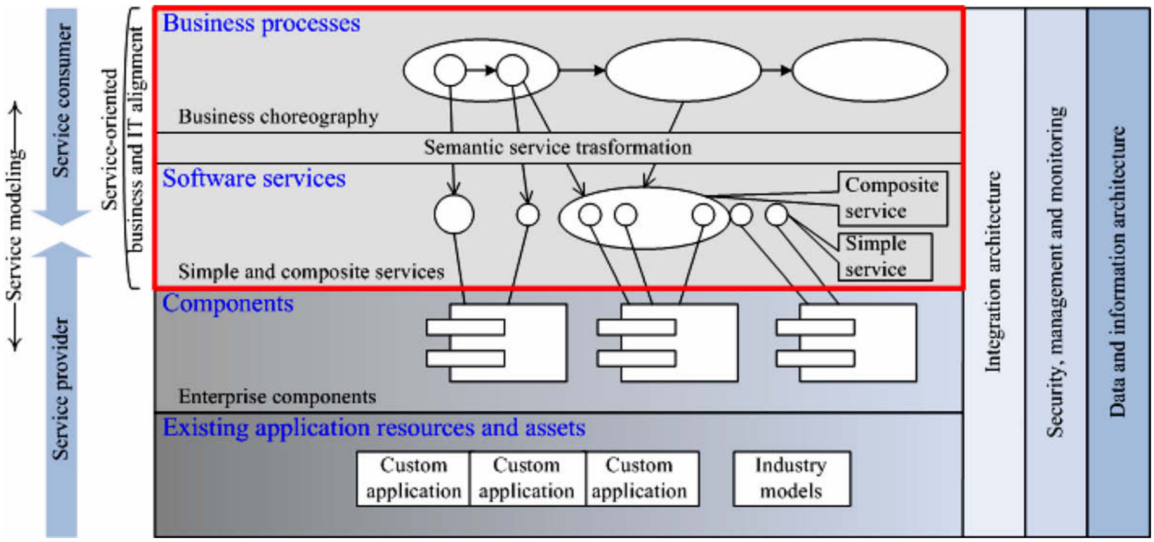

Fig. 2. Service-oriented architecture framework.

ing needs and wants, they may still be unable to react to these dynamic changes because of poorly architected IT infrastructures (Liftman et al., 2006; Zhao et al., 2007).

In addition, organizations need to learn how to act as *value networks* rather than *value chains*, and to place greater emphasis on service-oriented business and architecture models (Stabell and Fjeldstad, 1998). *Disaggregated value nets* can be realized through the creation of a *loosely coupled business and technical architecture* in which business and technical components provide reusable, dynamically discoverable, and complementary services. The successful realization of the new business and operational models require a holistic and integrated approach to IT, business processes, enterprise governance, organizational structure and culture. Transformation to the new model cannot be achieved through IT modernization alone.

Service-oriented architecture offers a practical and viable approach to explore services in relation to business needs (Zhao et al., 2007). In the IT context, it provides a framework for the commoditization of hardware (e.g., on-demand, utility computing, software-oriented infrastructure with virtualized resources, grid computing, cloud computing, and infrastructure service providers), software (e.g., software-as-service, software-oriented architecture, and application service providers), and business processes (e.g., the Information Technology Infrastructure Library, ITIL) (Davenport, 2005). Service orientation is becoming a primary IT architecture model that many organizations are utilizing to transform current silo architectures to more loosely coupled ones in support of flexible IT services (Erl, 2004).

To help explain how service orientation is used in enterprises, it is valuable to consider an architectural view of the building blocks that typically exist in an enterprise. Basically, this framework is based on using software components to create atomic and composite software services that are used to perform business processes with *business service choreographies* (Channabasavaiah et al., 2003).[2] (see Fig. 2.)

The building blocks range from the top-layer business and business process layer to mid-layer services, and extend to the bottom-layer components, and existing application resources and assets. The independent IT services may be comprised of one or many business transactions and functions, and can be accessed by business services without any knowledge of their underlying implementation details (Vitharana et al., 2007). These services are similar to reusable objects that represent repeatable business activities and tasks, and can be accessed through a network that enable the business to adapt environmental changes with agility (Peltz, 2003; Wilkes, 2006). Service-oriented architecture includes Web services but it is not limited to this. Instead, service-oriented is a *process-centric architecture* rather than a *program-centric IT architecture*. The former allows organizations to achieve the degree of IT flexibility that they are looking for (Leymann et al., 2002; Papazoglou and Georgakopoulos, 2003; Papazoglou and Heuvel, 2007). The most important developments taking place in the transformation to service-oriented architecture today involve *semantics*, *reuse* and *information*. We next discuss these in more detail.

3.1. Semantics

When approaching the ideas of a science of services from the viewpoint of business informatics, it becomes essential not only to address the challenges on the business level, but also to consider their alignment with how the requisite technical support is realized. (See Fig. 3 for a current conceptualization of these connections.)

Schelp and Winter, 2007 note that the proposal to move to a service-oriented architecture framework aims to address the issue of business and IT alignment, and enterprise architecture. On the business level, we observe several challenges in industry that impact the management of operations and the information requirements of decision-makers and stakeholders. For example, regulatory frameworks, compliance issues and increased global integration have affected our traditional views on business models, business processes and production schedules (Karagiannis et al., 1996; Karagiannis et al., 2007a). The underlying enterprise systems must meet these requirements and offer the necessary support (Davenport and Short, 1990).

By applying a more formal view, these requirements can be turned into machine-processable descriptions. These can be standardized formats using extensible markup languages (XML) or any other proprietary languages (Erl, 2004). The goal of this formalization is to enable the transition from domain-specific

[2] IBM defines *business service choreography* in terms of "the development and execution of business process flow logic, which is abstracted from applications. Inherent in this are rules which govern the sequencing and control of service invocations, which in turn support these business processes and workflows" (Nott, 2004).

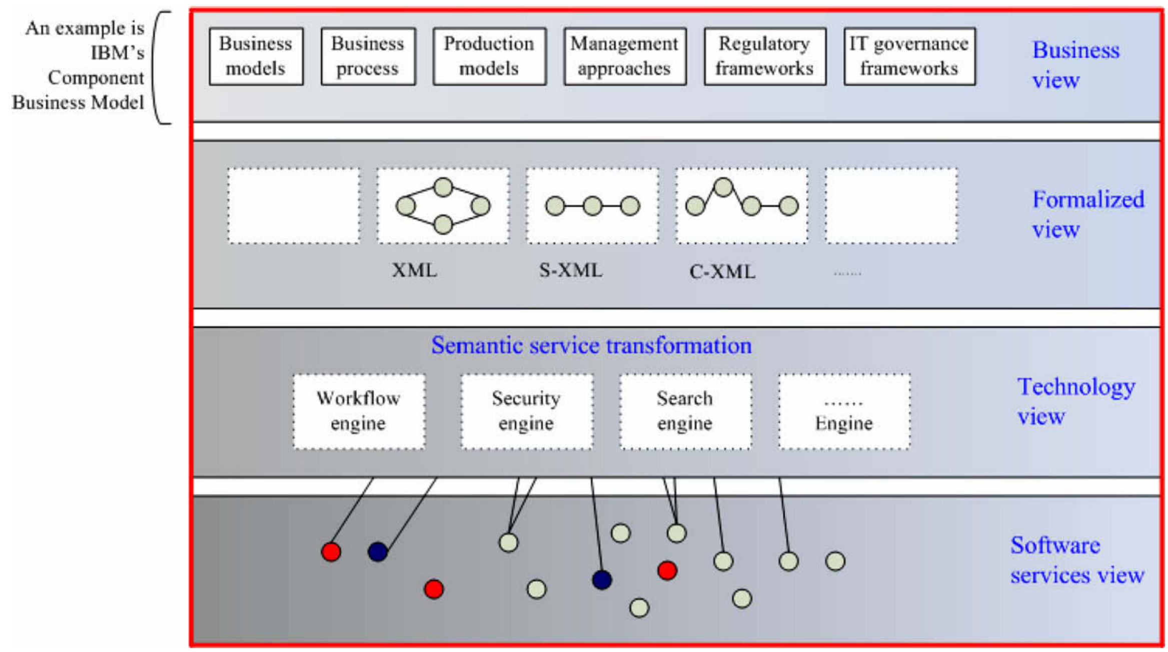

Fig. 3. Service-oriented business and IT alignment. *Note:* In the formalized view, the Extensible Markup Language (XML) is to facilitate the sharing of structured data across different information systems. C-XML is a protocol for communication of business documents between procurement applications, e-commerce hubs and suppliers. S-XML is another protocol for representing semi-structured data in human-readable textual form.

business views and implicit knowledge to explicit, formal specifications for IT alignment with model-driven business transformation and semantics (Lee, 2005).

Formal specifications usually are not directly executable, nor do they take into account IT services that can possibly provide opportunities for the reuse of existing functionality. As a result, a mapping between the formal view and the technology view needs to be made. This mapping is called a *semantic service transformation*, since it has to convey the semantics expressed in the formal view of the service-oriented business setting to the technology that enables the execution of the services (Karagiannis et al., 2007b). One approach to realize this transformation is through the application of the *workflow technology approach*.[3] With this approach, it becomes possible to convert domain-specific formalizations into machine-executable languages. To take into account accompanying factors, such as the business process context or security issues, additional information may have to be provided. The machine that executes these specifications can call upon Web-based services implementations (or Web services) to assemble the necessary functionality for what ever tasks or processes must be run (Leymann et al., 2002).

What is left open in the scenario depicted by Fig. 3 is how the business, formalized, technical and software service views – in other words, the different *horizontal layers* – can be integrated vertically and whether there is a coherent methodology to provide support to these layers (Karagiannis et al., 2007b; Kühn et al., 2001). In our view, this corresponds to three steps. First, the business models and their services have to be engineered as loosely coupled business process choreographies. Second, the corresponding IT support has to be designed and developed so that it will become a reusable IT service. Finally, the corporate resources and assets that are used have to be evaluated as virtual computing environments.

The formalization that we propose for these steps to enable service-oriented architecture is *meta-modeling* (IBM Research, 2004; Karagiannis et al., 2006; Zdun and Dustdar, 2007). (See Fig. 4.) A *modeling language* is composed of syntax, semantics and some notation that express information, knowledge or systems constructs in a structure that is defined by a set of rules. Meta-modeling conveys the idea that several of different modeling languages for business and technology can be abstracted to a common higher level that contains elements which are present in all underlying modeling languages (Schmidt, 2006; Uschold, 2003; Zhang et al., 2006). An example is a modeling language for business processes that can be abstracted to the level of process elements and the relationships between the process elements, including their attributes (Karagiannis et al., 1996; López-Sanz et al., 2007). The benefit derives from providing a coherent methodology for all of the underlying modeling languages. This opens up the possibility of applying generic algorithms and other analysis mechanisms so that transformations to a generic XML format can be further processed (Sen et al., 2007).

In contrast to other formalisms, Karagiannis et al., 2008 note that not all meta-modeling approaches enforce strict formalizations. Instead, the authors point out that it may describe a basic syntactic frame that consists of elements and relations. These can be further formalized according to the needs of the user. This enables a smooth transition from previously informal textual descriptions of the business process level to sufficiently formal specifications for execution at the technical and service levels. Further, this semantic continuum should be understandable by domain experts as well as technical experts. The visualization of these relationships plays a central role in the analysis and design process (Fill, 2006; Fill and Karagiannis, 2006). It helps to support

[3] [Dogac et al., 2003, p. 1, provide some useful definitions in support of this discussion. "In simplest terms, a *workfow* is the movement of documents and tasks through a business process. A *workfow system* provides for the automation of a business process, in whole or part, during which documents, information, or tasks are passed from one participant to another for [action], according to a set of rules. Another definition [states that] workfows are activities involving the coordinated execution of multiple tasks performed by different processing entities, mostly in distributed heterogeneous environments, which are very common [in] enterprises of even moderate complexity. These activities could be manual or automated, [or possibly] already-existing legacy programs."

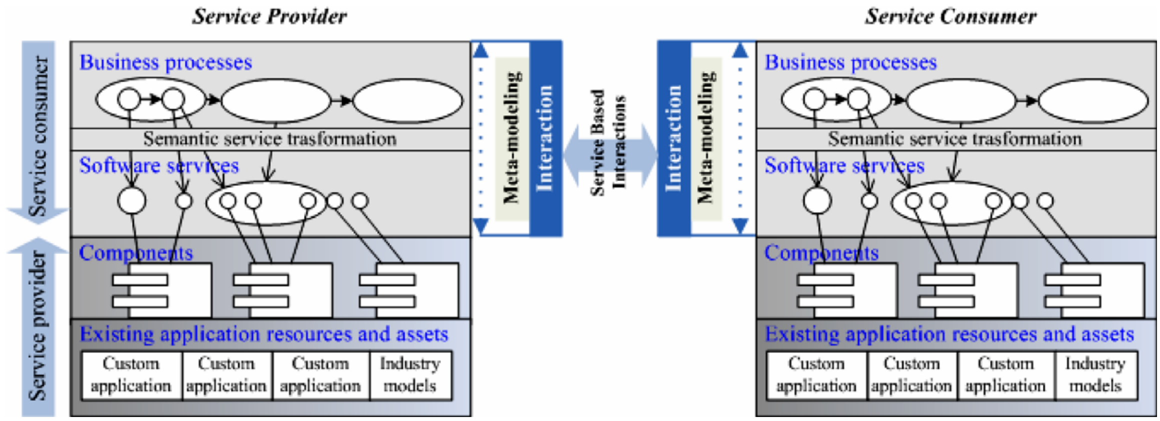

Fig. 4. Meta-modeling for service-oriented businesses in support of IT alignment.

analysts' and managers' understanding of the actors that are involved in the business process and service delivery at an abstract level.

The meta-modeling approach for transforming requirements on the business level to technical service descriptions has been successfully applied in a number of research and industry projects. Several large businesses in Germany, Austria, Spain, Switzerland and other European countries, as well as the United States have adopted this approach and have proven in practice that it creates appropriate benefits and enables them to achieve their goals (Berki, 2006; Vallespir et al., 2005). In parallel within a number of research projects funded by the European Union and national coffers, the theoretical foundations for the approach have been intensively researched in joint industry-academic projects (Cram, 1994; NESSI, 2008; Vallespir et al., 2005).

3.2. Reuse

One of the most practical and real challenges of designing and implementing a service-oriented architecture is *service identification* (Zhang et al., 2005). To identify useful, reusable, composable and discoverable business, technical and software services, it is appropriate to have a methodology to support examination of the business from multiple perspectives and to identify the basic building blocks of the enterprise. IBM Consulting Service's (IBM Consulting Services, 2008) *component business model methodology* is an example of such a methodology that can help an organization to identify its business building blocks (Ernest and Nisavic, 2007; Frankel, 2003; Lee and Ramchandani, 2008). The outputs that are obtained from the application of this methodology can be used to define business process level services that need to be supported by the service-oriented architecture. (See Fig. 5 for IBM's component business model.)

A second methodology that is of interest in this context is IBM's *service-oriented modeling and analysis* (SOMA). It provides a systematic way for identification, specification, and realization of business and technical services (Arsanjani et al., 2004).

3.3. Information

Many organizations have adopted service-oriented architecture to try to make it easier to reuse and share mission-critical information across different organizational business processes (Boo-Ghannam et al., 2008). The intention of doing this is to break down inappropriate information silos that tend to trap the information and increase transaction costs for information sharing, and to improve an organization's capacity to provide *trusted information services*. This makes them much more information-centric (Beyer et al., 2006). To achieve this objective, a hybrid architectural style is needed. This hybrid architecture brings together principles from *enterprise information architecture*, *event-driven architecture* and *service-oriented architecture*.

To understand this assertion, it is appropriate to consider the three types of architecture. Recall that *service-oriented architecture* is a technical architecture, business modeling approach, infrastructure conceptualization, and a means to integrate and view different units of automation within the enterprise. It provides a foundation to integrate data with applications and processes by creating loosely coupled components (Demirkan and Goul, 2006; Erl, 2005). It also enables delivery of information as a service by providing one-to-one communication between system components, consumer-based triggers, and standard specifications for information exchange. The service orientation of IT architecture and resources represents a paradigm shift in application modeling, development and IT management.

In contrast, an *enterprise information architecture*, which is based on the *Zachman Framework* (Zachman, 1987) and *The Open Group Architecture Framework* (TOGAF) (The Open Group, 2006), codifies standards for expressing the elements of an organization's information architecture, which defines the organizational logic for business processes and IT infrastructure that support the operations of an organization (Cook, 1996). It defines trusted sources of information, metadata, business data standards, data quality requirements, information integration need, and information aggregation techniques for the enterprise (Watson, 2000). Some of the key areas that need to be addressed that are related to enterprise information architecture include defining the data domains that are important to an organization, and how processes and technical metadata should be handled.

A third architecture is unique in that it is *event-driven*. An *event* within an organization, according to [Michaelson, 2006, p. 1, is "a notable thing that happens inside or outside your business [that] can trigger the invocation of one or many services. Those services may perform simple functions or entire business processes. A second interpretation of an event is that it can "signify a problem or impending problem, an opportunity, a threshold, or a deviation. Upon generation, the event is immediately disseminated to all interested parties (human or automated). The interested parties evaluate the event, and optimally take action. The event-driven action may include the invocation of a service, the triggering of a business process, and/or further information publication [or] syndication." So an event-driven architecture is one that captures the interactions between events and services, and is responsive to events that occur within an organization's relevant boundary (including its business processes, and its' interorganizational market and industry interfaces, and so on). Event-driven architecture

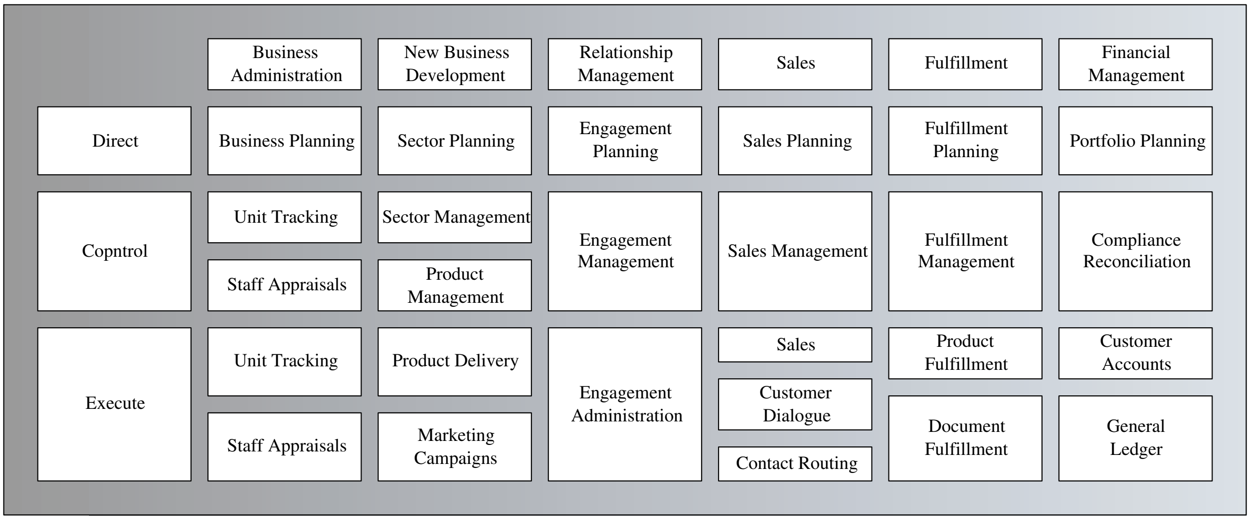

Fig. 5. IBM's component business model. *Source*: Adapted from Ernest and Nisavic, 2007.

provides a foundation for establishing asynchronous operations between data consumers and providers. Event-based triggers in different contexts include such things as a subscription sign-up, an application for a mortgage loan, or an inquiry to an email-based call center support desk. Natis, 2003 and Niblett and Graham, 2005 point out that event-driven architecture supports many-to-many communications between system components.

4. Characteristics of it services

As we mentioned earlier, service-oriented technology and management is all about delivering value added services to the customer. There are many different kinds and variations of services involving IT that can be offered, and there are also just as many different products. There are many different kinds and variations of services surrounding us, and they are provided for different reasons and when consumed produced different benefits for their users. Many services (e.g., maintenance of an automobile or a software application) started out as additional features related to an existing product or design project. Once they are packaged together, the product and additional feature benefits become more valuable. Over time, the service feature can become a differentiator for competitive advantage and profitability (Porter, 1998). We focus on the common characteristics and requirements of services for ultimate success.

According to past research, all services have common characteristics (e.g., Bitner and Brown, 2006; Fitzsimmons and Fitzsimmons, 2007; Hill et al., 2008; IBM Research, 2004; Looy et al., 1998; Vargo and Lusch, 2004). They includes knowledge-intensive professions (e.g., business consultant, physician, software engineer, legal council, financial advisor and university professor) to labor-intensive employment (e.g., in hospitality, personal services, IT and system services and transportation). These shared characteristics are:

Intangibility. This is a characteristic that differentiates products and services. Goods are produced in tangible, while services are not. As a consequence, there is no direct transfer of ownership that occurs when a service is performed, since nothing physical or tangible is exchanged.

Perishability. Perishable services cannot be used after certain time and cannot be stored for later use either, similar to perishable goods.

Customer contacts. The higher the customer contact, the higher the instantaneous demand for a service, and this will increase the immediate impacts on customers.

Simultaneity. Production and consumption, as we known from microeconomics, cannot be completely separated from each other. In the service-oriented technology and management paradigm, the consumer is no longer just someone who exhibits demand for products or services. Instead, the consumer is also a component in the production process. Thus the consumer becomes a co-creator of a service.

Heterogeneity. The degree of heterogeneity of a firm's customers is closely related to how much contact they have with the firm. Some demand highly refined services; other require only simple ones (Danaher, 1998). Service benefits typically are proportional to the interaction between the service provider and the customer.

Demand fluctuation over time. The variability of demand necessitates a higher degree of capacity management because the service offerings need to be produced concurrent with their consumption.

Customization. Value creation is typically not subject to standardized approaches. Instead, services are customized based on consumer needs and the competitive environment in which providers offer services and consumer purchase them.

Complexity. Simultaneity of production and consumption of services occur in highly complex service systems due to interaction of people, processes, technology and shared information.

We have been seeing a major change in IT innovations (Rai and Sambamurthy, 2006). Today's highly competitive, global economy, with high customer expectations, dynamically changing markets and technologies, and a fragmented regulatory environment increased needs for companies to be able to de-commoditize their assets and have transitioned from a focus on *goods* to a focus on *services* (Christensen and Raynor, 2003; Vargo and Lusch, 2004). The implications of this paradigm to technology and management are dramatic. (See Table 1.)

Just one element of this agenda, for example, from *transactions* to *relationships*, will have huge implications to management processes and personnel. Similarly, in technology, traditional *tightly coupled applications* are being transitioned to *loosely coupled solutions* that will affect virtually all organizations (Knorr, 2006). The service orientation for technology and management leads to a number of requirements for success.

Aligned business and IT strategies. With the service orientation, IT can become a key enabler of critical business processes rather than being just a cost center and provider of business support. The long-term strategy of an organization is what leads to changes in its IT infrastructure and its processes. So it is important to align

Table 1
Transition from past to present with the service orientation

From	To
Focus on goods	Focus on services
Cost reduction through manufacturing efficiency	Revenue expansion through services
Standardization	Customization
Mass marketing	One-on-one marketing
Transactions	Relationships
Function oriented	Coordination oriented
Limited ability to store and process data	Improved ability to store and process data
Limited information sharing capabilities	Improved information sharing capabilities
Application silos	Integrated solutions
Tightly coupled applications	Loosely coupled solutions
Contracts	Service-level agreements

the organization's business and IT strategies, as well as to provide a process for successfully implementing the service orientation (Brown and Carpenter, 2004; Zhao et al., 2007).

Organizational change. Firms across a number of different industries (e.g., manufacturing, IT, consumer goods, not-for-profits, etc.) have recognized the extent to which they can create value through the provision of desirable services to their customers. Yet most of these organizations operate under traditional business models that consider service but only as an afterthought or cost, and customers as passive recipients. For customers to participate in service design and delivery, changes will be needed in organizational roles and responsibilities, the day-to-day activities of individual staff, and organizational metrics and incentive mechanisms (Keel et al., 2007). This often entails a major culture change that will require time to effectively implement, and strong top-down and bottom-up organizational change support.

Skills. The skills required to accomplish this include expertise in component-based development, business analysis, business process reengineering and complex service orchestration (Cai et al., 2008; Krafzig et al., 2005). The evolving service-oriented technology infrastructure includes in-house and outsourced virtual resources, highly distributed data and information, loosely coupled components, customized solutions that will require complex integration and dissemination capabilities (O'Reilly, 2005). Demirkan et al., 2008 have recommended that a new role called *services conductor* needs to be defined. The services conductor should be responsible for orchestrating business service choreographies with virtual resources, reusable services and components. This role also must be effective in cross-disciplinary education with strong communication, negotiation, coordination, governance and technical skills.

Siloed business processes to business service choreographies. The service orientation requires cross-organizational management processes. Breaking siloed business processes into modular independent services that can be reused on-the-fly in loosely coupled dynamic business service choreographies is another important requirement (Demirkan and Goul, 2008). So is out-tasking this kind of work to external service providers for sourcing and technology services delivery. *Out-tasking* is about individual tasks or parts of the process sourcing strategy, and is much smaller in scale than traditional outsourcing (vom Brocke and Lindner, 2004). It is an outgrowth of e-commerce, outsourcing and process management, and it is enabled by service-oriented technologies (Keen and McDonald, 2000).

Complexity. IT-based service delivery systems are complex because they have to span business functions, enterprises and distance with in-house and outsourced systems. They also are difficult to plan, govern and adapt. The choreography of business services across-organizational boundaries can function properly and efficiently only if the services are effectively governed for compliance with quality of service and policy requirements (Papazoglou and Heuvel, 2007). In addition, the variability of service demand necessitates new ways to build dynamic capacity management and create meaningful service pricing structures (Cheng et al., 2003; Cheng and Demirkan, 2008; Demirkan et al., 2002).

Technology and collaboration. Service-oriented architectures have evolved as a new paradigm for enterprise systems development, supporting intra-enterprise and inter-enterprise collaboration through access to autonomous, implementation-independent interfaces to software and data services (Singh and Huhns, 2004). Service-oriented technology and management, and the prevailing global shift to a services-based economy, however, have together altered the delicate equilibrium between enterprise computing technology and the support it provides for product-generating business processes. The infrastructure for provisioning collaborative enterprise services is subject to market-driven changes in the component-based capabilities they offer, and the level of effectiveness they provide. This volatility has major implications for dynamic sourcing strategies. It forces management to acquire a deep understanding of how volatility affects interoperability within the horizontal and vertical layers of the service-oriented enterprise. IBM recommends evaluating the related issues using a methodology called *component business modeling* (Ernest and Nisavic, 2007). To source the necessary components, senior management needs to guide the firm to participate in the appropriate collaborative activities with other organizations that offer service-focused functionality for their business (Martin-Flatin et al., 2006). Establishing effective support monitoring and management in the service environment is essential for both business-to-consumer and business-to-business services (Kephart and Chess, 2003).

Service design and development. Service-oriented applications require a service-oriented engineering methodology (NESSI, 2008; Zdun and Dustdar, 2007). This will enable modeling the business environment, including key performance indicators for business goals and objectives. It also will enable the translation of the information that is codified into a workable service design. Several other capabilities of the methodology including identifying service patterns, implementing the service system, and testing for acceptable performance (Tsai et al., 2007). Periodic gap analysis also is required to verify that the business process and service mapping strategies effectively tie into the reference models (Papazoglou et al., 2007). Managing services also requires integrated and automated interorganizational relationships, with well-defined responsibilities for procurement, benchmarking, cost allocation and relationship maintenance (Goul et al., 2005). Service providers and consumers also need to establish efficient service production and value exchange in a way that emphasizes co-creation (Chung and Chao, 2007; Rai and Sambamurthy, 2006).

5. Economics and service-oriented technology and management

Whenever new ideas arise for the management of IS and technology, business processes, interorganizational relationships, and changing industry practices and structure, it is appropriate to seek new ways to understand and explain what is happening, and to assess how to make the new practices the best that they can be. Earlier, we asked: what new conceptual frameworks and theoretical perspectives are appropriate for studies of service-oriented technologies and management? What value would a science of services and business process modeling hold in store for the firms adopting them? What about the idea of building service-oriented infrastructure, and developing new services over time based on such infrastructure? We typically seek explanations that have a number of key characteristics. They must be obvious at one level, since practice demands solutions and ideas that are not overly or unnecessarily complex. They must also reach another more sophisticated level though, since the ideas will be called upon to sort out complex relationships. They also must be applicable to new situations that have not arisen before, and have the capability to be applied for somewhat different purposes by people with different backgrounds, knowledge and intentions. For example, they may include assessments of value as they pertain to process, design, infrastructure, architecture and management investments that are based on service-oriented perspectives.

For these purposes, *theoretical perspectives* have the potential to play an important role. Early papers on such varied topics as the pricing of IT services (Westland, 1992), and the evaluation of functionality risk in systems investments (Clemons, 1991) offered unique theoretical perspectives that suggest the later breadth and richness that would develop in the coverage of the literature. In the discussion that follows, we identify several theoretical perspectives from the body of knowledge of economics that are intended to provide a sampler of the rich interpretive knowledge that is available to guide industry practice in service-oriented technology and management. Since this is an issues-focused article, the idea here is <u>not</u> to apply theory to any particular setting or problem among those that have been discussed to this point. Instead, our goal is to showcase the thinking that makes the theoretical perspectives so valuable. The theoretical perspectives that we discuss include: (1) financial valuation of investments in technology involving infrastructure and service platforms, (2) financial economics analysis of risk management issues in IT services-related contracts and projects, (3) adoption of service-oriented technologies and management approaches as an economic diffusion phenomenon, and (4) ownership structure and incomplete contracts theory as it relates to joint corporate and interorganizational initiatives for service-oriented architecture and enterprise.

5.1. The business value of service-oriented technologies and management

One of the fundamental areas in which information systems and technology managers have needed assistance is *measuring the business value of information technology* – both in <u>prospective</u> "Should we invest?" and <u>retrospective</u> "What value have we appropriated from our investments?" terms. In the service-oriented technology and management context, financial valuation of investments in technology involving infrastructure and service platforms becomes especially important for the questions that arise which must be answered (Benaroch et al., 2007; Schwartz and Zozaya-Goristiza, 2003). But how should we conceptualize projects involving the associated new technological innovations and approaches? What do we need to do in order to ensure that the financial management thinking that we bring to the table is "smart" relative to the actual issues that need to be addressed? And what specific leading ideas will be helpful if they are applied properly?

Prospective valuation. Recent work related to investments in and the performance of IT infrastructure, and other large-scale applications that require an effective platform beneath them is likely to be especially helpful (e.g., Bardhan et al., 2004 on sequencing and timing of IT investment project portfolio elements Benaroch, 2002; Benaroch et al., 2006 on the use of real options to mitigate risk in IT). This is because some of the leading thinking in this area focuses on the notion of "Stage 1" and "Stage 2" investments (Dos Santos, 1991), where it is possible initially to build infrastructure, and then to later decide on when and how much additional financial commitment should be made to build on top of what has already been laid down for a platform (Benaroch et al., 2007). The key ideas that are leading this Stage 1 and Stage 2 thinking (without loss of generality if there are more follow-on stages of development) thinking relate to the*theory of investment under uncertainty* (Dixit and Pindyck, 1994; Dixit and Pindyck, 1995; Pindyck, 1991). A key observation of the theory is that, with the passage of time, many different kinds of uncertainties will be resolved through increasingly full but never complete information. As a result, future cost and benefit flows that are today only probabilistic outcomes will be able to be observed at some later date by senior managers, who should treat them as strategic options to be leveraged by the firm to create higher value (Majd and Pindyck, 1987; Trigeorgis, 1996). Obtaining different information – whenever it arrives – leads to a new capability to make a more effective and higher value decision. The underlying form of the decision tree for risk investment projects is changed in this kind of context (Smith and Nau, 1995).

This would seem to be the case for service-oriented technologies and management approaches. At the macro level, it remains to be seen, for example, even though the new technological approaches are interesting and appear to be valuable, how long it will actually take for organizations and industries to be able to leverage the new infrastructures, platforms, business process and component-based strategies to appropriate sufficient value to recoup the large costs that are involved. Under such circumstances, well-established knowledge about how to approach investing in strategic information technologies that change a firm's opportunity set and capabilities in the marketplace is critically important to create leverage to achieve high business value (Clemons, 1991; Clemons and Weber, 1990). Indeed, most observers would acknowledge that there is considerable value in waiting to invest in emerging technologies and emerging approaches (Majd and Pindyck, 1987; McDonald and Siegel, 1986). This is true in spite of their inherent capacity to push toward paradigm changes that ought to produce value in the long run – and so getting the timing right is both a consideration within a firm and also with respect to the "market games" it is forced to play with its competitors externally (Smit and Ankum, 1993).

Retrospective valuation. Similar concerns relative to retrospective assessments of business value are also worthwhile to discuss in the service-oriented technologies and management context. Strassmann, 1990, the one-time CIO of Xerox and the United States Department of Defense, has repeatedly reminded us that the business value of technology investments should be thought of in terms of the value of *managerial actions* and *management productivity*, rather than the specifics of the technologies, processes and technologies and systems that receive funding. This remains a useful perspective in the services context, and is further suggestive of the importance of managerial decisions that are made with respect to the funding and timing of rollout of service-oriented infrastructure. In addition though, it is important to remember that senior managers' decisions regarding services-oriented technologies and management approaches are founded on the manner in which the underlying business and organizational processes are transformed – especially the process of developing, acquiring and deploying systems involving IT services. Their perceptions of value are critical (Tallon et al., 2000).

From this point of view, the tenets of the business process approach (Mooney et al., 1995; Mukhopadhyay and Gadh, 1997; Mukhopadhyay and Kekre, 2002) for the retrospective assessment of service-oriented technology and management investments also seem to apply especially well. The business process approach to IT investment evaluation stresses the idea that measurement should occur at the *local level* at the relevant *locus of value* (Kauffman and Weill, 1989), where it is possible to gauge productivity and other process changes and benefits, as well as at a more *aggregate level* of firm in terms of economic and financial impacts on the organization (Davamanirajan et al., 2006). In addition, the process view recognizes that not all benefits will accrue immediately (Devaraj and Kohli, 2000); instead there will be lags of unknown duration from the time of investment to the time at which value begins to flow (Tallon et al., 2000). Current research is increasingly coming to understand how to gauge the duration of the lags though survey-based empirical research (Dong et al., 2006), and how to calibrate the nature of the effects through new methodological approaches (Goh et al., 2007).

5.2. Risk management of IT services

A second major stream of theory involves financial economics analysis of risk management issues in IT services-related contracts and projects (Benaroch et al., 2007; Clemons and Gu, 2003). Recent research in service-oriented technology and management science practice, where existing theoretical knowledge from financial risk management (Crouhy et al., 2000; Jorion, 2003) is waiting to be applied, has begun to provide a basis for a much stronger understanding of contractual issues in *service-level agreements* (SLAs) (Demirkan et al., 2005; Kenyon, 2005), risk-indemnifying approaches to outsourcing services (Aron et al., 2005; Clemons et al., 2004), and other kinds of software-as-a-service arrangements (Choudhary, 2007; Paleologo, 2004). With SLAs, for example, there is now the possibility for a vendor to optimize IT service contract prices by building models that involve the tradeoffs between investments to lock in resources that have risky costs over time to support the delivery of IT services. In this context, the issues that arise have to do with the volatility of the costs that the vendor faces, since the revenue stream typically is locked in contractually. The relationships can be modeled using well-known methods from financial economics for risk management, especially real option pricing and value-at-risk models.

In *real option pricing*, as we noted earlier, a vendor of IT services may wish to build in the right but not the obligation to stop the delivery of services, when the cost of doing such business becomes unprofitable. Option pricing methods typically emphasize the variance of the underlying costs of service delivery, and the extent to which they may become unfavorable to the vendor. With *value-at-risk* methods (Jorion, 2006; Kauffman and Sougstad, 2008), there is the opportunity to lock in a desirable payoff profile for an SLA, based on the interest of the vendor to achieve a margin of a given percentage with 95% or 97.5% likelihood, for example, in the face of migrating costs over time. Another application of value-at-risk thinking in the services management context comes with a desire on the vendor's part to identify the value-optimizing duration of an IT services contract (Kauffman and Sougstad, in press). This is an interesting approach, since it gives the vendor greater capacity to design contracts with value-maximizing service horizon lengths that are built in.

Still another application enables IT service vendors to treat circumstances in which the underlying resource cost dimensions for SLA service delivery are identified as being correlated to different degrees. Kauffman and Sougstad (Kauffman and Sougstad, 2008) have investigated how to design SLAs involving different proportions of dedicated and pooled labor in support of service delivery, with this in mind. The logic of their analysis is to identify how low correlations tend to be value-preserving to a greater extent than high correlations for SLA-required resources. The notions of volatility and correlation also span further, to a consideration of the relationships involved in multiple SLA contracts in a vendor's service portfolio (Demirkan et al., 2008). In the past few years, IT portfolio management (IBM Corporation, 2008a) has become recognized as a viable management approach for software development projects, product design efforts, and now IT services businesses. Similar to how investment bankers and investment managers think of the correlation and volatility of different financial instruments in investment management portfolios, so too can IT service vendor managers think about the extent to which different SLAs will tend to have correlated costs over time, or if they are natural "hedges" for one another, offsetting different risks in a changing environment. The most interesting thing that value-at-risk thinking delivers in the IT services context is the capability for the vendor to build a larger amount of service contract business on a given level of labor pool capacity or IT hardware and network capacity. This will be driven by an increasingly in-depth understanding of the future aggregate cost trajectory of operating an IT service portfolio on the part of IT service vendors.

5.3. Estimating diffusion

Many firms and organizations that operate in the environment of service-oriented technologies and management inevitably will face the question of how rapidly these new approaches will diffuse. Here too we see the opportunity for theoretical knowledge that has been developed in other contexts for emerging technologies to play an important role in providing foundational knowledge for how senior managers develop and adjust their expectations regarding IT-oriented service diffusion. A key insight is that the demand side of the marketplace for IT services is likely to express *rational expectations* (Muth, 1961). The idea of rationale expectations in technology diffusion has to do with the perceptions of market participants, and how their beliefs are conditioned by the beliefs of others (Au et al., 2008; Au and Kauffman, 2005).

At one extreme end, we see behavior that is suggestive of *information cascades*, with the result that many participants in the marketplace key off of one another in rapid fashion (Walden and Browne, 2008), leading demand to solutions that are becoming available in the market, but may not necessarily be the best in terms of economic welfare for those who acquire them. In more typical market settings, however, we will see a slow migration of beliefs – *consolidating beliefs*, if you will – that lead to increasing certainty on the part of the market as to what the concomitant demand will be for various kinds of IT services that vendors can provide from the supply side (Au and Kauffman, 2003). The idea that we are putting forward has been heard before, albeit in different terms and in different contexts: the *cheap talk* associated with information exchange among market participants, so that orderly exchanges and outcomes are possible (Farrell and Rabin, 1996).

The impact is that determining how diffusion for service-oriented technologies and management practices will likely be a matter of assessing how different emerging technologies, management approaches and vendor strategies will play out in the market, amidst a broader spectrum of considerations related to the evolution of IT standards (Kauffman and Li, 2005). Senior managers are faced with predicting outcomes in the marketplace associated with specific solutions, and identifying the risks that related to certain elements of the IT services bundles for which they must decide to contract. Some portions of the services will be relatively stable over time, for example, process outsourcing for call center services or off-site hot backup capabilities for a data processing center. But others can be expected to take on dramatically different forms of production and delivery, as the technological capabilities of IT services vendors change over time, for example, on-demand, grid computing, cloud computing capabilities (McKee et al., 2007; Nichols et al., 2006; Thanos et al., 2007), and software-as-a-service style offerings (Altmann et al., 2007; Choudhary, 2007). Being able to predict the outcomes in rational expectations terms will be helpful for all the parties involved: the supply-side vendors, IT services market intermediaries and demand-side clients.

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5.4. Organization, intermediation and ownership

A final area that will benefit from economic thinking is related to the market organization of IT services, and the manner in which ownership structures should be formed around interorganizational ventures that lead to new IT services platforms and joint capabilities.

Organization and vendor solutions. The reason that we are making this observation is that there appears to be ongoing consolidation in the marketplace for IT services, after an explosion of new providers hit the markets in the 1990s. Some of the changes in the current marketplace remind us of the changes that we saw in the provision of business-to-business electronic markets in the latter part of the 1990s and beyond the millennium to the crash of the dotcom firms in the digital economy. In particular, we saw "vanilla" market facilitation, transaction and settlement service providers which focused on mechanism design transform themselves into B2B software services providers, with a different basket of skills to offer. Dai and Kauffman, 2002 characterize these changes as bringing in new management and consulting services, but also providing the basis for technological adaptation in support of new e-market participation functionality on the buyer and supplier sides.

Although many organizations would like to find *single-vendor solutions*, the reality in today's market is that few vendors are able to meet the variety of needs in IT services for the largest corporations and government organizations. Nevertheless, Kauffman and Tsai, 2009 report on the emergence of an increasing number of single-vendor software and infrastructure solution adoptions having occurred during the past several years. Not all vendors are able to effectively deal with the range of technology and practice standards that must be met though. As a result, the marketplace not only has primary providers of these services, for example, the leading IT firms in the United States, the Indian offshore services providers, and smaller firms that operate in a variety of market niches. It also has other intermediaries, aggregators and consolidators of IT services that bring together brokered bundles of capabilities at prices that are attractive to firms that operate in the medium-size enterprise market. All of these things create transaction and agency costs, market frictions, and less than expected value for multi-vendor solution adopters unfortunately. Earlier theory informs us that firms that consume IT services will operate in much the same manner as firms that make contractual arrangements to procure other kinds of supplies from the market. They will "move to the middle", in the words of Clemons et al., 1993, eschewing the single-vendor solution because it "puts too many eggs in one basket". This will create risks for continuity in services and cause the IT service client firm to give away too much power to the vendor. By the same token, a *many-vendor solution* may also be untenable. Too many vendors mean too many contracts, and monitoring costs for service delivery that are likely to be too high too.

Intermediation. The *intermediation theory of the firm* (Spulber, 1999; Spulber, 2003) also should be helpful for senior managers who want to predict what will happen with the IT service industry's structure during the coming decade. According to this theory, *intermediaries* or middlemen will continue to exist in markets when the value that they create for transactions involving economic exchange delivers a margin over the costs incurred in market intermediation, and is greater than the value that can be appropriated when there is no intermediary (Chircu and Kauffman, 2000). Thus, where we see intermediated solutions in IT services emerging – especially consolidation of multiple firms' services under a single intermediary or aggregator – it is natural to evaluate whether the future equilibrium in the market can sustain the presence of these participants, or whether changing cost structures and demanded services will require a greater extent of vertical coordination. Another possibility is that fully integrated ownership is more suitable.

Ownership. The contrast between coordination and ownership relative to the creation of multi-firm service-oriented technologies and management capabilities stems from how value is best created, and the extent to which non-contractible investments influence risk and uncertainty in the appropriation of benefits (Bakos and Brynjolfsson, 1993; Bakos and Nault, 1997). The classic idea that created our contemporary capabilities to understand such settings is the *theory of incomplete contracts* (Hart and Moore, 1990). Business value for one firm in such contexts – for example, e-procurement platform investments – crucially depends on those of its business partners (Gebauer and Buxmann, 2000). When there is the possibility that full value cannot flow in spite of the actions of a participant who contributes a technology investment in a multi-firm IT services package, it typically is the case that we will observe *underinvestment* (Brynjolfsson, 1994). This is more likely to occur when a participant's investment is related to *systems implementation effort* – and so for IT services, *services implementation effort* – as opposed to *system asset acquisition investment* (Han et al., 2004; Han et al., 2008).

Recent research has made strong progress in various aspects of the ownership problem for systems and services that operate across different firms. Getting the ownership structure of an interorganizationally provided IT service "right" is not entirely about the underlying technologies that are shared. Instead, the participants in the development of such services need to have the proper incentives, so that they make value-maximizing choices on their own in a way that creates the greatest benefits in the partnership. As research over the years on incomplete contracts broadly suggests, e.g., (Bakos and Nault, 1997; Williamson, 1996), the *specificity of investment* in an IT services-related technology asset is a key determinant of how much value can be appropriated across multiple relationships and settings. When asset specificity is low, a participant's incentives to invest will be more limited, since there will be fewer ways that the IT services assets will be able to be mobilized so as to create value. A related consideration is what Han et al., 2008 have called the *relative importance* of a participant's investment. By this, we can view the IT services creation setting in terms of the relative contribution of a given participant's service-related investment to the overall value of the coalition-deployed IT service bundle.

This incomplete contract theory perspective puts the greatest emphasis on the potential impacts of the non-contractible aspects of the agreements that multiple cooperating IT service providers will reach. *Optimal ownership structure* identifies which of the service coalition participants should own the related service system assets, and a given ownership structure will be optimal when it produces the greatest value of any such ownership structure that can be chosen by the participants. In this kind of analysis, the starting point usually is the *first-best solution* in which a single firm, called the *integrated firm*, is the sole owner of the systems assets, and as a consequence, is able to make all of its own decisions relative to investment and the mobilization of the resulting capabilities. Relative importance and specificity of IT services-related investments often are the basis for determining whether one ownership structure is likely to produce greater value than another. Comparing other ownership structures to the first-best solution, it is natural to next evaluate whether a client or a vendor should be the natural owner of the service assets. When it is not optimal in terms of the value for a user to own the means of production for the IT services it consumes, the typical solution that the theory predicts is some form of outsourcing. When this is the case, the outsourcing vendor or a coalition of vendors will be central to ownership structure.

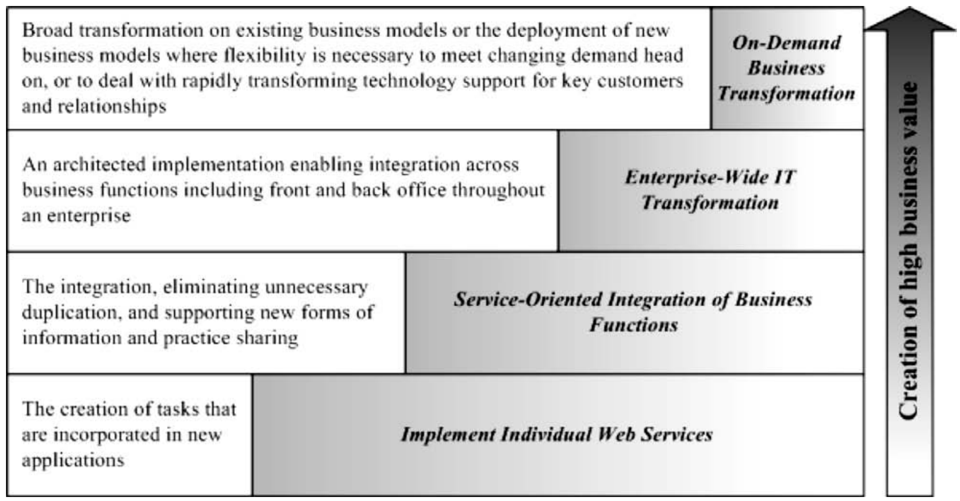

Fig. 6. Service-oriented architecture entry points.

5.5. Final thoughts

Although we have only touched on a few theoretical perspectives from economics and their applications in the context of service-oriented technologies and management, there are many more issues that can be treated with this domain of knowledge. Some of them include: the pricing of IT services; choices for whether to offer packaged software solutions or on-demand services; how to guide decision-making related to value-maximizing time for deployment and market release in projects that yield new IT service capabilities; and how to evaluate investments in strategic agility from the service-oriented perspective.

Economic theory becomes even more powerful in support of understanding how to make sense of emerging technologies, new practices, changing markets, value and payoffs, and risks and pitfalls when it is combined with other perspectives that shed light on what actually happens at ground level. For example, valuation (irrespective of how it is done) is often influenced by the misperceptions and cognitive biases of inexperienced or overly anchored decision-makers. Similarly, the economic forces that are present in markets are often inexorable, but sometimes the "deep pockets" of long-time entrenched competitors can hold up beneficial technological change. Senior management decision-makers also rarely express risk-neutral preferences when it comes to large-scale technology and process investments. In a word, one false move on a US$100 million-plus investment and you're out of your job. But very often too, risk-neutral preferences are what it takes to pursue an effective investment agenda. You do what you can to mitigate unnecessary risks, but a failure to approach risk as a parameter in decision-making with an understanding of the countervailing expected benefits and costs may lead to failed efforts to maximize value. Risk and reward go hand-in-hand, and so then must our understanding of how to get the most out of service-oriented technologies and management investments.

6. Conclusion

The complexities, costs and brittleness of current information architectures, infrastructures and distributed software have provided impetus to emerging conceptualizations of the service-oriented technology and management. The foundations for service-oriented technology and management can be found in current applications of service-oriented architecture, business process and workflow, computing resource virtualization, business semantics, service-level agreements, increasing standardization and other areas of applied research. Services computing can provide the agility many enterprises have been looking for, but only if they are considered as part of a more holistic enterprise perspective and agenda. Service orientation increases productivity, reduces development cycle time, provides an environment for reusability, flexibility and adaptability and multi-channel and multi-constituency support (Demirkan, 2008).

To put this discussion into proper perspective, we must clearly state that migrating to the new model and adopting the service orientation is a lengthy journey and its success and duration will depend on the business goals, executive support, enterprise governance, and technology and cultural constraints that are present in the organization (Demirkan and Goul, 2006). We expect each enterprise will have a different point of entry based on its business requirements. (See Fig. 6.)

At the lowest level of commitment is the interest to implement *individual Web services* that support the creation of tasks that are incorporated in new applications or will be deployed synchronously with new application. At a second level of commitment, and with a higher level of business value available if the implementation is done effectively, is the *service-oriented integration of business functions* within the enterprise. The potential for higher business value comes from the synergies that are available from carrying out the integration, eliminating unnecessary duplication, and supporting new forms of information and practice sharing.

Still another level higher in the potential for business value is *enterprise-wide IT transformation*. This requires an effort that is comprehensive, well-designed and carried out across numerous business functions within an organization. With transformation comes the opportunity not just for high-value from service system and information integration, but also with the capability to change the ways that business functions are carried out. This kind of IT-led transformation is as important for the front office as it is for the back office, and we expect that business value will be available from both sources. The final and best opportunity for the creation of high business value is the move to *on-demand business transformation*. This is an interesting prospect, especially in industry and enterprise contexts where flexibility is necessary to meet changing demand head on, or to deal with rapidly transforming technology support for key customers and relationships. We also expect that it will be the most difficult to transform potential value to realized value (Chircu and Kauffman, 2001; Davern and Kauffman, 2000), because the changes that will need to be made will be the most sweeping and complex. In addition, initially at least, the changes may be the most difficult for enterprise leaders to justify, since it will not be easy to identify where in an enterprise's value chain the bulk of the business value will actually arise. It is well-known in IS research that investments in architecture and infrastructure are the most difficult ones to justify, because no single or pair of stakeholders is able to justify the investment costs on their own. Instead, they must be justified on an enterprise-wide basis, with full awareness that it will be difficult to predict in advance of gaining experience with the new systems, information and approaches what will be the key shifts in the locus of IT value and who in the organization will be the beneficiaries (Kauffman and Weill, 1989). Fig. 6 depicts four different entry points for service adoption. The business value of adopting service-oriented technology and management increases as the enterprise expands the scope of service-oriented architecture from an IT and business unit scope to business processes at the enterprise level scope.

6.1. Contributions

The primary contribution of this article is to offer a variety of thoughts on service-oriented technology and management, as it is viewed by academic and industry experts who cover the diverse areas of computer science, business technology consulting, managerial economics and finance, IS and systems analysis and design, and marketing and supply chain management. One is based on current developments in the service paradigm in the business and technology economy. We also consider the emerging requirements and technology practices of modern organizations and enterprises that service-oriented technology and management seem to be able to address in new and useful ways. Another perspective relates to the new technological capabilities and methodologies associated with service systems, service-oriented architecture, business process choreographies, and transformed organizational structures beyond the silos of the past. A final perspective offered derives from current thinking in economics of services and services-oriented, with consideration given to issues including financial risk management, the emerging market for service-oriented software functionality, outsourcing and external acquisition, and the technology investment incentives and business value that is likely to emerge from adopting new service-oriented system solutions.

We have offered a full-spectrum survey of the literature that is mostly aimed at surfacing the coverage up to now of past research, and the opportunities for future work that will effectively pursue a jointly conceived academic-industry process of scientific, managerial and design science research. Although we have discussed theory and methods in various parts of this article, our intention was not to emphasize any particular theory or any particular method as a focal point for future work. Instead, our goal has been to inform the reader of where to begin to study the increasingly vast body of knowledge from industry and academia that is rising to match the interest of government agencies and organizations, and public and private enterprises in service-oriented technology and management.

To conclude, we will offer a number of managerial guidelines for service-oriented technology and management that have come into focus for us as we consider the confluence of our multiple perspectives. We should state we had no intention to present an exhaustive list, nor did we intend to offer findings that are especially based on theory or empirical results. Nevertheless, we offer up these insights with the idea of provoking additional discussion and follow-on research in service science in *Electronic Commerce Research and Applications*. Our insights should be relevant to other conferences and journals that reflect the interdisciplinary interests of practitioners and scholars who want to work at a new epicenter of knowledge creation with respect to information, technology, enterprise change, and business transformation.

6.2. Managerial guidelines and related research directions for practice

A number of early conclusions that we draw below are motivated by our individual industry and research experiences, as well as what we have been able to figure out from reading widely in this area, consulting with leading enterprises and technology innovators around the world, and interacting with one another. They include:

- **Managerial guideline 1:** *Service-oriented architecture should not be viewed as a standalone investment.*

This may seem obvious to the reader, but it is nevertheless important to point this out as a first principle for further discussion and consideration of the business value that can be produced by the service-oriented paradigm. The creation of service-oriented architecture must be part of a much more comprehensive enterprise application and information architecture that defines the collaboration of business unit architectures. A single enterprise view of existing and future service-oriented technology assets is required for an organization to minimize any tendency toward development redundancy that will inflate costs and create unnecessary inefficiencies. As a new managerial perspective, service-oriented technology and management emphasizes the importance of encouraging the sharing of IT, data sharing and technology-related business practice across different business units. As such, it is important to have an executive champion for service-oriented architecture for each business unit.

Related practice-oriented research directions. This first guideline prompts practice-oriented research to begin to focus on how to measure and assess value, how to gauge the investment synergies that exist between service-oriented architecture and the related business processes and software components, and how to deliver managerially relevant investment advice. The research that is necessary can leverage other work that has been done in the IS, economics and strategy disciplines, where similar issues have been discussed in somewhat different technology-based environments.

- **Managerial guideline 2:** *Service-oriented architecture governance is required fairly early in the cycle of commitment to the new service paradigm for the enterprise to be successful with it.*

To be successful with service-oriented architecture, similar to the creation of firm-wide financial, operational risk and intellectual property management system, a champion in the enterprise from among the ranks of senior managers is needed. In addition, it is appropriate to appoint middle to senior managers from the variety of affected business units as liaisons in the organization's firm-wide efforts with implementing service-oriented systems, architecture and management practices (Malinverno et al., 2006). We call for early efforts to formulate organizational governance in support of the service paradigm, similar to the call in the past several years for new governance approaches to the management of corporate information systems and infrastructures (Nolan and McFarlan, 2005; Nolan and McFarlan, 2005b; Weill and Ross, 2004). The best approach, in our view, may be to integrate services governance with the existing enterprise governance structure, so there is a clear understanding of how they will need to interoperate to achieve successful outcomes.

Related practice-oriented research directions. Research on the practice side of service-oriented architecture governance should focus on the development of the value of achieving effective governance practices, so it is possible for the firm to gauge whether it has orchestrated its efforts appropriately. Specific issues include: the composition of the governance body relative to the firm's business processes, organizational units, and operating capabilities; the extent to which governance for service-oriented system should be centralized or decentralized, or some hybrid mix of the two; and what can be identified as the contingency factors within an enterprise that make it appropriate to do different things to achieve high-value outcomes. This kind of work will require partnerships involving the enterprise, and its IT services vendors and consultants – as well as academic researchers who can bring new ideas to the others' attention.

- **Managerial guideline 3:** *Create a "service center of excellence" within the organization* (1) *to support organizational absorption of the new methods, practices and thinking,* (2) *to ensure that there is a repository for what is learned, and* (3) *to build a structure to transfer knowledge to the right people, business processes and business units to achieve a high level of success.*

In the face of the growing complexity of technologies, larger and more integrated organizations, intensifying cost and revenue generation pressures, and the need for organizational transformation due to commoditization and globalization, most organizations need more than *strategic vision*. They also need more than an operational plan for services. Effective analysis and design work to figure out how to transition to make services work within the enterprise probably will not be enough either. Our call for a *service center of excellence* makes sense in this context. We do not advocate a *defensive strategy*. Our view is that a service center of excellence can be a catalyst for an *offensive strategy* that aims to promote the optimal absorption of new practices, the archiving and sharing of highly valuable practice information, and the creation of leverage for enterprise-wide participation in the benefits from implementing the service paradigm.

Related practice-oriented research directions. This guideline suggests that practice-focused research should study the role and structure of service centers of excellence, and define the different archetypes that are likely to make them effective in different enterprise, market and technical environments. Also, little is known about how strategy should be redefined in the presence of service centers of excellence. For example, it may be that in their presence the absorptive capacity of the organization for service-oriented systems and projects increases dramatically. But it also may be the case that other co-specialized investments will need to be made such centers deliver on the value propositions that they offer.

- **Managerial guideline 4:** *Institutionalize the provision of corporate-level guidance about service-oriented technology and management for the business units, and implement metrics for adoption and performance to gauge progress and outcome value.*

In the years leading up to the 2000 millennium, many enterprises devoted a lot of time and effort to figuring out how to effectively implement shared services, common infrastructure, and integrated information management capabilities (Weill and Ross, 2004). The reason that this is a necessity for organizations is that the implementation of the service paradigm should be carried out with common capabilities and knowledge across the range of organizational units that are likely to benefit from it. This should be especially important for organizations whose operations are geographically far-flung, whose financial performance is not fully consolidated from day-to-day, whose operating environments and technology support requirements vary in different markets, and whose innovation efforts are subject to intellectual property and information loss risks. For example, a basic issue that many senior managers will have to deal with is how service-oriented technologies lead to new concerns in the area of information and computer security. As a result, we expect that there is an important role for services standards and shared design criteria for consistent and interoperable services that are properly protected and cost-effectively deployed.

Related practice-oriented research directions. To define this role though, practice-oriented research will need to study the service infrastructure-information security infrastructure links carefully. In the meantime, senior managers and their IT and business function staff members will need to begin to think of the *new service portfolio* that exists in the enterprise. There is already a lot of highly useful work on managing IT projects with a portfolio perspective, and managing the entirety of a firm's IT assets (Weill and Aral, 2006) and investment projects with portfolio and risk management methods (Bardhan et al., 2004; Kauffman and Sougstad, 2008; Kauffman and Sougstad, in press). Software and hardware metrics, organizational and business process metrics, and other kinds of evaluation approaches can be used to assess the trajectory of the enterprise's technology-based performance (Banker et al., 1993; Banker et al., 1994). Indeed, an excellent direction for practice-oriented research in the service-oriented technology and management area is to begin to explore what it will take to define a new "balanced scorecard" for this emerging area.

In addition to what we discussed earlier, most measures for service-oriented architecture implementation apply over the long-term. According to Pieterse, 2006, implementing *efficiency measures* (represented by output/input times 100%) should help organizations to gain better control and an understanding of the performance of their service-oriented architecture on a day-today operational level. Efficiency measures should be used to identify waste and deficient problem areas, and stabilize the operating environment. They are likely to be a valuable pursuit for practice-oriented research to take, similar to what we have seen over the years with software metrics. The output of a service is the value of information based on its contribution to the creation of customer value. Major inputs to the production of services involve communications bandwidth and processing power. These both can be readily evaluated in terms of their costs, which will permit an analyst to establish the required input–output relationship.

- **Managerial guideline 5:** *Leverage business unit architecture review councils to ensure compliance with service-oriented architecture standards.*

In most organizations, compliance with technology standards is all about optimizing business operations – including software, hardware and telecommunication services – so it is possible to engineer highly profitable performance. Open standards for service-oriented architecture are emerging rapidly, as adoption in the global economy of these new practices diffuses (Johnson et al., 2007). Value accrues from the implementation of technology standards because of common and widespread use, which builds installed base, drives operating costs down, and creates the possibility for a high level of service component reuse. As a result, enterprise and business unit architecture review councils have the potential to be instrumental in creating the basis for high-value intraorganizational and interorganizational network effects from the service-oriented systems choices that they make.

Related practice-oriented research directions. What remains to be seen though is how technology standards will shape up in the coming years related to service-oriented architectures. Practice-oriented research will support the implementation of this guideline well if common approaches and a shared understanding of the risks, adoption paths and technology evolution develop over time. This is never easy in a world of fast-paced technological change.

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The cliché that "it is necessary to change the tires while the car is still being driven" seems to apply here – with a catch. For some observers though, there may still not be any agreement that a car is the vehicle that is being driven, and that tires are what it rolls on. So practice-oriented research will be helpful if it can uncover those things that tend to bias the vendors', the managers' and the consultants' views of how things will change with time. Architecture review councils need to be examined more carefully to ensure that they are not a source of bias, instead of a solution that will flatten it.

- **Managerial guideline 6.** *Work to develop common and normalized business semantics to define business services consistently.*

One overriding lesson that the authors are able to put forward from our interaction is that the service orientation is about people, processes and technologies, and the ways that they engage with IT and systems to execute processes in a loosely coupled environment. It is also about the semantics that can be exploited to put people and machines together in new ways, including the rapidly developing commoditization of processes and services. It also is about organizational change, and new ways of thinking about "service providers" and their "customers."

Related practice-oriented research directions. There are other areas where we can offer similar advice, and where practice-oriented research will be appropriate. They include how to build effective partnerships among corporate, business unit, and development organizations. We also expect that success with the service orientation will be driven by a combination of: top-down CIO-led initiatives; middle-level business unit initiatives; and bottom-up efforts by the software and systems development organizations of the enterprise. Measuring the different performance levels associated with these choices is another challenging issue for practice-oriented research. It goes without saying that building an understanding of the service orientation in an enterprise is not just about getting senior management and middle management on the same page. Management will need to understand the importance of getting buy-in from systems designers, software developers, business and technical analysts, and infrastructure architects. Chances are that they will have a deep skill base in the paradigms of the past. So it will be important to set aside funding for *complementary investments*, for example, staff training, awareness-raising, other educational efforts with the new paradigm, and ongoing research that is practice-focused. Understanding the leverage that different complementary investments can provide with respect to service-oriented system initiatives is another area that practice-oriented research has an opportunity to address.

6.3. Pitfalls to avoid in the implementation of the service-oriented paradigm

In spite of the upside potential for achieving value and higher performance with the service-oriented paradigm, it is appropriate for us to point out the potential pitfalls that await unwary managers. Analysts at Gartner have suggested that there are two critical factors that are likely to determine the success of service-oriented architecture (Natis and Pessini, 2007; Pessini, 2007). They include the extent to which the organization achieves *agility* and how *costs to deliver new services* are controlled. The associated cost drivers include the impacts of changes to the service-oriented architecture that are prompted by strategy shifts, and how changes in business process and organizational structure can be accommodated through adjustment of the architecture. Some of the issues with agility and cost control can be taken care of by the organization over time. It is natural that learning occurs within the firm about how to adjust, refine and extract value from the services-oriented architecture. Effective management practice will require enterprises to understand the *value trajectory* for the flow of benefits leading to return on investment – and to learn how to effectively manage it.

Natis and Pessini (Natis and Pessini, 2007) offer their thoughts a dozen mistakes that enterprises make with the deployment of service-oriented technologies and management. The most important ones, in their view, include being caught up in the hype cycle of irrational exuberance, and implementing all the tools of the service-oriented paradigm without capturing the value in cost reduction and agility that are possible. When this happens, it is possible that managers will lose track of the importance of building an effective data model for the firm and mistakenly leave too many decisions in the hands of technical staff (Roch, 2007). This is critical because problems with organizational culture related to reluctance to use the IT services of other organizations are likely to arise. In addition, over-committing to too rapid adoption while there is still a lack of understanding in the organization is likely to be problematic.

Weill and Ross, 2004 have offered a number of *archetypes for IT governance* within the firm (including anarchy, business monarchy, federation, IT function-led and IT duopoly). Implementation of the service-oriented paradigm also needs to be thought through in a way that appreciates the differences with these archetypes. Obviously, *anarchy* or lack of organized governance in the enterprise is what it wishes to avoid with efforts to implement service-oriented technology and management practices. A *business monarchy*, in which operating executives of the enterprise are in charge of technology-related decisions, is also unlikely to be appropriate due to the need for people to appreciate the benefits associated with organization-wide infrastructure and standards. It is more likely, instead, that a blend of IT and senior operating managers, an *IT duopoly*, or a *federation of many business groups* will lead to a greater understanding of what kinds of coordination will be necessary to succeed. Excess centralization is likely to be ineffective, even with the *IT function-led* governance approach (Pessini, 2007). There will be a value trade-off for emphasizing technical perspectives on service-oriented systems and architecture, as opposed to perspectives that involve organizational culture and complementary assets, financial risk management and cost control, and usability and organizational ergonomics.

Wall, 2007 defines the different levels of IT governance somewhat differently than Weill and Ross, 2004. He points to the levels of governance as: *no governance, individual bargaining, advisory centralized, empowered centralized*, and *market-based centralized*. He mentions the idea of a *tragedy of the commons*, similar to the ecology parable of sheep over-grazing their meadow based on greedy shepherds (Hardin, 1968). With the service-oriented paradigm, it is likely that a small amount of slippage with compliance to standards here and insufficient design with the intention to support reuse there within the firm will eventually degrade its capability to create business value.

6.4. Limitations

In spite of the new perspectives that we offer, it is important for the reader to consider the limitations associated with our approach. Our analysis has focused on the adoption of the service-oriented in a general sense. We did not evaluate the relative benefits that might accrue from stratifying our analysis of the adoption of new practices on the basis of some different variables. For example, it may be possible that service-oriented architecture and technology management may yield a higher payoff in some settings rather than others. Some "splits" that come to mind include *IT-intensive* and *non-IT-intensive firm*s and industries, or *public versus private organizations – or government agencies and enterprises* for that matter. The overall goal of public organizations is to provide services to the public. By the same token, the goal of private organizations is

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to be profitable and return the greatest amount of wealth to shareholders. Different goals and the processes the organizations follow can play very important roles for success. We also do not know about the effects of the *rapidity of change of an organization's competitive environment*, nor do we know about the effects of the *depth of prior experience with external sourcing of systems*. Some of these splits would be worthwhile to look at with senior management and vendor case studies, as well as field study data and empirical analysis. No doubt there are other stratifiers that may be equally meaningful or even more so.

It also will be beneficial if future research examines the similarities, differences and relative degrees of commitment to the service paradigm for different types of organizations. Is the service orientation an all or none "hookup or lose out" proposition (Clemons and McFarlan, 1986)? What will be the dynamics in firm-to-firm cost competition terms? Will first movers with service-oriented architectures be more profitable firms in the long run? Since services-oriented technology and management will mature in the coming years, it will be important to examine when a given enterprise made its initial commitment to see what its unique "take" on the paradigm is – and how that has translated into service-oriented system functionality and return on investment.

The business environment and organizational culture of different enterprises also may play a big role in mitigating the success and realized business value of implementing service-oriented systems. An area for future inquiry will be to investigate what comes out in organizations that are more people-centric, or more customer-centric, or more process-centric, or more metrics-centric and so on. The nature of the firm's existing business activities may be a critical determinant of how well the service paradigm works. For example, financial service organizations are likely to be more mature service organizations than manufacturing companies that have been operating with an engineering and physical production culture. Organizational culture is also importantly founded on the capabilities of the people who lead them. What are the qualities of leaders who will champion this approach most successfully? Will they be finance-oriented or operations-oriented, as we saw was the case in the late 1990s and early 2000s with chief information officers? Or will there be room (and demand) for senior leaders with more multi-disciplinary backgrounds, and the capacity to more fully appreciate the changes that are needed to transform multiple business processes into tightly bound, highly effective operating companies, albeit with loosely coupled, highly flexible service-oriented systems support?

The service innovation process from consumer behavior and marketing literature needs to be analyzed in order to improve the technology innovation process. For example, service innovation is more about how to recover a failed service, but the production innovation is more about making money with new product.

7. Afterword

Electronic Commerce Research and Applications readers should recognize the importance of the new research agenda in services-oriented technology and management that we have proposed. It truly is about applications of new technologies, the problems that they create for practice, and some of the ideas that may be useful in addressing them. According to the National Academy of Engineering (National Academy of Engineering, 2003), there has been only very limited academic research to meet the needs of service businesses. Major challenges to services industries that should be taken up by universities include: (1) the adaptation and application of systems and industrial engineering concepts, methodologies, and quality-control processes to service functions and businesses; (2) the integration of technological research and social science, management, and policy research; and the (3) the education and training of engineering and science graduates who are prepared to deal with management, policy, and social issues. We heartily encourage e-commerce, computer science, IS, marketing, supply chain and management researchers to respond to this call, and develop multi-disciplinary research efforts that will begin to address these issues.

The issues discussed in this article can be found in the service orientation for people, including their roles, capabilities and characteristics. They also are present in organizations, in terms of their strategies, structure, culture and processes. They further figure in the technologies that are applicable, including the semantics, the applications, the architecture and the infrastructures of the modern enterprise. Various research paradigms and methods can be leveraged to investigate the challenging managerial and technical problems in service-oriented systems. Researchers can use quantitative, qualitative and experimental methods, case and field studies, and design science approaches. They can also work to build theory, test theory, extend theory and synthesize multiple theories as a means to improve our understanding. (For a more detailed consideration of the interdisciplinary perspectives and underlying theories, the interested reader should see Bardhan et al., 2008.)

For this research, we established a multi-disciplinary research team to provide different perspectives on service orientation, the new developments that surround its implementation, and the assessments that will be necessary to figure out if it is a good thing long-term for the enterprises that adopt it. Our team includes academicians and practitioners from three large organizations: IBM Corporation, Arizona State University and the University of Vienna. Our team has both business and cultural diversity, with multiple countries of origin represented, including Austria, Greece, Iran, Turkey and the United States. We formulated a large portion of this article through our participation in the 2007 International Conference on Electronic Commerce, but we have worked with one another since then to further refine our thoughts and perspectives. This enabled us to create a much more comprehensive assessment of where the service-oriented paradigm is headed with respect to new services and systems, transformed processes, and new organizational design thinking as we move toward 2009.

We hope that the interdisciplinary approach that we have adopted in our inquiry will lead other researchers to establish research teams that represent a breadth of relevant perspectives. We had no intention to present an exhaustive survey of research articles, nor did we intend to offer a comprehensive reading on the research agenda for service-oriented technology. We are in the process of extending the discussions from this panel into a survey paper that covers the IT services management from the computer science, economics, finance, IS, strategic management, marketing, and operations management. This will permit us to provide a fuller statement of the directions for theory-based research in this arena.

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