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DEVELOPING A UNIFIED SERVICE MODEL FOR COLLABORATIVE MODELING OF LOGISTICS SERVICES

Abstract: Engineering and management of service systems and services is complex and involves the legwork of many different stakeholders. A structured approach may lead to significant better results in these tasks. Modeling becomes necessary to cope with the complexity of service systems and services. Due to the big variety of stakeholders and their interests, many models on the same services exist. In this paper we therefore present a method on how to develop a unified service model for the logistics domain which has the ability to integrate various stakeholder models and to keep them in a consistent manner, so that each model stays valid when put into model space.

Keywords: service model, modeling, logistics.

1. Introduction

Engineering and management of service systems and services is a complex task and involves the legwork of many different stakeholders. Depending on the individual purpose, distinct aspects are necessarily to be modeled. As a result, more than one model for a specific service will be created and need to be handled uniformly. In order to assure that emerging models are not predominantly overlapping, a framework should be provided prescribing valuable perspectives on a service. Stakeholders, who want to develop new models with certain content, are then to consult the framework and pick up necessary properties from the contained perspectives. With such requirements, managing a set of models becomes easier. Stakeholder can also check the available set for already existing models by comparing the used set of properties.

Due to the fact that different stakeholders need different views on the same business, they develop different models for each purpose as already stated above. A second problem which arises then is: Even if at the beginning the same service is modeled from different perspectives it will get more difficult over time to maintain the link between these models.

For this, the use of ontologies as a glue between different models is proposed in the following. A business-oriented ontology serves as common ground between different models. While a business-oriented ontology in logistics helps to maintain the context and therefore helps a stakeholder to maintain a certain language to model his or her point of view, the service ontology maps the service concepts like actions or events to concrete business concepts like transport or road accident.

So the approach is twofold. A common base of perspectives has to be developed for all models which arise from different stakeholders and represents a backbone for a unified service model and there has to be a schema-like segmentation on how viewpoints can be added to the existing set of models so that it is assured that models are not duplicated after time. The second part is the integration of a business-oriented and service ontologies which maintain consistency over the whole set of existing models. In this paper the authors present first insights into this work-in-progress and want to highlight some interesting points under investigation.

2. Use case: value-added logistics provider

The reason for developing a unified service model is based on the business model of value-added logistics provider. Among other industries the shift towards cross--enterprise collaboration especially affects the logistics service sector [Kleine--Kleffmann, Bößer 2006]. With an increasing number of manufacturers outsourcing their formerly internal logistics functions and demanding these outsourced logistics services need to be customized to their individual needs, logistics service providers are required to become more flexible. Hence, logistics service providers increasingly evolve towards integrators and customizers of services offered by different providers and become managers of end-to-end value-added services and of inbound and outbound value chains respectively. Several specialized business models have been established focusing on this kind of service providing, namely third- and fourth-party logistics provider as well as lead logistics provider. They differ in the amount of own assets and in the know-how they can offer to their clients and customers. Most sophisticated business models are the fourth-party and lead logistics provider. Those two concentrate mainly on the management of value-added logistics services in terms of planning, configuration, monitoring and optimization. Therefore, they focus on mediating logistics services between providers and requestors and as such, they act as a requester of logistics services from different providers, and as aggregator and manager of complex value-added logistics services and provider of these services towards shippers and their customers.

Complex services in the meaning of multiple involved stakeholders lead to the necessity of developing multiple specialized models. Each model has to provide a certain piece of information so that the demanding stakeholder can act appropriately on the mediated services. In the case of a value-added logistics provider stakeholder interests can vary from business (processes, management ratios, disposition plans, SLA) to technical (resource plans, service compositions, life-cycle-management) aspects. Further on, stakeholders can be categorized upon their usage. Do they create models or are they using the outcome of other's development. Another viewpoint is the strategic vs. operative view where in the strategic view long-term planning of the service portfolio can be visualized and in the operative view more the daily work is focused on.

As a result, many different models may exist on a single service each one conveying special information for one or more stakeholders. Stakeholders can be within the logistics provider itself or on the customer and on service provider side respectively. They can be in management or operational level.

So for the provisioning of such complex services the act of creation and of documenting (in form of different models/views on the service) becomes crucial for the logistics provider. Then, added value is optimized and the customers of such value-added services are satisfied. This can be achieved by supplying the logistics provider with a unified service model as a kind of backbone and central pivot for a set of models describing a distinct value-added service in their portfolio.

3. Related work

This section encompasses a brief overview of research in adjacent fields of study. Modeling different viewpoints is done in enterprise modeling especially with respect to multi-perspective modeling and current research of modeling of services itself is presented.

3.1. Multi-perspective enterprise modeling

Integrating different viewpoints on services leads to the need of a multi-perspective way of modeling. Enterprises, which are heterogeneous and complex in nature, provided the field of study for several approaches.

MEMO (Multi-purpose enterprise modeling) [Frank 1994] and the St. Galler Business Engineering [Österle 1995] proceed in a similar way. Both approaches gain insights into enterprises or reduce complexity in the modeling of enterprises by capturing three perspectives of enterprises, namely Strategy, Organization and Information systems in MEMO and Strategy, Processes and Information systems in the Business Engineering respectively.

With ARIS [Scheer 1997] and the Zachmann framework [Zachmann 1987] two additional approaches for modeling enterprise information systems in particular use multiple perspectives. Whilst ARIS is using five different perspectives to describe a business process, the Zachmann framework uses six distinct perspectives to answer the questions "What, How, Where, Who, When and Why" from the points of view of different stakeholders within enterprises.

Common goal of all approaches is to provide several specialized information models to reduce complexity of a single model comprising all information. The use of multiple perspectives additionally has the advantage of analyzing problems from different angles.

MEMO and Business Engineering want to describe enterprises as a whole, ARIS and the Zachmann framework focus on architectures of enterprise information systems.

In contrast to the unified service model which is further explained in the next section, all presented approaches use a closed world assumption and a fixed set of dimensions or perspectives. The field of service management instead needs an open world assumption because the number of stakeholders might not be known in advance. Therefore and because new aspects of services can come up in the future, the modeling method needs to be open for further aspects.

3.2. State of the art service modeling

Service modeling is deeply investigated. Early approaches often focused on a single aspect like the Service Blueprinting [Shostack 1984] which focuses on processes. An analog approach which focuses also on the description of service processes is SADT (Structured Analysis and Design Technique). Congram and Epelman [1995] use the method originally called IDEF which was not intended for services in the first place. For these and for further approaches the report of Alonso-Rasgado, Thompson et al. [2004] provides a good insight into the specific details. Alternatively Kaner and Karni [2006] present an approach to describing services by using an analogy to the master data management. In their method they developed a catalogue of properties divided in a complex class system with which they are able to classify and therefore describe services. At last this approach also focuses on a single aspect, in this case the classification of services according to their content and clients.

Newer approaches in the field of service modeling consider different aspects and combine them into a more complex view on services. Examples here are the Service Systems Modeling [Böttcher, Fähnrich 2009] which encompasses four dimensions: Product, Process, Resources and Component Models.

A similar approach to the unified service model is the ISE Framework of Scheithauer, Voigt et al. [2009]. Along five aspects of services and four conceptual levels (from strategic to technical) they prescribe for each combination of aspect and level a certain type of model with which a given service should be modeled. The major drawback in this case is the fact that transformations between each used modeling language are needed, an enormous effort and depending on the language not always fully manageable.

4. Unified service model

As illustrated above, the complexity of integrating all aspects on a service is exceptionally high to put it into a single model. Besides, a modeling language able to express every aspect would have to be too generic and with that, the explanatory power of such a model would be too weak. A feasible solution exists in modeling different viewpoints in separate models. The unified service model facilitates the development of such models. On the one hand it serves as a framework for defining viewpoints by spanning a solution space along a set of dimensions. Each of these dimensions has a set of properties which allows specifying certain aspects of a service like used resources or the components it consists of (see section 4.1). On the other hand the unified service model contains a business-oriented (logistics) and service ontology. Equivalent concepts in both ontologies are bound to each other. A stakeholder who wants to model a specific viewpoint of a given logistics service can benefit from this connection by selecting a service concept and with this, getting a list of matching logistics concepts. A second advantage using ontologies is the fact that multiple viewpoints on the same service can get connected through the utilized concepts (see section 4.2). First insights into the development and management of service models and the underlying ontology is finally presented in section 4.3.

4.1. Multi-dimensional service model

In this section first candidates for service dimensions are presented. In Figure 1 these candidates are drawn as independent and partly orthogonal dimensions of services.

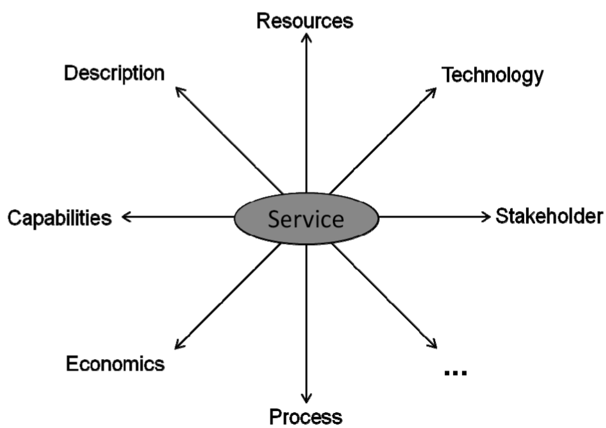

Figure 1. Service dimensions

Table 1 outlines the particular content of each dimension.

Table 1. Description of dimensions

Dimension	Description
Stakeholder	Contains a certain role model for services. Stakeholders can either be direct participants of services in the meaning that they are involved in service delivery or they are indirectly affected by the service execution.
Description	Textual description of a service. In comparison to the process dimension this one contains verbal descriptions. A description can also be formalized e.g. SLA-Agreements for service delivery.
Process	Processes are described using formalized modeling languages in which the process is plotted with a set of actions, events, roles and so on. Therefore, this dimension contains usable modeling languages and artifacts for the modeling.
Technology	Technological artifacts, architecture blueprints, usable technological specification like W3C standards.
Economics	Specification of economical performance figures and important measures for the operational efficiency in the meaning of adding value to the business itself.
Resources	Services operate on resources. This dimension comprises a set of different resource types which can be used for service delivery.
Capabilities	With this dimension unique features of each service can be modeled with. In detail, this dimension encompasses, e.g., the kind of transport a service can provide or more in terms of software supporting activities like route planning.

Some of the dimensions can easily be combined to complete a certain view on the service. Process and resource for example can be combined in a model to express that a given service consists of several other services orchestrated in a service composition. On the one hand services are resources for the composite service and as such are part of the resource dimension. On the other hand each of these processes has a certain functionality which has to be brought in correct order for the overall service.

Example: A multi-modal transport of DVD players from a plant in Far East to the distribution center in Europe might serve as a real world example. Several transport services (shipment, charging, packaging, route planning) have to be combined for this service by a value-added logistics provider. Each part of the transport represents a separate service which has to be brought in correct order and coordinated.

Each of the described dimensions has a set of properties which are specific to this dimension (see Figure 2). In case of the models these properties represent the characteristics a stakeholder wants to express with his model.

In contrast to the presented approaches in the related work section, the set of dimensions for the unified service model is not fixed. For the beginning, an initial set of dimensions is given to the various stakeholders. This set is then aligned with the needs of the stakeholders and can be broadened if necessary. Hence, flexibility is ensured because new properties or even dimensions can be added. It is also possible to exclude a dimension for the future work if it is determined that it will be no longer

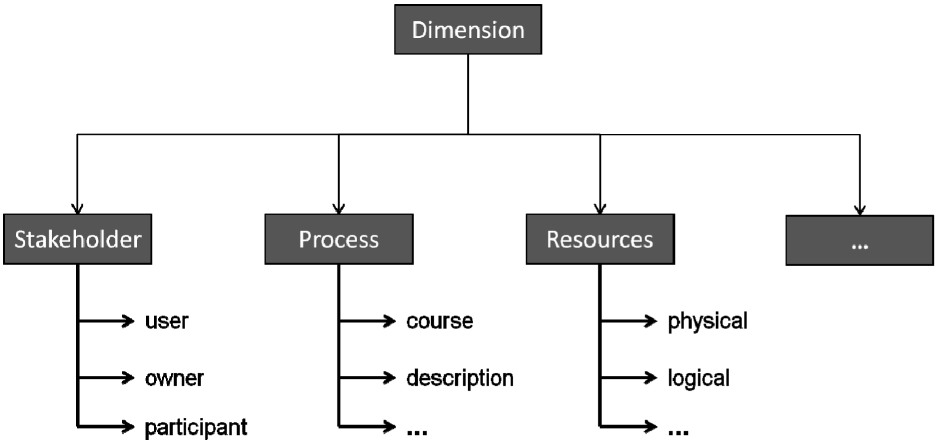

Figure 2. Properties of service description

used. This is one of the major research points in the near future to provide a concise method for realizing the change management of the unified service model.

4.2. Preserving semantics with the use of business and service ontology

A major problem when modeling the same issue from different perspectives is to maintain consistency over time. When creating two different models on the same service for example, it is not possible to easily connect these two models together. Both seem to be separate models even on the identical service.

A solution might be the use of ontologies as glue. An ontology is a collection of concepts and their relationships to each other forming a hierarchy of concepts [Gruber 1993; Fensel 2001; Noy, McGuiness 2001; Gomez-Perez, Fernandez-Lopez et al. 2004]. For the logistics domain the use of a business-oriented and logistics specific ontology is necessary. The Interloggrid project at the Information Systems Institute is cooperatively developing such a logistics-oriented ontology. This will be used for the unified service model. Moreover, a service-oriented ontology is also needed for the service model. Figure 3 shows the reason for this.

Figure 3. Business oriented modeling

Whilst the business-oriented ontology yields the logistics context, with the help of the service ontology, it is possible to map modeling aspects of a stakeholder on the appropriate business concept. The idea behind this is the fact that multiple business concepts lead to the same service concept. For instance, the service concept of an action can have several counterparts in logistics like transport, charging, packaging, etc. On the side of the stakeholder modeling his or her perspective, he or she is free in use of an adequate modeling language which in effect also leads to the same result: multiple modeling concepts lead to a single service concept. With this in mind, a future tool support can be sketched in an example:

Again a stakeholder wants to create a process model of a multi-modal transport of DVD players from the plant in Far East to a distribution center in Europe with given time restrictions. For such a model the following artifacts are needed: Objects, Actions, Events, and Roles. These artifacts represent concepts from the service domain. If the stakeholder chooses BPMN as modeling language, he can use swim lanes, triggers and activities as seen in Figure 4.

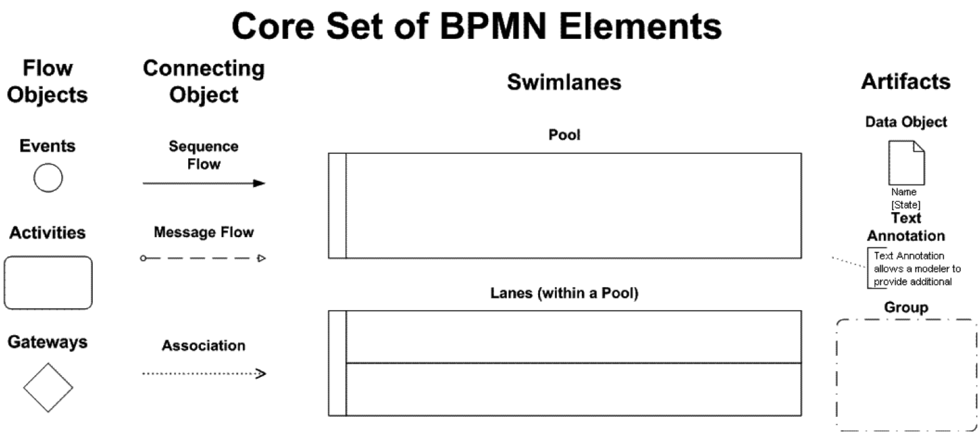

Figure 4. BPMN elements

Source: OMG at http://www.bpmn.org.

With the help of the service domain, the BPMN activities can directly be linked to logistics concepts like the shipping by plane or ship, the packaging at plant site or the storage in the distribution center of the DVD players. If the stakeholder wanted to model this circumstance with EPC instead, equal connections between the set of EPC artifacts and the service domain could have been established.

Finally Figure 5 brings all parts together. Business-oriented and service ontologies are bound together over equivalent concepts. Different modeling languages, respectively the graphical or verbal representation of each language, are also bound

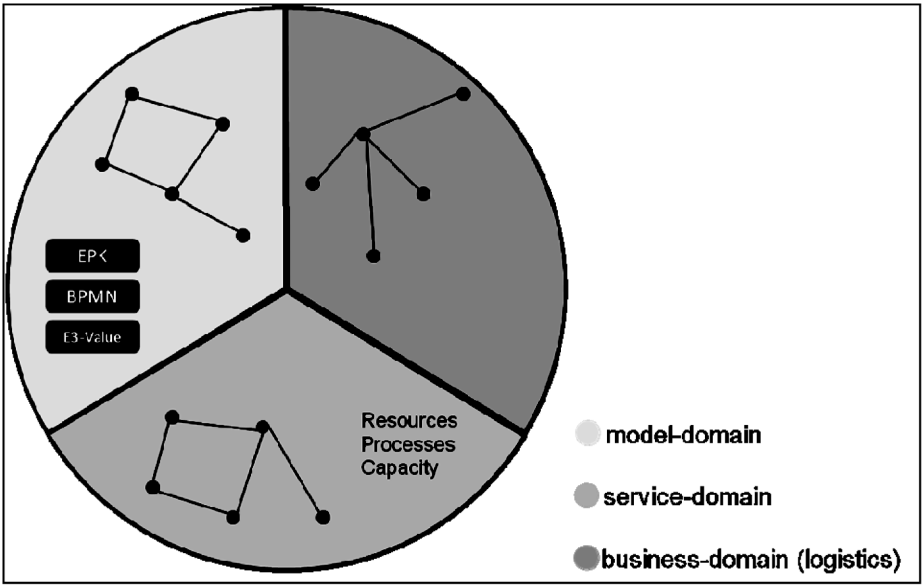

Figure 5. Service model ontology

to the concepts of the service ontology. Hence, the representations of the various languages are bound to the business concepts in the particular ontology.

Moreover, through the use of ontological concepts in different models, it can be asserted that these models are to convey the same part of reality, i.e. the same service in particular.

4.3 Development and management of service models

After having described the core of the unified service model, in this section the development and management of models is shown. As stated above, the number of models is directly bound to the heterogeneity of stakeholders, when at an average each stakeholder uses at least one model in order to express his or her viewpoints on a service.

Development of the unified service model consists of ontology building and identifying an initial set of models. Therefore an initial set of stakeholders is to work with the unified service model and for this, these stakeholders are to give input for the ontology and the initial set of models. The stakeholders who help building up an initial unified service model are co-researchers working within the same research agenda. The requirements they have on modeling services serve as a good starting point and comprise several distinct viewpoints on services. With this, the initial set of models is also fixed. For the ontology the already mentioned ontology from Interloggrid project is used. On this base, interviews can be conducted with the stakeholders and additional concepts can be integrated into this ontology.

Management of unified service model is about adding new models to the model space and changing existing models in model space. Deletion is less regarded so far.

For a stakeholder who wants to add a model to model space, first thing is to compare the requirements of the new model to be developed with the existing models. This is done by describing the model with the help of the concepts from ontology. A measure for evaluating the similarity between two models is the amount of concepts they share when describing certain aspects of a service. This can either be on the service level or on the business level or on both levels. Especially when two models share many concepts on service level as well as on business level a similarity is obvious (see Figure 6).

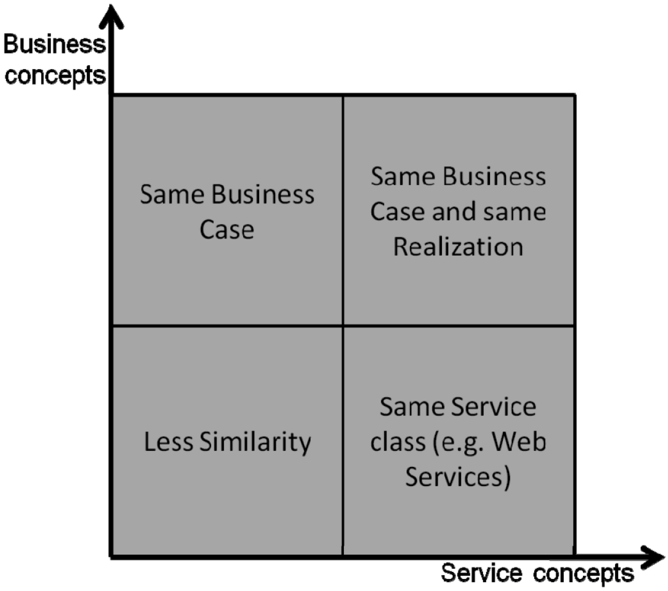

Figure 6. Shared amount of ontology concepts

For this reason three outcomes are possible:

- A similar or near identical model is already in the model space and can be used by the stakeholder.
- There are models which consist partly of the same ontological concepts but many concepts have to be added to complete the model. In this case either the adaptation of an existing model might be an option or the creation of a new model.
- The model to create and the existing models in model space are different in scope and so a new model has to be developed for the stakeholder.

For the outcomes two and three the ontology in the background of the unified service model has also to be updated. In these cases, interviews have to be held with the stakeholder(s) in order to get the missing concepts and integrate them in the ontology in the appropriate places of the concept hierarchy.

Afterwards the already existing models in model space have to be analyzed if the added concepts do have an impact on them. One possible impact may be that the similarity of the regarded models may rise in a sense, that the models share more concepts in describing a certain service.

Changing an existing model is a similar process to adding new models. When changing a specific model in model space by adding or deleting information items from the models, e.g. adding new process details to a process model, additional concepts have to be used to model this information. Therefore, the similarity of this model has again to be checked with the remaining in the model space, leading to either a new model or in the merging of two, now similar models.

5. Conclusions and outlook

The paper has shown the need for the development of a unified service model which is able to integrate various stakeholder models. Then, first activities of the development and a big picture of the service model have been drawn up. The creation of an initial set of models and the management of adding new models or changing existing ones has been also presented at the end. For running a service-oriented business, in this case in the logistics domain, a service provider has to present his assets according to the specification of his customers. In addition, different internal views are needed to cope with certain aspects like composition, granted service-levels or resources. As a result, many viewpoints have to exist on the same service and what is crucial, these viewpoints have to be merged for a holistic view on the service. According to our research, this can be realized by developing a unified service model which delimits the aspects to be modeled and which preserves consistency over all available viewpoints or models respectively by providing a domain-specific ontology.

Future work will focus on completing the unified service model and developing a method for adding and removing dimensions and properties collaboratively. Furthermore, two additional aspects will be investigated in more detail. First, when having established a unified service model with a certain size and complexity, will it be possible to derive new viewpoints from the existing base of dimensions and properties? Second is the development of a modeling tool, which comprises the unified service model and which enables stakeholders to model their viewpoints according to the service model specification.

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BUDOWA ZUNIFIKOWANEGO MODELU USŁUG DLA KOLABORACYJNEGO MODELOWANIA SERWISÓW LOGISTYCZNYCH

Streszczenie: Inżynieria i zarządzanie systemami usług jest przedsięwzięciem kompleksowym, co wynika z udziału wielu uczestników. Przyjęcie podejścia strukturalnego w projektowaniu tego typu systemów prowadzi do uzyskania interesujących wyników. Modelowanie staje się zatem koniecznością w rozwiązaniu problemu złożoności systemów usług i usług. Ze względu na dużą liczbę uczestników i różnorodność ich zainteresowań może powstać wiele modeli tych samych usług. W tym artykule proponujemy metodę budowy zunifikowanego modelu usług dla branży logistycznej, gdzie istnieje potrzeba integracji różnych modeli zainteresowań uczestników i zachowania ich zgodności w systemie.