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ICIS 2007 Panel Report: Bridging Service Computing and Service Management: How MIS Contributes to Service Orientation

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Abstract:

Service computing has become the new frontier of enterprise computing in the continued pursuit of organizational agility. Many major corporations are in the midst of implementing significant initiatives to re-architect their IT through service computing to help meet fast changing business requirements. As a result, many new and interesting research questions arise in this area, spanning technical, organizational, and economic issues. Currently, there is a great need for a framework for aligning the issues of technology and management in the era of service computing. This paper outlines the key points presented at the International Conference on Information Systems 2007 panel on Bridging Service Computing and Service Management. The first few sections of the paper contain viewpoints of each panelist on why and how MIS should take leadership in this research area. Then, a joint perspective on bridging service computing and service management is presented.

Keywords: service computing, service management, service science, management, and engineering, SSME, enterprise agility

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I. INTRODUCTION

Service computing has become the centerpiece of enterprise IT infrastructure and includes Web services, service-oriented architectures, software as a service (SaaS), and application service providers (ASPs). Additionally, existing legacy applications and packaged applications are being re-factored and delivered as service-oriented business applications. Corporations are in the midst of implementing significant initiatives to re-architect their IT through service computing to help meet fast-changing business requirements. As a result, new and interesting research questions are arising in this area, spanning technical, organizational, and economic issues. This significant paradigm shift in application development and enterprise IT infrastructure has caused new thinking in the way business is managed and goes beyond the traditional scope of Service Management in Marketing to integrate multiple disciplines [Chesbrough and Spohrer 2006].

Currently, there is a great need for a unifying framework that can better bridge technology and management in the era of service computing [IBM Research 2004]. This is a major challenge since, traditionally, service computing is considered a technical research area, and service management is considered a managerial area. We believe there is an enormous opportunity for the MIS community to take a leadership role in this research direction.

The International Conference on Information Systems 2007 panel on Bridging Service Computing and Service Management gathered a number of leading scholars from academia and industry who are interested in exploring the various research and development issues in service computing and service management [Zhao et al. 2007b]. In particular, the panelists presented their positions and insights and discussed with the audience why and how MIS should take leadership in this research area and change the MIS curriculum to incorporate new service-oriented materials. The specific objectives of this panel include: (1) Discuss issues related to development of a unified framework for service computing and management; (2) Identify research issues dealing with challenges enterprises must confront in the era of service computing; and (3) Identify opportunities for curriculum changes in MIS in order to train future employees for service-oriented enterprises.

The remainder of the paper is organized as follows. In Section II, J. Leon Zhao, Professor and Interim Head of MIS at the University of Arizona, provides an overview of service computing and service management, discusses how they can be bridged via service orientation, and outlines the challenges facing the MIS community in both teaching and research. Then, Jim C. Spohrer, Director of Almaden Services Research at IBM, describes the scientific foundations of Service Science, Management, and Engineering (SSME) in the context of ongoing IBM research projects and presents IBM's efforts to establish SSME certificate programs at universities in many countries around the world in Section III. Mohan Tanniru, Dean of Business School at Oakland University, introduces the role of service-dominant logic on service computing and management in Section IV and Hemant K. Jain, Professor of MIS at the University of Wisconsin, Milwaukee, explains in Section V how service computing help better align IT with business and identifies major research issues in this new research area that need to be addressed. After that, Cheng Hsu, Professor of Decision Sciences and Engineering Systems at Rensselaer Polytechnic Institute, presents a new mode of production caused by the large-scale digital connection, discuss its impacts to existing disciplines such as computer science, industrial and systems engineering, and management, and advocates new doctoral programs for the new service-led economy. Section VII synthesizes the viewpoints to form a unified perspective on bridging service computing and service management. Section VIII concludes the paper by calling on the IS community to make more concerted efforts to advance the unified field of service computing and service management.

II. SERVICE ORIENTATION: OVERVIEW OF SERVICE COMPUTING AND SERVICE MANAGEMENT (J. LEON ZHAO)

We first define three key terms that are central to the panel: service computing; service management; and service orientation. Service computing refers to an emerging area of computing science and engineering that includes a collection of techniques such as service-oriented architectures, Web services, and the associated computational techniques such as security, service choreography and orchestration, and service composition. These service computing techniques are developed to facilitate information integration, enable business process automation, and increase the agility of enterprise information architectures. In many ways, service computing is the continuation of previous attempts in making computing more manageable via object-oriented programming, component-based software development, and model-based application development. Various other similar terms have been used to describe this area such as services computing, service engineering, software as a service, service-oriented computing, and service-centric computing [Zhao et al. 2007a]. We use "service computing" in this paper because of its simplicity and the parity with "service management."

Service management is a well-known term in marketing and operations management. The recent marketing literature has emphasized the service-centered view of marketing, which implies that marketing is a continuous series of social and economic processes while a firm is constantly striving to make better value propositions than its competitors [Vargo and Lusch 2004]. In operations management, service management is an important step in supply chain management that lies between the actual sales and the customers. According to Wikipedia, for the most innovative companies in service, post-sale services (maintenance, repair, and parts) often generate more than 50 percent of the profits (http://en.wikipedia.org/wiki/Service_management).

In this paper, we focus on service management within the information technology domain, leading to information technology service management. IT Service Management (ITSM) centers on the customer perspective of the business contribution of IT. ITSM is meant to provide a deliberate contrast to technology-centered approaches to IT management and business interaction. Under ITSM, providers of IT services must consider the quality of the services they provide and focus on the relationship with customers [van Bon, 2002].

Service orientation is a key concept that bridges service computing and service management although the former focuses on computational issues while the latter emphasizes issues related to business and customer relationships. Paul Andrew [2007] from Microsoft stated the four tenants of service orientation. First, service boundaries are explicit and interactions between services may have a cost and are formal, intentional and explicit. Second, services are autonomous and decentralized, which can evolve over time and be managed independently. Third, services share schemas and contracts, not classes. They can interact with schemas for structure and contracts for behavior for purposes of maintaining service integrity. The contracts and schemas can evolve over time. Fourth, service compatibility is determined based on policy, which separates interactions from interaction constraints. As such, capabilities are expressed in policies, and assertions are uniquely identified.

In service computing, components become services if the four tenants of service orientation hold true. Service orientation will lead to information systems that evolve over time by deploying and maintaining services with clearly described behaviors and interaction patterns. Since services can be governed via policies, service orientation makes it easier to manage IT services that evolve gracefully. As a result, IT service management can benefit from service computing because of the commonality in service orientation.

As in any discipline, bridging two or more fields of study can cause confusion. There is no exception in the case of service computing and service management. First, service has different meaning in different fields. A service in service computing refers to a computational unit that has certain computational functionality and behavior, whereas in service management, a service means an offering of certain human attention and a delivery of certain meaningful results in terms of product or information. Second, the subject of service administration is different. Service administration in service computing generally concerns a piece of software; in contrast, service administration in service management concerns a person or an organizational unit. Third, the people who care about services are also different. In service computing, the concerned people are mostly programmers and system developers; conversely, in service management, the concerned people are generally managers and users. These significant differences between service computing and service management in terms of concepts, subject of administration, and concerned personnel make the two areas difficult to bridge.

A natural question to ask is therefore why we should care about bridging service computing and service management. The answer to this question lies with the nature of MIS as a discipline between computing technology and business management. Traditionally, enterprise computing has been about dealing with objects, components, and systems; on the other hand, service management has been about dealing with relationships among business units and people. The two areas of study are clearly separated with distinct problems and subjects of study. However, with the introduction of service computing as the new paradigm of enterprise computing, the word "service" suddenly becomes overloaded and confusing, and enterprise computing becomes service computing. Consequently, there is an immediate need for conceptual clarity about service orientation in both computing and management.

So, how should we achieve conceptual clarity between service computing and service management? One way is to examine the idea of service orientation in the triangle of people, software, and organization as follows.

As shown in Figure 1, there can be altogether six types of service relationships in the world of services, where each arrow indicates a type of service relationships. It is clear from the diagram that service computing mainly deals with service relationships involving software components; on the other hand, service management mainly deals with service relationships involving people. Naturally, there is a relationship between service computing and service management since they both involve people and software. Figure 1 is very simple yet quite powerful since it clearly illustrates the potential confusion and similarity between service computing and service management. In addition, the diagram in Figure 1 shows that it is possible to unify some of the concepts found in service computing and service management, thus making communication between engineers and managers more effective. From the MIS education perspective, this unification can also make teaching and learning more efficient since it is possible to share some principles between service computing and service management.

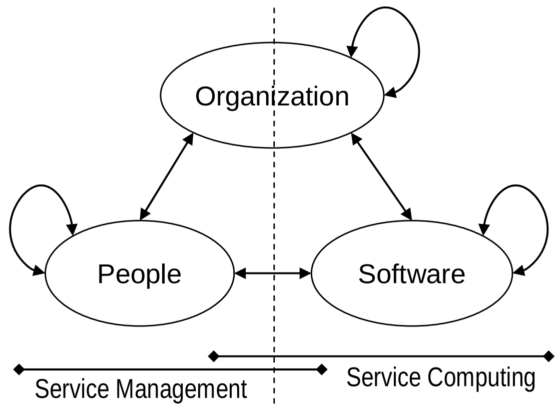

Figure 1. An Illustration of Service Orientation

In the near term, instructors of service computing courses should be able to learn from the literature in service management since the latter has been around for quite a long time. Conversely, the innovative techniques in service computing could also benefit service management in the e-business era where more and more services are delivered via the Internet. We are now ready to shed some light on the following questions posed in the panel synopsis [Zhao et al. 2007b]:

- Why should the MIS field pay attention to the ongoing service revolution in information technology and management? As aforementioned, information technology must become service-oriented, leading to service computing, and information management should learn from the traditional service management disciplines, resulting in new paradigms of IT service management.
- How could the MIS field contribute to the emerging service orientation? MIS is the home for interdisciplinary research and development, as the fundamental mission of MIS is to bridge computing and management. Service orientation is expected to cause major changes to the education of the next generation of IT managers, consequently impacting the MIS curriculum. MIS must lead this change.
- How can various disciplines in engineering and management work together to help the business world move forward in service orientation? This will come about as MIS works with other disciplines in engineering and management. Since service orientation also involves business process modeling and optimization with both internal and purchased services, many disciplines such as operations management, marketing, workflow management, and social network computing must work together to achieve the best service results.
- What might be the overall impact of achieving service orientation on the MIS field? It is difficult to predict what might ensue from adopting service orientation in MIS teaching and research. But, it is clear to the panel that the result of service orientation will lead to new courses and even new degree programs. According to Horn [2005], the business world needs a new generation of talents that can easily move between engineering and management for the optimization of business strategies and operations in the new world of service orientation.

III. SERVICE RESEARCH TO IMPROVE/INNOVATE SERVICE SYSTEMS (JIM C. SPOHRER)

Innovation is a word that gets used a lot and defined in many ways. No definition of innovation can be truly operational without measurement. How can innovation be measured? In this section, an answer to this question is proposed in the context of the emerging *service systems worldview*. The answer seeks to be precise rather than vague. By being precise, the definition leaves out a lot of what people mean by commonsense notions of "innovation" and thus provides fertile ground for future debate and elaboration.

The service systems worldview, simply stated, is a view that the world is made up of populations of *service systems*, interacting via *value propositions* leading to either value co-creation or disputes [Spohrer, Vargo, Maglio, and Caswell 2008]. In this worldview, innovation is a function of the value of new knowledge over time, as that new knowledge is applied ("put to work") in populations of interacting service systems. The measure of innovation, simply stated, is the cumulative value of applied knowledge. Populations of interacting service systems can be viewed as performing knowledge value computing [Spohrer, Maglio, Bailey, and Gruhl 2007]. A great innovation starts with new knowledge, that is applied, and then leads to the creation of a lot of value quickly; then continues to deliver value and be a part of future service system value chains (*service networks*), far into the foreseeable future.

This worldview helps to make clear that the knowledge economy (discover knowledge) and the service economy (apply knowledge to create value) are just two sides of the same coin (perhaps called the innovation economy). As the service economy evolves, we get better at both applying new knowledge (ever more rapidly) to create more value quickly (e.g., franchise business model and digitally connected service offerings, both can scale up rapidly) as well as understanding which specific new knowledge (research agenda) might create the greatest value when it is applied.

Service Science, Management, and Engineering (SSME) is basically the realization that knowledge creation (science), knowledge application in a well-specified, cost-effective instance (engineering), and ongoing knowledge application to create and capture value as part of a business model or value proposition (management) are intimately linked in a meta-service-system value chain. The outlines of a "Moore's Law of Service System Investment" can start to be seen [Baumol 2002].

So what are service systems, and what is the linkage to MIS? First consider Checkland and Howell [1998/2006], who describe information systems as a type of "soft system" and further elaborate this notion:

> A consequence of the nature of the process, in which intentions are formed and purposeful action is undertaken by people who are supported by information, is that "information system" has to be seen as a service system: one which serves those taking the action. Hence its form and content will have to be dictated by how the action supported is conceptualized. This means that "information systems development" must start by carefully defining the action to be served, in its specific context, and using that definition to decide what information is needed and how technology will help provide it. (This reverses what often happens today in organizations—with poor results—which then lead to spectacular headlines about 'another IT failure'.) [Pp. 219-220]

The key point is that information system has to be seen as a service system, if for no other reason than understanding where disputes arise between parties who do not see value being created as intended when a new information system is deployed. Next, we consider Alter [2002]:

> "An information system is a work system whose business process is devoted to capturing, transmitting, storing, retrieving, manipulating, and displaying information, thereby supporting other work systems." [Pg. 6]; "A system is a set of interacting components that operate together to accomplish a purpose." [Pg. 8]; "A system's purpose is the reason for its existence and the reference point for measuring its success." [Pg. 9]; "A business process is a related group of steps or activities in which people use information and other resources to create value for internal or external customers. [Pg. 10].

And more recently, Alter [2006]:

> "I wrote this book because I believe that many applications of IT would be more successful if business and IT professionals had an organized but non-technical approach for communicating about how current work systems operate and how they can be improved with or without changing technology." [Pg. v]; "Basic Ideas. This book's central concept is the work system. All businesses and organizations consist of multiple work systems that perform essential functions such as hiring employees, producing products, finding customers, selling to customers, providing customer service, and planning for the future." [Pg. vi]; "A work system is a system in which human participants and/or machines perform work using information, technology, and other resources to produce products and/or services for internal or external customers. Businesses operate through work systems." [Pg. 12].

Even more recently, Alter [2008] has specified precisely the relationship between work systems and service systems, noting that service systems are a type of work system. These authors make the connection between MIS and specific types of systems, not a simple notion of managing information systems per se, but in both cases, lurking just below the surface, is the notion of customer-provider interactions and value co-creation. Service systems interact (normatively) with the purpose of value co-creation. Every service system is both a provider and receiver of service and is connected by value propositions to other services systems (linked into longer service networks or value chains).

Hopefully, what is coming into focus is that information systems embedded in the real world, the ones that need real people to use them and manage their design and evolution, are a lot more than just *information* systems. They are in fact *complex adaptive systems*, and if we want to understand how to innovate service systems, to create value, then we should reflect on this just a bit.

At this point, we will take a step back and ask: "What is science?" We have said that "science creates knowledge" — but of course, this is a simplification of "*People who are scientists*, and study phenomena using the scientific method, *create knowledge* that through peer reviewed publications can add to the body of scientific knowledge within their discipline, and provide models or theories that progress by clearly demonstrating better descriptions, explanations, predictions, or ability to control real world phenomena." We recognize a science both by the phenomena studied (physical systems, chemical systems, biological systems, computing systems, economic systems, social systems, and so on) as well as its methods and levels of mathematical and logical rigor (quantitative, qualitative, statistical significance, proofs, and so on). We also recognize a science by the data it compiles and the success of its models or theories.

In the early stages of the formation of a new science, a community must reach a reasonable consensus on a few fundamental concepts and questions. Typically, the concepts deal with the types of entities, interactions, and outcomes under study, and the questions relate to either identifying the boundaries and limits of the phenomena, creating a taxonomy of the entities, interactions, and outcomes that give rise to the phenomena, or determining causal patterns that can be used to make predictions about specific outcomes given a set of initial conditions or at least statistics related to population dynamics when parameters of the system are varied (dependent and independent variables).

In the case of service science, a reasonable consensus [IfM and IBM 2007] is forming that the entities under study are service systems, the interactions are guided by alternative value propositions, and the outcomes of the interactions are either value co-creation or disputes [Spohrer, Vargo, Maglio, and Caswell 2008]. The most general form of the core question is how to invest in the creation and application of knowledge (independent variables) to create the most new value or innovation (dependent variable). The specific question can take many forms ranging from seeking to understand the learning curves associated with service systems versus manufactured product systems [Argote 2006] or the optimal ratio of investment in new knowledge creation (exploration) versus knowledge application (exploitation) [March 2000].

At IBM Research, we have developed tools to model service systems (Component Business Modeling (CBM) tool) and connect those business architecture models to Service Oriented Architecture (SOA)-based technology architectures of the enterprise. Furthermore, we mine the structured and unstructured information associated with those business components, and their KPIs (Key Performance Indicators), for business insights that can increase the value created by activities within the components—ranging from patent analytics to corporate brand reputation management. We have also been applying Intelligent Document Gateway (IDG) capabilities to innovate processes and apply standard business rules and business logic to processes within the components. Virtual world technology is being used to address improving the skills of people in these service systems, by rehearsing in a safe environment the types of performance that lead to best results. We've been applying these and other tools in conjunction with call centers, data centers, and other IT-enabled service systems.

Underlying all of these research efforts is the foundational work in developing a deep theory of service systems, and working with universities around the world to establish SSME certificates [see http://www.ibm.com/university/ssme]. Recently, the America COMPETES Act called out "The Study of Service Science" (Section 1005) as an important area for future investigation. *US News and World Report* has also reported that SSME is a smart choice for future engineering students along with environmental engineering. A number of universities have also begun work on service science labs that will allow students from multiple disciplines to work together to improve real world, virtual world, and simulated world service systems. All of these efforts are creating more "T-shaped professionals," who are both deep in a home discipline, but also have the breadth of experience to be adaptive innovators in an increasingly dynamic, and innovation-driven, knowledge-intensive, global service economy.

IV. DEFINING SERVICE TO SUPPORT SERVICE DOMINANT LOGIC (MOHAN TANNIRU)

According to Service-Dominant (S-D) logic, service—a process defined as the use of one's resources or competences for the benefit of another entity [Vargo and Lusch 2004] —is the basis of economic activity, and the firm is "co-creating value" to the customer with the product use. S-D logic can be summarized as follows:

- Identify or develop core competences, the fundamental knowledge and skills of an economic entity that represent potential competitive advantage.
- Identify other entities (potential customers) that could benefit from these competences.
- Cultivate relationships that involve the customers in developing customized, competitively compelling value propositions to meet specific needs.
- Gauge marketplace feedback by analyzing financial performance from exchange, to learn how to improve the firm's offering to customers and improve firm performance.

While P-D (product or goods-dominant) logic creates a product with a customer in-mind, S-D logic calls upon a firm to make its internal operations and external relationships with partners sufficiently "agile" to react to value propositions co-created by the firm and the consumer. Some of these value propositions are supported with the production and delivery of products.

Application development work in MIS has used the spirit of the S-D logic to a certain degree. Within software development [Boehm and Turner 2002], the traditional systems development life cycle (SDLC) has relied on user requirements to produce the "software product" and brought new versions of the software as requirements changed over time. The spiral approach is used when a developer has to work with the decision maker rapidly, with each new version resulting from constant learning occurring between the user and the developer on how effective the system is in support of decision making. DSS research [Carlsson and Turban 2002; and Shim et al. 2002] has looked at ways to modularize decision processes, and used model, data, interface and knowledge components to support such evolution. Even in the development of enterprise applications, the focus recently has been in the use of the evolutionary approach to develop software by using modular and reusable components that can be parameterized, customized and combined, so systems can adapt to requirement changes quickly [Vitharana, et al. 2003]. Web-based technologies today such as Web services and service-oriented architecture are enabling process components to become easily accessible via the Internet and integrated with others to support organizational workflows [Zhao et al. 2007a]. This again reflects the IT community's desire to support implicitly the flexibility needed in the application development environment and support the co-creation of value. In summary, *software application development methodologies have used decomposition of a complex system into components, which can be calibrated and integrated on demand to develop information products that can meet the changing requirements of the users over the last three decades*. Can the same approach be used to support the value co-creation in S-D logic?

When co-creation of value concept is extended beyond an information product to a tangible product (e.g., automobile, toy) or a service product (e.g., insurance/investment product), the value network incorporates many physical and information products and spans many organizations, especially when the product has a long life. For example, in an automotive supply chain or value network, each node in the network is a firm representing a dyadic relationship between a service agent (e.g., dealer/automotive firm) and service recipient (e.g., automotive buyer). Many individual processes are embedded in this relationship (e.g., customer and firm) and are supported by *infomediaries* (those who provide information such as customer reviews, product comparisons, and so on) or intermediaries (those who ship products, assemble components, and so on). So, when an automotive firm (OEM) is to co-create value with a customer, many of the nodes (or firms) in the value network have to act as service components and react quickly to changes in the OEM's co-creation of value. In addition, many of the OEM's internal processes have to be structured as service components for adaptability to changing value propositions. Also, given that many of these service components are physical processes, they have to be seamlessly integrated with information products.

If an automotive firm with such a complex value network is to support S-D logic, it has to continually evaluate that part of the network impacted by changing value propositions (scoping the sub-network), arrive at options to identify serviceable components that can be architected to address the value propositions, execute these using the appropriate mix of technology, processes and people (internal and external), and use feedback mechanisms to continually refine this network based on performance. For example, when value propositions changes (e.g., color and style of interior design of vehicles ordered, delivery options, order fulfillment due to interruptions in the supply chain, recall strategies when design flaws are detected during product use, and so on), different parts of the OEM's value network have to react with agility. So, in order to support agility of such a value network, we need to

- Define service components (both internal and external) around core competencies the firm uses to support its co-value creation process,
- Develop the architecture (Web X.0 and service computing technologies) needed to ensure that appropriate *service components* are *selected, integrated and interfaced (*as a "service system") to support a value proposition,

- Establish metrics to evaluate the effectiveness of the service system in meeting the value proposition, and propagate appropriate feedback to those components that need change, and
- Set up strategies to radically alter both service components and their architecture when the learning generated by monitoring the performance of the service system calls for shifts in value propositions.

In summary, the calibration and integration of service components on-demand (i.e., the scoping and execution of a subnetwork) to address changing value propositions will continually be challenging. This is going to become even more pronounced as Web technologies continue to evolve [Getting 2007] from those which support communication (Web1.0) to those that support interaction (Web 2.0) and eventually to those that are willing to take automatic action (Web 3:0). Any broader analysis, design and adaptation of service components within a value network in support of S-D logic, thus, calls for thought leadership among scholars and practitioners across multiple disciplines such as operations research, engineering systems and management control, information technology and MIS, as well as marketing and human resource management.

V. BRIDGING THE GAP BETWEEN IT AND BUSINESS (HEMANT K. JAIN)

The alignment of IT and business has been a major issue of concern for practice and academics alike. In spite of significant efforts, the gap between IT and business remains [Liftman et al. 2006]. One of the fundamental reasons for this is rooted in the architecture of IT infrastructure and systems along with the approaches for analysis, design and development of application systems. The primary focus in developing IT architecture and applications has been the ability and ease of development, management, maintenance, and efficiency. For example, one of the major strong points of relational databases and normalization techniques has been its ability to manage consistent data by reducing redundancy. However, this type of representation of data may not be very natural to the business and may not facilitate access and manipulation. The developments in data warehouse design such as dimensional modeling and star schema is a good example where business users find these types of representation more natural and easier to manipulate than the third normal form relational tables. Similarly, object-oriented modeling and design is very useful for modeling and programming business applications. However, studies have found that users think more in terms of processes and find approaches like data flow diagrams more understandable [Agarwal et al. 1999].

Recently, with the development and widespread acceptance of Web services standards, Service Oriented Architecture (SOA) is becoming the mainstream IT architecture that many organizations are leveraging to transform their enterprise infrastructures to achieve higher level of agility [Erl 2004]. SOA is “an application architecture within which all functions are defined as independent services with well-defined invokable interfaces which can be called in defined sequences to form business processes.” [Channabasavaiah et al. 2003]. The independent services may include purely business functions, business transactions composed of lower-level functions, or system service functions and can be accessed without any knowledge of their underlying implementation details [Vitharana et al. 2007]. These services represent repeatable business tasks and can be accessed on demand via standard interfaces over a network, enabling the business to quickly adapt to changing conditions and requirements [Peltz 2003]. SOA is an architectural style, which is more than any particular set of technologies, such as Web services. It promotes process-centric architecture as opposed to the existing program-centric architecture of IT systems [Leymann et al. 2002; Zhao and Cheng 2005]. SOA allows each of the constituent services to be independently developed, managed and maintained, thus creating a supply chain of IT services that bring significant flexibility and efficiencies to IT systems. Thus, SOA represents a major paradigm shift in IT application modeling, development, and management.

We argue that the service orientation is much more natural to the business and can play a major role in bridging the gap between IT and business. By allowing the underlying implementation details to be encapsulated in the services, service orientation facilitates understanding and communication between IT and business. As indicated by previous research, by focusing on the business processes, business can better understand and manipulate the system models and designs that are process focused. Service oriented architecture, with its focus on process management and workflow, provides a much better fit with the businesses.

Even though significant progress has been made in the development of underlying technology, concepts, and standards, the widespread adoption and success of SOA will require addressing significant issues that lie at the interface of technology and business. Thus, major gaps in research exist that are not being addressed by either the computer science community or marketing and the operations management community. We argue that MIS is uniquely positioned to address these issues. Based on my ongoing discussions with researchers in computer science (through my involvement in IEEE Services community) focusing on Web services, there is a keen desire on their part to collaborate with business and especially the IS research community to address these interface issues. Successful collaboration between these two communities is essential to derive business value from the SOA technology and to prevent it from becoming another fad that disappears in few years.

Opportunities for Research

Here we outline some of the open research issues the MIS community may consider addressing. This list is not intended to be comprehensive or complete.

Architecting Event Driven Service Oriented Organization

Time may well be the single most important factor affecting enterprises in the 21st century. Decreasing cost of sensors, including RFID, bar code and GPS-based devices and networks have made it practical to acquire and process real time information from all parts of the organization. However, organizational structures, processes, and systems need to be aligned to take advantage of this [Roberts 2004].

Real-time enterprises are characterized by zero latency in decision making, enabled by massively distributed decision making, by attaching intelligent cyber devices (connected through the Internet) to physical objects. These enterprises have *situational awareness*, which enables them to quickly *sense-and-respond* to opportunities and threats, and *track-and-trace* important items. Architecting a real-time enterprise requires research addressing significant issues related to organizational structure, design of business processes, automation of routine processes, and providing visibility into the processes, which allow mangers to focus on exceptional situations requiring manual intervention, understand the reasons for deviation, and help decide on the appropriate plan for action. Technical issues related to architecture and integration using technologies like SOA, Event Driven Architecture (EDA), Business Intelligence (BI), and Business Activity Modeling (BAM) need to be addressed.

Service Granularity

Services symbolize a way to offer highly interoperable chunks of information system capabilities at various levels of granularity. As Broy et al. [2007, p. 1] highlight, "they emphasize functionality (services), rather than structural entities (components) as the basic building block for system composition." Deciding on the appropriate level of granularity of the service is a complex problem. It impacts the costs, customizability and agility of end applications and potential for its reuse in multiple scenarios. Artus [2007] considers the granularity to mean the number of operations a service provides. Future research could examine the optimal level of granularity, as too coarsely granular services are less likely to be reused because of possible "excess baggage" they carry, while too finely granular services carry unwanted overhead in their discovery and utilization [Vitharana et al. 2007].

In many cases, services are built piecemeal based on specific technical and business needs. Nonetheless, generating a set of services for a particular domain such as the human resource function or auto insurance could prove most useful. From a research perspective, the challenge is to embody the domain knowledge and corresponding functionalities in loosely coupled services that then could be used to compose applications for the domain. For instance, once corresponding services in the human resource domain are available, a customized payroll application could be composed to support business processes of a specific organization. While our understanding on segmenting domain knowledge in terms of traditional artifacts such as objects is mature [Gomma 1992], there is little research on how to abstract and package domain knowledge as services that can be marketed and sold as independent products/services, and combined with products/services from multiple sources to build end-to-end solutions [Vitharana et al. 2007]. Along these lines, research could examine methodologies for aligning business processes with corresponding services. The emergence of standards such as Business Process Execution Language (BPEL) for specifying how to define a business process in terms of services could further serve as a catalyst for the construction of services for their alignment with business processes.

Service Standardization and its Impact on Competitiveness

Realization of service orientation in various business verticals such as banking, insurance, manufacturing, retail, and healthcare heavily depends on standardization. While the development of technical standards such as Web services [Ciganek et al. 2005] and business process choreography standards [Curbera et al. 2003] are at an advanced stage, domain specific standards are at the early stage of development. Many interesting research issues in this area exist.

Wide scale adoption of the service oriented model in a specific business domain requires development and adoption of domain specific ontologies [Belll et al. 2007] to facilitate service design, description and search. Such ontologies exist in domains like healthcare (UMLS), however, they are nonexistent in many other domains. The process of developing such ontologies needs to be studied. Another important ingredient of success is standard business architecture for the domain which can serve as the blue print for service design at various levels of granularity and standardization of service standards. However, adoption of these standards raises questions related to its impact on business competitiveness. If all companies in a domain use standard services, how will they differentiate themselves? One of the possibilities is to compete based on how businesses can put together their unique business processes using standardized services. Another possibility is that even though service interfaces may be standard, actual services may differ based on performance, reliability, user interface, and so on. More research relating to business architecture description and representation, and architecture development process is needed.

Development of Services Supply Chain

The success of service orientation heavily depends on the ability to reuse services at large scale. This requires reuse to span organizational boundaries and development of a vibrant market place for selling and purchasing these services. Many interesting issues related to the development of services marketplaces remain. The issues range from description of the services, hosting of the services, performance guarantees and their monitoring and enforcement, service pricing, economics for buyers and sellers, risk assessment, vendor customer relationship management, and so on

Service Oriented Requirements Analysis

Requirements analysis (RA) plays a key role in traditional application development based on the classical life-cycle model. In the service paradigm, applications are built by composing services possibly sourced from various providers archived and described in some repository. In the instances where such a repository contains domain encompassing services, the requirements analyst could learn about the domain by examining related services. Because an analyst's knowledge of the business domain is critical to RA success [Pitts and Browne 2004], future research could examine if and how such a repository could help the analyst acquire the domain knowledge [Vitharana et al. 2007].

Moreover, in traditional application development, requirements are used as the blue print in the subsequent design stage. In service-based development, design takes a much different view. It is likely that the design would turn into an exercise in matching user requirements with existing services. Further research is needed to examine how the service paradigm alters both the requirements analysis and design stages of application development. In cases where a particular requirement does not exactly match with the functionality of existing services, a new service might have to be built which can then be placed in the repository for future use. In the instances where some requirements do not perfectly match services, users could be given the opportunity to alter their requirements based on the cost-benefit analysis of using existing services and building of services anew.

VI. MAKING INFORMATION SYSTEMS RELEVANT: A CASE FOR A NEW PARADIGM OF DOCTORAL PROGRAMS (CHENG HSU)

We ask three questions in this panel: Is the field of information systems (IS) in need of an innovation? Should IS embrace the new service science? How do we make IS research relevant, again? If the answer to the first question is a resounding no, then we have little reason to analyze further. However, as many speakers in the ICIS 2007 conference indicated, it may be a good idea to at least contemplate the possibility that the discipline has gradually been losing its appeal to students for quite sometime now, despite the short-lived spike at the time of the IT bubble. Therefore, we propose to innovate IS. We submit that IS faces fundamental intellectual challenges as many other disciplines do in today's digitally connected world, and the new service science provides a new perspective and a new paradigm for IS research.

Digital Connections Scaling

Service, as defined in the emerging field of service science [Chesbrough and Spohrer 2006], is the co-creation of value between provider and customer. This definition is generic enough to be applied to enterprise providers and customers, such as consulting for global supply chains, as well as personal cares such as hair cutting. However, it does not explain how to improve the quality and productivity of services. An approach to explaining this is considering service scaling. One perhaps cannot easily explain how to gain economies of scale for hair cutting, other than, e.g., for hair dresser training; but one might, for digitally connected services such as e-business, globally integrated enterprises, and social networking. When the co-creation employs digital systems to achieve the life cycle tasks of the customer and provider, then service scaling may become attainable. This is the digital connections scaling perspective [Hsu 2007; Hsu and Spohrer 2008].

The model of Digital Connections Scaling (DCS) postulates on the basic approaches to improving service quality and productivity. It requires digitization of service resources (people, organization, technology, and shared information), builds on scientific understanding of connection (e.g., the emerging science of networks), and obtains scale through business design. We submit that the field has plenty of results on these three aspects separately (digitization, connection and scaling), but until now it has largely left their integration, i.e., the design for digital connections scaling, to practitioners alone. In fact, the recent National Innovation Initiative [NII 2006] recognized three pillars for the new world: ubiquitous networking (based on digitization), open standards (enabling connection), and new business designs (gaining on scales). They are actually three pillars for digital connections scaling. The ongoing explosion of social networks is another prime case of digital connections scaling.

From the perspective of the DCS model, service can expand along both the demand chain and the supply chain of the co-creation at the level of individual production factors, such as the individual knowledge workers in the provider enterprise and the customer enterprise, as well as the individual providers and customers. Scaling can then reformulate societal value chains, create new business designs, and expand and intensify value propositions. The IT realization of service systems for DCS must be comprised of users, processes, data and knowledge, computers, and networking infrastructure. In other words, they cannot be anything other than information systems; except that these systems may be different from the previous IS foci in terms of the scale (e.g., extended enterprises) and paradigms (e.g., population orientation). They need to respond to new genres of value propositions that guide digitally connected services. The science of system design for digitally connected services may provide a new paradigm for IS research. More than just being a coincidence, much of the core challenge that service science faces have also been daunting IS for a long time. In particular, we recognize some well known large-scale challenges in the scientific community for further analysis from the DCS perspective.

Large-Scale Challenges

The Internet, in particular, challenged computer science from its start, and still represents a core set of computing requirements of DCS. The traditional scientific foundations of computer science are based on models of single machines, especially the von Neuman machine and Turing machine. They now need to scale for massively multiplex environments of IS required by Internet enterprises. Emerging results such as collaborative computing, Web services, and data and application ontology represent attempts to respond to these large-scale challenges, but their scientific proofs remain scarce. Similar observations also arose from other disciplines that enable digital connections, ranging from industrial and systems engineering to management and economics.

Industrial and systems engineering are disciplines that standardize, rationalize, and optimize the design and operation of products, processes, and facilities. Previous studies tend to focus on the off-line analysis and modeling that feature steady state solutions, and derive inference based on small samples. Digitally connected service systems, in contrast, require real-time regimes that perpetuate the transient state, and population-based planning and control. Their complexity, uncertainty, and dynamic nature defy many classical results. Examples include global network flows (of data streams as well as physical goods) in supply chain integration and co-creation of e-business services.

Management and economics also have their traditional premises challenged by digital connections. As discussed earlier, many emerging economic activities feature collaboration due to digital connections. These new business designs have made extended enterprise collaboration a significant if not primary mode of production. However, raditional micro-economics uses the concept of “firm” —single firms and not extended firms—as its theoretical corner stone; and the field of management always observed (or even promoted) the boundaries of a firm. The firm may be justified on the basis of transaction costs, but transaction costs of co-creation are not confined to some fixed regimes when flexible (one-of-a-kind) value propositions become the driving force, such as in service scaling. The situation has already caused issues in collaborative manufacturing (agile manufacturing, virtual engineering, e-engineering, etc.). It is now made even clearer by many new models of service.

These large-scale challenges will become even more pronounced as the explosion of digital connections reaches the level of individual production factors, beyond the traditional reliance on firms to control them. We do not address any particular large-scale challenges in the paper, but we submit that a design science can be developed by using available results in the field for service systems and the discipline of IS, for at least the domain of digitally connected service.

A Bigger Future

The significance of digitally connected service in today’s economies is not confined only to the service sector; but rather, it has implications on the whole knowledge economy. We discuss this point from the perspective of growth economics [Solow 1999].

We postulate that service and product were not separated before the Industrial Revolution. That is, a product was custom made according to the utility that it was supposed to deliver to the customer; and hence production was but a genre of service that happened to involve the making of products. We refer to this mode of production as the Output Pulling Paradigm (O). In this O-Paradigm, the economical connections were characterized by pair-wise relationships, or direct pairing between the provider and the customer. The science is the co-creation and the performance is the utility. Each co-creation has an individual Ratio of Output to Input (O/I), and the performance of the economy under the O-Paradigm is basically the average of all such individual ratios. It was difficult to scale separately either input or output in a co-creation.

Then, machinery made the pooling of the input possible, and the Industrial Revolution ensued. Both the product and the production became so significant that they dominated the customer-provider pairs. What resulted was a new mode of production that alienated utility (e.g., the 1/4-inch holes) from the means of providing utility (e.g., the1/4-inch drills) —we refer to this mode the Input Pushing Paradigm (I). Service was separated from product in this I-Paradigm since co-creation was abandoned and product aggregated. The paradigm features connections of production factors in a hierarchy of economical entities, of which the firm that minimizes transaction costs became the anchoring institution of economy. The science of the I-Paradigm is the science of products, and the performance is the scaling of production (including design, manufacturing and distribution). The end users of products are connected neither with the production, nor with other users. Service continues to be dominated by the O-Paradigm even in the post-Industrial Revolution economies.

Connections in these two previous paradigms were based on physical means, such as buildings, roads, and telecommunications. The advent of digital means opens a completely new dimension of connection, i.e., cyberspace. Through this connection, all production factors are potentially connected, all end users of knowledge are potentially connected, and all providers and customers are potentially connected. The value co-creation pairs can now be scaled up in any configuration of O, I, and O-I aggregation to change the O/I ratio favorably. Therefore, we are afforded a new mode of production which promises to fuse both the O-Paradigm and I-Paradigm and reap their benefits—the Output-Input Fusion Paradigm (O-I). In this paradigm, the science is the digital connections, and the performance is the scaling of value propositions for persons and enterprises. We consider the O-I Paradigm a signature property of the knowledge economy.

New Paradigms of Doctoral Programs

The IS field has always subscribed to the scientific research methods established in management (e.g., survey, field studies, theory building), behavioral science (e.g., clinic experiments), and engineering (e.g., modeling, prototyping, and laboratory experiments), as they apply to the problems in the field. New paradigms, especially the science of networks [Watts 2003], have seemed to increasingly impact IS research in major ways. What is interesting about these new paradigms is their focus on the entire space of practices using comprehensive empirical data, or even data streams generated in real time. For simplicity, we refer to this type of study as population modeling: abstracting the population from the realization data of the population. The population orientation is by definition large-scale *and* collaborative, since the population of any significant space easily defies the limits of traditional data collection and analysis regimes by any individual researchers or researcher groups. Population modeling is more reminiscent of the paradigms of astronomy than those of traditional management, behavioral science, and engineering. From the perspective of the DCS model, we consider population modeling to be a paradigm "cyber-enabled" (a phrase borrowed from an NSF program), since it collects data in and of the cyberspace, and use the cyberspace as a means for collaboration to carry through the study.

Therefore, new paradigms that we wish to use to help bring about innovative IS research may include the interdisciplinary studies of digitization (engineering), connection (science), and scaling (management) for, e.g., the design of service systems and the creation of value propositions; and the studies of population modeling. The common denominator of these paradigms is collaboration: collaboration between academia and industry, and collaboration among researchers. The best and arguably necessary way to establish the new research paradigms, promoting collaboration among researchers and between academia and industry, is new doctoral programs. They facilitate the new research and train new breeds of faculty and researchers to consolidate, sustain, and grow the new research. *We propose that new doctoral programs be devised and developed on the basis of this dual collaboration*.

VII. HOW MIS BRIDGES SERVICE COMPUTING AND MANAGEMENT?

The foregoing sections of this article discuss various research and practical issues of service computing and management from several unique technical and managerial perspectives. In this section, we present our collective viewpoints on how MIS, a discipline that is uniquely situated between computing and management, might bridge service computing and management.

Bridging Service Computing and Service Management via Service Orientation

As stated in Section II, service computing and service management refer to the intellectual output and business activities from the information technology domain and the management domain, respectively. In this paper, we emphasize the management of IT services in particular. For the first time, the IT domain has begun to take on the service orientation in IT architectures and system design and can learn a lot from operations management and marketing science. However, we also need to recognize that service orientation will exhibit forms in computing different from those in management. In operations and marketing, service orientation is mainly directed towards the mentality of relationship building and maintenance; on the other hand, in enterprise computing, service orientation is mainly directed towards the way software is developed and integrated. Nevertheless, service orientation will lead to common principles for managing information technology that both engineers and managers can understand and therefore significantly facilitate the effective communication in the planning and coordination of enterprise systems, both physical and informational.

Service Orientation as the New Hallmark of the Information Society

Part of the drive toward service orientation is reflected in the information society, where the service sector becomes dominant over the manufacturing sector, leading to the so-called service economy. This is because the information revolution enables more specialization in knowledge work and for more effective integration of economic activities around the global. According to Williamson, the economic activities of a capitalist society are of two forms, markets and hierarchies [Williamson 1987]. The economic activities of this society are being conducted as efficiently as possible within firms via planning and between firms via market mechanisms. The service orientation in the context of this paper is really a market mechanism in Williamson's world, which goes beyond mere selling of a product by focusing on servicing customers, thereby maintaining a long-term, value co-creation relationship. Dowson [2005] also pointed out that knowledge and relationships are where almost all of the value resides in today's economy. Nowhere is this more evident than in the world of professional services.

Service orientation can also be used within firms where multiple business units collaborate on delivering services to other firms. In this perspective, service orientation is a new hallmark of the information society, where it is possible to understand more about the needs of the buyers because of the very low cost of information processing.

Service Orientation Provides a New Opportunity for MIS

As discussed in previous sections, service orientation signals many new ideas, new protocols, new programs, and other innovations in terms of research, teaching, and business applications. MIS, as an interdisciplinary field, is in the middle of the intersection of computing as an engineering endeavor and management as a business effort. Therefore, it is natural for MIS to take possession of the opportunity towards service orientation in both computing and management. This will require the attention of MIS scholars with various backgrounds and research concentrations, be it information science, system engineering, behavioral studies, organizational science, and others. We believe that this will also take concerted efforts from the relevant professional organizations such as AIS, INFORMS, IEEE, and ACM. The fact that this panel was presented in a premier conference such as ICIS bodes very well towards achieving this goal.

VIII. CONCLUSIONS

This article reports the outcome of the panel on Bridging Service Computing and Service Management at the ICIS 2007 conference, Montréal, Canada, on December 12, 2007. Sections II to VII of this article contain the viewpoints of the panelists[1] on such topics as service orientation, service science, service-dominant logic, service-oriented software development, service systems, and service-based value co-creation. Section VIII contains the collective perspective on service computing and management. We hope that this report helps the panel attendees better understand the key points of the panel. Further, this report should reach people who could not attend the panel.

We hope that this report helps shed lights on some common concerns and questions in the recent emergence of service-related developments. We believe that the service orientation is a revolutionary concept with an impact beyond the concept of structured programming and object-oriented programming because the former is going to make the alignment of business and IT a much easier task, as has been illustrated in the paper.

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[1] Dr. Harry Wang was recruited to help coordinate the writing process of this article. His expertise in this area made him an ideal facilitator of the co-authoring process for this article.

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