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Business System Management and Engineering

From Open Issues to Applications

Springer

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Preface

The next generation of business process management (BPM) methods and tools will support the development of a new generation of service-enabled applications that change and evolve over time. The trend is moving from relatively stable, organization-specific applications to dynamic ones supporting business process.

Currently, service-based applications (SBAs) concentrate on composing software services into processes, but do not explicitly correlate business activities and events, such as delivery dates, shipment deadlines and pricing, of different processes in a single end-to-end process. This lack of correlation introduces discontinuities within end-to-end business processes, as information flows may be disrupted. For instance, a possible decoupling of payment information in payment and invoicing processes from delivery data in order management and shipment business processes may violate data integrity and contractual agreements. Furthermore, it may introduce discrepancies, requiring expensive and time-consuming manual reconciliation.

With these backdrops in mind, there is a need for management techniques that can be applied to various tenets of service networks (SNs), including business data, events, operations, process fragments, local and aggregated quality of service (QoS) and associated key performance indicators (KPIs), in order to guarantee the continuity of information flows and the correlation of end-to-end process properties. Currently, this information is deeply buried in SBA code, severely hindering maintenance and adaptation which are essential in SNs. Several research groups have been working on this challenging scenario, focusing on enhancing business system management relying on SBAs.

This book was partially an outcome of the International Workshop on Business System Management and Engineering (BSME 2010) held in Malaga, Spain, during June-July 2010, in conjunction with TOOLS 2010 federated conferences and under the aegis of the EU Network of Excellence on Service Software and Systems (S-Cube). The goal of the workshop was to bring together experts in the field of business process management, service-oriented architectures, and service security to discuss the current state of research and identify new issues, challenges, and research directions. The results of the discussions are reflected in this book that includes extended papers from the authors who had a paper accepted for the workshop.

The book comprises three main parts. The first part, "Open Issues in Business Management," provides a complete and comprehensive overview of emerging issues and research directions in the context of business management, introducing

possible approaches and solutions. Chapter 1 describes the evolution of business trends and business process support during the last few decades, and then discusses some pressing research challenges to be considered in the development of business value networks. Chapter 2 analyzes the problem of providing a digital ecosystem for business services, and then proposes a digital business ecosystem composed of distributed service systems whose business knowledge is exchanged using business artifacts. Chapter 3 presents an approach based on reference modeling techniques that addresses the needs of inter-organizational systems.

The second part, "Open Issues in Assurance and Dependability," discusses research problems and open issues in the context of assurance evaluation, with particular focus on security and dependability of services and business processes. Chapters 4 and 5 consider the problem of providing service-based solutions that address assurance and dependability requirements. In more detail, Chap. 4 discusses issues in the development of a service-oriented collaborative business model with high dependability level that self-adapts to changing environments, while Chap. 5 presents an approach to the modeling of assurance requirements for business services. Chapter 6 introduces security certification of services as a suitable solution to increase user trust and confidence in the correctness and security of services, and then discusses a solution for certification of services at the level of the container deploying them. Chapter 7 presents a layered architectural style for the development of SBAs that constrains dependencies between software elements to allow lifecycle management of software complexity.

The last part, "Open Issues in Composition and Transaction Management," deals with two important aspects of service-based business processes, namely, service composition and transaction management. Chapter 8 explains how the consideration of a cross-organizational SBA changes service composition and orchestration requirements with respect to a closed enterprise, and then describes a conceptual architecture for business transaction management. Chapters 9–11 consider the problem of service composition from different points of view. Chapter 9 studies requirements for service composition and then proposes an approach able to provide service applications whose components come from multiple service domains. Chapter 10 proposes an ontology-based approach that allows one to retrieve process fragments from business process repositories and reuse them in the composition of new business processes. Chapter 11 presents a graph grammar-based approach for dynamic reconfiguration of service-oriented architectures that preserves the quality of service in perturbation-prone environments.

We gratefully acknowledge everyone that contributed to the publication of this book. First, we would like to thank the research community working on service architectures and business process management, and the high quality of their research work, which is hopefully reflected in the book. We would also like to thank the organizers of BSME 2010, the BSME 2010 Program Committee, and all the reviewers involved in the evaluation process for their hard work and dedication. A special thanks goes to Mike Papazoglou, who started the effort

toward BSME 2010 and encouraged us to submit this volume to the Springer Service Science series. Finally, thanks are due to the authors for contributing to this book with the best results of their work. We hope that this book will serve as a valuable reference for researchers and developers working on service-oriented business process management and engineering.

May 2012

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On Some Challenges in Business Systems Management and Engineering for the Networked Enterprise of the Future

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Abstract. Business value networks will become increasingly important in the world's economy in the future. Their appropriate IT support must efficiently realize business collaborations between globally spread organizations. The ability to adapt to changing market and business requirements together with the ability to reflect the business adaptations on the level of the connected ICT systems constitute key challenges for the support of business network formations. In this paper, the evolution of business trends and business process support during the last decades is briefly addressed. After the introduction of a reference model of business value networks, this paper discusses some pressing research challenges that have to be addressed to realize business value networks and their ICT system support in the future.

Introduction

There is a rapidly increasing pressure in the market forcing the industry into the transition from fixed supply chains to flexible business value networks. Business Value Networks are constituted by the interoperation of businesses in a chain or a grid of interdependent service activities. In practice, business value networks *"dominate all major industries, e.g. automotive, pharmacy, chemicals, assigning roles of service, production and development to the most suitable organizations that deliver the best service at the lowest cost"*[1].

In business value networks as well as in new service businesses, services are delivered by socio-technical service systems; these may be individuals, business, or IT operations that deliver specific services. Service systems form a huge and further growing proportion of the world economy and are changing the way businesses, governments, and individuals work. Service systems increasingly transform into service networks by connecting to other service systems.

[1] Kagermann H, Österle H 2006, Geschäftsmodelle 2010 - Wie CEOs Unternehmen transformieren. Frankfurter Allgemeine Buch, Frankfurt.

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The transformation from fixed supply chains to more flexible business value networks implies changes to the business models and processes of participating enterprises which have to become much more collaborative, flexible and agile, and focused on innovative value co-creation in order to successfully adapt to constantly changing value generation and distribution in the business network.

These business-driven requirements have to be linked to and reflected in the architecture, design, and lifecycle management of enterprise systems implementing the business services at the ICT level. Enterprise systems are by their very nature process-based, i.e., behind virtually any service interface there is a process representing the service implementation. The relatively stable processes often customized and optimized according to organization-specific needs as implemented in the enterprise systems in the past will increasingly move towards more dynamic and adaptive processes, with the main focus on supporting dynamic and collaborative business process interactions between networked enterprise systems. The main challenge for the enterprise systems of the future is the ability to constantly follow and adapt to the changing business requirements at the ICT level at the required speed of business-driven innovation by ensuring at the same time integrity and consistency of collaborative end-to-end business processes in the business value network.

1 Evolution of Business Trends and Flexible Business Processes of the Future

From the historical perspective the evolution of business trends can be described by three main phases which are displayed in Figure 1:

- Hard-wired value chains
- Specialization and consolidation
- Business Webs (Business value networks)

In the 70ies and 80ies the value creation has been dominated by business processes remaining stable for many years. The production, service operations, and sales channels remained stable over many years. The frame contracts guaranteed stable relationships to customers and suppliers. The main focus was on increasing the efficiency of an organization by optimizing the internal processes and service operations. The ICT systems supporting and controlling production and service operations have been implemented in a hard-wired way.

In the 90ies specialization and consolidation bit by bit replaced hard–wired value chains as a dominating business trend to further increase the productivity of value creation chain. The companies increasingly focused on their core competencies (specialized) with respect to value creation. The production processes and service operations with low value creation have been outsourced to partners that could achieve scaling effects by aggregating outsourced production processes and service operations in a standardized way, i.e., profit from consolidation. The ICT systems became more granular and offered interfaces for B2B integration with systems of customers and suppliers.

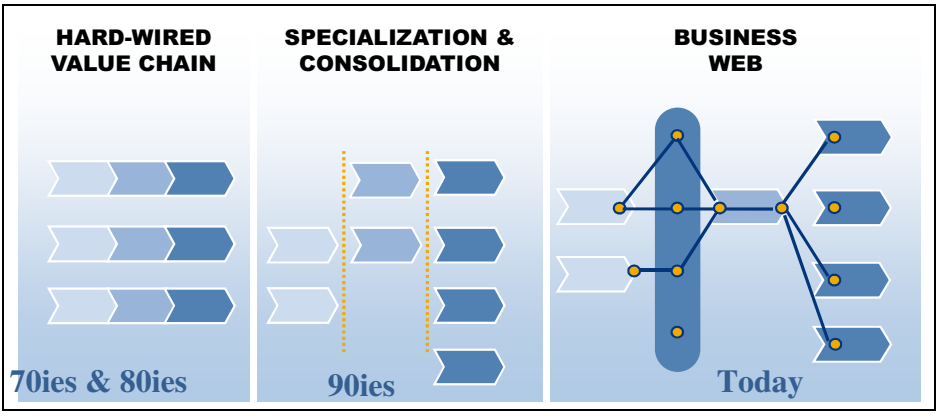

Fig. 1. Evolution of business trends

Today, business value networks are rapidly becoming the dominating business trend. The Internet, globalization and increasing speed of innovation shift the focus from efficiency to flexibility, agility and fast adaptation with respect to production as well as service operations. The relationships to customers and suppliers are more volatile, the sales channels are increasingly dominated by open market places enabling to find the best offerings at lowest price at the global scale. The companies have to develop and offer innovative products and services with a unique value proposition at competitive price. This is often only possible in an innovative but volatile business partner network based on principles of joint value creation, collaboration and competition. Furthermore, there is a new business trend based on convergence of physical products and services into offerings of bundled solutions, e.g., selling "drilling holes" instead drilling machines. This trend is leading not only to deep business model transformations within a company but also to fundamental changes in the structure of the business value network, the business processes, the roles of the business partners, the ways how value is created, and even the requirements on product design and nature of service operations.

Additionally, from the technology perspective, the rapidly increasing bandwidth and coverage of the Internet accompanied by technologies like Smartphones, Cloud Computing, network-enabled sensors and physical devices (Things) increasingly contribute to virtualization of resources, decoupling from space and time, and fusion of the physical world with the Internet. In the future, these developments will ultimately lead to real-time business webs residing in mobile business clouds.

The requirements on ICT systems able to efficiently run business value networks by preserving consistency of end-to-end business processes are manifold. In the following some challenges and approaches are discussed.

2 A Reference Model of a Business Network

Looking at business networks, one has to separate the business and the ICT layer as displayed in Figure 2 to understand the challenges.

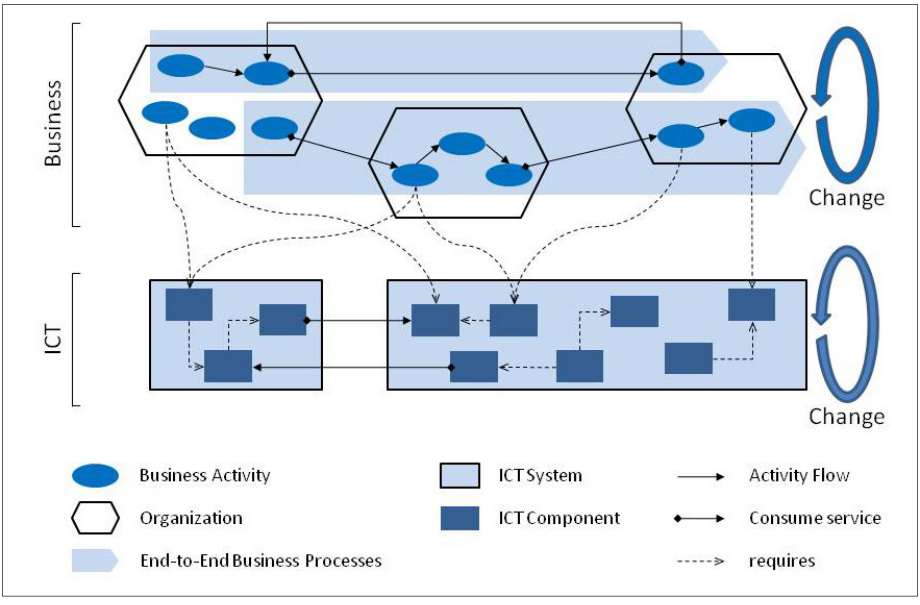

Fig. 2. Business and ICT layers of business value networks

On the business level, the main actors are organizations which perform business activities. An organization may be a company or even a department of a company. The business activities are primarily performed for the benefit of the company, but may also provide benefit to other organizations. Financial reporting or managing the hiring process is classically purely internal business activity without benefit to other companies. Other companies classically benefit from business activities like producing, selling, and delivery. Whenever an organization benefits from the business activities of another company through a direct interaction, it consumes a business service. The business activities of a company are performed in a logical activity flow, which forms a business process. An end-to-end business process includes all interdependent business activities and service consumptions inside and across enterprise boundaries.

A business activity may make use of one or more ICT components on the ICT level. An ICT component is for example an ERP, CRM, or HR software module. An ICT component is part of an ICT system. An organization on the business level can rely on none, on a single, or on a multitude of ICT systems. An ICT system can be as small as a desktop PC or as large as a computer center that is hosted by the company itself or by a 3rd party hosting provider. Also ICT components have dependencies. If the dependencies cross ICT system boundaries, then an ICT system consumes the ICT services of another ICT system.

The complexity arises due to increasingly accelerated change on both layers and the necessity to keep them consistent. If connected to ICT systems, changes on the business level must be reflected in the ICT level to avoid unnecessary manual overhead in process execution. As long as the enterprise network on the business level

is rather fix, each company can focus on optimizing their internal business processes to reduce processing costs and large-scale technical integration projects with the ICT systems of business partners pay out in the long run.

However, the periods of time where the business value networks are stable with respect to the structure of the network as well as the distribution of created value within the network are shortening due to the following main drivers:

- Globalization (competition politically enabled)
- Internet (cooperation technically facilitated)
- Speed (results from innovation driven by globalization / competition)

Through opening the local markets on the world-wide level by the increasing globalization, the number of competitors increases for each company. In addition, the Internet allows for completely new business models and ways to connect businesses' ICT systems. Both globalization and the Internet led to an increasing speed at which enterprises have to innovate and restructure their business. Being economically successful strongly depends on a company's flexibility on the business and ICT level. The term business value network underlines the decreasing stability of the enterprise networks. In a business value network, optimizing to the current status of the network becomes less important than flexibly adapting to changing opportunities in the network. In practice that means that organizations and systems running a business value network are impacted by changes on all levels.

3 Basic Types of Changes in Business Webs

In the following we illustrate and discuss the changes in the business webs by visualizing them as graphs (see Figure 3).

On the top-most modeling level on business value networks, business services are modeled as business activities which are part of a business process and which are executed on business network nodes (e.g. organizations). To be able to deal with the described challenges regarding the end-to-end business processes on the network level (e.g. ability to cope with changes in the business networks), adequate and sufficient means of modeling are necessary. A prominent way to model business networks is to model them as *graph structures* (other models are also possible). In a graph notation, business activities are modeled as graph nodes and interdependencies between activities are modeled as graph arcs that connect nodes. Business activities can be understood as business services if they form a part of a cross-organizational interdependency.

Changes on business networks can then be reflected as *graph transformations* in such graph structures and a set of primary change operations can be identified. Figure 3 illustrates this modeling approach with a selection of four example changes and their corresponding graph *transformations*: moving a service, replacing a service, decomposing a service, and composing a service:

- The outsourcing of a business service within an end-to-end business process from one network node to another node can be modeled in a graph as the *moving* of a service between network nodes (Part A.) in the graph model.

Although easily visualized in the graph abstraction, a set of complex questions has to be answered when this business network change has to be realized, such as: Will the change be visible to the participants of the business process, which organization remains responsible for the execution of the business service for the consumer of the business process, how are service level agreements affected by this change.

- In part B., the replacement of a business service implementation is modeled as a graph node replacement where one business service node is deleted and replaced with another business service node. Such a network change can be necessary for example when defined service level agreements are not met.
- A business service (node) can also be decomposed into multiple other services (nodes) that together (more or less) substitute the effects of the decomposed original service (Part C.). Similarly, a set of business services (nodes) can be composed or aggregated into a new business service (node) as shown in Part D.

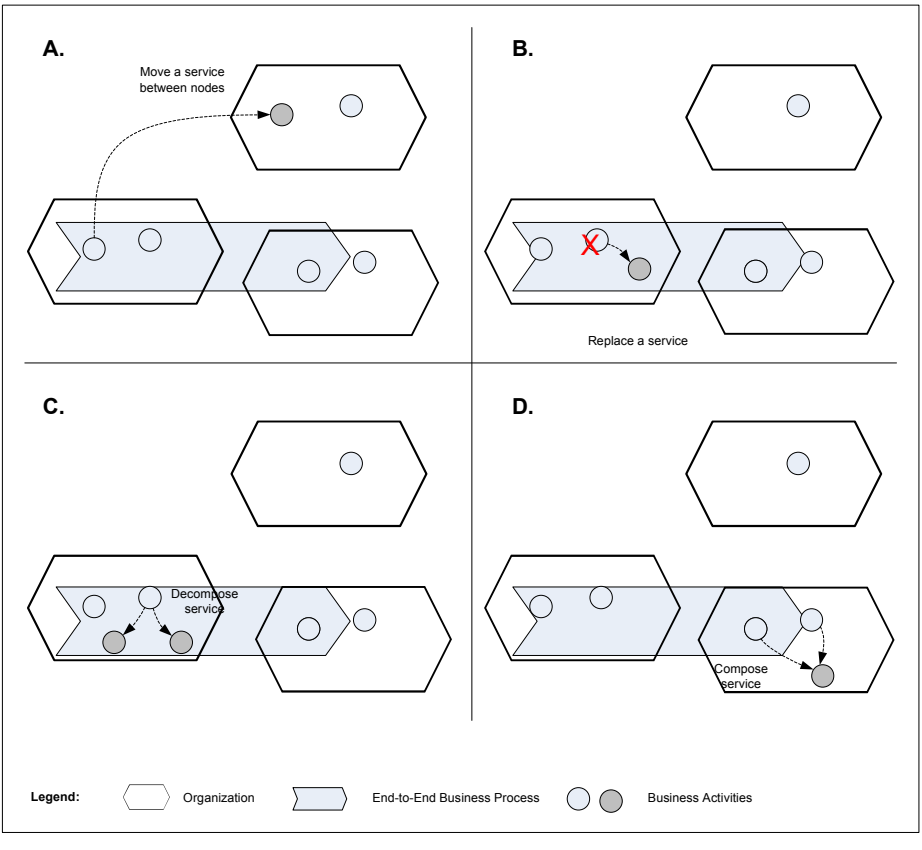

Fig. 3. Exemplary types of business network changes

4 Challenges

In the following we discuss some research challenges from the perspective of business value network level (upper layer in Figure 2), the ICT level (lower layer), and some research challenges regarding the linking of both levels.

4.1 Challenges in Business Webs

As we have seen, the business value network can be understood as a graph. The business-driven transformations of the network such as outsourcing, splitting of organizational structures, and aggregation due to the fusion of enterprises or organizational structures can be seen as graph transformations. The challenge for the businesses in that network is to live up to the speed of the transformations enforced by the competitors in the market to improve the company's value gain in the network. That requires a strong **ability to change** of each company. Ability to change falls into adapting the own, internal processes of a company, but also into transforming the cross-company business processes the enterprise is part of. Ability to change can be further broken down to the following sub-challenges:

- **Monitoring.** Knowledge is power: The better a company understands rising opportunities and threats in the enterprise network, the more appropriate it can react. The process of understanding requires both an in-depth analysis of existing interdependencies and a continuous monitoring of recent changes in the constantly evolving network. Dependencies have to be analyzed both along a value network but also vertically from a business level down to infrastructure level. Furthermore, the ability to monitor certain aspects may sometimes impact the adequateness of certain services within a larger network [Theilmann, 2010]. On the one hand, resources may per se have limited monitoring capabilities. On the other hand, the access the monitoring capabilities might be restricted, which is particularly the case if services are consumed by other providers. The challenge is to establish a consumer-side monitoring, which despite the limited access to runtime information allows meaningful evaluation of the consumed services, e.g. regarding their SLA or coordination protocol compliance [Momm, 2010]
- **Simulation.** The core of traditional business process optimization is the what-if analysis: Hypothetical process changes are analyzed with respect to the expected improvement. Traditional process optimization targets at improving a process in a relatively stable environment. For the rather unstable environment of constantly evolving enterprise networks, simulation is even more important to identify beneficial change strategies. Furthermore, simulations become by ways more complex if dependencies of processes on underlying software, infrastructure and human resources are taken into account. [Gilani, 2011], [Winkler, 2010]
- **Coordination.** A strategy has to be implemented to have an impact. The essential properties are speed and correctness. For a networked enterprise, implementing a new strategy means coordinating services. Service coordination

includes not only the network transformations on the business level that were described before, but also transforming the technical service network to match the new business service requirements. Thus, flexible organizational structures on the business level and easy adaptability, extensibility, and integration on the technical level are essential for improving speed and correctness of coordination. Existing works on cross-organizational business processes, such as [Greiner, 2007] or [Grefen, 2001] already provide methods and tools for dealing with this problem, but still require extensive manual adaptations of the involved IT. The desired flexibility and speed might be achieved by offering native ICT support for coordination activities required to perform the change operations and further driving standardization for establishing a common understanding of concepts in business webs.

- **Continuous Optimization.** Resting is rusting: Especially for the networked enterprise, it is important to constantly react to rising opportunities and threats in the evolving business web. Successful companies at some point in time provided a service that was beneficial in a certain environment. It is only a matter of time until legal regulations, innovative technology, or more efficient competitors endanger the once successful business model. Constant identification of trends and timely reaction by the continuous and cyclic monitoring, simulation, and coordination are essential for sustainably successful networked enterprises. One important issue in this context represents a continuous assessment of the partner/business service credibility for supporting a risk-based optimization of partner relationships decision support in service value networks [Michalk, 2010]
- **Enterprise Interoperability.** Enterprise Interoperability is the ability of networked enterprises building a business web to cooperate at the business level (i.e., exchange information and services). Hence, Enterprise Interoperability is about compatibility of involved actors and systems at all levels relevant to exchange of information and services in a business web. This includes but is not limited to compatibility of the business models, processes, services and their compositions, legal compliance, contracts and agreements, terms and conditions, as well as involved actors and systems. Lack of compatibility has its origin in the heterogeneity of various kinds between related systems and actors that have to interoperate. There is always an inherent risk of interoperability problems if heterogeneity is present. Despite the intensive research in the field of enterprise interoperability, the fundamental interoperability problems have been studied only fragmentally and mainly from the viewpoint of two related systems but not within a dynamic network of collaborating systems where the relationships are a subject to constant change. The understanding of barriers in all situations of non interoperability is required [Poler, 2009].

All these challenges equally apply also in the case of partial network visibility.

4.2 Challenges in IT System Management

The formation and management of business webs as well as the offering of IT capabilities as tradable (business) services imposes new challenges on the

fundamental structure and capabilities of IT systems. Eventually, IT systems have to deliver their functionality and resources in a service-oriented way, i.e. embedded in a clear business context, according to the needs of concrete customers and in a dynamic way – exactly as the customer needs arise. Virtualization can serve as enabling technology. We see four main challenges in this area which are about scalability, dependability, flexibility, and interoperability.

- **Scalability.** Service-based IT systems are built without knowing the concrete set and demands of their customers. Consequently, they have to support scenarios with rather small adoption rates but also very large adoption rates. This means that the IT system must allow for excellent scalability, both in terms of scale-down (operating efficiently for small and few customers) and scale-up (operating efficiently for large and numerous customers). As a consequence service-based IT systems must (a) offer very small marginal costs for deployment of single services (b) acquire resources in an elastic fashion and (c) scale (at worst) linearly. And last but not least a service-based IT system must be elastic in order to support the fast adaptation to different load situations. [Rochwerger, 2009]
- **Dependability.** In order to turn IT-services into tradeable goods they must be operated with a clear specification of their dependability characteristics (security, safety, availability, performance, etc.). This requires clear specification of the agreed characteristics (e.g. via a service level agreement) and a change of the system management approach, clearly focussed to manage those SLAs and to support system adjustment as soon as SLA violations occur. [Theilmann, 2010]. A system management approach properly based on SLAs encompasses all the major operation areas such as configuration management, (self-)optimization, (self-)healing and (self-)protection [Butler, 2011].
- **Flexibility.** Demand-based provisioning of services poses new challenges for IT systems. One is about the ability for instant creation of a specific service instance – whenever a customer requests for it [Vouk, 2008]. The second is that apart from very few standardized mainstream services customer requirements for a particular service typically differ from one customer to the next. Therefore, service-based IT-systems must support the customization of general service offers to particular customer needs. The capturing of those specific requirements, their implementation and the management of a system with multiple co-existing service variants is a significant challenge in itself [Mietzner, 2009]
- **Interoperability.** The counterpart to customization (and equally important) is the interoperability of service-based solutions. Interoperability is the key enabler for low-effort adoption of services and their fast embedding into larger business webs. Following the model-view-controller paradigm, interoperability can be achieved at three different layers: At model layer it is about interoperable data models which support the use of data in other services. At control layer it is about interoperable interface signatures and process models which support the embedding of functions and process parts into larger processes and networks. At view layer it is about interoperable user interfaces which support the combined consumption of UI services in a common context. Orthogonal to these aspects is

the management perspective, where interoperability is about consistent and interlinked management of artefacts across layers. Most prominent aspect herein is the interoperability of service level agreements which specify the operational constraints under which services are delivered. [Theilmann, 2010]

- **Mobility.** The IT and the telecommunications worlds converge based on the same principles of Service-oriented Architecture (SOA) paradigm. This opens an enormous innovation potential towards service-oriented business applications combining IT and telecommunication services and creating unique new user experience. However, the service composition principles in IT and telecommunication domains are fundamentally different. A converged service layer for IT and telecommunication able to handle compositions of services from multiple technological worlds is required [Niemöller, 2010].

5 Challenges in "Linking Business to ICT"

In the following we discuss some selected crosscutting research challenges for a networked enterprise that need to be addressed in order to link business to ICT in an efficient way.

5.1 Business-Aware Transaction Management

Flexibility at the IT level is required in order to address monitoring, coordination and continuous optimization at the business level. Currently, Service-oriented Based Applications compose software services into business processes. However, explicit correlation of critical business activities and events, QoS requirements, and application (business) data, such as delivery dates, shipment deadlines and pricing, in one process with related activities, events, QoS and business data in other processes in an end-to-end process constellation is missing. The management of application information and procedures is hardwired having as a consequence that any change or update to the application management logic already fabricated within an application requires programmatic changes to the application itself. This makes the potential reuse, customization, and monitoring of application management capabilities very difficult and introduces intrinsic discontinuities between end-to-end business processes as information flows may be disrupted.

Explicit management of fine grained business data, events, operations, local and aggregated QoSs and associated KPIs is required to guarantee a continuous and cohesive information flow, correlation of end-to-end process properties, and correct termination of interacting business processes that is driven by application control and integration logic.

[Papazoglou, 2010] and chapter 8 of this book describes the above issues in more detail and introduces a multi-modal transaction processing scheme enabling reliable business-aware transactions that correlate front-end Service-oriented Business Application requirements with back-end system-level transaction support that might span several interacting organisations.

5.2 Data Integration: Diverging Data Standards

The diverging data standards have always represented a major interoperability burden for Enterprise Application Integration of heterogeneous application within or across businesses. Data standards have been developed in the past for electronic communication in various business domains, such as automotive, chemicals, and high-tech. The developed standards are RosettaNet, CIDX, and UN/EDIFACT to name a few. The standards are usually underspecified such that companies can interpret and extend the standard in slightly different ways to address their specific communication needs. The advantage of using a standard is that the messages types of different companies are at least structurally similar if they base on the same standard. If they use different standards, at least some standard documentation about the message types is available. However, correctly mapping differently interpreted fields of the same standard and mapping different standards to each other remain the main challenges.

The CCTS Modeler Warp 10 addresses the issue of diverging data standards [Stuhec, 2007]. Using the CCTS Modeler Warp 10, message standards from different domains can be managed together with their different interpretations by the communicating companies. Deviations from a standard can be assigned a specific context using the context driver principle [Stuhec, 2005]. The context consists of different context categories which, amongst others, carry information about the geopolitical region, the industry, and the business process. Using that information, the CCTS Modeler Warp 10 can show the links of different message type to ease the implementation of mappings that are necessary for electronic communication.

5.3 Process Integration: Orchestration vs. Choreography

Orchestration and Choreography play an important role in Business Process Management and Modelling.

Orchestration means that a process is described as a controlled flow of partially ordered tasks, i.e., there is a central point of control having knowledge about the global status of the process and able to enforce the execution of tasks. The process can be orchestrated by a process engine (e.g., BPEL).

Choreography means that two or more processes interact with each other according to a globally defined contract (e.g., a message exchange sequence, WS-CDL). Each process has to follow this message exchange sequence according to its role in the contract in order to ensure consistency of end-to-end business process as defined in the choreography. There is no entity at execution time having knowledge about the global status of choreography execution. The processes have to follow the global choreography locally.

At the business level a process under a control of an organization is modelled as a process orchestration. The collaborating B2B processes are modelled as process choreographies. The tasks and message exchanges can be described and implemented as services.

At the ICT level the implementation of business functionality is often encapsulated into more or less granular process components offering service interfaces for

communication to the outside world. The consistency within an ICT component and therefore the services offered by that component is typically enabled by a (configurable) constraint-based state model. An organization maps its business processes to a set of such process components by configuring their state models, enabling/disabling the offered services and grounding the service calls to services offered by different process components within the same organization (A2A) or to services offered by a different organization (B2B).

From the perspective of a process component process orchestrations exist only within the process component itself. Any communication to the outside world (A2A/B2B) has to be considered as process choreography even within the same organization. Hence, there is a mismatch between orchestration and choreography modelling at the business and ICT level. Linking and mapping of business service models to ICT services is a challenging issue. Especially, the flexibility requirements resulting from the required ability to change impose complex research questions with respect to modelling and mapping of extensibility, adaptability, and variability/configurability of services and processes at both business and ICT level.

5.4 Decision Support for Optimization of Service Networks

Networked service systems connect and integrate isolated IT solutions of enterprises into coherent systems in order to support the seamless execution of end-to-end business processes. Thus, optimization and simulation activities helping to support decision making on the business level have to consider ICT resources as integral production equipment for their value creation, whereas on the ICT level the business impact has to be taken into account in ICT design decisions. In addition to this, the (economic and technical) effect of external business as well as ICT services provided by partner enterprises on internal ones has to be estimated and taken into account. Particular challenges in this scenario are: (1) The establishment of feedback loops between simulation approaches on the two layers instead of a purely top-down development process, where business-level requirements are treated as constants for ICT design. (2) Supporting the high degree of flexibility required in networked service systems and enabling rapid evaluation of different change scenarios in an integrated way.

5.5 Platform as a Service

In order to support end-to-end business processes across several organizations, a set of different interoperability problems has to be addressed with respect to data or process interoperability issues. Traditionally, the ICT systems of the collaborating organizations are integrated with each other with additional ‘glue’ technology (e.g. based on existing process or data mediation techniques). In this way, semantic or syntactic differences in data description, process description, and other integration aspects have to be overcome in each individual case by mutual agreement between the organizations.

The introduction and usage of Platform-as-a-Service (PaaS) platforms can provide an important integration advantage with respect to interoperability issues between