Reference Process Flows for Telecommunication Companies

An Extension of the eTOM Model

New business models, innovative services and technologies require transformations in the telecommunication industry. With the Enhanced Telecom Operation Map (eTOM), the TM Forum offers a recognized reference process model for telecommunication companies. However, eTOM only offers a hierarchical collection of processes on different levels of abstraction. In this paper, we extend the eTOM model by reference process flows. We offer a control view in terms of a sequential ordering of tasks and hence a real process flow. This provides an end-to-end view on the customer. Furthermore we show how the reference process flows assist companies towards a structured and transparent re-design of their processes. Our results have been accepted and published as standard by the TM Forum.

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The Authors

Dipl.-Wirt.Inf.
Christian Czarnecki (✉)
Detecon International GmbH
Sternengasse 14–16
50676 Cologne
Germany
christian.czarnecki@detecon.com

Prof. Dr. Axel Winkelmann
Julius-Maximilians-University
Wuerzburg
Stephanstrasse 1
97070 Wuerzburg
Germany
axel.winkelmann@uni-wuerzburg.de

Prof. Dr. rer.nat./Griechenland habil. Myra Spiliopoulou
Otto-von-Guericke-University
Magdeburg
Universitaetsplatz 2
39106 Magdeburg
Germany
myra@iti.cs.uni-magdeburg.de

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Christian Czarnecki is also a PhD student at the Otto-von-Guericke-University Magdeburg.
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1 Introduction

Telecommunication markets and companies have been subject to extensive changes over the last decades (Grover and Saeed 2003, pp. 119–120). The need for large-scale transformation projects has emerged, in which technology and enterprise architectures play a central role (Czarnecki et al. 2011, pp. 183–185). New value chains must be developed to realize innovative bundle products (Mikkonen et al. 2008, p. 178; Pousttchi and Hufenbach 2011, p. 287), cost reductions must be enforced (Bruce et al. 2008, p. 16), and high customer expectations regarding service quality must be accounted for (Peppard and Rylander 2006, p. 134).

With these changes, the need for process reengineering in the context of new products and communication technologies is apparent (Peppard and Rylander 2006, p. 130; Minerva 2008, p. 38). Bub et al. (2011, p. 253) point out that in the telecommunication industry the use of specific reference models is essential for the harmonization of business processes and information technology. We therefore propose an industry-specific process reference model in the form of reference process flows (RPF), in which we abstract and generalize the knowledge about processes in telecommunication companies and assist in restructuring and re-designing processes in a more disciplined and structured way than before.

The concept of reference models is widely accepted in information systems research (e.g., Thomas 2005; Fettke and Loos 2007). Cost and time savings, as well as increased quality, can be seen as main motivations for the use of reference models. However, a reference model makes sense only if it covers an adequately large problem domain. At the same time, a reference model is of benefit only if it can serve as basis for the construction of a (company-) specific model (Thomas 2005, pp. 23–24). In literature this issue is discussed mainly from a methodical perspective (Becker et al. 2007; Thomas 2007; vom Brocke 2007). In contrast, Fettke and Loos (2007, p. 13) point out that research should provide insights in the application of reference models in practice. Our work brings forth these in-

sights for process reference models in the telecommunication industry.

A reference model tailored tightly to practice demands is "enhanced Telecom Operation Map" (eTOM), a de facto standard (ITU-T M3050) for best-practice telecommunication processes, developed by the international non-profit organization TM Forum. However, eTOM has "only" been a hierarchical collection of process activities so far: it does not contain a recommendation on how to combine such activities to sequences, i.e. process flows. This means that the control aspect, though indispensable for the execution of a business process (Kelly 2003, p. 111), is lacking in eTOM. Further missing elements are: the definition and documentation of interrelations in process activities, considered crucial in process design (Axenath et al. 2005, p. 48), and a graphical representation (including swim lanes and interfaces), which is essential for the use of business process reference models in inter-organizational cooperation (Legner and Wende 2007, p. 116). Due to those shortcomings the potential of eTOM is not yet fully exploited.

In this study, we address the demand of the telecommunication industry for a reference model that explicates and puts structure into the interplay of strategy, processes and information systems. In particular, we extend eTOM with RPFs; these are sequences of process activities towards a predefined outcome dictated by eTOM. We define as RPF an end-to-end sequence of activities, designed to adhere to the hierarchy and decomposition scheme of eTOM. These RPFs concretize the generic processes defined in eTOM, keeping them company-independent but in accordance with the process terms and normative statements specific to the telecommunication industry.

Our approach encompasses an explicit domain structure: the RPFs we propose are organized in four domains, which cover and interlink primary activities and support activities of the value chain. In doing so, we particularly emphasize customer orientation: our four domains distinguish value chain activities into (a) such that incorporate customer interaction and (b) such that support customer interaction. On the basis of this domain structure, we define concrete RPFs and link them to predefined eTOM tasks (called "activities" in eTOM).

Our contribution is twofold. First, we propose a reference model for the telecommunication industry, which builds upon an established framework (eTOM) and enriches it with process specifications and an indispensable control aspect. As a second contribution, the procedure we followed for designing, introducing, and evaluating this reference model encompasses steps that are applicable beyond the telecommunication industry, so that other industries may benefit from it.

The paper is organized as follows. In Sects. 2 and 3 we survey existing frameworks and reference models that provide guidelines for the transformation of information systems and processes: Sect. 2 describes general approaches, while Sect. 3 covers solutions for the telecommunication industry. In Sect. 4 we briefly describe our research goals and procedure. In Sect. 5 we present and detail our RPFs. In Sect. 6 we then evaluate our approach by means of (1) the implementation of two case examples, (2) the standardization by the TM Forum and (3) the application of the multi-perspective approach of Frank (2007). In Sect. 7 we recapitulate our approach to distinguish among industry-specific and industry-independent elements, and elaborate on how the latter can be transferred to other industries. Summary, limitations and further research steps are discussed in Sect. 8.

2 Supporting Transformation – A Literature Overview

Research on systems and processes that support transformation includes enterprise architecture frameworks, reference models and process reference models. Common among these advances is the challenge of being generic (i.e., independent of concrete companies and contexts), and at the same time easily adaptable to specific requirements and formalisms. Accordingly, there is a proliferation of concepts designed to address the demands and constraints of whole industrial sectors.

In Sect. 2.1 we discuss enterprise architecture frameworks and distinguish among those that are mostly industry-independent and those designed for a specific industry. Reference models and process reference models are mostly industry-dependent. Hence, we provide only general definitions in Sects. 2.2 and 2.3; we then discuss the reference models and process reference models relevant to the telecommunication industry in Sect. 3.

2.1 Enterprise Architecture Frameworks

On the basis of the ANSI/IEEE Standard 1471-2000, the "enterprise architecture" (EA) can be considered as a fundamental structure of an organization, reflecting its individual elements and their relationships to one another and to the environment (Winter and Fischer 2007, p. 7). An enterprise architecture captures the as-is or to-be state of a specific enterprise, while an enterprise architecture framework includes meta-models for the description of enterprise architectures, methods for their design and evaluation as well as a standardized vocabulary (Winter and Fischer 2007, p. 7).

There are many generalized frameworks, including the "Zachman framework" that offers a categorization of aspects and methods for the alignment between IT and business (Zachman 1997), and "The Open Group Architecture Framework" (TOGAF) (Open Group 2011). TOGAF is particularly appropriate for setting up a company-specific enterprise architecture transformation procedure.

Many EA frameworks distinguish among layers that capture systems and business processes separately (Winter and Fischer 2007, p. 8). In the context of supporting transformation, decision makers and designers might use such frameworks to first record the transformation tasks at each layer, and then work on the interplay among layers. However, the use of a general EA framework requires further detailing and development of specific solutions, based on the problem domain. To assist with this task, Noran (2006, pp. 144–145) proposes a structured repository of reference models to select from for specific EA tasks, while Moser et al. (2009) propose concrete process patterns. Although these patterns are industry-independent, they need further detail to transform existing systems and processes in a specific sector. For a detailed insight and comparison of many different EA frameworks, including some for specific industry sectors, the reader is referred to Aier et al. (2008).

2.2 Reference Models

Many EA frameworks – especially those for specific sectors – contain reference models that incorporate best-practice solutions. While a concrete model has to fit a clearly defined situation, a reference model is a point of reference for a whole range of situations with the clear purpose of reuse (Thomas 2005, pp. 21–24). Distilling lessons learned by a company into a reference model for a whole sector is of obvious benefit to further companies of the same sector.

Fettke and Loos (2004, p. 332) propose the following interpretation of reference models, while a concrete reference model can combine one or more types:

- A reference model as terminological instrument contains a collection of terms or a frame of reference for terms. It is comparable to an ontology.
- A reference model as a set of singular statements means the exact modeling of an artifact observed in reality, i.e., in one specific company.
- A reference model as a set of general statements contains generalizable models that are true for a specific problem domain, i.e., for a class of companies.
- A reference model as a set of normative statements contains rules and policies that are binding in a specific context.
- A reference model as technique sets the focus on the applicability and benefits.

The reference models we discuss in Sect. 3 mostly serve as terminological instruments.

2.3 Process Reference Models

A process model is an enterprise-specific description of the activities, people and artifacts involved in the execution of a process. There are various notations for process models, like Business Process Modeling Notation (BPNM), Unified Modeling Language (UML), or Event-Driven Process Chain (EPC). For the standardization of process models, Axenath et al. (2005, p. 45) identify a specific category of reference models, which they call process reference models. Fettke et al. (2005) survey the similarities and differences of 30 process reference models. Later, Fettke and Loos (2007, pp. 3–4) point out that a process reference model should be generalizable from a specific enterprise and have a recommendation character for a problem domain. Our problem domain is process transformation towards customer orientation, flexible product bundling and separation between service and support.

Axenath et al. (2005, pp. 45–49) stress the challenge of devising a process reference model that is both general and customizable. To facilitate customization, they propose following aspects/categories:

- Integral aspect comprises the activities of a process which can be atomic or compound.
- Structuring aspect contains the distinction between atomic and compound activities.
- Organizational aspect links the organizational structure to the activities of the process.
- Informational aspect describes the information objects and their exchange between different activities.
- Control aspect defines the order in which the different activities are executed.

We use these aspects to discuss the extension of eTOM in the next section.

3 Transformation in the Telecommunication Industry

Transformation in the telecommunication industry is often triggered by the increasing importance of services – both with respect to customer expectations and with respect to technical requirements. As Chesbrough and Spohrer (2006, p. 36) point out, services are of paramount importance in the post *manufacturing world*. The services offered by telecommunication companies are highly dependent on the underlying technologies. New technologies like Next Generation Networks can be used as a basis for innovative communication services, but they require major changes in the provider's value chain and demand the harmonization of processes and systems to it (Bub et al. 2011, p. 253). Examples of such changes include:

- Formation of new kinds of strategic partnerships: Grover and Saeed (2003) found out that "a significant number of partnerships [in the telecommunication industry] are focused on controlling emerging technologies".
- New system requirements: Bruce et al. (2008) discuss how the cost models of new communication services lead to changes in the IT requirements of the underlying systems.
- Changes in the value chain: Pousttchi and Hufenbach (2011) developed a reference model for the changed value chains of mobile operators.
- Changes in processes: In Czarnecki et al. (2012), we analyzed 180 transformation projects in the telecommunication industry and found that companies define multiple projects dedicated to the modification/adaption of processes and systems according to new demands.

To support telecommunication companies in aligning their processes and systems to emerging technologies, to increased customer expectations and to new partnerships, the TM Forum has designed an industry-specific EA framework for the telecommunication industry (Reilly and Creaner 2005) which is called "Frameworx".[1] Frameworx adheres to the general structure of EA frameworks (especially TOGAF) – its layers contain recommendations for business processes, and for application, information and system integration, as well as a repository of documentations, models, and guidelines.

In this study, we focus on the Business Process Layer of Frameworx. This layer contains the "enhanced Telecom Operation Map" (eTOM), an industry-specific reference model for the business process layer of an enterprise architecture. eTOM has become a de facto standard by the International Telecommunication Union (ITU-T M3050). eTOM Version 8.0 organizes business processes into levels. At Level 0, eTOM distinguishes among (1) *strategy, infrastructure, and product processes* containing mostly internal tasks that realize the prerequisites for telecommunication products, (2) *operation processes* that cover all tasks for sales, delivery, usage, and after-sales, and (3) *enterprise management processes,* i.e. all support tasks, including accounting and HR. These tasks are refined further, as in the example of **Fig. 1**. For example, the Level 0 process group "Operations" contains a subgroup "Customer Relationship Management" at Level 1, and "Selling" and "Order Handling" processes at Level 2. The process "Selling" is further detailed in activities at Level 3, e.g., "Manage Prospect" and "Negotiate Sales".

[1] In the past, the TM Forum has used different terms for their EA framework (least recent one first): NGOSS, Solution Framework, TM Forum Frameworx. They can be seen as equivalent. We use the most recent one, TM Forum Frameworx.

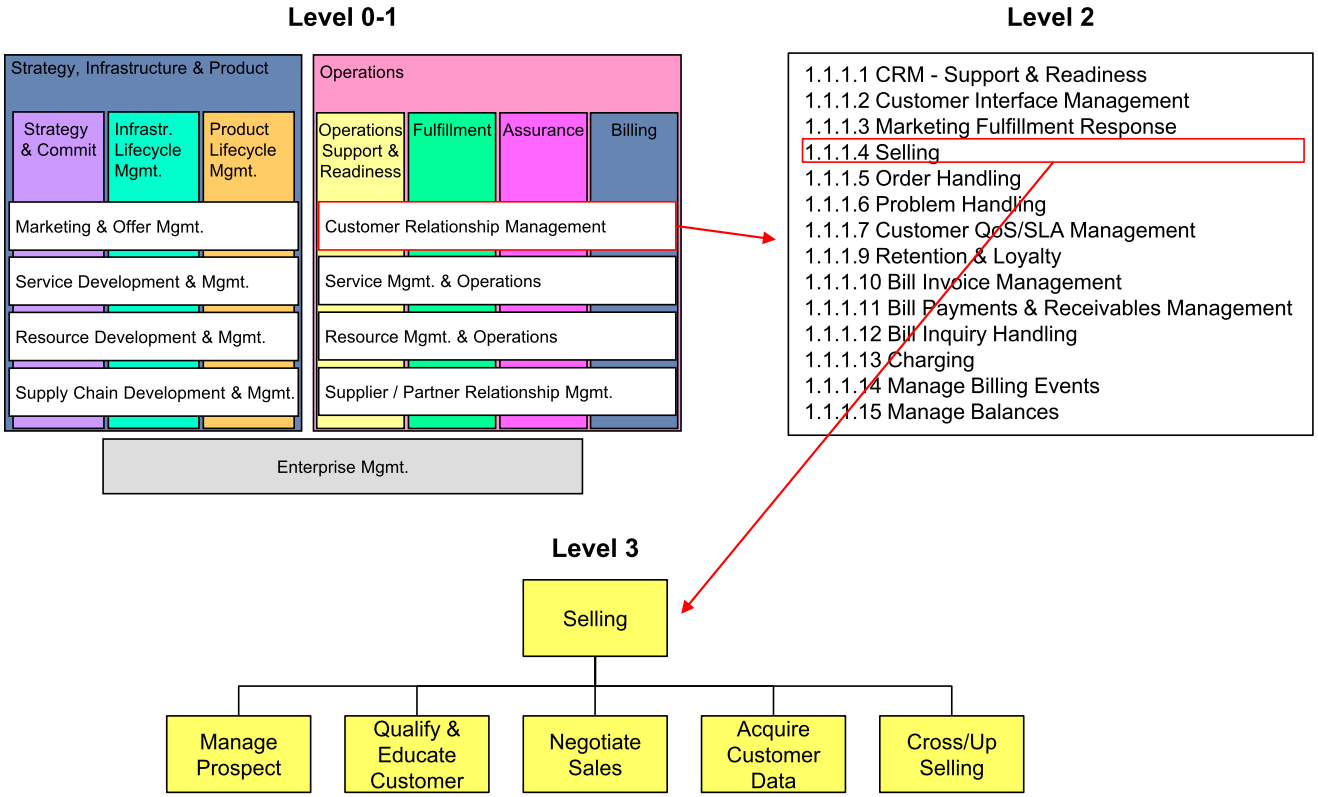

Fig. 1 eTOM example with tasks from Levels 0-3 and links among the levels

According to the typification of Fettke and Loos (2004, p. 332), eTOM (Version 8.0) is a terminological instrument: it contains a hierarchical structure and vocabulary for business processes in the telecommunication industry. With respect to the specific aspects proposed by Axenath et al. (2005, pp. 47–49) for process reference models, eTOM covers the *integral* and *structuring aspects* in its hierarchical structure, and it addresses also the *informational aspect* in its information layer (see **Table 1**).

However, Version 8.0 of eTOM does not provide any means for sequencing the activities of a process, i.e., it lacks the control aspect. For example, observe the eTOM decomposition of the selling process into "Negotiate Sales" and "Cross/Up Selling" in **Fig. 1**. Which activities provide input for "Negotiate Sales" and which activities follow after a successful "Cross/Up Selling"? To overcome this shortcoming, Snoeck and Michiels (2002) proposed the design of an ordering process flow for telecommunication companies but focused on a single product catalogue.

In this work, we extend eTOM Version 8.0 with the control aspect: to this purpose, we introduce RPFs, i.e. sequences of activities that concretize eTOM's abstract reference processes.

4 Research Goal and Procedure

In accordance with the design objectives of the German Business and Information Systems Engineering (BISE) community, this work proposes a process reference model for a specific industry. The objective of this process reference model is to capture the most important processes in this industry at an abstract level, anchor them in the value chain, highlight their role in serving the customer, and record their interplay with underlying technologies, systems and other processes. Our process reference model encapsulates best practices and research findings in RPFs, i.e. abstract processes, which are sufficiently concrete to express the demands of telecommunication companies. Hence, the use of RPFs allows practitioners in the telecommunication industry to plan and coordinate the transformation of processes across the value chain more adequately than before.

In our research we adhere to the principles of the Applied Design Science Research Methodology (Hevner et al. 2004; Peffers et al. 2007): after the initial problem identification, we developed and designed the RPFs in an iterative way. While a concrete model has to fit to a clearly defined situation, a reference model is a point of reference for a whole range of situations (Fettke and Loos 2007, p. 4). Hence, we have studied the applicability of our RPFs by their implementation in two different projects. We have also undergone the standardization procedure of the TM Forum, at the end of which our RPFs were added to the eTOM framework. Furthermore, we have applied the evaluation approach proposed by Frank (2007) in Sect. 6.

5 Design and Development of Reference Process Flows

In order to specify the RPFs we conduct the following steps. We first impose a domain structure over the value chain; the domains reflect the high-level business structure of telecommunication companies which cannot be mapped one-to-one to the abstract activities of Porter's value chain (Porter 1985). Using the new domain structure, a telecommunication company can map its business processes

Table 1 Aspects of process reference models (Axenath et al. 2005, pp. 47–49) as covered by eTOM

Aspects of process reference models (Axenath et al. 2005)	eTOM
Integral aspect	Contains activities for processes on different level of detail
Structuring aspect	The hierarchical structure distinguishes between atomic and compound activities
Organizational aspect	Normally processes are linked to the organization during their implementation
Informational aspect	The information layer provides the informational objects
Control aspect	Not included in version 8.0 $\Longleftarrow$ *scope of our study*

to domains, and then indirectly to the value chain. This has three advantages: (1) the domains are closer to the business processes of a telecommunication company, hence the mapping for both old and new processes is more intuitive; (2) the value chain view can be exploited for high-level decisions during the transformation process, e.g., for the outsourcing of activities, while (3) the impact of such a decision upon the affected business processes can be assessed and valuated for each domain. The domain structure is described in Sect. 5.1.

In Sect. 5.2, we present the RPFs we have defined in each of the four domains. These RPFs have been designed after extensive interaction with company stakeholders, abstraction from various transformation projects and discussion with telecommunication consultants. Hence, although we do not claim completeness, we can state that our RPFs do reflect the needs of telecommunication companies. Moreover, extensions towards the needs of specific companies are possible and can be conducted in a disciplined manner, since our RPFs are seamlessly embedded to eTOM, as described in Sect. 5.3.

5.1 Development of a Domain Structure for Reference Process Flows

On the basis of research advances we have identified the following requirements:

- Flexible bundling of services to market products (Bruce et al. 2008, pp. 16–19), including the interoperability along the value chain (Czarnecki et al. 2010) as well as services implemented with different physical resources (e.g., network elements),
- Separation between service and technical transport (Knightson et al. 2005, pp. 49–50), which can be realized by, e.g., a Next Generation Network (Czarnecki et al. 2009),
- Customer-oriented business processes (Czarnecki et al. 2011, p. 178), in which customer orientation is the response of telecommunication companies to increased competition and high customer expectations (Peppard and Rylander 2006, p. 134).

As a starting point we structure the activities of a telecommunication company in high-level domains, as suggested by Snoeck and Michiels (2002, pp. 331–334). We organize the aspects "customer", "product", "services" and "technical network" (Bruce et al. 2008, pp. 16–19) into following domains:

- Customer domain: it covers all marketing activities initiated by the telecommunication company, such as marketing campaigns, definition of customer segments, design of segment-specific products or service bundles, and assessment of customer lifetime value.
- Product and service domain: it covers the development, launching and bundling of new products, in response to the requirement of flexible bundling.
- Network domain: it covers the logistics and production of services and resources, as well as the relevant technology and supportive infrastructure for after-sales; the market products themselves are covered in the customer-centric domain (see below). This differentiation is response to the requirement for separation between service and technical transport.

Furthermore, we introduce an additional domain to underline our end-to-end view as well as the required customer orientation:

- Customer-centric domain: it contains all sales, production, logistics and after-sales activities initiated by the customer, while the customer domain contains those initiated by the company.

In **Fig. 2** we depict our domains as layers over Porter's value chain. As becomes apparent from the figure, our new customer-centric domain alleviates the rather limited scope of the customer domain. The new domain is as wide in scope as the network domain, but obviously covers the aspects concerning the customer and not those concerning the products, services, and infrastructure.

The four domains are not overlapping, but have interfaces to each other. For example, the reporting of a technical problem is defined as an RPF in the customer-centric domain and is linked to an RPF on solving the technical problem – the latter is in the network domain. As another example, marketing campaigns are conducted by so-called outbound agents in the call-center (and often outsourced to other companies), while incoming requests by the customer are dealt with by sales agents. In our domain structure, marketing campaigns belong to the customer domain while incoming requests belong to the customer-centric domain.

5.2 The Reference Process Flows for each Domain

In the following, we present 18 end-to-end RPFs: seven for the customer-centric domain, seven for the network domain and four for the product domain.[2] We have derived them from the findings in Bruce et al. (2008), Knightson et al. (2005), Czarnecki et al. (2011), Snoeck and Michiels (2002), and from the analysis of several redesign projects in international telecommunication companies of one of the largest telecommunication consultancies worldwide.

The seven RPFs in the customer-centric domain capture customer interaction with the telecommunication company, as initiated by the customer. The flows are end-to-end, starting with a customer request (or similar activity) and

[2] The RPFs for the Customer domain are currently under development, using the proposed methodology.

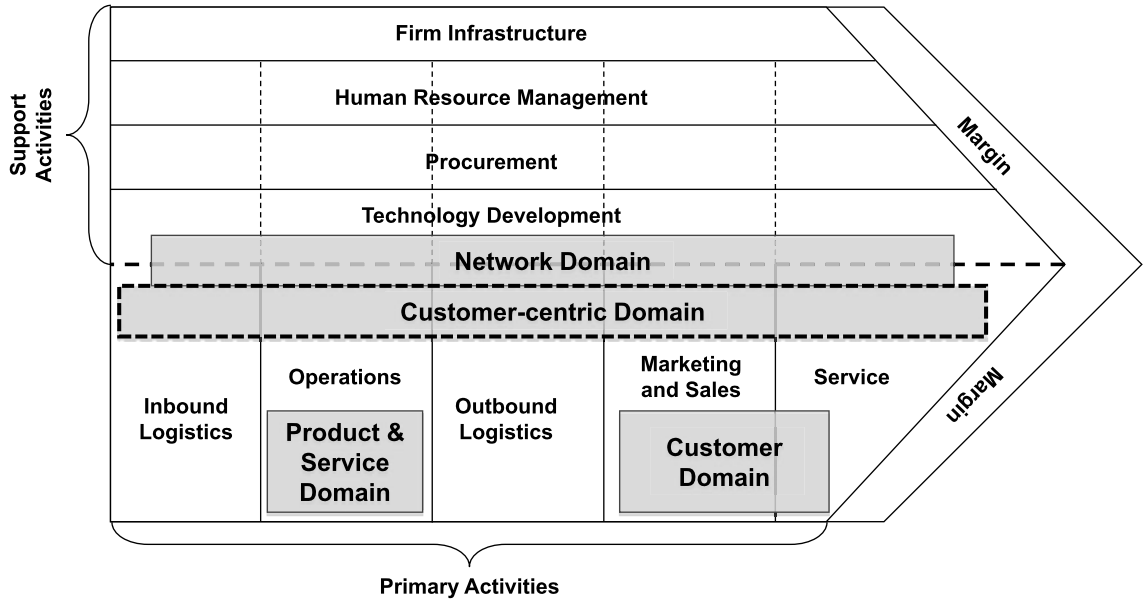

Fig. 2 The four domain layers on Porter's value chain (value chain picture based on Porter (1985)) (The support activities have been re-positioned, so that the Network domain box covers only the relevant activities)

ending with the fulfillment of the request. We propose a name for each RPF based on the initiating event and the typical result:

- Request for information/offering: it deals with all tasks related to questions and inquiries from the customer, therefore we name it "Request-to-answer". A possible end is an offer for a specific product.
- Placement of an order: it covers all tasks that convert the customer request to a product/service order, including payment. This RPF is comparable with the typical sales process and is named "Order-to-payment".
- Usage of a service: the usage process itself is an important part of the communication service. It contains all usage related tasks after the customer has purchased a product or service. We call it "Usage-to-payment".
- Request for modification of an existing service or contract: it covers all tasks from a request for a service change to modifications in billing; we name it "Request-to-change".
- Termination of a contract related to the usage of a product/service: it contains customer retention, processing of the termination order, capturing customer feedback, terminating the service and initiating the final bill preparation; we name it "Termination-to-confirmation".
- Reporting a technical problem: it receives a troubleshooting request from the customer, analyzes it to identify its cause, initiates a solution, monitors the troubleshooting process until its completion and then closes the trouble ticket; we call it "Problem-to-solution".
- Reporting an issue or complaint: it deals with customer complaints in a similar way as troubleshooting requests are handled. Possible complaints are caused, e.g., by bill discrepancies: we call it "Complaint-to-solution".

The network domain consists of seven RPFs that cover the view of network operations and the interaction with the telecommunication company. Such operations and interactions include order handling, trouble ticket management, billing, capacity management, service lifecycle management, and continuity management, among others. We define following RPFs:

- The production of a service covers all network-related tasks regarding provisioning, modification and termination of services and the respective technical resources. This RPF is normally triggered by a production order, i.e. from the Customer-centric domain. We call it "Production-order-to-acceptance".
- The analysis and resolution of technical troubles starts with issuing a "trouble ticket" (i.e., a description of the technical problem and of the assignment of responsibilities). The trouble ticket is either issued by an RPF in the Customer-centric domain or generated by an alarm of the service or technical resource itself. We name this RPF "Trouble-ticket-to-solution".
- The technical part of the usage is mainly related to the collection and mediation of usage records from technical resources. This RPF also covers the authentication and the allocation of new services or technical resources. It is triggered by the activation of a service, hence we call it "Activation-to-usage".
- The development and management of communication services encompasses all activities related to the implementation, updating, operation and discontinuation of services which are part of new and existing products. We name it "Service lifecycle management".
- For the development of technical resources we propose a counterpart to the previous RPF, but intended for resources. This RPF encompasses the implementation, updating, operation, and disengagement of physical and logical resources under the name "Resource lifecycle management".
- Providing the right capacity for services and technical resources is also an RPF. It can have a planning component and a monitoring component. In both cases, it covers activities associated with the management of capacities (e.g., of elements of the network infrastructure), hence we call it "Capacity management".

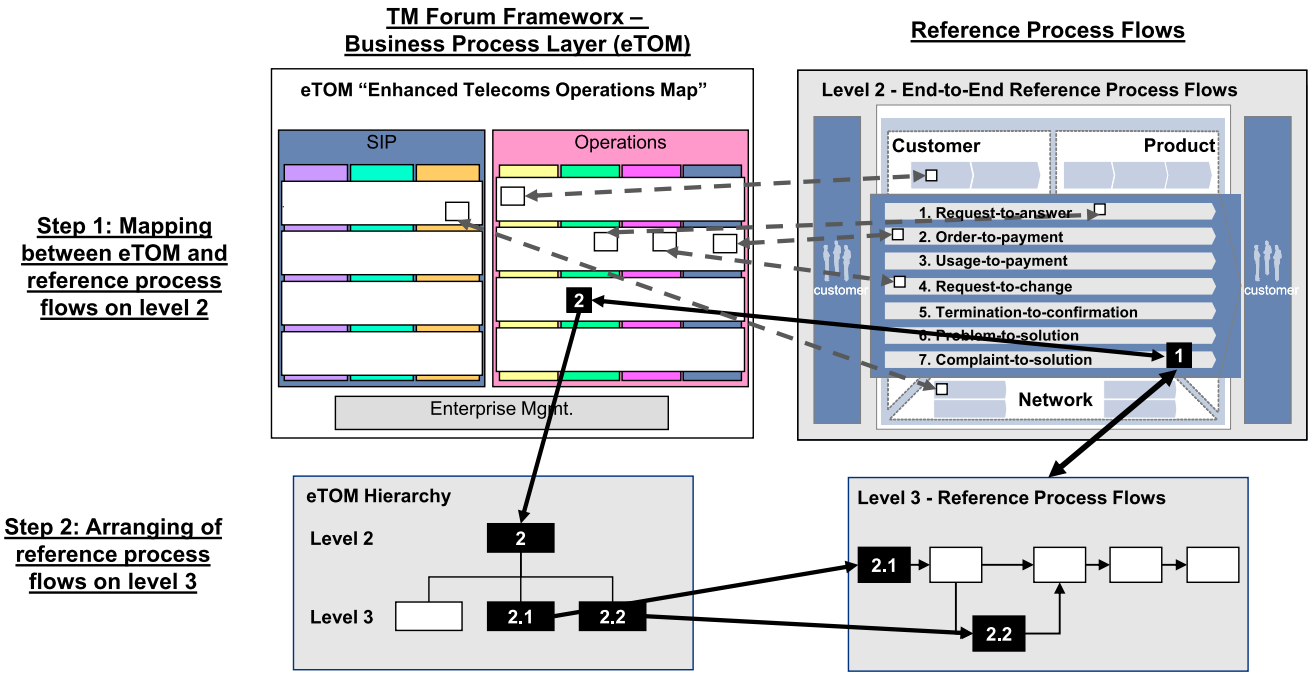

Fig. 3 Mapping the RPF to eTOM Level 2 (*Step 1*) and incorporating the corresponding Level 3 activities to each RPF (*Step 2*)

- Continuity management contains all activities related to the identification of critical services and resource components and to the specification of strategies, policies, and plans for dealing with disruptions.

The product domain contains four RPFs, depicted below. They represent the product view and capture interactions within the telecommunication company:

- The generation of a new product idea includes activities such as specifying guidelines for future innovations, defining a roadmap for identified business opportunities, idea generation, and assessment of a new idea's potential. We call this RPF "Idea-to-business-opportunity".
- The launch of a new product covers the evaluation of identified business opportunities, preparatory activities before introducing the product to the market, activities associated with the realization and testing of new products, the launch itself, and the monitoring of the targeted market segment. We name this RPF "Business-opportunity-to-launch".
- The launch of an improved and modified version of an existing product is intended to prolong a product's lifetime and sustain revenue. This RPF, named "Decision-to-relaunch" includes the selection of the activities in the previous RPF needed for preparing the relaunch.
- The termination of a product's lifecycle is also an RPF, named "Decision-to-elimination". It includes the activities needed for removing the product from the market.

In the next subsection, we describe how we embed these 18 RPFs in eTOM.

5.3 Embedding the Reference Process Flows to eTOM

We embed our 18 RPFs in eTOM by performing the following steps (cf. **Fig. 3**). For each RPF, we first identify the Level 2 eTOM processes that are conceptually associated with it (**Fig. 3**, upper part) – this is the mapping step. For each such process, we depict its underlying Level 3 activities, identify those that conceptually belong to our RPF (**Fig. 3**, lower part, left), place them in a logical order (sequencing), and then incorporate them into the RPF (**Fig. 3**, lower part, right) – this is the arrangement step. The arrangement step is performed for each Level 2 process, so that an RPF is gradually explicated as a sequence of Level 3 activities. In doing so, we do not simply use eTOM as a terminological instrument: our RPFs are expressed as sequences of eTOM Level 3 activities, thereby identifying and linking all eTOM activities that should be part of the RPF.

Thus, the embedding steps ensure compliance to the eTOM standard, and they constitute a vade mecum for embedding additional RPFs in eTOM.

All specifications and mappings are available from the TM Forum.[3] In the following, we describe how we embedded the RPF "Order-to-payment" in eTOM. First, we associated "Order-to-payment" with 14 Level-2 eTOM processes. In **Fig. 4**, we see that these Level 2 processes belong to different sub-groups (Level 1) of the eTOM process group "Operations" (Level 0). Each of the processes depicted in **Fig. 4** consists of several Level 3 activities. In the arrangement step, we have identified the relevant ones, which became part of the "Order-to-Payment" specification at eTOM Level 3 (cf. **Fig. 5**). Furthermore we see in **Fig. 5** that some of these activities come from the information layer ("service inventory", "resource inventory", and "customer subscription inventory").

We have arranged the "Order-to-Payment" RPF into four swim lanes[4] that are independent from a concrete

[3] See http://www.tmforum.org for further information. The document (72 pages total) is stored under "GB921 Addendum E".
[4] For more details on swim lane flowcharts please refer, e.g., to the Business Process Modeling Notation (BPMN).

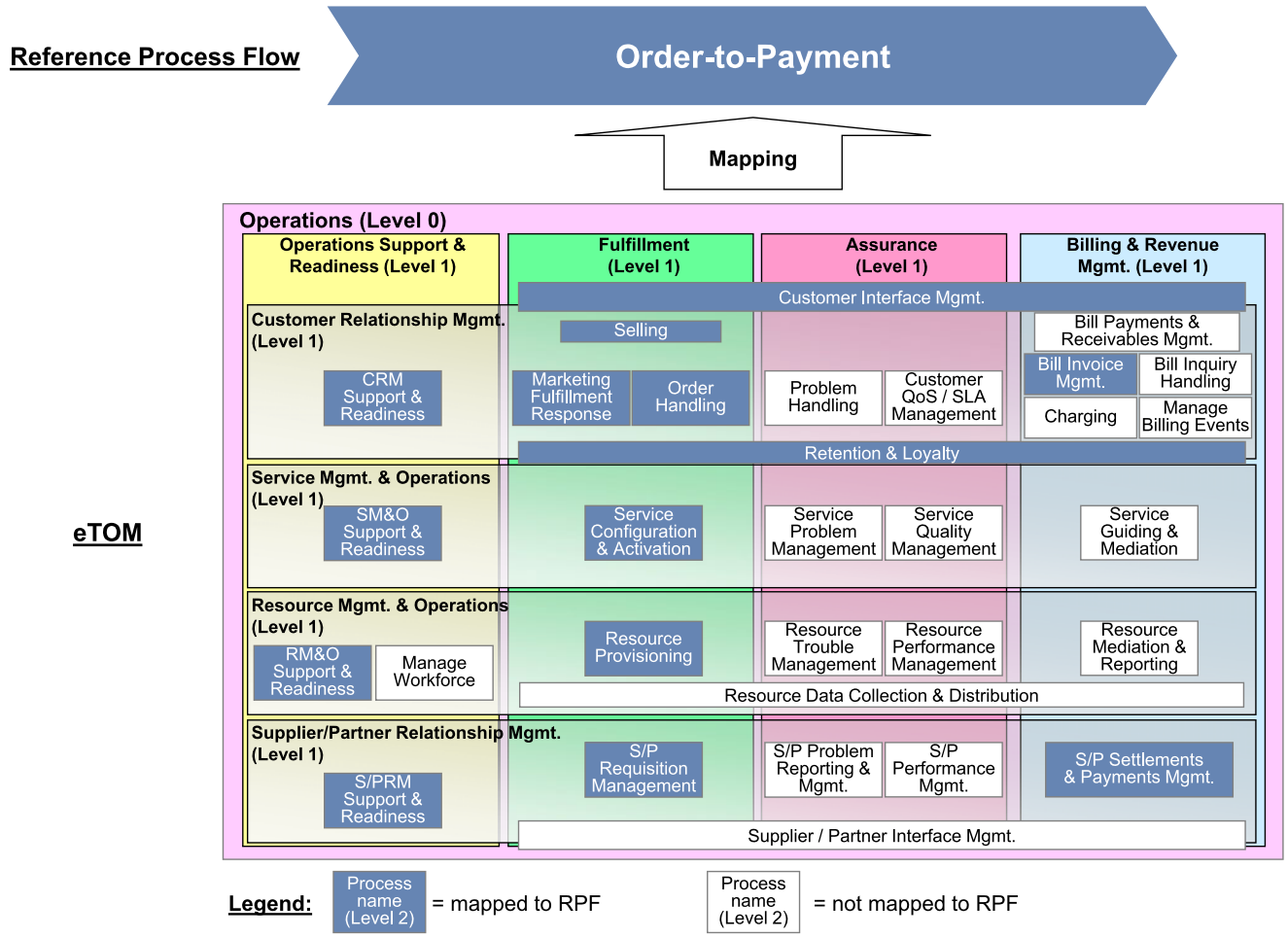

Fig. 4 Embedding the "Order-to-Payment" RPF in eTOM Level 2 – mapping step

organizational structure and reflect the requirements for customer orientation, flexible product bundling and separation between service and transport (cf. **Fig. 5**):

- Market, product, and customer: this lane consists of all activities that refer to a bundle of services in a specific package and with a specific price.
- Services: this lane contains all activities related to functionally independent elements of a product, which can be combined flexibly.
- Resources: this lane refers to the technical capabilities required to deliver a service. These might depend on the specific client location.
- Supplier/partner: this lane contains all activities related to the inter-organizational exchange concerning products, services and resources.

After the embedment in eTOM, our RPFs have become concrete sequences of activities, but still allow customization within a company. Moreover, compliance with eTOM does not dictate the implementation of all RPFs. For example, if a company decides to buy network services from another company instead of running their own telecommunication network, then this company needs to implement only a subset of the RPFs in the network domain.

6 Demonstration and Evaluation of the Applicability of the Reference Process Flows

To evaluate our RPFs, we have first used them in two transformation projects. According to Yin (2003, p. 4), research based on case studies can be applied to phenomena that are dynamic in nature and have not yet been fully developed and established. Thus it is appropriate to apply our method in case studies in order to demonstrate its applicability; we report on the findings in Sect. 6.1.

Furthermore, we have undergone the review procedure of the TM Forum, as required for all official publications. At the end of this review, the TM Forum incorporated our research results as official extension to the eTOM standard (TM Forum 2010). We report on the review process in Sect. 6.2. Finally, in Sect. 6.3 we evaluate our RPFs by means of the criteria proposed by Frank (2007) for the evaluation of reference models.

6.1 First Application in Two Transformation Projects

We used our RPFs (1) in a process reengineering project in the Middle East and (2) in a process design project in Africa. Both projects encompassed the development of company-specific processes as mandatory task; its purpose was to make interrelations among process activities explicit. Adaptation of a reference model to a specific situation is a young research topic (Schermann et al. 2008, p. 1577), therefore there are no agreed-upon criteria for measuring the efficacy of the adaptation. We measured the impact of our RPFs as the number of processes that had

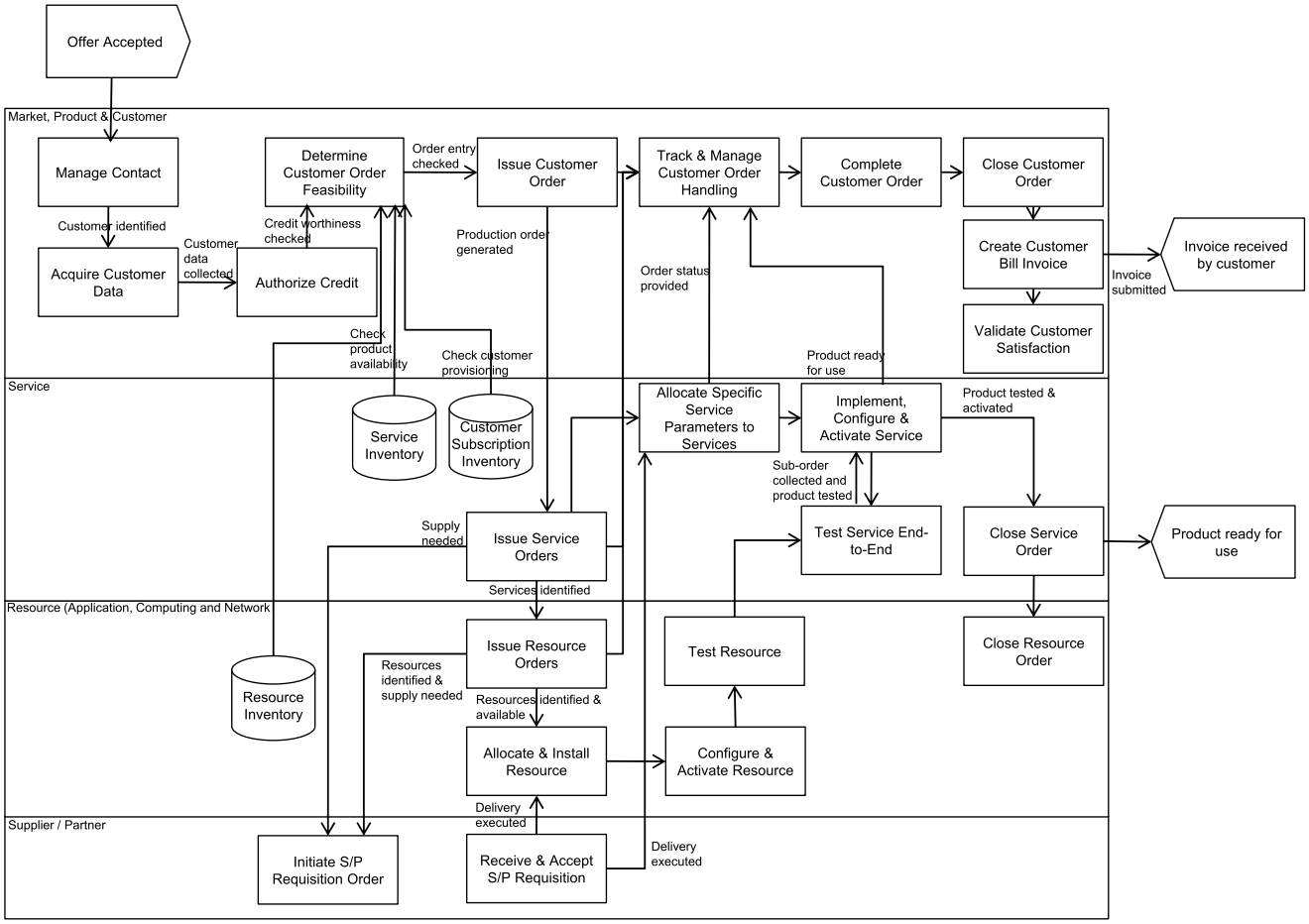

Fig. 5 Embedding the "Order-to-Payment" RPF in eTOM Level 3 – arrangement step

to be developed from scratch – the fewer the better.

The client company of the first project is one of the major service providers in the Middle East. This company offers fixed line, mobile communication, and IPTV products. The company was facing changed market conditions and concluded that they had to re-engineer their customer-centric process domain and the related IT in order to remain competitive. In this project, we used the seven end-to-end RPFs of the customer-centric domain as starting point. We first mapped the existing processes and organizational responsibilities to our end-to-end RPFs. It turned out that our RPFs could be used as they were in that phase, no changes were necessary. In the next phase of detailed process design, we used the RPFs as a starting point: we adapted them to the specific requirements of the company, and refined them further by aligning them to the IT architecture and to existing input and output templates. In total, only 28 operational changes became necessary to adapt our RPFs to the historically grown structures. These changes were of minor nature, performed in response to company-specific requirements – a usual task in the implementation of a reference model within an existing context.

The client company of the second project is a service provider in Africa; they mainly offer mobile products. At the time of the project, the processes of this company were not yet documented. Hence, the goal of the project was the development of a first set of high-priority processes up to an operational level. This project had to be completed at a very tight schedule; hence, a rigid procedure, as supported by our RPFs, was indispensable. In fact, the existence of our RPFs was a reason for deciding to launch the project in the first place. First, we used our four domains and the end-to-end RPFs as a basis for a priority list, which was then agreed upon with the top-management. According to this priority list, we selected to design three processes in the customer-centric domain and three processes in the network domain. For the design of these processes, we used our existing RPFs: the only adjustment we made was a simplification: we deleted the elements of the Information Framework. After designing the processes, we identified process activities that needed further refinement at the operational level, and we specified business rules for them. These business rules were recorded as free text, but we used a template to structure this text. For example, the process step "receive pending charges" (part of the billing processes) had to be refined to allow re-activation of blocked accounts. We specified this refinement in a business rule.

In **Table 2**, we summarize how our RPFs were used in the projects. The last row shows that the RPFs were almost completely taken over; only adjustments at operational level and company-specific business rules were necessary. This means that our RPFs have sped up project completion.

Table 2 Summary of two projects, serving as evaluation of our process reference model

	Company 1	Company 2
Region	Middle East	Africa
Product categories	Fixed, mobile, and IPTV	Mobile
Project focus	Reengineering of customer-centric processes	Specification and implementation of six high-priority processes
Project duration	6 months	3 months
Evaluated part of RPFs	Customer-centric domain	All domains with focus to the prioritized six processes
Necessary changes to RPFs	28 adaptations at the operational level, dictated by specific company requirements and by the need to align with existing IT systems	Additional refinements of the processes by means of company-specific business rules

6.2 Evaluation in the Standardization Process of the TM Forum

Our RPFs have become an extension of the eTOM standard after a rigorous validation process within the TM Forum organization. A formal evaluation and approval procedure specified by the TM Forum (cf. http://www.tmforum.org) is mandatory for all artifacts, before they are officially published. This procedure is described below.

As soon as the TM Forum Project Team decides that an artifact has an adequate level of maturity, it subjects it to "team approval"; this starts off the formal review process by the program manager. During a 30 to 45 day review and evaluation phase, the entire eTOM working group reviews the artifact. This working group is open to all members of the TM Forum. The development of our RPFs was aligned with existing TM Forum initiatives, so that the existing procedures (including regular team workshops) ensured proper involvement of industry representatives.[5] Parallel to the review performed by the eTOM working group, the "Technical Committee" (a sub-committee of the TM Forum Board) evaluates the compliance of the artifact with the technical strategy and with the overall quality requirements of the TM Forum. Thereafter, all member companies are asked to provide comments. During the whole evaluation process, all comments are recorded, and changes of the artifact are performed whenever required. Once approved, the artifact appears in an official publication of the TM Forum.

Our RPFs have now reached final approval and were published with version 9 of the eTOM framework. The first proposal was submitted in April 2009, the approval by the eTOM working group was effected in January 2010. The official review and evaluation process ended with the final approval in July 2010, whereupon our RPFs became part of the eTOM standard. This is a positive evaluation result for our RPFs in the sense of design science (Hevner et al. 2004).

6.3 Applying General Criteria for Reference Model Evaluation

Frank (2007, p. 119) understands the evaluation of a reference model as a problem related (a) to the evaluation of conceptual models and (b) to the evaluation of modeling languages. Hence, he proposes a multi-perspective evaluation framework that contains the economic, deployment, engineering and epistemological perspectives. For each of these perspectives he proposes concrete evaluation criteria, such as the level of industry commitment or the existence of training modules for the reference model. Thus, Frank (2007) provides a comprehensive, well-defined approach for the evaluation of reference models, which has already been used by other researchers (e.g., Otto and Ofner 2010).

Frank (2007, pp. 136–137) points out that the evaluation of a specific reference model requires identifying the relevant criteria and concentrating on them. Our process reference model is intended to assist telecommunication companies in improving the conduct of their business. Hence, we consider criteria from the economic perspective and from the deployment perspective, as explained below.

The economic perspective covers costs, benefits and protection of investments. Costs are mainly related to the introduction and maintenance of the reference model, while the benefits are reflected, among others, in the changes of existing business processes, as dictated by the reference model. The protection of investment is mainly related to the dissemination of the reference model and to future changes that may have an effect upon it. The deployment perspective evaluates the reference model from the users' point of view; this perspective encompasses understandability and appropriateness, and it also captures the users' attitude.

For our evaluation, we selected the 16 criteria (economic perspective and deployment perspective) depicted in the second column of **Table 3**. The first column of **Table 3** refers to the group to which each criterion belongs, the second column describes the criteria, and the third column summarizes our evaluation with respect to each criterion. This last column shows that our RPFs are positively assessed. This is an additional proof-of-concept for our process reference model.

7 Applying our Approach outside the Telecommunication Industry

Many IS scholars in the domain of reference modeling discuss methods for the construction and application of reference models (Becker et al. 2007; Thomas 2007; vom Brocke 2007). Our telecommunication reference model is industry-dependent, but the approach of designing, introducing, and validating it is to some extent industry-independent. We

[5] In August 2010, the working group had 1680 members from telecommunication companies, consultancies and research institutions.

Table 3 Summary of multi-perspective evaluation according to the framework of Frank (2007)

Group	Criteria	Summary of Evaluation
Costs	Acquisition of reference model, training for using the reference model, adaption of the reference model, adaption of the organization, integration with existing models, integration with existing tools, maintenance support	As our RPFs have become part of eTOM, all existing TM Forum infrastructure can be used without additional costs (e.g., for training, online portal, technical forum). The flexible design of the RPFs allows for easy adaption. The implementation of a new process will lead to changes of the operational structure, but our design is independent of an organizational structure. Hence, it can be mapped to every organization.
Benefits	Efficiency of affected business processes, number of relevant IT-vendors that support model, integration with other reference models, communication within company, inter-organizational communication/coordination	Our RPFs stimulate standardization (e.g., in dealing with different products or functional entities). This contributes to process efficiency (Bruce et al. 2008). Since our RPFs are not constrained by departmental boundaries, they stimulate disciplined interaction across departments. Since our RPFs are part of a standard, they contribute towards forming a common understanding, as needed, e.g., for outsourcing, in alliances, and in other forms of inter-organizational coordination.
Protection of investment	Industry commitment, technological changes	The standardization approval within the TM Forum is a good indicator of high industry commitment which naturally goes hand-in-hand with protection of investment.
Deployment	Understandability, attitude towards our process reference model	Our RPFs comply with eTOM (including its terminology), so understandability within the community (represented by the TM Forum) is ensured. The approval of the standard is an obvious indicator of the community's positive attitude.

now summarize this high-level approach and show how it contributes to the understanding of reference model usage in practice.

Our approach has the following steps:

1. Specification of a framework for the design of RPFs (cf. Sect. 5.1)
2. Specification of the RPFs (cf. Sect. 5.2) and embedment in an existing process reference model (cf. Sect. 5.3)
3. Iterative involvement of practitioners in the development process (cf. Sect. 4)
4. Integration of a process reference model into an EA framework (cf. Sects. 3 & 5.2)
5. Application of different evaluation types for a process reference model (cf. Sect. 6)
6. Standardization as part of the evaluation (cf. Sect. 6.2)

Those steps can be mapped into the following elements:

(A) Selection of a specific level of abstraction for which RPFs are to be designed: industry-independent element, step 1 is its industry-specific implementation

(B) Specification of concrete RPFs: industry-specific element, step 2 is its implementation

(C) Considering Strategy, Information Systems, and Processes simultaneously for the RPF specification, while taking their interdependencies into account: industry-independent element, steps 1 and 2 constitute its industry-specific implementation

(D) Standardization of the RPFs: industry-independent element, steps 3 and 5 constitute its industry-specific implementation

(E) Incorporation of a close interplay between conceptual work, live testing in companies and feedback, as integral part of RPF specification and evaluation: industry-independent, steps 4 and 6 constitute its industry-specific implementation

We elaborate on these elements below and highlight the nature of industry-specific versus industry-independent contribution.

The concrete artifact RPFs (element B) is peculiar to the telecommunication industry. The study of this industry constitutes an independent research topic in the IS discipline (e.g., Bub et al. 2011; Bruce et al. 2008; Czarnecki et al. 2010; Grover and Saeed 2003). In this context, the artifact itself (i.e., the RPFs) is a contribution to research on the telecommunication sector. Considering reference modeling as a scientific discipline, as postulated, e.g., by Becker et al. (2007), we contribute to this body of knowledge a specific instance – a process reference model for a specific industry.

The distinction between strategy, information systems and processes (element C) has turned out to be imperative for the telecommunication industry, but we believe that it transfers to other industries, especially to those that (1) are largely dependent on Information Technology, (2) intend or are forced to outsource parts of their processes and of the underlying mission-critical IT, and (3) face the need for root breaking changes in their business model because of the other two aspects.

The decision for RPFs as modeling instrument (element A) is obviously industry-independent. The hierarchical specification of RPFs we have used in

the industry-specific implementation is transferable and helps specifying the location and the semantics of specific RPFs in a transparent way. Second, RPFs can be described with the same modeling instruments as conventional processes; hence, RPFs can be understood and refined by the process designers inside a company. This leads us to element D of our approach, namely the decision to turn RPFs into a standard.

The standardization of the RPFs (element D) is a mission-critical aspect of our approach. Standardization guarantees first that the process flows of a specific industry are fixed and understood, and second that the IT-providers become aware of the IT demands and design IT solutions that satisfy these demands. Since the design of complex IT requires investments and acquisition of know-how, the standardization of RPFs ensures that IT-providers deliver technology for well-defined process chunks that can be consumed by all companies in the industry. Similarly to elements A) and C), standardization is an industry-independent element of our approach and is most crucial for industries with mission-critical, complex IT that needs to be outsourced, thus leading even to transformation of the companies in this industry (aspects 1, 2, 3 above).

Which industries are likely to face the need for a framework as we proposed it for the telecommunication industry? The aspects of (1) mission-critical IT, (2) need for outsourcing and, consequently, (3) need for transformation pertain to other industries, too. For example, the energy sector is experiencing cost pressure due to market liberalization. Outsourcing (aspect 2) is an option that deserves consideration, all the more because market liberalization also dictates flexible bundling of services, for which more sophisticated IT support is needed (aspect 1). The increasingly central role of sophisticated IT in the otherwise conventional products of the automotive industry makes it also a candidate for a standardized "RPFs"-based framework.

Obviously, a targeted investigation into the potential of our approach for each of these industries is a study by itself and goes beyond the scope of this work. Nonetheless, the TM Forum has already started initiatives to expand their reference models towards the needs of other sectors, including energy and healthcare.

8 Conclusion, Limitations, and Outlook

Business processes of telecommunication companies are subject to reorganization initiatives, not least because of innovative technologies and far-reaching changes in the targeted markets. Customer orientation leads to the need for flexible product design and bundling, and thus to the need to redesign product development, marketing and customer support in a more customer-centric way. Outsourcing of non-core competencies and the formation of alliances that jointly exploit emergent technologies are further motivators for process redesign. Telecommunication companies need guidance in that context and can greatly benefit from lessons learned and best practices introduced in other companies of the sector.

The industry-specific process reference model eTOM partially addresses this need for guidance, but still does not provide concrete guidelines, e.g., on how customer-centricity should be implemented for the many activities that involve interaction with a customer. In this study, we propose a process reference model, whose core is RPFs. These are archetypal end-to-end processes associated to (a) services & products, (b) the network infrastructure, (c) interaction of the company towards the customer, and (d) interaction with the company, initiated by the customer. Into these RPFs we have incorporated findings from scientific literature and lessons learned from practitioners, thus allowing companies to benefit from past best practices.

We have applied our proposed RPFs in two transformation projects. Adjustments were necessary only on the operational level during both projects. Hence, we understand the outcome of these projects as a first proof-of-concept. Furthermore, we have successfully undergone the evaluation procedure of TM Forum. Our proposed RPFs were accepted and are published as part of eTOM version 9. In addition, we have applied a multi-dimensional evaluation framework for process models to evaluate our RPFs.

Our process reference model is a contribution to practice, as it assists practitioners in planning and orchestrating the redesign of their processes in a disciplined, transparent way. Also, since our process reference model has become part of the eTOM standard, compliance with it ensures compatibility with the processes of other players in the telecommunication sector.

Our contribution to theory is twofold. First, we have enriched the body of knowledge on reference models with a new instance, designed for the needs of the telecommunication sector. Second, our approach for designing, developing and testing our artifact can serve as (industry-independent) guideline for the introduction of process reference models in an industry sector.

A first future work task is the extension of our process reference model by adding further processes. In particular, it is unlikely that the 18 RPFs we have proposed will cover all thinkable situations and scenarios that a company can face when redesigning its processes. To this purpose, we intend to monitor the use of our RPFs, to collect experiences from practitioners, and to participate in the eTOM working group responsible for refinements of the process reference model.

In this work, we assumed that the strategic objectives are customer-orientation, flexible product bundling and de-coupling from technical transport – objectives that can be (and often are) achieved through outsourcing and strategic alliances. Currently, these objectives are true for most telecommunication companies but additional or different objectives may hold and require changes of our RPFs.

Furthermore, the focus of our work was on specifying the RPFs. Their instantiation requires further, finer concepts that reflect the requirements within a given company. In particular, RPFs could be introduced as they are in a green-field situation (e.g., in a start-up company). In contrast, if a company has already defined and optimized its processes and is member of strategic alliances, then it likely to be subject to constraints that require adjustments to the RPFs. How can we support optimal decisions in this case? Which factors are relevant to distinguish between a specific solution and the reference solution? These questions are a starting point for further research on the utilization of RPFs in transformation projects.

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Abstract

Christian Czarnecki, Axel Winkelmann, Myra Spiliopoulou

Reference Process Flows for Telecommunication Companies

An Extension of the eTOM Model

The telecommunication market is experiencing substantial changes. New business models, innovative services, and technologies require reengineering, transformation, and process standardization. Enterprise Architecture Frameworks support the transformation by specifying methods, procedures, and reference models. With the Enhanced Telecom Operation Map (eTOM), the TM Forum offers an international de facto reference process framework, based on specific features and requirements of the telecommunication industry. However, this reference framework only offers a hierarchical collection of processes on different levels of abstraction; a control view in terms of a sequential ordering of tasks and hence a real process flow as well as an end-to-end view on the customer are missing. In this paper, we extend the eTOM reference model by reference process flows, in which we abstract and generalize the knowledge about processes in telecommunication companies. With reference process flows, we aim to assist companies in achieving a structured and transparent restructuring and re-design of their processes. We demonstrate the applicability and usefulness of our reference process flows in two case studies, and evaluate them by means of criteria for reference model evaluation. Our reference process flows have been accepted as a standard by the TM Forum and published as part of eTOM version 9. We further elaborate on those components of our approach which can be applied outside the telecommunication industry.

Keywords: Process standardization, Process flow, Process modeling, Reference modeling, eTOM, Telecommunication

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