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SPECIAL THEME

Services in electronic telecommunication markets: a framework for planning the virtualization of processes

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Abstract The potential of electronic markets in enabling innovative product bundles through flexible and sustainable partnerships is not yet fully exploited in the telecommunication industry. One reason is that bundling requires seamless de-assembling and re-assembling of business processes, whilst processes in telecommunication companies are often product-dependent and hard to virtualize. We propose a framework for the planning of the virtualization of processes, intended to assist the decision maker in prioritizing the processes to be virtualized: (a) we transfer the virtualization pre-requisites stated by the Process Virtualization Theory in the context of customer-oriented processes in the telecommunication industry and assess their importance in this context, (b) we derive IT-oriented requirements for the removal of virtualization barriers and highlight their demand on changes at different levels of the organization. We present a first evaluation of our approach in a case study and report on lessons learned and further steps to be performed.

Keywords Telecommunication · Services · Process virtualization · Product bundling · Transformation

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Introduction

Telecommunication markets and companies have been subject to tremendous changes over the last several decades (Ahn and Skudlark 2002). In the "post-manufacturing" world services are of paramount importance (Chesbrough and Spohrer 2006), and service providers must ensure an efficient integration of intra- and inter-organizational service processes with their own backstage processes (Rust and Kannan 2003). Electronic markets are ideal for the formation of partnerships and for the realization of such inter-organizational processes: they coordinate the flow through supply-and-demand forces and external transactions between different actors (Brousseau and Chaves 2005). But electronic markets are not fully exploited by the telecommunication industry, because existing processes are too tightly coupled with backstage technologies. New technologies and service-oriented architectures alleviate the technical obstacles, but the re-design of business processes towards flexible bundling with partners is also and primarily a strategic issue. In this study, we focus on the "orchestration" of process re-design—in the sense of high-level planning as a strategic task. We use a customer-centric perspective for this task and study customer-related business processes. We identify requirements to be satisfied

for the virtualization of customer-oriented processes and provide guidelines for the removal of virtualization barriers.

The unexploited potential of electronic markets in the telecommunication industry is not due to unawareness: the need for product bundling is broadly recognized, primarily in the context of stronger customer orientation (Peppard and Rylander 2006; Minerva 2008). Technological impediments are also vanishing: already in 1987, Malone et al. (1987) pointed out that new Information Technologies allow a closer integration of adjacent steps of the value chain. Technical solutions allow for more flexibility by making process virtualization technically feasible. Grover and Saeed (2003) show that "a significant number of partnerships [in the telecommunication industry] are focused on controlling emerging technologies (35%) such as optical networks, […], and wireless Internet." However, such alliances are different from the partnerships stimulated in electronic markets, where a critical success factor is *interoperability,* in the sense of seamless integration of electronic partnerships (Yang and Papazoglou 2000; Legner and Vogel 2008). As Bertin and Crespi (2009) point out, the vertically disaggregated structure of telecommunication companies hinders even the modularization of processes. Service orientation can be a key to successful interoperability (Rust and Kannan 2003). Indeed, service orientation gains momentum in several industries, in accordance to the shift from a "goods-dominant logic" to a "service-dominant logic", as proposed by Vargo and Lusch (2004). The shift from products to services is also encountered in the telecommunication industry, where communication services are customer-oriented bundles of basic services (Zeithaml et al. 2006): both the provisioning of these basic services as well as the bundling (seen as an intermediary entity) is realized through new partnerships (Grover and Saeed 2003). However, the virtualization of formerly physical processes in the telecommunication industry into bundles of interoperable services is particularly challenging, in part because many physical processes are tightly coupled to a specific network technology (Bruce et al. 2008). In general, the overhead for the virtualization of physical processes may vary substantially, and the prioritization among them is a strategic matter.

In this study, we focus on customer-orientation as basis for the prioritization of processes to be virtualized. Customer orientation is a key factor in the highly competitive telecommunication industry (Czarnecki et al. 2010). We identify several tasks that strengthen the relationship between customer and company. We then determine factors that affect the virtualizability of processes, using the underpinnings of the Process Virtualization Theory (PVT) (Overby 2005; Overby 2008) as basis. We organize the identified tasks and the derived requirements for their virtualization into a framework with prioritization guidelines. In particular, our approach encompasses the following:

(1) *Mapping* the propositions of Process Virtualization Theory into the context of customer-oriented processes in the telecommunication industry, assessing the relevance and importance of each proposition for different kinds of products and services;
(2) *Deriving* IT-oriented requirements for the removal of virtualization barriers and assessing the radius of changes needed in the organization, in order to satisfy such requirements.

We thus assist the decision maker in setting priorities for the virtualization of processes, taking virtualization barriers, potential and side-effects of virtualization into account.

The rest of the paper is organized as follows. In the next section, we discuss related work on the transformation of business processes towards virtualization. In the section thereafter, we detail the components of our framework, which we outlined in the previous paragraph. We then present a case study, where we applied our framework to select the processes to be virtualized as part of a large transformation project. The last section concludes our study with a summarizing discussion and outlook.

Related work

Our study focuses on the orchestration of process virtualization at the strategic level, namely on selecting the processes that are candidates for virtualization, identifying the factors affecting their virtualizability and organizing processes and factors into a framework that can serve as basis for company-specific prioritization. To our knowledge, there are no studies with this objective. There are many advances on framing and promoting process virtualization at the operative level, e.g. through services and ontologies, and we review them below. At the strategic level, one can observe process virtualization as a task that requires large-scale company transformations. Enterprise Frameworks can assist in framing and organizing transformation projects in general, so we also discuss them in the following subsection and build upon them.

Enterprise architecture frameworks

Enterprise Architecture Frameworks deliver a proper fundament for the design of large-scale transformation projects. We elaborate on their goals, scope and shortcomings with respect to our objective. We first discuss general purpose frameworks and then proceed to frameworks designed for the telecommunication industry.

General enterprise architecture frameworks

The transformation of existing systems and processes towards a target situation can be described by the changes required to achieve it (Österle and Blessing 2003). Such changes require the coordination of strategic positioning, organizational structures and of business processes with IS design in an Enterprise Architecture (EA) framework (Winter and Fischer 2007). According to the ANSI/IEEE Standard 1471-2000, the "enterprise architecture" is a fundamental structure of an organization, its individual elements and their relationships to one another and to the environment. Whereas "enterprise architecture" represents a concrete representation of the as-is or to-be situation for a specific enterprise, an "enterprise architecture framework" includes meta-models for description, methods for design and evaluation as well as a standardized vocabulary (Winter and Fischer 2007). Hence, the aim of an EA framework is to provide an abstract context for the scope, analysis and structure of a company and its components, to better align business and IT requirements to each other. There are many generalized frameworks (Urbaczewski and Mrdalj 2006), such as the Zachman framework (Zachman 1997), which offers a categorization of aspects and methods for aligning IT and business with each other, and "The Open Group Architecture Framework" (TOGAF), which is particularly appropriate for setting up an enterprise architecture transformation procedure. For a detailed discussion and comparison of different EA frameworks see (Urbaczewski and Mrdalj 2006).

Enterprise architecture frameworks for the telecommunication industry

The TM Forum is a non-profit consortium that provides strategic guidance and practical solutions for the needs of telecommunication companies. When the need for a sector-specific enterprise architecture framework emerged in the telecommunication industry, the TM Forum designed a reference framework for service providers, suppliers, solution integrators, consulting companies and research institutions (Reilly and Creaner 2005). Their process model "Enhanced Telecommunication Operations Map" (eTOM) has become a de-facto reference standard (ITU-TM3050) for architecture and implementation in telecommunication companies (Knothe et al. 2007). eTOM is part of an integrated EA framework called "TM Forum Frameworx."[1]

Transformation projects in the telecommunication industry require guidelines for re-designing business processes and aligning them with the underlying information systems. To this end, eTOM categorizes business activities into different levels of detail (TM Forum 2009). At the highest level, it distinguishes among (1) *strategy, infrastructure and product processes,* which contain mostly internal tasks that realize the prerequisites for offering telecommunication products, (2) *operation processes* that cover all tasks for sales and delivery, usage and after-sales, and (3) *enterprise management processes,* i.e. supporting business processes (including accounting and human resources).

eTOM is a blueprint for standardizing business processes and represents the basis for managing IT applications, like operations support systems (OSS) and business support systems (BSS) from a process perspective. However, eTOM does not explain how to seamlessly de-assemble and re-assemble business processes from a strategic viewpoint, as required for electronic markets, nor does it address the requirements for virtualizing these processes to achieve the goal. In response to that, Czarnecki et al. (2009) propose an IT-business architecture that encompasses a framework for the implementation of Next Generation Network (NGN) on top of the eTOM processes. The framework consists of the layers "strategy", "business processes" and "Information Systems" in the context of business transformation towards flexible product/service bundling (cf. Fig. 1). The main concepts proposed are (1) the separation between service and transport, (2) the flexible bundling of services to product, (3) the streamlining of the IT infrastructure, (4) the alignment of strategy, processes and information systems, since the introduction of NGN requires changes throughout the company, and (5) an incremental migration plan. However, this framework is tailored to NGN. Moreover, it does not address the issue of virtualizability of business processes.

Technological drivers in telecommunication markets

Process virtualization requires technological changes, but they are only a specific sub-set of all requirements. Nonetheless, technological drivers are important for the realization of process virtualization, so more because the development of new products in most telecommunication companies has been earlier triggered mostly by technical innovations.

The decoupling of products and services from the underlying network is promoted by emerging technologies, like Next Generation Networks (NGN), which allow the separation of products, services and their supporting business processes from the transport (Knightson et al. 2005), and hence the design of services that are independent from the concrete technical implementation (Grida et al.

[1] In the past the TM Forum has used following terms for their EA framework: NGOSS, Solution Framework, TM Forum Framewox (in historical order). In our study we use the most recent one "TM Forum Frameworx."

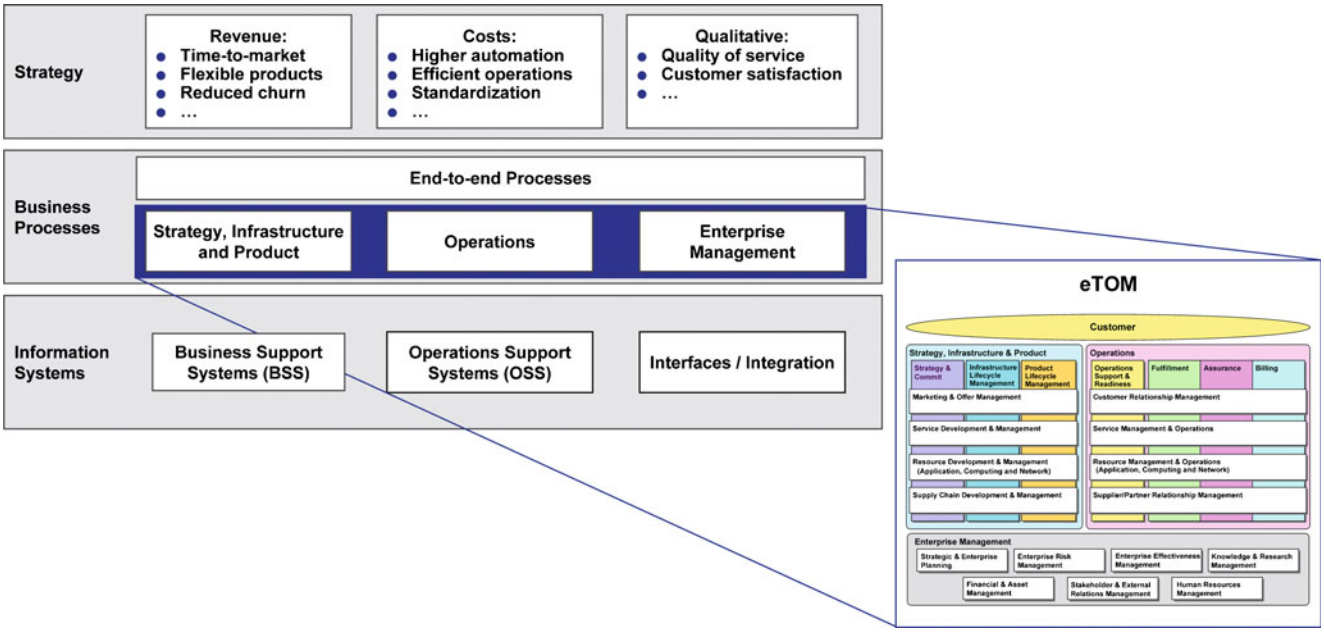

Fig. 1 IT-Business architecture for framing the transformation towards an NGN (Czarnecki et al. 2009)

2006). With such an infrastructure, telecommunication companies are able to offer technology-independent communication services (e.g. mobile phones with fixed line features at defined locations) with flexible product development and high process automation. We understand those technical features as an excellent technological basis for process virtualization. However the focus of our study is on strategic guidance; for technical aspects of process virtualization with NGN, the reader is referred to Knightson et al. (2005), Grida et al. (2006), and Czarnecki et al. (2009).

Flexibility and reusability of services is further promoted through service-oriented architectures (SOA) (Bertin and Crespi 2008): functionalities can be realized by IT-services, each of which performs a defined and limited task and is invoked in a well-defined way. However, telecommunication companies have discovered that the major challenge in applying SOA is not a technical one, but rather the identification and re-definition of the IT-services from a business perspective (Bertin and Crespi 2008). The SUPER project[2] (Born et al. 2007) offers a semantic business process management: it delivers a telecommunication-specific ontology for data, processes and goals (Pedrinaci and Domingue 2007; Born et al. 2007). Our study is orthogonal to SUPER, because we focus on the conceptual design of the process of virtualization itself.

[2] "Semantics utilised for Process Management within and between Enterprises" (SUPER) is a research project founded by an international consortium of software vendors, service providers and research teams. See www.ip-super.org for further details.

Orchestrating the task "process virtualization" with help of the process virtualization theory

In the following, we describe our stepwise approach for the virtualization of business processes. First of all, we organize business processes from the viewpoint of serving the customer. We then turn to the identification of virtualization barriers: we transfer the propositions of Process Virtualization Theory (PVT) into the context of customer-oriented processes and assess the importance of each proposition in that context. We next refine the propositions into IT-oriented requirements; their fulfilment waives the identified barriers. We map these requirements on the layers "Strategy", "Processes" and "Information Systems", thus indicating how far-reaching changes are required for virtualization. By this, we provide a framework with which a decision maker can prioritize the virtualization of processes, ranking them on the impact they will have, given the company's strategy, expertise and products.

Three steps towards process virtualization

A process is intuitively perceived as an assembly of activities towards a goal. Typically, a process requires physical interaction among people, or between objects and people. A "virtual" process is a process in which physical interactions have been removed (Fiol and O'Connor 2005; Overby 2008). To identify the changes required for virtualization of an existing process, we use the Process Virtualization Theory (PVT) proposed by Overby (2005). In Fig. 2, we show the three steps of framing PVT for our

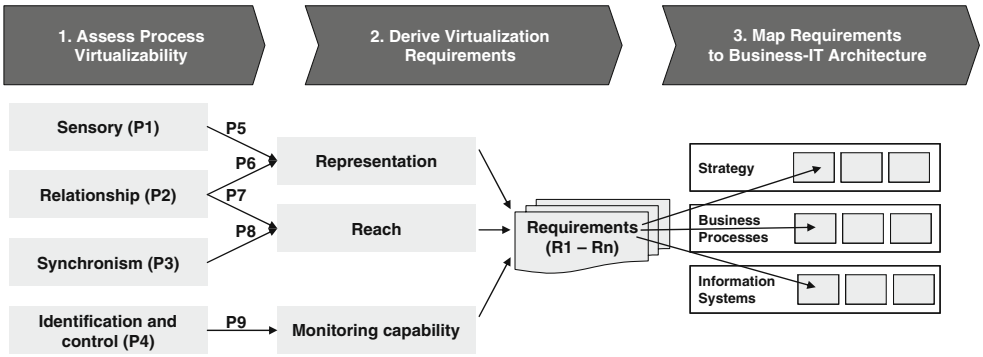

Fig. 2 Structure of our conceptual framework for process virtualization

objective. In step 1, we frame the propositions of PVT to the demands of customer-oriented processes. In step 2, we derive IT-oriented requirements for process virtualization. In step 3, we map these requirements to the layers of "Strategy", "Business Processes" and "Information Systems", highlighting their impact on the whole organization.

In particular, PVT offers four main "propositions" (cf. Fig. 2, leftmost part), namely sensory barriers (P1), relationship barriers (P2), synchronism barriers (P3), and identification and control barriers (P4); they are used to assess how suitable a specific process is for virtualization. For example, if customers demand haptic experience with a cellular phone before purchase (e.g. to test the touchscreen), then the sales process for this product has sensory barriers. We transfer these four propositions to the context of a telecommunication company, and identify processes for which virtualization barriers exist and must be dealt with. This is described in the first part of the next section.

PVT explicitly addresses the significance of IT in process virtualization. A *suitable representation of information* in virtual processes can compensate high sensory barriers (P5) and relationship barriers (P6), while a *reach* beyond formerly physical boundaries removes synchronicity barriers (P7) and relationship barriers (P8). The *monitoring capabilities of IT* (P9) can be used e.g. to ensure secure sales transactions, while a suitable description of products on the Web, including pictures and ratings, may help to overcome sensory barriers (P5). For our process virtualization framework we refine the IT-oriented moderated propositions P5-P9 into requirements for IT-support in the telecommunication industry, as described in the second part of the next section. To capture the organizational changes necessary for satisfying these requirements, we map them to a specific business-IT architecture (cf. rightmost part of Fig. 2), which encompasses the layers "strategy", "processes" and "information systems", as described later in more detail.

Prioritizing the PVT propositions for customer-oriented processes

We place the four propositions of Process Virtualization Theory (PVT) in the context of telecommunication companies. To achieve this, (1) we use the eTOM standard as basis and (2) we organize business processes from the perspective of customer-orientation into the categories "sales", "usage" and "after-sales (support)", as shown in Table 1 and explained in sequel.

To assess the importance of each proposition, i.e. each type of barriers for sales, usage and after-sales processes, we use literature advances. We found that the virtualizability of the processes is not completely independent of the

Table 1 The four PVT propositions, transferred on customer-oriented processes in the telecommunication industry

	P1: sensory barriers	**P2**: relationship barriers	**P3**: synchronicity barriers	**P4**: identification & control barriers
Sales	HIGH for lifestyle products LOW for other products	HIGH for product bundles LOW for simple products	HIGH especially for product bundles	HIGH mostly SATISFIED
Usage	HIGH for lifestyle products LOW for other products	not applicable	HIGH especially for product bundles	HIGH mostly SATISFIED
After-sales support	HIGH for products requiring support on site	HIGH for product bundles LOW for simple products	HIGH especially for product bundles	HIGH mostly SATISFIED

products themselves, since literature refers to very different kinds of telecommunication products: sensory barriers are very important for lifestyle products (e.g. a mobile phone with touch-screen) during the sales phase (Mikkonen et al. 2008), but less so for a fixed-line phone connection. The latter may rather require physical interaction for trouble-shooting; hence it exhibits sensory barriers in the after-sales phase (Isenberg 1998). Services like roaming are virtual and thus pose no sensory barriers during usage (Bertin and Crespi 2008). The argument of Mikkonen et al. (2008) on the sensory barriers of lifestyle products hold also for their usage. These results are reflected in the leftmost two columns of Table 1.

Synchronicity barriers are obviously important for any bundle of products or services during all three phases. Isenberg (1998) mentions this for products, the provisioning of which requires physical work. However, it is apparent that synchronicity covers more cases than fixing cables in the vicinity before the Internet access service can be used. Beyond that, Minerva (2008) also points out the need for real time synchronization during the usage of some products. We capture these results in the third column of Table 1.

Identification and control requirements can be seen from different perspectives. Identification of customers and of services to which they have subscribed is valuable during sales (Bruce et al. 2008) and usage (Cameron and Velthuijsen 1993; Ondrus and Pigneur 2007). Authentication and control of usage are needed to prevent misuse; this aspect is important, but the nature of telecommunication products allow us to consider it satisfied.

We can see from Table 1 that measures to overcome barriers are mostly needed for lifestyle products and for product bundles. This is expected, since the need for process virtualization and the interest in exploiting the potential of electronic marketplaces to that end have essentially emerged from the need to serve customers with flexibly designed product bundles. Table 1 can thus assist the decision maker in identifying virtualization barriers, as well as processes for which virtualization is easy.

Virtualization barriers can be overcome with judicious IT-support. PVT already stresses the significance of IT in this context. We maintain the PVT categorization of the IT-oriented, so-called "moderated" propositions P5-P9 (cf. Fig. 2) into "Representation", "Reach" and "Monitoring", since they fit excellently to our customer-oriented categorization of processes. In Table 2, we link these three aspects to the sales, usage and after-sales processes in the telecommunication industry and we refine propositions P5-P9 into more concrete requirements.

The IT-oriented requirements on Table 2 are at different levels of abstraction: contrast e.g. requirement R10 on supporting the usage of product bundles to requirements R7 on secure transactions and R1 on product representation. This difference in the degree of abstraction reflects the extent to which telecommunication companies can exploit background knowledge from other sectors and modularized processes from the own sector. For example, it is known that secure transactions (R7) are indispensable and, indeed, this requirement is mostly satisfied (cf. Table 1, rightmost column). It is also known that proper representation of products (R1) can compensate sensory demands, at least for some products (cf. Table 1, leftmost column, box on Sales). Contrast this with R10: the type of IT-support required for seamless usage of all components of a product bundle, e.g.

Table 2 Derived requirements for moderating propositions for virtualized processes in telecommunication

	Representation (compensating sensory and relationship barriers with IT)	**Reach** (compensating sensory and relationship barriers with IT)	**Monitoring** (compensating identification & control barriers with IT)
Sales	IT-support for • product description **(R1)**, e.g. multimedia • product selection **(R2)** • access to non-virtualized assistance **(R3)**	IT-support for contact channels with • high reachability **(R4)** • remote fullfillment **(R5)** • reliable time commitment (**R6**)	Secure transactions **(R7)** Reliability in • customer identification **(R8)** • portfolio processing (**R9**)
Usage	• IT-support (also at network level) for seamless usage of the components in a product bundle **(R10)**	Network level support for • high quality of the communication **(R11)** • high coverage **(R12)**	Reliability in • authorization and usage control **(R13)** • mediating usage data (**R14**)
After-sales support	IT-support for • troubleshooting **(R15)**, e.g. case-based reasoning • access to non-virtualized assistance **(R3)**	IT-support for contact channels with • high reachability **(R4)** • reliable time commitment **(R6)** • remote assurance **(R16)**	Secure transactions **(R7)** Reliability in • customer identification (**R8**)

of broadband Internet combined with TV services, can only be detailed by the service providers.

The derived requirements of Table 2 serve two purposes. First, juxtaposition with Table 1 allows a decision maker to assess how easy it is to satisfy these requirements and thus benefit from process virtualization. For example, the first and second column of Table 1 indicate that requirements R1-R3 on IT-support for product representation (Table 2) are easy to satisfy for simple products, so that Sales processes for those products are candidates for virtualization and perhaps delegation to a competent partner. On the other hand, R1-R3 are difficult to satisfy for lifestyle products, R10 is indispensable for bundling, and R4-R6 require coordination with the partners providing the components of the product bundle. Hence, a decision maker obtains an overview of the requirements that involve coordination overhead.

Further, Table 2 assists the decision maker in assessing the changes needed within the own institution. In particular, we place the requirements in Table 2 across the layers "Strategy", "Processes" and "Information Systems" as explained in the next section. Obviously, requirements appearing only in the Information Systems layer can be realized with less organisational changes than requirements appearing also in the Strategy layer.

Addressing virtualization requirements

The mapping of the IT-oriented requirements of Table 2 on the layers of an enterprise has been an iterative process, guided by real-life implementations of the IT-Business Architecture proposed in (Czarnecki et al. 2010) and expert roundtable discussions. The objective of this process was to deliver insights into the complexity associated with the removal of virtualization barriers for product bundles (cf. Table 1), using the more concrete requirements of Table 2 as basis. The complete mapping is depicted in Fig. 3 and explained hereafter.

As we see in Fig. 3, use of multimedia for product description (R1) belongs to the Information Systems layer and should be considered in the redesign of the business support system (BSS). However, the operations processes themselves do not need to be modified. Contrast this with requirement (R13) on reliable authorization and control, which demands IT-support in the BSS and also the redesign of the corresponding business process; this may ask for arrangements among several partners. We also see that the virtualization of operations processes affects further processes. For example, the realization of remote fulfillment (R5) requires changes of infrastructure-related and product-related processes. Thus, some requirements imply only changes in one part of the architecture, while other requirements need several changes. Hence, the removal of virtualization barriers must be considered against the associated overhead at each layer, as follows.

Alignment to strategic goals Convergent products (e.g. combination of broadband Internet with TV services) as product bundles (R10) allow customers to experience innovation and thus contribute to goals like customer satisfaction. High coverage (R12) and high reachability of contact channels (R4) overcome limitations in time and distance, but give raise to additional costs. For example, R4 may incur additional staff. So, the requirements must be aligned with the goals at the "Strategy" layer.

(Re-)design of "operations" processes Product bundles are complex and often have short time-to-market cycles.

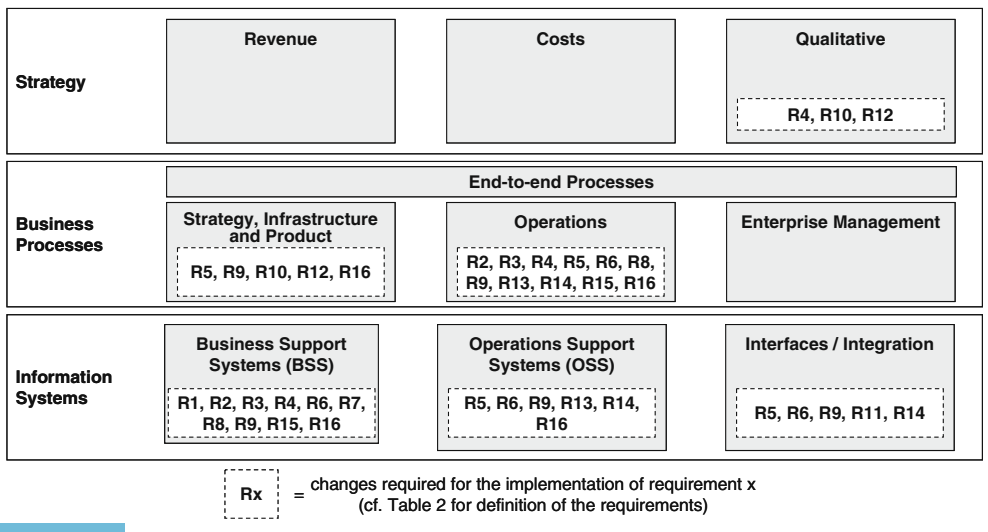

Fig. 3 Mapping the derived requirements into the IT-Business architecture

Systems can be used to support product selection (R2) and problem solution (R15), next to a non-virtualized support (R3). Such IT affects the Operations: to deliver correct recommendations and to assist in troubleshooting for complex products, a reliable connection between system and human experts is needed, delivering feedback from the humans to the system and vice-versa. To ensure high reachability of contact channels (R4), the business processes must be adapted. Reliable identification of customers (R8) and reliable mediation of usage data (R14) are needed at every customer-contact process; billing and customer-contact processes must be adjusted accordingly.

(Re-)design of "strategy, infrastructure and product" processes High coverage (R12) and the realization of convergent products (R10) affect production. They also demand synchronization with external partners, possibly via an electronic marketplace. This implies changes in the infrastructure, including compliance to standards, all of which require strategic, long-term planning.

(Re-)design of "operations" and "strategy, infrastructure and product" processes Requirements like remote fulfilment (R5) and remote assurance (R16) go one step beyond the requirements of the previous category, by demanding both strategic, long-term planning, as well as adjustment of Operations. Appropriate infrastructure for information exchange among processes of different partners is also needed for retrieving a customer's product portfolio (R9) and deciding what further products to recommend.

(Re-)design of BSS and/or OSS Most requirements appearing at the higher layers are obviously propagated downwards to the IS layer, and need not be repeated here. Others, like multimedia for product descriptions (R1) may be observed as purely technical; they are realized within the BSS without influencing processes. However, IT solutions can be exploited within a process (e.g. for marketing purposes). This corresponds to upward propagation (here: towards the "Processes" layer); we have not addressed propagation towards higher layers, but it seems worth investigating further.

Interfaces/integration Remote fulfilment (R5), remote assurance (R16), reliable time commitments (R6), retrieval of a customer's product portfolio (R9), and reliable mediation of usage data (R14) are all requirements at the business process level and demand interfaces to the network technology. The quality of service (QoS) (R11) refers to the technical quality of communication services; it is a purely network related requirement but is indispensable for reliable virtualization.

With help of our framework, a decision maker can proceed with the virtualization of business processes across the following guidelines: (1) existence of virtualization barriers, as captured in Table 1 for different types of telecommunication products; (2) availability of and expertise on IT solutions for the requirements on representation, reach and monitoring, as depicted in Table 2; (3) impact of the requirements upon the different layers of the architecture depicted in Fig. 3; and (4) alignment with the strategic objectives of the organization.

From the technical perspective, the *migration* from a formerly physical process to a virtual one incurs investment costs. Further, the interdependencies between a process to be virtualized and other processes may have effects on the migration plan (Schekkermann 2005) and must be taken into account. The recording and categorization of all those aspects can be assisted by methods that capture the semantics of business processes, as proposed in the SUPER project (Pedrinaci and Domingue 2007).

A first validation of our framework

The first part of our framework, summarized in Table 1, is directly supported by literature. For the derived IT-oriented requirements (Table 2) and the mapping to the layered architecture of Fig. 3, we provide here a first validation through a real project. That project was in many ways representative of how process virtualization efforts take place in the telecommunication industry; details on it can be found in (Czarnecki et al. 2009).

The project took place in a large telecommunication company, offers phone, broadband and mobile services in a highly competitive market environment. Purpose of the project was to introduce a NGN technology. At the upper part of Fig. 4, taken from (Czarnecki et al. 2009), we depict the strategic objectives, the processes and the systems that were affected. We mark them with numbers in dotted circles and map them, in the lower part of Fig. 3, to the components of the layers of our framework. This design of the transformation towards NGN can be observed as generalizable to other companies of the same size in the telecommunication sector.

The appearance of Customer Relationship Management (CRM) in the upper part of Fig. 4 must be stressed first. The strategic goals that led to the introduction of an NGN were: turnover increase, production cost reduction, and churn decrease through stronger orientation towards customers. Hence, the strong customer-orientation attributed to telecommunication companies according to literature is also reflected in this project. This justifies our decision for the customer-oriented perspective from the practitioners' viewpoint as well.

The separate assignment of requirements to the BSS, OSS and Interfaces of the Information Systems layer (cf. lower part of Fig. 4) finds a justification here. The separate treatment of BSS and OSS is promoted by the TM Forum Frameworx. In the project itself, the project team has

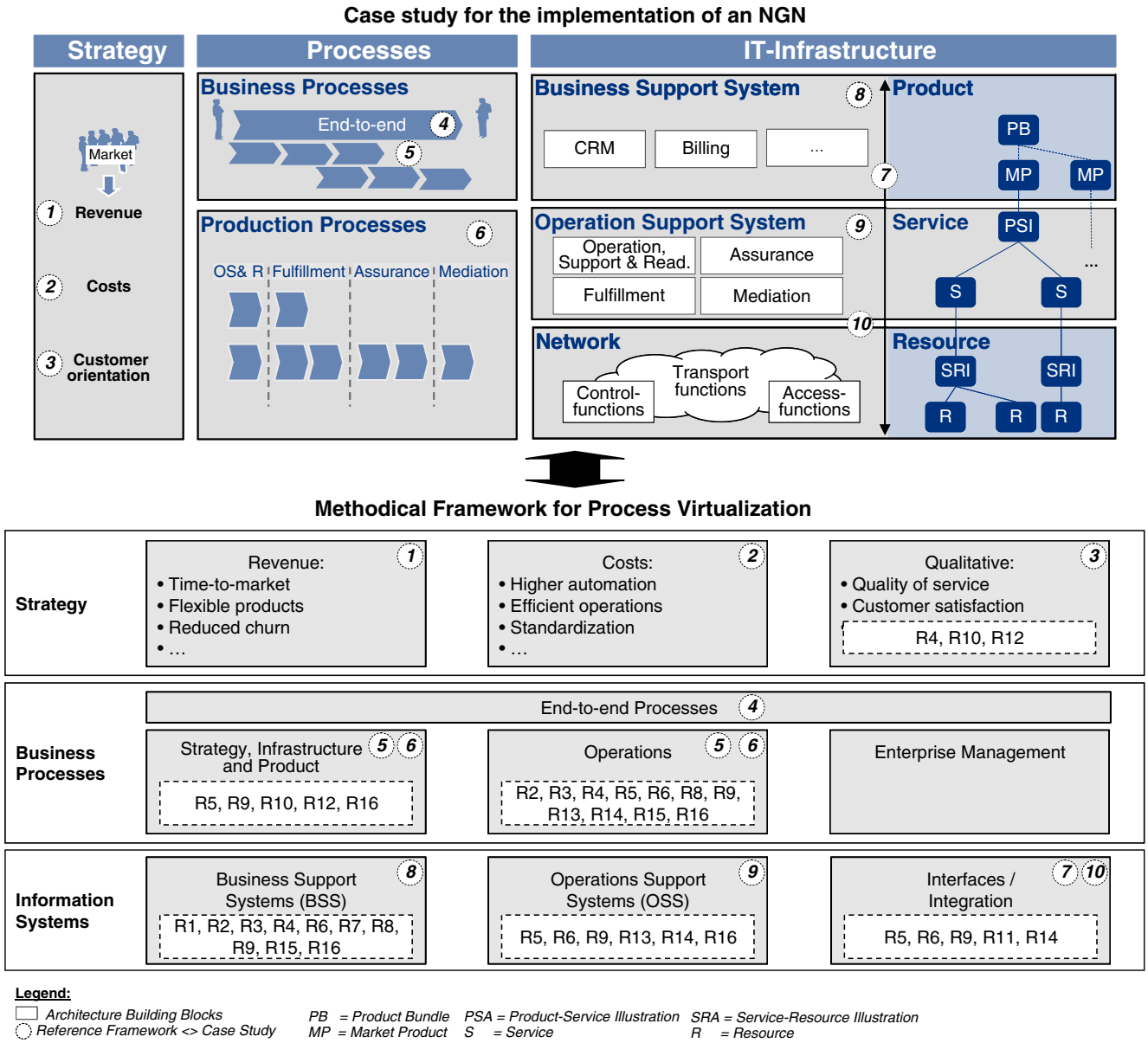

Fig. 4 Case study on NGN implementation (*upper part*), mapped to our framework (*lower part*)

redesigned the OSS completely, but managed to leave the BSS unaffected. This indicates that a separation between Operations Support and Business Systems Support allows the decision maker to focus on processes whose virtualization is only within the OSS.

The IT-oriented requirements of Table 3 are generalizations of the requirements recorded by the project team for the specific needs of the company. In particular, we see that several requirements were satisfied as part of a Web-based shop solution, while others required dedicated IT-support and involved changes at the Operations ("Business Processes"). This indicates also that some rather intuitive requirements like R1, R2 and R7 can be satisfied easily with state-of-the-art technology.

At the end of such a project, one faces the question of how to transfer lessons learned to future projects. One of the early lessons learned was that close steering by the top-management, combined with fast decision making, are mission-critical: the implementation required changes in many different parts of the company, while interplays with existing processes and systems and side-effects on other projects had to be taken into account.

Further, the top-management ensured that experts are available for advice and troubleshooting throughout, and actively promoted awareness on and visibility of the project from its early stages on. Moreover, changes that would affect employees and customers were identified and planned carefully; supportive measures like training and

Table 3 Requirements in our framework and customer-oriented tasks identified and realized in the case study

Relevant project parts	Addressed virtualization requirement
Web-based shop solution integrated with processes and systems of other contact channels	R1, R2, R7
IT system to support product choice based on existing portfolio and configuration for all contact channels	R2, R4
Interface to root customers between internet and customer care centre	R3, R4
Automation of fulfillment process by optimized IT implementation	R4, R5
Workforce management processes and system for service technicians integrated in all contact channels	R6
Optimized contact management processes and systems to assure an integrated view on the customer and his existing product portfolio	R8, R9
Development and launch of convergent product bundles (including required changes of processes and IT)	R10
Improvement of network based on NGN technologies	R11, R12
Introduction of usage process for convergent products (including required IT realizations)	R13, R14
Optimized assurance process and systems and integration in all contact channels	R4, R15, R16

dedicated marketing campaigns were scheduled. These measures contributed greatly to the smooth realization of the project, and we believe that they are of major importance for similar projects.

Discussion, limitations and future research

Telecommunication companies need means for flexible bundling of communication services from various stakeholders, and the ideal environment for satisfying this need is an electronic marketplace. However, the prerequisites for exploiting the full potential of interoperability, smooth interaction with partners, flexibility in the combination of services and in the exchange of data are not yet satisfied, not least because of the entanglement of complex products with product-specific processes. In this study, we propose a conceptual framework that serves as guidance for the virtualization of processes in the telecommunication sector: We have taken the barriers for process virtualization, stated by the Process Virtualization Theory (PVT), as input, and derived requirements for customer-centric processes in the telecommunication industry. We have ranked the barriers on relevance for different types of products. We have derived IT-oriented requirements for the removal of virtualization barriers and highlighted the impact of these requirements on strategy, business processes and information systems. Hence, our framework can assist a decision maker in setting priorities in the virtualization of processes. Our framework does not dictate these priorities, but allows a decision maker to select processes on the ease with which they can be virtualized, the availability of IT-solutions that can serve as basis for the satisfaction of IT-oriented requirements, and the impact of virtualization at different layers of the enterprise.

Further steps are needed to consolidate the proposed framework towards concrete guidelines for the virtualization of processes and the establishment of flexible partnerships using virtualized processes. First of all, the IT-oriented requirements for the removal of virtualization barriers must be extended and possibly ranked on importance and difficulty. Furthermore, the mapping into the three layers “Strategy”, “Business Processes” and “Information Systems” must be refined to shed more light into process interdependencies.

We have validated our framework on a real-life project. Frameworks of this scale are difficult to validate empirically, since their success in a real-life scenario also depends on external factors that cannot be controlled. We therefore intend to use literature findings and to aggregate insights from independently conducted case studies, primarily for the validation of the IT-oriented requirements.

Presently, our emphasis has been on customer-orientation in the telecommunication industry, focusing on the customer as only stakeholder. This is somehow limiting. For the deployment of the potential of electronic markets, the perspective of other stakeholders, notably that of potential market partners, should also be taken into account. For our framework, this implies further differentiation between general and industry-specific parts.

Other stakeholders can be integrated by organizing business processes from multiple perspectives, one per stakeholder, and then allowing the decision maker to define priorities for virtualization, depending on the strategy of the company towards each of the stakeholders.

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