Service Value Properties for Service Ecosystems: A Reference Model and a Modeling Guideline

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Abstract. With the rise of service-oriented computing and web service ecosystems, services and their electronic descriptions become crucial to foster significant value propositions toward potential service consumers. While there exist ample technical specifications to describe web services, conceptual approaches are rare. On top of this, an alignment between business models and information technology is lacking. This paper is a step toward this direction in that it offers a reference model to classify service value descriptions depending on their purpose, presents a generic model for service properties, proposes two meta models for conceptual modeling, and finally introduces a modeling guideline.

Key words: service description, reference model, service ecosystems

1 Introduction

Tertiarisation describes a structural change in developed countries concerning the sectoral composition. Countries shift from an industry economy toward a service economy. Drivers of this change include Globalization, technological change, and an increasing demand for services [24]. Considering this trend, it becomes clear that services and the service economy play an important role in today's and tomorrow's business. In line with this trend, service ecosystems emerge, such as eBay, Google Base, Amazon.com, SalesForce.com, and SAP Business by Design. The vision of service ecosystems is an evolution of service orientation and takes services from merely integration purposes to the next level by making them available as tradable products on service delivery platforms [3]. They aim at trading services over the Internet between different legal bodies, compose complex services from existing ones, and IT-supported service provisioning [11].

Figure 1 depicts the steps involved in service trade: (1) service proposition, (2) service discovery & selection, (3) service negotiation & contracting, and (4) service monitoring & profiling (cf. [15]). Midst service proposition, service providers advertise their services toward potential consumers, whereas during discovery &

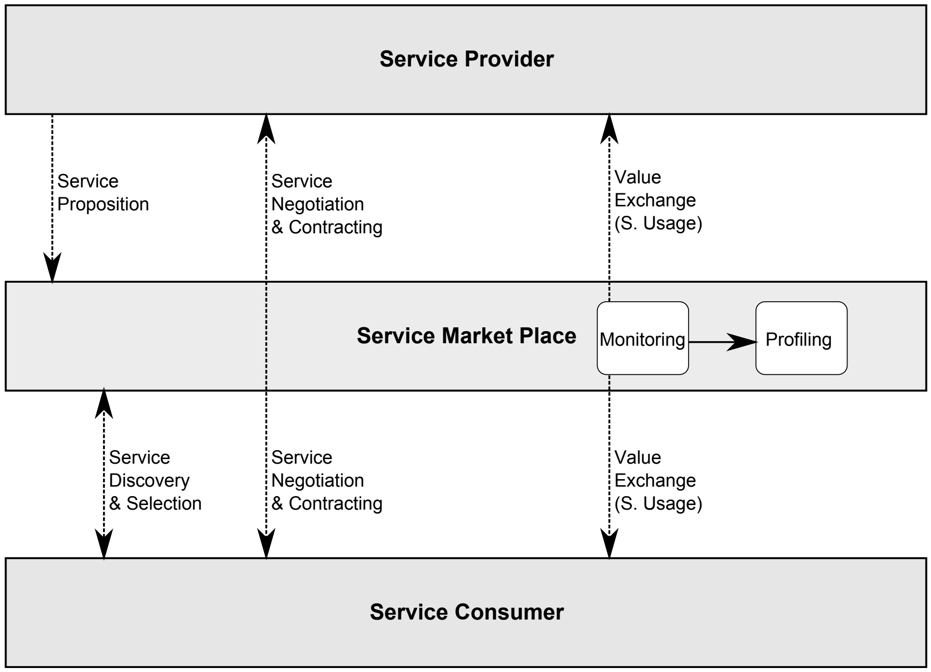

Fig. 1. Trade in Service Ecosystems

selection, service consumers specify their service preferences toward providers. In case a service consumer selects an appropriate service, providers and consumers negotiate and finally agree on service levels (SLA) which are monitored throughout value exchange. In the event service levels are not met, compensations must be triggered. During service profiling, valuable information on services' performance is stored, which is gathered while value exchange and monitoring.

In order to enable service trade, a shared and common understanding of services must become available. Nonetheless, no established language exists to define, to agree on, and to monitor service properties [15]. On top of that, Booms and Bittner [4] argue that services are different to goods, that is services are intangible, and thus, can neither be stored, transported, nor resold. Goods are produced at some point, stored, and eventually consumed at a later point. In contrast, production and consumption of services take place at the same time. Goods can be transported from one point to another. Services, on the other hand, are consumed at customers' locations, thus, production and consumption happen in one place. Whereas goods can be resold, services' outcome cannot be sold to another party. Additionally, services can hardly be standardized, since service experience is unique and depends on the individual expectations.

While ample technical specification exists to describe web services, conceptual notations to elicit business-relevant domain knowledge are lacking [28]. Suitable technical specifications for web service descriptions include: (1) Web

Service Description Language (WSDL) [25], (2) Web Ontology Language for Services (OWL-S) [16], (3) Web Service Modeling Ontology (WSMO) [26], and (4) Service Level Agreements for Web Services (WSLA) [13], just to name a few. Currently, semantic concepts to describe web services base on formal approaches, such as first-order logic and predicates. This hinders domain experts to describe services with these concepts. A more sophisticated approach must become available. Recent work concentrates on the *business service modeling* discipline with a focus on how to formalize the relationship between business operational requirements and to implement them with service-oriented architectures (cf. [5]). However, the focus of these approaches lies in business process transformation [22]. No attempt has been made for service value descriptions.

This paper contributes in that it explores the conceptual gap of service value modeling. It offers a reference model to classify service value descriptions, introduces a generic property model, proposes two meta models for conceptual modeling, and finally presents a modeling guideline.

The remainder of this paper is structured as follows: section two discusses important work which is related to the proposed solution. Whereas section three suggests a reference model, section four offers a generic model that specifies *how* to model value descriptions. Section five introduces two meta models with specific properties which address *what* properties are of significance. Following this, section six brings out a modeling guideline to support a continuous modeling process. Finally, section seven concludes this work as well as offers prospects about future work.

2 Related Work

Prior to dive into the reference model and the service value properties, this section discusses available work in the area of conceptual service descriptions.

Baida et al. [2] provide a study of different semantics for the terms: service, web service, and e-service from three different perspectives: Computer Science, Information Science, and Business Science. Currently, there is no common understanding of the term service in the different research areas. Consequently, they provide definitions for real-world services, e-services and web services.

Papazoglou [23] describes an extended service-oriented architecture which comprises a basic service description. It includes the aspects: service capability, service interface, service behavior, and service quality attributes.

Oaks et al. [17] write about the lack to specify service capabilities, that is, what services, or agents, can do. They offer a structured and machine interpretable capability description. This approach will be of help to specify a services functional properties.

Complementary to Oaks et al., O'Sullivan [21] presents a wide range of quality attributes to describe real-world services. These attributes include availability, obligations, price, payment, and discounts, just to name a few. This property set is the main source for the value model which is shown in section 5.2.

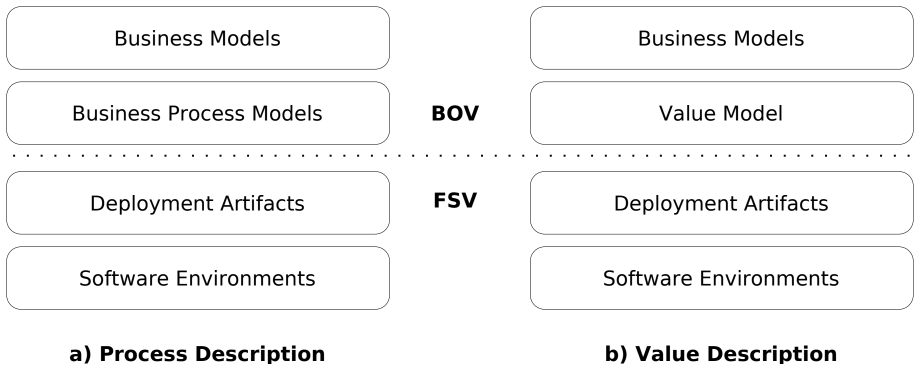

Fig. 2. Refined Open-EDI Reference Model (cf. [5])

Analog to the proposed solution in this paper, the aforementioned approaches acknowledge the existence of a service description with its different aspects. Furthermore, they elaborate on specific dedicated facts. On the other hand, the proposed solution in this paper goes beyond these disjoint approaches in that it offers a general method which addresses every aspect of a service description. Additionally, it suggests means to bridge the gap between business specifications and information technology.

3 Reference Model

This section proposes a reference model to differentiate between service value description modeling phases. It is based on the open-EDI reference model [10], work of Dorn et al. [5], and Scheithauer et al. [28].

Whereas technical specifications aim to describe services themselves, this work concentrates on the value services offer. Value descriptions formalize services' value and are composed of value properties, which support the phases of service trade. Such a description is considered as an external view on services [28], unlike a process description, which depicts an internal view on services' behavior.

The open-EDI reference model [10] distinguishes between the Business Operation View (BOV) and the Functional Service View (FSV). BOV comprises business data semantics as well as business transaction rules, such as agreements and obligations between partners. FSV on the other hand, focuses on information technology which includes interfaces, functional capabilities, and protocols. Dorn et al. [5] add subtle refinements to the open-EDI reference model, which figure 2a shows. They refine BOV into *business models* and *process models*. Business models express value exchange between different actors and business analysis. Process models represent how each actor realizes value exchanges. Likewise, they refine FSV into *deployment artifacts* and *software environments*. Deployment artifacts address implementations of business processes with technical specifica-

Table 1. Classification of Models and Specifications

Business Model	Value Model	Deployment Artifacts
BMO [20]	Property Model [28]	WSMO [26]
e^3 value [7]		OWL-S [16]
		WSDL [25]
		SA-WSDL [6]

tions, e.g., BPEL [1]. Software environments describe runtimes to execute technical artifacts. This refined model serves as a classification system for concepts and modeling notations as well as to define means to bridge the different layers. It is important to note that the refined open-EDI reference model by Dorn et al. focuses mainly on process descriptions. Hence, the reference model for value descriptions adepts subtle changes (cf. figure 2b). Scheithauer et al. [28] argue that value properties in the business model layer own a strategic semantic and take into account services' final purpose and context. The next layer changes from process model to value model to reflect the actual modeling purpose of value descriptions. Value properties on this layer reflect a firm establishment with concrete values. The result is a value proposition toward potential customers. Deployment artifacts describe technical-related specifications to implement value properties.

The following sections employ this reference model. Section 4 offers a meta-meta model for all reference layers. Section 5 present specific meta models for the business model layer and the value model layer.

The following subsections introduce briefly available approaches and technical specifications for each layer of the reference model, which are shown in table 1. However, the software environment is omitted here, since it is out of scope of the proposed solution.

3.1 Business Model

This section elaborates on the Business Model Ontology (BMO) and the e^3 value model. Both approaches are suitable for the reference model's business model layer. Evidence for this is found here [5, 14, 27, 28].

BMO [20] is an ontology to accurately describe companies' business models. Osterwalder did an exhaustive literature analysis of existing business model definitions and theories as well as some real-world case studies in order to build and to evaluate the ontology. The author's main influence is the work from Kaplan and Norton [12] about balanced score cards. The ontology's complexion is that of pillars, building blocks, and attributes. The first tier nodes depict the pillars, the following nodes represent the nine building blocks. The third tear nodes are attributes for each building block. Osterwalder [20] provides a far more detailed description.

Gordijn et al. [8] argue that current requirement engineering methodologies are inadequate for the e-commerce domain, and hence, develop the e^3 value model. e^3 value model offers a structured approach, to gather requirements for e-commerce applications. It includes three levels of abstraction and a six steps process for guidance. The three levels of abstractions are: (1) e-business model development, (2) e-business process design, and (3) software architecture requirements. Moreover, they provide six steps to guide the requirement creation process: (1) identification of actors in the e-commerce process, (2) construction of the list of the relevant value activities, (3) definition of the associated value ports, interfaces, and value object types, (4) allocation of the value activities to the actors, (5) analysis of the trade-offs occurring in the alternative business models, and (6) tracking down the associated implications for requirements on the information systems architecture.

3.2 Value Model

This section introduces the service property model [28], which is appropriate for the value model layer.

Scheithauer et al. [28] investigate valid service properties for service ecosystem, available modeling notations for service properties, and an appropriate framework in order to categorize modeling notations according to the needs of the different roles involved in the service engineering process.

The motivation to find valid service properties is to describe services in such a way to allow aimlessly service trade over the Internet. It is envisioned that these properties support service proposition, discovery, selection, contracting, and monitoring in service ecosystems. In order to elicit valid service properties, the authors investigate available literature and analyze proposed properties, whereas work from O'Sullivan [21] is the main source. The result are 15 service properties and their relationships. For a better understanding and readability these properties are grouped into the following categories: (1) functionality, (2) financial, (3) legal, (4) marketing, and (5) quality.

The authors find the Zachman framework's perspectives as appropriate means to categorize available modeling notations. They argue that the origin descriptions address the internals of a solution, which is not sufficient for service ecosystems. Rather, it is required to model the external view of services. Therefore, they motivate another description for the Zachman framework: service description. The basic descriptive model is that of properties and values and is valid for all perspectives in the Zachman framework. Benefits include: (1) integration of service description modeling into the whole service engineering process, (2) categorization of available notations for each perspective, (3) discovery of missing service description notations, (4) recognition of overlaps, and (5) first deliberations on how to bridge different perspectives.

3.3 Deployment Artifacts

The following paragraphs shortly present available specifications for the deployment artifacts layer.

The Web Service Modeling Ontology (WSMO) [26] is an ontology dedicated to web services. Its main elements include: (1) ontologies, (2) web services,

(3) goals, and (4) mediators. The ontology element codifies domain knowledge, which is used by all other elements. Web services' capabilities are expressed with pre- and postconditions to describe services' value offering. On the other hand, goal elements formalize desired value. Finally, mediator elements are means to overcome interoperability problems between other WSMO elements.

The Semantic Markup for Web Services (OWL-S) [16] is an upper ontology and base on the Web Ontology Language (OWL). It aims to describe web services in a semantic manner to enable automatic web service discovery, automatic web service invocation, and automatic web service composition and interoperation. OWL-S defines four main elements. The service element is the root element. The service profile element represents a service's functionality. The service grounding element discloses how to access the service. This is a bridge to a WSDL document. Finally, a service model element describes how a service works in terms of parameters and process descriptions.

Semantic Annotations for WSDL and XML Schema (SAWSDL) [6] offers a way to annotate WSDL documents with semantic annotations. Whereas OWL-S brings its own means of grounding, WSMO uses SA-WSDL to do so.

Web Service Description Language (WSDL) [25] is an XML specification to describe web services as a set of message types, message formats, port types, operations, and protocol bindings.

4 Service Value Properties

This section defines the value description and its refinement into value properties, and eventually proposes a generic model for value properties and is considered as a meta-meta model (cf. section 5).

Baida et al. define services in general as *...business activities that often results in intangible outcomes or benefits; they are offered by a service provider to its environment"* [2]. This paper refers to intangible outcomes and benefits with the term *value*. Scheithauer et al. [28] define a service value description as an external view on services to describe a service's proposition [9] a company offers toward its customers. They refine value descriptions into a collection of properties and their values.

This paper adds a subtle refinement to this definition in that it introduces a generic model for value properties. It is generic for it is capable to express properties from different approaches, and hence, provide a common semantic for value properties. This common semantic harmonizes different approaches (lessens the heterogeneity) and it enables to compare individual properties.

Definition 1 (Property). A property $p \in P$ is defined over the alphabet $(vc \in VC, m \in M)$ with the set of value classes VC and the set of metrics M.
$VC :=$ {Single Value, Range Value, ...}
$M := \{M_{Quantitative} \bigcup M_{Qualitative}\}$
$M_{Quantitative} :=$ {Currency, Granularity, Percentage, Time, ...}

$M_{Qualitative} := \{$(In-)tangible, Text, Condition, $\dots\}$

A property either has an exact value or a value range. For example, a service provider might settle for an exact price (exact: 5.00), but prefer to define a service's availability with a range (min: 0.995; max: 0.998). Metrics, on the other hand, add semantic to a property. In general, metrics are distinguished between qualitative and quantitative characteristics. However, it is possible to further refine metrics (e.g. Quantitative Metric → Currency → {EUR|USD|AUS}). A price property, for example, is defined as *Price = (Single Value, Currency Metric).*

Definition 2 (Property Bundle). A property bundle $pb \in PB$ is defined as (PC) with the set of property compositions PC.

Property bundling supports property nesting. Hence it is possible to combine properties into more complex properties. In fact, a value description is a property bundle.

Definition 3 (Property Composition). A property composition $pc \in PC$ is defined over the alphabet $(p \in P \vee pb \in PB, c \in C)$ with the set of cardinalities C. $C := \{0:1, 1:1, 0:*, 1:*\}$.

A property composition element combines either a property or a property bundle with a cardinality to support property bundling. For example, a value offer as defined by Osterwalder [20], is represented as a property bundle which is refined into the property compositions *(Price Level; 1:1)* and *(Target Customer; 1:∗).*

5 Meta Models for Value Descriptions

This section presents two meta models, which integrate into the reference model's business layer and value layer, respectively. Both meta models build on the generic property model (cf. section 4). The graphical notation shows *property bundles* (PB) as rectangles with no attributes, *properties* (P) as rectangles with the attributes value class and metric, and *property compositions* as directed edges.

5.1 Business Meta Model

The Business Model Ontology (BMO) [20] as well as the e^3 value approach [7] form the basis for the business meta model.

The resulting business model selects only specific concepts which contribute to the value description (cf. [14, 27, 28]). These include: (1) value offer, (2) distribution channel, (3) target customer (4) relationship, and (5) revenue model.

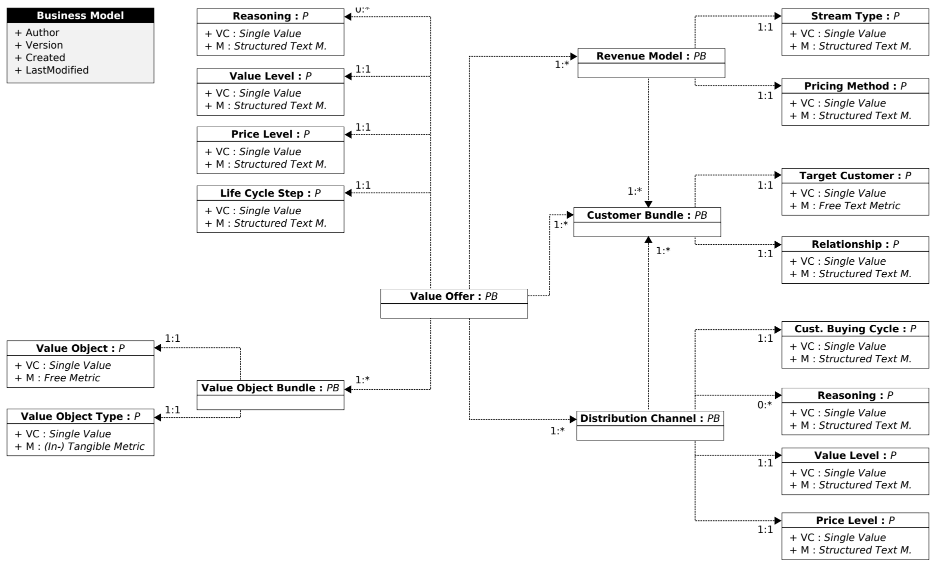

Fig. 3. Business Meta Model

Figure 3 shows the resulting meta model. The following paragraphs discuss each concept.

Value Offer is the root element and bundles the following properties: reasoning, value level, price level as well as life cycle step. Moreover, it bundles the value object property bundle, the revenue property bundle, the customer property bundle, and the distribution channel property bundle. Reasoning describes in which way a service is valuable for targeted customers. Osterwalder [20] distinguishes three elementary characteristics: value is either created by *using* a service, reducing any kind of *risk* for targeted customers, or reducing customers' *efforts*. The value level states to what extent services distinguish themselves from offers other companies. Osterwalder provides four possible classifications: either a value offer is a *commodity*, an *innovative imitation*, an *excellence*, or an *innovation*. The price level expresses services' qualitative pricing strategy. Services are either offered for *free*, for an *economic* (low) price, for an appropriate *market* price, or for a *high-end* price. The life cycle step formalizes when value is created during the service life cycle. Osterwalder explains the life cycle with five steps: *value creation*, *value purchase*, *value use*, *value renewal*, and *value transfer*.

Value Object Bundle is the actual value which is exchanged by companies offering services and companies consuming services. Evidence for this element is found by Osterwalder as well as by Gordijn. Its properties include the value object itself and the value object type. The type attribute tells whether the value object is *tangible* or *intangible*.

Revenue Model describes the transformation of value offerings into income. It comprises the following properties: stream type and pricing method as well as a link to the customer property bundle. The stream type property formalizes how income is generated. Possible stream types include: *selling*, *lending*, *licensing*, *transaction cut*, and *advertising*. The pricing method describes in which way a price is determined. According to Osterwalder, a price is either *fixed* and is agnostic to the environment and customer characteristics, is *differential* and depends on product as well as customer characteristics, or is *market-based* in that the price is determined dynamically between provider and customer.

Distribution Channel tells how companies deliver value to targeted customers. The element bundles the properties: reasoning, value level, price level, and customer buying cycle. The properties reasoning, value level, and price level have the same semantic as in the value offer bundle, and hence, these can be setup for each channel. The customer buying cycle tells which step the channel addresses. Osterwalder proposes four steps for the buying cycle: *awareness*, *evaluation*, *purchase*, and *after sales*.

Customer Bundle specifies customer segments. Segments base, for example, on geographical criteria. The relationship property depicts in detail the type of connection between companies and their target customers. The relationship element classifies target customers according to their equity goals. Osterwalder offers three classes, namely *acquisition*, *retention*, and *add-on selling*.

5.2 Value Meta Model

The value meta model base upon work from Scheithauer et al. [28] (cf. section 3.2). Figure 4 shows the resulting value meta model, which is curtated due to space limitations. The following paragraphs elaborate on each first level property bundle.

Properties in the *functionality* category provide the service consumer with an understanding of what the service is actually providing and thus, what the consumer can expect from the service. Properties include capabilities along with value objects and service classifications.

Financial properties comprise monetary related aspects, such as price, discounts, and payments as well as their interrelation [21]. Though the meta model does not show it, the price property comes in the variations: absolute price, ranged price, proportional price, and dynamic price. The discount property can be refined into payment discounts and payee discounts.

The *legal* property bundle embodies properties which state terms of use. The properties are rights, obligations, and penalties. Whereas rights state what service consumer are allowed or expected to do with the service, obligations determine and settle the commitment for a service provider and a service consumer. The penalty property dictates compensation in case an obligation was not met by one party. Each obligation property relates to one penalty property to cover the effects. Penalties are represented with semantically defined terms.

The *marketing* property bundle allows promoting services toward potential customers. Properties in this bundle should both attract customers and establish a trusted relationship. A certification would provide a rather neutral view on a service provided by a third party. On the other hand, expert test ratings provide

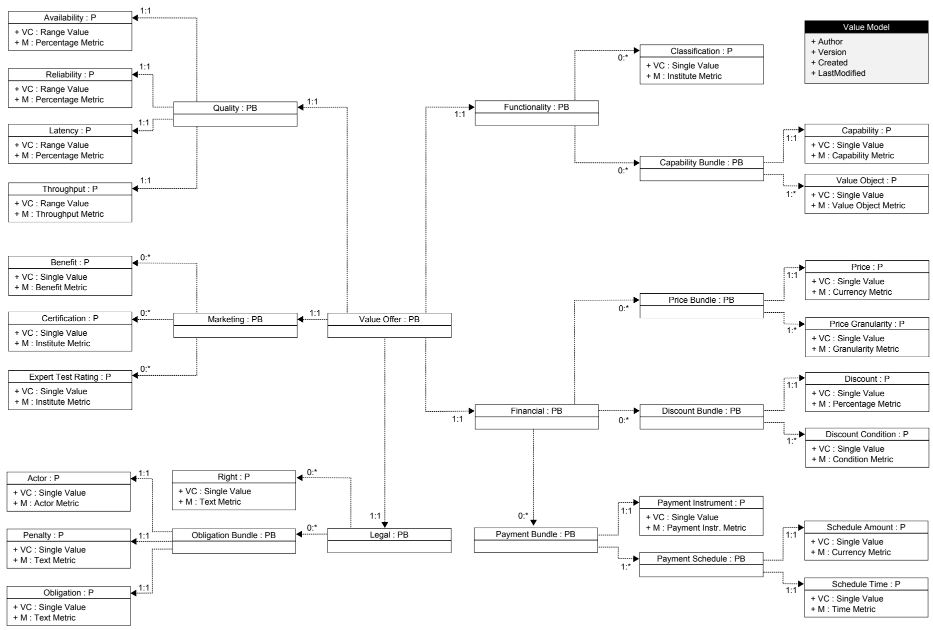

Fig. 4. Value Meta Model

a subjective view on the service from an expert perspective. Service benefits are the gained outcome of the service with respect to the potential service consumer.

Quality of services comprise: (1) latency, (2) throughput, (3) availability, and (4) Reliability. As aforementioned, service provisioning in service ecosystems is conducted over the Internet, technical properties of the network and the service itself can be of importance for service discovery and selection.

6 Modeling Guideline

This section introduces an initial modeling guideline for value descriptions. It aims at bridging the business model and the value model layer by means of twelve abstract steps (cf. figure 5). The guideline is a result of the authors' practical experience as well as a deep knowledge in this research domain. Steps one to six support the modeling of the business model, whereas steps seven to twelve assist the modeling of the value model.

6.1 Define Business Model

The first six steps support business strategists to transform a service idea into a tangible foundation for business strategists, business analysts as well as business owners to decide whether to implement a service or not (predetermined breaking point). The activities for this step include: (1) Establish exactly one value offer

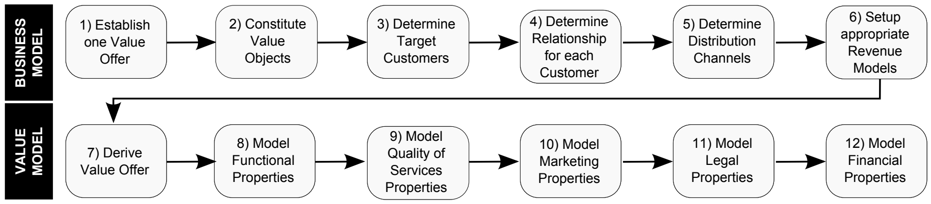

Fig. 5. Modeling Guideline

with its direct properties, (2) constitute appropriate value objects, (3) determine one or more target customers, (4) determine exactly one relationship for each target customer, (5) determine one or more distribution channels, and finally (6) setup one or more revenue models.

In order to identify the concepts for this model, a deep understanding of the business domain as well as marketing is necessary. The outcome of this step is an instance of the model described in section 5.1: a value offer which describes the service from a strategic perspective.

6.2 Define Value Model

The steps six to twelve support business analysts to conceptualize a value offer, hence determine *how* to implement it. The outcome of a value model serves as means for communication and as a support for decisions. It is neither technical nor platform-dependent. Furthermore, it is a starting point for a transformation into technical specifications [29]. The goal is to operationalize aspects from the strategic perspective into a value proposition which is available to potential customers. Hence, all strategic artifacts with internal knowledge must be revealed, including the value level, the target customer, the revenue model, and the and the price level.

The general order of value modeling is: (1) Value Offer, (2) Functionality, (3) Quality, (4) Marketing, (5) Legal, and finally (6) Financial. Tables 2 shows a mapping between business model properties and value model properties. This light-weight mapping between the business model and the value model eases the value description modeling.

The challenges involved in value modeling are manifold: transformation of abstract value offers into concrete capabilities, definition of quality of service properties, establishing marketing concepts, investigating legal implications, and calculating financial numbers. The outcome is an instance of a value model (cf. section 5.2).

7 Conclusion & Future Work

Service Ecosystems are market places to trade services over the Internet, which are pushed by Globalization and technological change. Considering this trend,

Table 2. Mapping between Business Model & Value Model

Value Model	**Business Model**	**Value Model**	**Business Model**
Capability	Value Offer	Certification	Value Offer
	Value Object		Target Customer
	Target Customer		Revenue Model
			Dist. Channel
Classification	Value Offer		
	Target Customer	Exp. Test Rating	Value Offer
			Target Customer
Right	Value Offer		Revenue Model
	Target Customer		Dist. Channel
Obligation	Value Offer	Benefit	Value Offer
	Target Customer		Target Customer
	Revenue Model		
	Dist. Channel	Price	Revenue Model
			Target Customer
Penalty	Target Customer		Value Level
	Revenue Model		Price Level
Availability	Value Offer	Discount	Value Level
	Price Level		Price Level
			Target Customer
Reliability	Value Offer		
	Price Level	Payment	Target Customer
			Life Cycle Step
Latency	Value Offer		
	Price Level		
Throughput	Value Offer		
	Price Level		

it becomes clear that services and the service economy play an important role in today's and tomorrow's business. Consequently, services and their electronic descriptions become crucial to foster significant value propositions toward potential service consumers. While there exist ample technical specifications to define web service value descriptions, conceptual approaches are rare. On top of this, an alignment between business models and information technology is missing.

This paper contributes in that it explores the conceptual gap of service value modeling. It offers a reference model to classify service value descriptions, introduces a general property model, proposes two meta models for conceptual modeling, and finally presents a modeling guideline. Business information science benefits from the incorporation of actual studies in the areas of service value descriptions and conceptual modeling. The modeling guideline enables industries to apply the framework. Furthermore, the whole solution complements the Inter-enterprise Service Engineering (ISE) framework [14].

This work's major limitation is a missing verification of the presented approach. This issue will be addressed in the next step of the Theseus / TEXO research project [11]. Ongoing work includes tool development for the proposed meta models (cf. section 5) and improvements in the alignment between the business model and the value model. Future work will address Electronic Business using eXtensible Markup Language (ebXML) [18] and Universal Description, Discovery and Integration (UDDI) [19]. It is envisioned to automatically generate artifacts for these specifications. Likewise, the approach will be extended toward semantic web services. The proposed value model will be codified with an ontology language and an algorithm needs to be invented which transforms a value model instance into a semantic web service description.

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