Preface

The developed economy is shifting from being manufacturing based to services based. Different from the traditional manufacturing business, the services business is more complicated and dynamic, and end-user driven rather than product driven. To stay competitive, an enterprise thus has to rethink its business strategies and revamp its operational and organizational structures by taking advantage of its unique engineering expertise and application experience. With the fast industrialization of information technology, services sectors have expanded their territories substantially from traditional commercial transportation, logistics and distribution, health-care delivery, and issuance to financial engineering, e-commerce, e-retailing, e-entertainment (and "e-everything" if possible), supply chains, knowledge transformation and delivery, and services consulting.

Today's market reality is that the consumer or customer demands more innovative and flexible goods and services with high quality and shorter lead times. For a competitive enterprise, unique and satisfactory services differentiate the enterprise from its competitors; on the other hand, a highly satisfactory services delivery indeed drives more product sales. To meet the needs of the service-led economy, as a matter of fact, enterprises are gradually embracing defining and selling anything as a customer value service for competitive advantage (Rosmarin, 2006).

Research and education in services-enterprise engineering to cultivate and empower the ecosystem driven by services, technology, and management have lagged behind when compared to many other areas. Nevertheless, the services and services-en-

terprise engineering scope have evolved and expanded enormously as the world economy accelerates the pace of globalization. To ensure the delivery of superior services outcomes to end users, it is indispensable to align IT and business goals for efficiency and cost effectiveness (IBM, 2004; Karmarkar, 2004). However, little is really known about how IT as a service can be systematically applied for the delivery of a componentized business (Rangaswamy & Pal, 2005).

Only recently have there been some international initiatives to promote research and education in this emerging field in a comprehensive manner (Cherbakov, Galambos, Harishankar, Kalyana, & Rackham, 2005; IBM, 2004). The U.S. National Science Foundation (NSF, 2006) officially launched the Service Enterprise Engineering (SEE) program on October 1, 2002, aimed at promoting research on the design, planning, and control of operations and processes in commercial and institutional service enterprises. In parallel with many other worldwide initiatives, the Services Science Global (SSG, 2006), a nonprofit research consortium, initiated the Institute of Electrical and Electronics Engineering (IEEE) International Annual Conference on Service Operations and Logistics, and Informatics (SOLI) to provide worldwide scholars and professionals with a timely and effective platform to exchange their new findings, ideas, and experiences in research on services sciences, management, and engineering. The conference is the first one of its kind to provide such a collective forum in a comprehensive manner for the dissemination of services research, and to promote services sciences, management, and engineering research worldwide, aimed at facilitating the growth of this newly emerging interdisciplinary field from both research and educational perspectives. The first IEEE SOLI international conference was successfully held in Beijing from August 10 to 12, 2005, which drew about 200 attendees from over 30 countries; about 200 quality papers from over 300 submissions are published in the conference proceedings (SSG, 2005).

As information has always been one of the most competitive factors for today's business operations, IT as a service plays a critical role in deploying adaptive enterprise service computing. The delivery of the right information to the right user in a timely manner in an enterprise ensures that management makes informed decisions, productions produce high-quality products on schedule, and customers are provided satisfactory services. As we know, the componentization of the business is the mainstream of the day for constructing best-of-breed services components for delivering superior services to end users, while the successful operations of a componentized business require seamless enterprise integration (Cherbakov et al., 2005). However, enterprise integration in practice is still time consuming, costly, and inconsistent, which results in the fact that many integrated enterprise systems lack the flexibility of adapting to market fluctuations and the capability of evolving as technologies advance and human capitals migrate.

During the last decade or so, networking and computing technologies have made substantial advances, which makes it possible to establish effective communications among people, disparate control and management systems, and heterogeneous information silos across enterprises. To increase the degree of enterprise business-

(system) process automation and accordingly improve enterprise productivity, enterprises integration has gone through several waves, such as *ad hoc* point-to-point integration, data integration, application integration, and work-flow management. Enterprise service computing emerges as a new enterprise integration technology and implementation model that has significant potential in addressing enterprise systems integration challenges, such as agility, performance, scalability, security, heterogeneity, and adaptability.

Recently, a lot of research and development advances have been achieved in adaptive enterprise service computing, integration, and management, for instance, the emergence of business-process management, service computing, service-oriented architecture technology, and grid computing. The results of the advancement have stimulated the creation of a new class of mission-critical infrastructures, a new category of integration methods and software tools, and a new group of business platforms for cost-effectively exploiting and managing business processes. Inspired by the fast advancement in the emerging areas, this book covers many areas of interest to professionals, managers, graduate-school students, professors, and researchers working in the general field of adaptive enterprise service computing. However, as many chapters have broad discussions of services science, management, and engineering, we encourage you to read this book to have some fundamental understanding of this emerging and promising interdisciplinary field even though you might not exactly be in the field of enterprise service computing.

Book Organization

Enterprise service computing emerges as a new wave of IT in support of the best practices for enterprises. As the phrase "only change is certain" is the reality, the best practices of business operations change from time to time. To ensure that IT-driven businesses can keep their competitive edge, the underlying IT systems should be able to quickly and optimally align the changing business goals, which essentially requires a suite of new technologies to support the implementation of the IT systems from concept to deployment. Similar to a typical software-engineering approach, the book is essentially organized into six sections covering the life cycle of enterprise service computing's development. These six sections are as follows.

- **Section I: Business Aspects of Enterprise Service Computing** — The business view of adaptive IT-supporting systems
- **Section II: Enterprise Service Computing: Requirements** — Provides answers to the following questions: What is the specification? What are the essential needs for delivering the business from the IT perspective?

- **Section III: Enterprise Service Computing: Modeling** — Design methods and methodologies to ensure that the requirements will be met during the implementation
- **Section IV: Enterprise Service Computing: Technologies** — The right technologies for implementing the verified models of the needed IT system
- **Section V: Enterprise Service Computing: Formal Modeling** — The necessary verification and validation of complex systems, given the fact that adaptive enterprise service computing typically exists across the heterogeneous and geographically dispersed value net
- **Section VI: Enterprise Service Computing: Best Practices and Deployment** — The deployed solutions aligning the best practices of enterprises

Although the reader is encouraged to read from start to finish, it is absolutely appropriate to hop around from section to section. As the edited book is more or less research oriented, each chapter presents its own view of technology and business. To be self-contained, each contributed chapter in sequence does not need the prerequisite of having read previous ones. The given sequence of chapters in the book is just one possible way to help readers cluster their systematic thinking as they read through the book, or to simply help them locate their interests easily. The following paragraphs give a brief description of each contributed chapter.

Business Aspects of Enterprise Service Computing

IT as a service has many aspects, such as the points of view of the end user, business, operations, management, and technology. As the complexities, uncertainties, and changes reconfigure the business world from time to time, an enterprise should be able to quickly adapt to the change. Given that today's business is highly driven by IT systems, to appropriately design and develop an IT system to enable adaptive enterprise service computing, a comprehensive while visionary business aspect of the IT system lays the sound and solid foundation of the IT systems deployed across an enterprise. This section gives introductory discussions of enterprise service computing from certain business perspectives.

Chapter I, "Information Technology as a Service" by Robin Qiu, discusses the concept of IT as a service in great detail. To ensure the prompt and cost-effective delivery of innovative and satisfactory goods and services to customers, enterprises nowadays have to rethink their operational and organizational structures by overcoming a variety of distance, social, and cultural barriers. Qiu explains that IT plays a critical role in helping enterprises transform their business in an optimal manner. As challenges appear in many aspects from business strategy, marketing, modeling, innovations, design, and engineering to operations and management, the successful

deployment of adaptive enterprise service computing aligning business goals will be the key to gaining the future competitive edge.

Chapter II, "Aligning Business Processes with Enterprise Service Computing Infrastructure" by Wei Zhao, Jun-Jang Jeng, Lianjun An, Fei Cao, Barret Bryant, Rainer Hauser, and Tao Tao, argues that for the IT-driven business operations of many enterprises today, there exists a natural gap and disconnection between the decision and evaluation at the business level, and the execution and metrics at the IT level. As a solution to bridging the gap, they provide (a) a model transformation framework that effectively transforms business-level decisions into IT-level executable representations based on the concept of SOA, (b) a framework based on a service-level agreement that can monitor and synthesize IT-level performance and metrics to optimally provide the end users with satisfactory services, and (c) certain techniques that enable the dynamic adaptation of IT infrastructure as needed.

Chapter III, "Service-Portfolio Measurement (SPM): Assessing Financial Performance of Service-Oriented Information Systems" by Jan vom Brocke, focuses on the decision making of the service portfolio enabled in a service-oriented enterprise, aimed at aligning the decision making and the company's financial situation to ensure better long-term economic consequences. For a selected service portfolio, Brocke provides a framework for facilitating the assessment of the various financial consequences, which thus can help management justify the strategic plan of developing and deploying a service-oriented information system to support the service-oriented business operations.

Enterprise Service Computing: Requirements

Successfully soliciting the comprehensive requirements of an IT system is the foundation of the design and development of enterprise service computing. Although there are numerous approaches to engineering requirements for IT systems in general, the following two chapters use examples in two different IT operational environments to demonstrate how the requirements can be best captured to ultimately support service-oriented businesses.

In **Chapter IV**, "Requirements Engineering for Integrating the Enterprise," Raghvinder Sangwan reasons that understanding the need and level of cooperation and collaboration among the different segments of an enterprise, its suppliers, and customers is indispensable to the success of integrating enterprises' disparate IT systems. Given the complexity and heterogeneous nature of IT systems deployed in enterprises, capturing the requirements in a comprehensive manner relies on solid formulism and modeling. Specifically, Sangwan reviews the research to date on model-driven requirements engineering and examines a case study on integrating health-care providers to gain insight into the challenges and issues.

In **Chapter V**, "Mobile Workforce Management in a Service-Oriented Enterprise: Capturing Concepts and Requirements in a Multiagent Infrastructure," Dickson Chiu, S. Cheung, and Ho-fung Leung look at the requirements engineering in support of a mobile workforce by considering the mobility needs in a service-oriented computing infrastructure. They indicate that the demand of the deployment of mobile workforce management (MWM) across multiple platforms is increasing substantially. They demonstrate that a multiagent information system (MAIS) infrastructure provides a suitable paradigm to capture the concepts and requirements of an MWM as well as a phased development and deployment. Through a case study, they show an approach to formulating a scalable, flexible, and intelligent MAIS with agent clusters.

Enterprise Service Computing: Modeling

Once the requirements are successfully solicited from the end users, appropriate design methods and methodologies should be adopted. Different models typically provide different points of view for the future implementation of the IT system, for instance, architectural, communication, functional, object-component, failure, security, and deployment models. Using different modeling techniques essentially ensures that the requirements will be met during the implementation.

Chapter VI, "Designing Enterprise Applications Using Model-Driven Service-Oriented Architectures" by Marten van Sinderen, João Paulo Andrade Almeida, Luís Ferreira Pires, and Dick Quartel, presents a model-driven service-oriented approach to the design of enterprise integration applications. As the model-driven architecture (MDA) is well recognized as an adequate approach to managing system and software complexity in distributed objected-oriented design, they argue that the combination of MDA and the modeling of service-oriented computing will be an applicable approach to facilitating the development and deployment of enterprise integrated applications to support the dynamic changes of the business processes of an enterprise.

In **Chapter VII**, "A Composite Application Model for Building Enterprise Information Systems in a Connected World," Jean-Jacques Dubray emphasizes that the Web as a ubiquitous, distributed computing platform has changed dramatically the IT systems in support of business operations today. As a specialization and composition of activities empowers each economic agent to use and contribute the best of its abilities in the business world, IT-connected systems should behave in the same manner to best support business operations. The service-oriented composite application model should be appropriately applied to the development of IT-connected systems. Dubray argues that the enabled real-time and federated information systems through enterprise service computing will allow units of work to be executed more cooperatively to optimally fulfill the determined business goals across enterprises.

More specifically, in **Chapter VIII**, Xiang Gao and Jen-Yao Chung elucidate their three-point service-oriented conceptual design and modeling methodology for Web-services composition based on the design principle of SOA, aimed at providing a design approach to warranting the semantic consistency in support of business operations. They identify issues on the semantic consistency of Web-services composition at the conceptual level, while using the standard schemes of an order-handling system to define and demonstrate the semantic consistency of Web-services composition. Moreover, a formal service model is also applied to formally define the semantics of services interactions and formal history semantic conformances within Web-services interactions and composition at the conceptual system level.

Enterprise Service Computing: Technologies

The right technologies for implementing the verified models of the needed IT system should be determined as they lead to the future scalability, maintainability, and adaptability concerns. Given the complexity and heterogeneity in the nature of enterprise service computing, different implementing technologies (e.g., networking, programming, data storage, and security) should be applied to different parts of the implementation. The pick of run-time technologies for leveraging the interoperability and adaptability is more critical for enterprise service computing as the deployed IT systems focus on the ongoing change of business needs across enterprises.

In **Chapter IX**, "Data-Replication Strategies in Wide-Area Distributed Systems," Sushant Goel and Rajkumar Buyya indicate the importance of fast and effective access to data in support of efficient business operations. As replication is a widely accepted phenomenon in distributed computing environments, replication protocols are the mechanisms to guarantee the proper synchronization between replicated data sources. As applications vary with business settings, different replication protocols may be suitable for different applications. In the chapter, the authors present a survey of replication algorithms for different distributed storage and content-management systems. The survey covers a variety of systems, from distributed database-management systems, service-oriented data grids, and peer-to-peer (P2P) systems to storage-area networks. In particular, the replication algorithms of contemporary architectures, data grids, and P2P systems are provided with great detail.

Chapter X, "Web Services vs. ebXML: An Evaluation of Web Services and ebXML for E-Business Applications" by Yuhong Yan and Matthias Klein, explains relevant aspects of the Web-services and ebXML technologies and compares their capabilities from an e-business point of view. By exploring the similarity and difference between Web services and ebXML, they argue the two technologies have many things in common and should complement each other. The Web-service technology provides an excellent solution to integrating heterogeneous systems over the network. When combined with business-process management initiatives, it is a perfect fit in adaptive enterprise service computing as an interoperable run-time technology.

In **Chapter XI**, "Leveraging Pervasive and Ubiquitous Service Computing," Zhijun Zhang reviews the different wireless networking technologies and latest mobile devices in the market of the day and discusses how the recent advances in pervasive computing can help enterprises better bridge the gap between their employees or customers and information. Zhang proposes a pervasive and ubiquitous service-computing-based service-oriented architecture to maximally leverage the provided mobile capability in adaptive enterprise service computing so that service-oriented businesses can be optimally supported and the right information service can be made available at the point of need.

Enterprise Service Computing: Formal Modeling

The necessary verification and validation of complex systems is very important given that adaptive enterprise service computing typically exists across the heterogeneous and geographically dispersed value net. As the dynamics and behavioral properties of IT supports come directly from design and development, some future needs might be skipped during the design or certain undesirable features (e.g., blocking, deadlocks, security implications) may be unexceptionally embedded or introduced. A formal approach to modeling the dynamics of the future deployed system can assure that the desirable trajectories of the IT system better align the business objectives currently and in the future.

The advances of Web-services technology gradually make the deployment of adaptive enterprise service computing easier as engineering enterprise Web applications in support of business operations can be rapidly realized by composing Web-services components. However, the services results of the composed network components (e.g., Web-services components) are hardly guaranteed to be satisfactory. Thus, it is necessary to have a formal approach to validate and reason about the properties of an enterprise system composed of Web-service components. In **Chapter XII**, "A Petri-Net-Based Specification Model Toward Verifiable Service Computing," Jia Zhang, Carl K. Chang, and Seong W. Kim introduce the Web-services net (WS-Net) for realizing the verification and validation of IT systems composed from Web-services components. WS-Net essentially is an executable architectural description language. By incorporating the semantics of colored petri nets with the style and understandability of the object-oriented concept and Web-services concept, WS-Net is able to facilitate the simulation, verification, and automated composition of Web services in enterprise service computing.

In **Chapter XIII**, "Service Computing for Design and Reconfiguration of Integrated E-Supply-Chains," Mariagrazia Dotoli, Maria Pia Fanti, Carlo Meloni, and Mengchu Zhou apply a formal approach to the design and reconfiguration of an integrated e-supply-chain (IESC) network. A three-level decision-support system (DSS) is proposed. The performance of all the potential IESC candidates is evaluated and

the best ones are selected at the first level. Then at the second level, a multicriteria integer-linear optimization technique is used to configure the needed IESC network. Finally, the configured network is evaluated and validated at the third level to ensure that the identified services are enabled across the network.

Enterprise Service Computing: Best Practices and Deployment

The deployed solutions aligning the best practices of enterprises are the ultimate goal of adaptive enterprise service computing. On one hand, the research and development of IT (e.g., enterprise service computing) is a service. On the other hand, when IT helps enterprises streamline their business processes to deliver quality and competitive goods and services, it essentially functions as a knowledge service. To maximize the return of IT investment, the implementation of IT applications must also follow the best practices in service computing.

Chapter XIV, "Best Practice in Leveraging E-Business Technologies to Achieve Business Agility" by Ehap Sabri, presents the fact that the implementation of e-business solutions to enable best practice leads to achieving business cost reduction and agility. As an example, Sabri discusses the strategic and operational impact of e-business solutions on supply chains and explains the performance benefits and implementation challenges enterprises should expect when the best practices will be adopted. Sabri provides the best-practice framework in leveraging e-business applications to support process improvements aimed at eliminating non-value-adding activities and enabling real-time visibility and velocity for the supply chain.

Finally, in **Chapter XV**, "Concepts and Operations of Two Research Projects on Web Services and Context at Zayed University," Zakaria Maamar shows the deployment results of two research projects applying context in Web services. The success of enterprise service computing relies on the successful deployment of the developed IT system. The IT system should also deliver the desirable services to the end users to best support the business operations. In the first project, called ConCWS, the deployment focuses on using context during Web-services composition. In the second project, called ConPWS, the deployment then focuses on using context during Web-services personalization. In the two projects, Zakaria also demonstrates how agent technology can actively participate in enterprise service computing. Through the successful deployment of the two projects, Zakaria essentially shows how enterprise service computing can ultimately deliver the right information services to meet the needs of end users.

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References

Cherbakov, L., Galambos, G., Harishankar, R., Kalyana, S., & Rackham, G. (2005). Impact of service orientation at the business level. *IBM Systems Journal, 44*(4), 653-668.

IBM. (2004). *Service science: A new academic discipline?* IBM. Retrieved February 4, 2006, from http://www.research.ibm.com/ssme

Karmarkar, U. (2004). Will you survive the services revolution? *Harvard Business Review, 82*(6), 100-107.

National Science Foundation (NSF). (2006). *Service enterprise engineering*. Retrieved February 4, 2006, from http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=13343&org=NSF

Rangaswamy, A., & Pal, N. (2005). Service innovation and new service business models: Harnessing e-technology for value co-creation (eBRC white paper). *2005 Workshop on Service Innovation and New Service Business Models.* Retrieved September 10, 2005, from *http://www.smeal.psu.edu/ebrc/*

Rosmarin, R. (2006). *Sun's serviceman.* Retrieved February 6, 2006, from http://www.forbes.com/2006/01/13/sun-microsystems-berg_cx_rr_0113sunqa_print.html

Services Science Global (SSG). (2005). *The Proceedings of 2005 IEEE International Conference on Services Operations and Logistics, and Informatics* (Online program abstract). Retrieved September 10, 2005, from http://www.ssglobal.org/2005

Services Science Global (SSG). (2006). *Services Science Global: A non-profit research consortium*. Retrieved February 6, 2006, from http://www.ssglobal.org