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ABSTRACT

Divergent requirements of customers limit the potential of information technology (IT) service providers to achieve economies of scale through the standardization of service agreements. Continuous change requests in ongoing IT-service relationships complicate matters even more. Mass customization strategies have successfully addressed similar challenges in industrial sectors by reusing, i.e. composing and adapting standardized modules.

Transforming this strategy to IT-service management, we present an approach of reuse-based IT-service customization in order to increase both effectiveness and efficiency at the stages of initial service specification, customization of offerings, and continuous adjustment of ongoing service agreements. This is proposed to be achieved by adopting well-established reuse-mechanisms of reference information modeling. Their strict application in service agreement specification aims for enabling industrialized on-demand service contracting and provisioning. The approach has been developed and prototypically applied in close cooperation with IT-organizations.

Keywords

IT-Service Management, Mass Customization, Modularization, Reuse-Mechanisms, Reference Modeling, Industrialization.

MOTIVATION

In recent years, increasing requirements of shorter time-to-market, higher quality and lower cost have advanced the professionalization efforts of IT-organizations in providing service for their customers' businesses. Similar to the evolution of the industrial sector, initial individual made-to-order approaches are aimed to be replaced by predefined, catalogued service offerings that enable repeatable processes in IT-operations and reduced negotiation efforts in service agreements (OGC, 2007). We use the collective term of '*IT-service engagements*' as specifications of such offerings as well as agreements in structure, i.e. configuration logic, and in content, i.e. service propositions as outcome-oriented commitments.

However, the IT-service providers' high ambitions with regard to service definition and cataloging (Govekar, 2009) lack best-practice models and mechanisms enabling their customization according to provider and business demand specific issues. Furthermore, such predefined service offers leave certain customer demands unfulfilled and often require the individualization of commitments that are commonly set in customer-specific service level agreements (SLAs) (de Kinderen and Gordijn, 2008). Completely individually negotiated "one-of-a-kind" services though do not only require intensive time and personnel efforts but also impede repeatable, standardized IT-operational processes. Permanently individually negotiated requests for ongoing IT-service adaption due to changing business requirements further complicate matters (Ivens, 2005). Thus, IT-organizations are additionally challenged to efficiently handle the customization of service engagements.

Addressing these challenges, this article aims to contribute to the research question of how to structure and design IT-service engagements that support both economies of scale and of learning as well as variety along customer demands at reduced time-to-market and provisioning lead time. Therefore, orientation by established concepts from the goods and services industry to "industrialize" IT-service management seems promising (Zarnekow, Brenner and Pilgram, 2006). Transferring the mass customization types for reusing and composing modular elements at different points of customization interaction, we propose to adopt reuse-mechanisms from the field of reference modeling to enhance both effectiveness and efficiency in composing and adjusting IT-service engagements.

The paper is structured as follows: First, we introduce the foundations of reuse-mechanisms in the domains of mass customization and reference modeling and give an overview on related work per domain. Subsequently, dimensions of reuse-oriented composition and reuse-mechanisms per stage are derived. Afterwards, we illustrate their application by an example and give implementation insights. The paper closes with a summary of results and an outlook on future research aspects.

FOUNDATIONS OF REUSE-BASED MECHANISMS

Reuse-Mechanisms in Mass Customization

Mass customization has become a common principle for industrial manufacturers to meet varying customer demands by individually designed products and services at costs near that of mass-produced items (Hart, 1995). It aims at configurations that satisfy the customer's requirements without including undesired features (Pine and Gilmore, 1999,p.79). This implies the distinction between variety and customization and, to ensure the latter, the customer must be involved in the individualization process (Mintzberg, 1988). The point of such customization involvement in the product or service lifecycle determines the degree of individualization (Lampel and Mintzberg, 1996). That degree, i.e. the level of customization, ranges from the adaption of already delivered items up to the total customization of design and fabrication (Hart, 1995). This leads to a variety of customization differentiations, that are summarized and combined by Da Silveria (2001, p.3). As one of the most cited, Mintzberg (1996; 1988) views customization as taking on one out of three forms dependent on the point of customer interaction in the product or service lifecycle: pure, tailored, and standardized. *Purely customized* items are designed and produced from scratch for each individual customer. *Tailored customization* alters a basic design to meet the customer's needs. In a *standardized customization* strategy, the solution is assembled from a predetermined set of standard components.

Apart from the lifecycle's point of customization, the second key indicator of customization types is the method of achieving customization under cost restrictions (Duray, Ward, Milligan and Berry, 2000). Specifically, it is the type of modularity employed, since modularity is the key to achieving mass customization (Pine, 1993). Duray et al. (2000, p.608) and Blecker et al. (2005, p.163ff.) summarize literature statements about modularity forms. One of the most popular typologies of modularity has been developed by Ulrich and Tung (1995; 1991). They distinguish *component-sharing modularity* as the design around a common base unit, *alter/cut-to-fit modularity* as the alteration of dimensions, *bus-modularity* as the addition of an existent base unit, *component-swapping modularity* as the ability to switch options, as well as two swapping-similar types explained and visualized in Figure 1. Following Duray et al. (2000) these types of modularity can be classified into two groups according to the degree and point of customization involvement: component-sharing and alter-to-fit modularity support the stage of original design or its alteration with a high degree of customization. In contrast, the other types build on already standardized and repeatable components in the stage of arrangement (c.f. Figure 1).

Mass customization is not limited to a production principle but may also include modular product design (McCutcheon, Raturi and Meredith, 1994) and focus on distributive and marketing aspects when mass customizing offerings and deals (e.g. Kahn, 1998). Suitable to the addressed challenges of our research topic, some authors state that in general, these mass customization concepts may as well be applied to intangible products, i.e. services, in order to balance variety, time-to-market, and mass efficiency (e.g. Choi, Stahl and Whinston, 1997; Jiao, Ma and Tseng, 2003; Moon, Simpson and Kumara, 2007). However, studies of mass customization in services mark one of the main gaps in mass customization research (Da Silveira et al., 2001, p.9). While in the beginning, mass customization in service systems was assumed to be similar to manufacturing systems (e.g. Hart, 1995; Jiao et al., 2003, p.817), Peters and Saidin (2000) identified the challenge of implementation due to the intangibility and perishability of services. They suggest prioritizing service modularity in regard to implementation issues for applying service mass customization. However, current service research lacks insights on concepts of how to design IT-service engagements that are customizable and adaptable along business demands (Buhl, Heinrich, Henneberger and Krammer, 2008; Teubner, 2006).

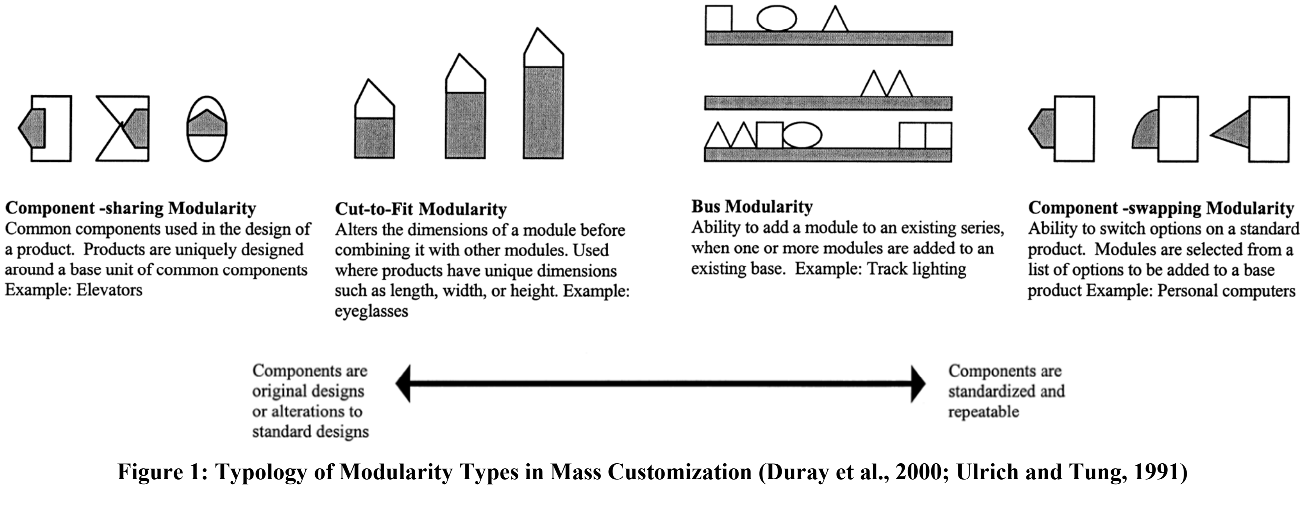

Figure 1: Typology of Modularity Types in Mass Customization (Duray et al., 2000; Ulrich and Tung, 1991)

Reuse-Mechanisms for Conceptual Models

Assistance in the development of customized artifacts through configuration, reuse and adaption of existing ones has not only been addressed in the field of industrial production, but is also a subject of model research in general. Reference models are generic, conceptual models that claim generalizability and formulate recommendations for the structures (e.g. service structures) in a certain domain (e.g. IT-Service Management) (Fettke and Loos, 2003; Rosemann and van der Aalst, 2007). Thus, reference modeling aims to provide generic information models that may be reused in the design process of specific ones (vom Brocke, 2007). Their reuse shall increase both effectiveness and efficiency of specific information model design (Becker et al., 2004; Scheer and Nüttgens, 2000). Existing approaches to this issue differ by the way they support the modeler during the adaption process. Whilst conventional reference models are monolithic and may be modified without any guidance, Soffer et al. (2003) enhance the models by relationships between attributed model elements and different application scenarios. A similar approach is proposed by Becker et al. (2007a), who describe the application context using configuration terms. A failing condition removes predefined model elements according to configuration rules. Their approach does also provide a set of five *configuration mechanisms* to manage variants of models (Delfmann and Knackstedt, 2007).

Apart from that, adaptive mechanisms have been identified by vom Brocke (2007) based on experiences in the area of software-engineering (Peterson, 1991). In particular, he identified the four reference modeling mechanisms of instantiation, aggregation, specialization, and analogy as promising: (1) *Instantiation* allows equipping reference models with placeholders. When a specific model is created, the placeholders are filled with valid occurrences of an instantiation domain – such as (alpha-)numeric values or distinct model elements. (2) *Specialization* enables the modeler to take over general models or parts in order to adapt, extend or modify them according to specific needs. (3) Through *aggregation,* a specific model is built by assembling various independent part models. Their combination and compatibility is defined by interface descriptions. (4) Finally, *analogy construction* may be applied to answer to similar requirements by existing model solutions in a creative way. Thus, a reference model can be useful for conclusions by analogy in domains they were not intended to be applied in.

Although the specification of these mechanisms has been predefined on a general, model language-independent level (vom Brocke, 2007, p.54), they have predominantly been applied to Enterprise Systems (Soffer et al., 2003), method engineering (cf. Becker et al., 2007b) as well as conceptual process models for designing organizational structures and operations (Becker et al., 2004). Reference modeling of service engagements has not been sufficiently addressed yet. Existing reference models in the domain of *service engineering* rather seek to systemize and improve the process of service development, which is to date largely dominated by ad-hoc decisions. The most noted and frequently discussed reference models are the ones by Ramaswamy (1996), DIN (1998) and Jaschinski (1998). In addition, already in the 1980s, Anglo-American literature analyzed the development and design of services with a strong focus on marketing. Frequently applied models of the so called *New Service Development* (NSD) originate from Shostack and Kingman-Brundage (1991) as well as Edvardsson and Olsson (1996). Schneider et al. (2006, p.119) provide an overview on 14 approaches of NSD and 13 service engineering models. The multitude of models undermines the importance of this kind of support to the development and configuration of services. Nevertheless, they reveal considerable weaknesses in regard to (1) level of detail, (2) practical orientation and (3) configurability enabling the adaptability and composition of services to the customer's demands (Bullinger et al.2003, p.10; Kunau et al. 2005, pp.192;196). This is especially true for IT-service design. Indeed, specific approaches of rule-driven composition have been developed in the field of web services (Dustdar and Schreiner, 2005), but build on domain specific standards like BPEL. The objective of this article is to transfer the reuse-mechanisms for conceptual models to IT-service management research.

TOWARDS A REUSE-ORIENTED APPROACH OF COMPOSING IT-SERVICE ENGAGEMENTS

Modularizing IT-Service Engagements

The strict application of modularity is the critical aspect for gaining scale volume or "mass" in mass customization, decreasing the possible variety of commitments and allowing for reuse and repetitive operations (Duray, 2002; Pine, 1993). Adapting the characteristics of modularity to the specification of service engagements, commitments need to be distinct, self-contained and loosely coupled with each other, while their relationship has to be well-defined (Blecker et al., 2005, p.163ff.; Wolters, 2002). Each selection, interchange or addition of a commitment shall ensure a specific value at the customer's business. ITIL identifies two primary elements to create permanent value (OGC, 2007, p.17): for one, *utility* as the right functions for the right user; for another, *warranty* as the right performance at the right time. Accordingly, a self-contained, value-oriented commitment contains both functional and non-functional properties (Dumas et al., 2003; O'Sullivan, Edmond and Ter Hofstede, 2002). We thus define a '*commitment*' as a self-contained, distinct module that contains the specification of a certain functionality and output, the obligation to cooperate to enable it, its transfer point, and the quality values to be kept for this functionality (Brocke et al., 2009). A *service engagement* is composed of commitments with the help of rule-based reuse-mechanisms as detailed later in this paper and meta-modeled in Figure 3.

Dimensions of Reuse-Oriented Construction

Duray (2000) differentiates mass customization strategies by points or stages of individualization in the product's lifecycle. We adopt this criterion for differentiating requirements on customization along the stages of service engagement construction. Garschhammer et al. (2001) and Hegering et al. (1999) define the service-lifecycle stages as *design, negotiation, provisioning, usage* and *deinstallation*. Since the latter three stages commonly base on single requests, they may be grouped as an ongoing stage of *service arrangement*. Thus, we differentiate these three timely separated stages of customization efforts in service engagements as illustrated in Figure 2.

New service offers are specified into potential engagements at the *stage of service offering design*. The engagements represent offers of potential commitments that may be assembled and agreed-upon. Aiming for mass customization effects, the design of these offerings has to take IT-operational capabilities into account and basically integrates product and manufacturing design (cf. Blecker et al., 2005). Once specified, the composition of the new service engagement by the reuse of existing ones as a kind of "reference" may increase both efficiency and effectiveness of this complex design process. Therefore, either the provider's existing service engagements or prospective best-practice reference IT-service engagements may be referred to.

Representing the negotiation or *service agreement stage*, respectively, customers may conclude master-agreements that specify the extent of potential commitments as selection of IT-service agreements. Therefore, the predefined service offerings may be configured to the customer's requirements. Aiming for repeatable IT-operational processes and reduced negotiation efforts, the possibilities for service agreement customization are restricted.

Based on the master-agreement, the agreement on potential services may be applied by the customer requests, i.e. commitments may on-demand be assembled and instantiated according to the customer's current need and within the scope of his master-agreement. Representing an 'inventory' of agreed-upon ongoing services, the resulting *service arrangement* is continuously adaptable to changing requirements on information technological support by requesting additional IT-services.

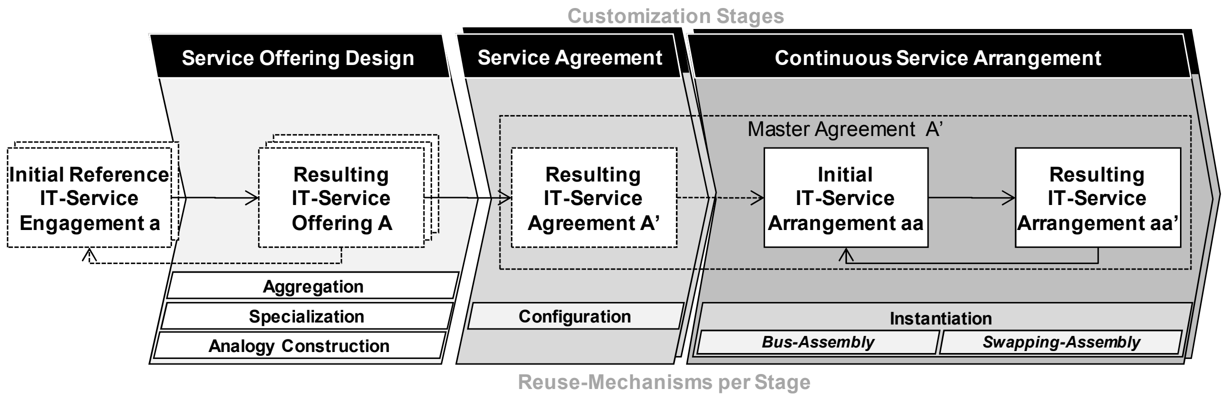

Figure 2: Three stages of reuse-oriented composition and the corresponding reuse-mechanisms per stage

Deriving Reuse-Mechanisms for IT-Service Engagement Composition

Adopting the reuse-oriented approach of reference-modeling to service engagements, customization at all of the identified stages shall be supported by reuse-mechanisms. However, requirements on construction support differ between stages and thus lead to different mechanisms per stage as allocated in Figure 2. The mechanisms will be introduced in the following and are specified as meta-model of reference IT-service modeling in Figure 3.

In the stage of service offering design, existing parts of reference IT-service engagements shall be reused to efficiently design a new specific engagement according to additional market and customer requirements. These upcoming demands are predominantly unforeseen and thus cannot be covered by a configurative way that encounters all relevant variants during the build-time of a reference engagement. As vom Brocke (2007) addressed these limitations in reference modeling, we build on his supplementary reuse-mechanisms of *aggregation*, *specialization,* and *analogy* in order to support the stage of service offering design.

However, such unrestricted composition mechanisms would be of no avail when concluding a master-agreement and its extent of potential service: the focus on consideration of IT-operational capabilities at the service offering design stage would become unstable. In order to restrict customization to predefined variants that are compliant to IT-operational processes, *configuration* is an adequate mechanism (Becker et al., 2007a) that saves time and consistency with standardized capabilities.

At the ongoing stage of service arrangement, the commitment potentials are to be instantiated and assembled as required. Thus, *instantiation* mechanisms support this stage of customization. We additionally derive well-established assembly mechanisms from the industrial sectors to detail the support of instantiation and assembly.

Aggregation

The mechanism of aggregation as a composition of various service engagement components supports the service specification through the unaltered reuse of existing commitments and engagements for different service offerings. The corresponding mass customization approach would be *component-sharing modularity*, which applies a base unit of common components for unique product design. Unaltered reuse of engagement components in different contexts may not only lead to reduced time to market due to fewer specification efforts. It furthermore supports the constructor to define same commitment-parts with same text-specifications in order to raise the ease of understanding as well as chances to keep IT-operational processes repeatable. A system of rules assures that conflicting components are not joined together.

Specialization

Transferring the mechanism of specialization to service engagement composition, generic commitments may be specialized in resulting offerings whilst retaining all specifications. This mechanism allows for applying generic reference engagements to provider and objective specific service offerings by detailing and adapting general statements. Referring to types of modularity in mass customization, the basic idea is also applied by *alter-to-fit modularity* that adapts a module before combining it with others.

Analogy

Analogy may be used to respond to similar requirements by similar solution patterns in a creative way. Within the scope of this paper, commitments as service engagement components may be designed analogously to existing ones that are similar in a certain characteristic. The mechanism shall support but not limit the constructor in freely designing new commitments and engagements. Thus, it rather applies *pure customization* as non-restrictive specification of new service offering components, whilst the previously introduced reuse-mechanisms represent a *tailored customization* of basic engagements due to rule-based restrictions.

Configuration

The configuration of a service engagement may be applied in order to tailor it to customer-specific requirements when adding it to a master agreement. Based on the prior selection and annotation of configuration parameters, types of commitments or single commitments may be eliminated or defined as separately optional available upon request. Additionally, configuration mechanisms allow the modification of the commitment presentation such as the derivation of a management view.

Instantiation

Whilst the service agreement is characterized by optionality of available services, its application takes place by selecting, assembling, and instantiating commitments on-demand based on service requests. For using the mechanism of instantiation, the commitments are equipped with placeholders that are to be filled with valid, customer-individual data required for service creation (such as user-data or customer-specific scripts). Thus, the customer may assemble multiple differing instances of the same commitment. Regarding mass customization approaches, different types of modularity support this kind of *standard customization*: as Duray (2000, p.611) points out, only *bus modularity* and *component swapping modularity* - including its variants - use standard modules without alteration and therefore can be combined during the assembly stage. We thus differentiate between these kinds of modularity to detail the instantiation mechanism in service arrangements.

Bus assembly: When assembling and instantiating commitments, certain commitments can become “buses” to which others can be attached (cf. Peters and Saidin, 2000, p.113). Thus, ongoing basic commitments become the bus or pre-requisite engagement, while additional service aspects may initially or later be added according to predefined combination rules in the service agreement. This illustrates the continuous adjustment as regeneration notions applicable to service agreements.

Swapping assembly: Whilst bus assembly allows for composing additional service components, specific functional or performance specifications may also be subject to adjustment needs during the ongoing period of service creation. Component swapping modularity in goods-dominant mass customization refers to a basic product body that may be adapted by exchanging one component in the range of its component family (Salvador, Forza and Rungtusanatham, 2002, p.560). Transferred to the IT-service engagement composition, a service specification component may be exchanged – as for example the committed availability time of a service.

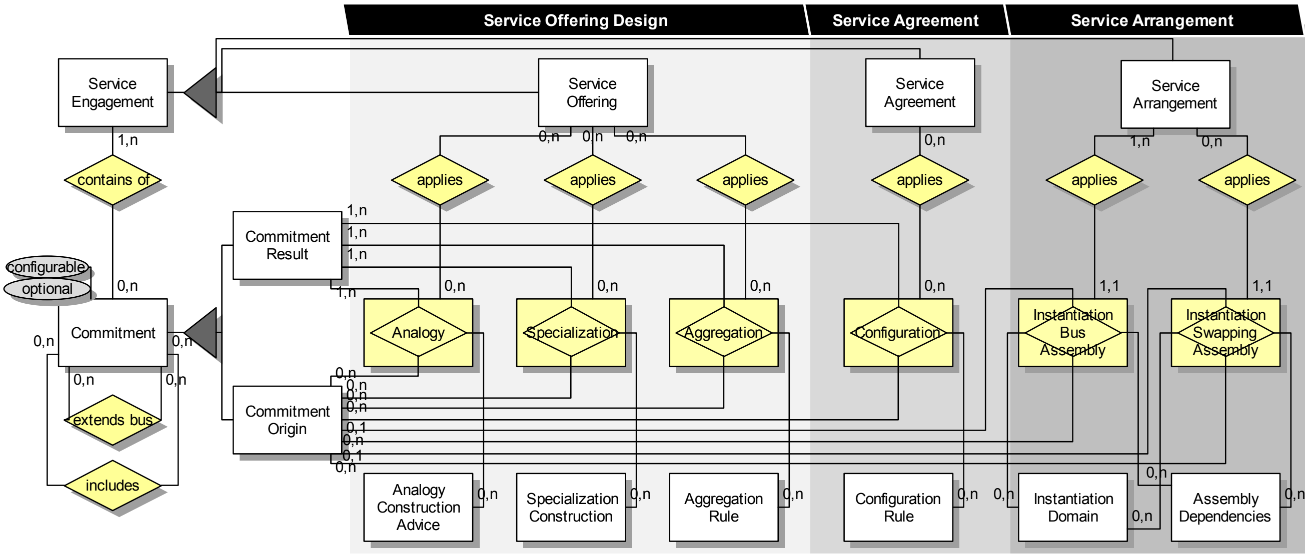

Figure 3: Meta model of the generic part of an adaptable reference IT-service engagement [eERM-notation]

SCENARIO-BASED APPLICATION OF THE REUSE-MECHANISMS

In the previous sections, we introduced three stages and five reuse-mechanisms for the composition of service engagements. Based on a scenario, their application and corresponding efficiency in service engagement customization shall now be illustrated. Given a generic reference service engagement, it may first be used by IT-service providers in order to specify the service offering (1). Subsequently customer-specific adaption leads to declared, customer-individual service engagements that are contracted in master agreements (2). Based on that, the customer may continuously assemble commitments and configure the current service to his changing demands (3). As the scenario shows, the appropriate reuse-mechanisms per stage may be used independently and in conjunction in order to customize the service engagement (cf. Becker et al., 2007a).

An example for applying the reuse-mechanisms in these steps is given in Figure 4 that illustrates a scenario of service engagement composition. It builds on a generic service engagement for basic B2B application hosting services. Thus, it predominantly specifies the provision and operations of basic database and operation systems for software applications as well as the required coordination of interface and release changes or updates.

In the scenario, an IT-service provider derives a business accountancy specific service offering by applying according reuse-mechanisms to the reference engagement (1). Specialization construction has among others been performed by detailing potential software applications as well as the range of interfaces. Specific IBM application components have been defined in analogous construction to existing SAP components. Commitments for access rights and roles have been attached via aggregation of corresponding components. The resulting service engagement complements the provider’s offering.

Building on this offering, one of the business departments has concluded a master agreement that determines the relevant functional extent of the service engagement according to the customer’s requirements (2). Therefore, the agreement has been configured as follows: Reporting activities have been defined as an optional commitment on request and the proposition of rights and roles management has not been demanded and thus was eliminated.

Based on the service agreement, the customer has placed requests in order to assemble a hosting service as required for a specific expense report process (3). The basic service commitments have been extended by the selection and configuration of a process specific software application, an IBM process server and an SAP portal as well as one of the proposed database interfaces. Substitution of commitments took place through a request for accelerated incident management.

IMPLEMENTATION AND EMPIRICAL EVALUATION

The introduced reuse-mechanisms for gaining “mass” in mass customization of service agreements have been developed and applied in close cooperation with four IT-service providers. The development followed “design research” guidelines as promoted by Hevner et al. (2004) and Peffers et al. (2006). We identified that all providers suffered from the same problem: inefficiency through highly customized service agreements, while laboriously defined service catalogues were hardly utilized. In addition to relevant literature and in-depth interviews with experts, we analysed existing service catalogues and service level agreements of diverse divisions and subsidiaries with their customers (cf. Brocke, Uebernickel and Brenner, 2010b).

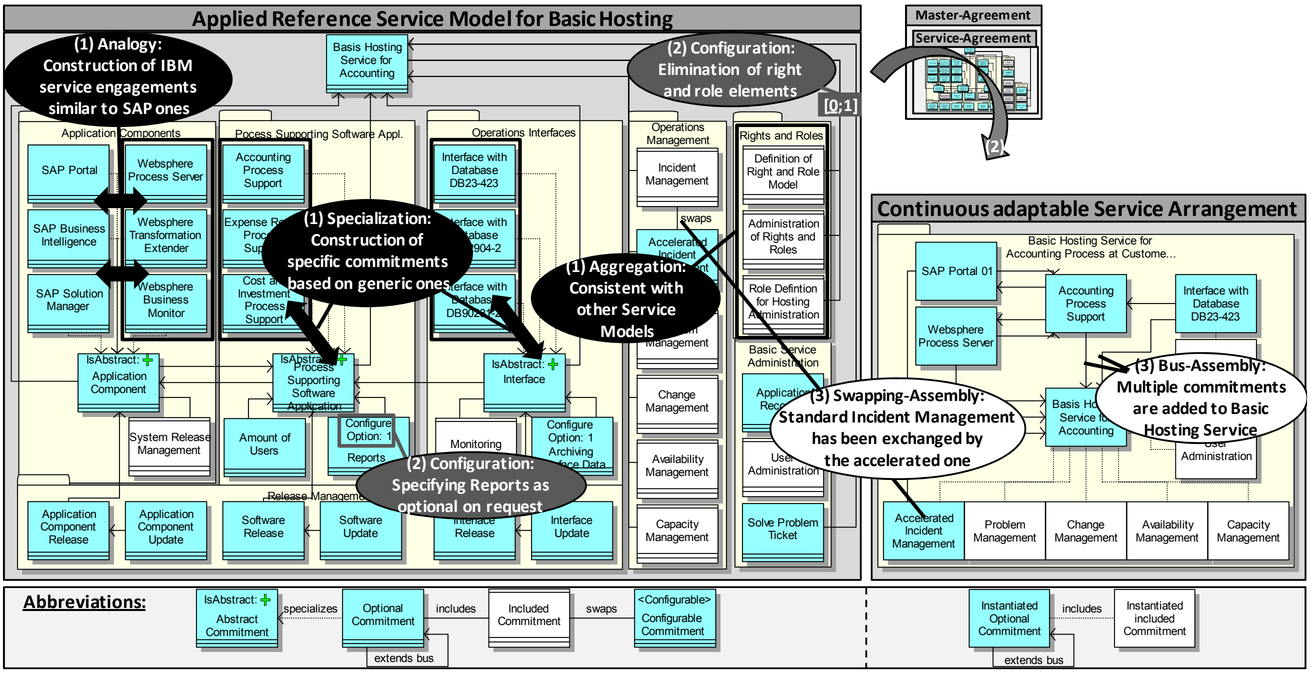

Figure 4: Application of reuse-mechanisms in a reference service engagement for basic hosting [UML-class notation]

On this basis, we first iteratively developed, discussed with IT-professionals, and refined multiple samples of customizable service engagements that consist of self-contained, reusable commitments. We subsequently enhanced the samples to reference IT-service engagements that specified opportunities of configuration, swapping-assembly and bus-assembly (Brocke, Uebernickel and Brenner, 2010a). Potentials for analogous construction, specialization and aggregation became obvious as we identified communalities when defining a wide range of service engagements in very different domains - such as 'End-to-End Accounting', 'Company Internet Access' and 'Application Hosting'. Numerous workshops with IT-professionals were used to evaluate their potential appliance in practice. We additionally implemented a self-service portal that supports bus and swapping assembly when instantiating commitments. Subsequently, the reuse-mechanisms and their application in a service portal became conceptual parts of a pilot project. The project aimed for industrializing the IT-service management of a multinational ICT provider that records revenue of nine billion euro. Representatives of the IT provider's customer organization tested and evaluated results by points-based questionnaires and vote for extended implementation.

SUMMARY AND FUTURE RESEARCH

Customer-specific demands of individual adjustment in service specifications cause both high efforts in service offering design and service agreement negotiation as well as unrepeatable and project-based ad-hoc implementation in IT-operational processes. Two fields of related research seem promising to contribute to a solution for this challenge. Reference modeling concerns itself with the adaption and configuration of generic models to specific requirements whilst mass customization concepts aim to turn out individual solutions to costs of mass production. Thus, we proposed to transfer the mass customization approach to the domain of IT-services and implement it through applying reuse-mechanisms of the reference modeling domain. Following the two critical aspects for applying mass customization, we determined modular components of IT-service engagements and stage of customization in the IT-service lifecycle. We then transferred reuse-mechanisms to the domain of IT-service engagements and allocated them to the three identified stages of mass customization. A scenario-based application of the reuse-mechanisms originates from close collaboration with cooperating IT-organizations and illustrates the mechanisms' utilization and potential effects.

The definition of reuse-mechanisms enables their empirical evaluation and fosters theory building. However, this requires the voluminous enhancement of current IT-service engagements with appropriate reuse-mechanisms. One future research objective is the identification and collection of best-practice IT-service engagements in order to derive reference service engagements for IT-service providers. Furthermore, the development of software-based support for adapting and applying IT-service engagements is necessary. Regarding the software-support of the service arrangement stage, we aim for further findings in usability-aspects from our implementation of a customer self-service portal, which is currently under revision. Further research includes a machine-readable meta-language to specify the required data of resulting service engagements.

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