Serviguration: Towards Online Configurability of Real-World Services

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ABSTRACT

Current eCommerce is still mainly characterized by the relatively straightforward trading of commodity goods. Next-generation efforts in worldwide information infrastructure, especially the Semantic Web and Web Services, contribute some necessary, but not sufficient, steps on the way to much more advanced business scenarios, such as collaborative design over the Internet of sophisticated goods and services. This paper discusses additional steps needed to achieve collaborative eCommerce concerned with real-world services. First, a component-based description of services and what they contain is needed, such that electronic design and production of services can be simplified to a configuration task: 'serviguration'. Second, a configurable service approach must be linked with a clear conception of customer value over the Internet, such that it is ultimately expressable in computational terms. We discuss associated requirements and generic components, in the form of a service ontology needed to achieve online configurability of real-world services in a Semantic Web environment.

Categories and Subject Descriptors

H.4 [**Information Systems Applications**]: Miscellaneous

Keywords

Collaborative eCommerce, Semantic Web technologies, product/service description, ontology, configuration

1. INTRODUCTION

Advanced economies are service economies: today, economic production is dominated not by industrial manufacturing and sales of goods, but by the service sector. It is plausible that the increasing information and knowledge intensity of labour and economy contributes to this. In contrast, current eCommerce is still mainly characterized by the trading of relatively straightforward commodity goods. For eCommerce to continue to expand, therefore, it is necessary to be able to handle service provisioning by electronic means.

Real-world services (e.g., a haircut, bike repair, Internet connectivity, an insurance, medical treatment) differ fundamentally from physical products, however. A key characteristic of services is that they entail a productive process in which several actors are involved: service provider personnel, but often the customer as well. Another important feature of services is their composite nature, as they usually consist of a bundle of related activities. This bundled character leads to many options — for both the service provider and the customer — for design, production, selection, and quality level. Already in the 'old' economy (and even for such a simple thing as going out for dinner), services are very much a sophisticated form of collaborative business.

It comes as no surprise, then, that the electronic means to deal with real-world services over Internet and Web still leaves many things to desire. Existing eCommerce product classification systems (e.g., UNSPSC, eCl@ss) lack several essential features: (1) they are often designed from a supply rather than a demand perspective, providing useful categorization schemes for the suppliers but leaving the customer with counter-intuitive and inadequate support, (2) standards dealing with the composition of products into more complex products are still lacking, and (3) they address commodity goods rather than services [9]. They furthermore lead to many ontological mapping problems and inconsistencies [27]. Next-generation efforts in worldwide information infrastructure, especially the Semantic Web and Web Services, contribute some necessary, but not sufficient, steps on the way to much more advanced eCommerce scenarios than electronic trading of goods. The aim of this paper is to outline the ontological steps needed to achieve collaborative eCommerce concerned with real-world services.

2. 'SERVIGURATION'

Take as an example the online organization of events, such as conferences, board meetings, executive courses, exhibitions, et cetera. Their electronic facilitation requires many capabilities, including a good predefined classification of such events, together with a description of their properties, plus the constraints they pose on, for example, suitable times and spaces (rooms, halls, room setup). Essentially, an on-

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tology is needed that defines the core *contents* of the service. In addition, electronic facilities should provide the capability to select relevant supplementary services, such as coffee breaks, video facilities, Internet connection, translation, sound, technical assistance, or catering. This again in a predefined and standardized, ontology based way, such that associated additional relationships and constraints can be automatically catered for. Next, customer needs, perceptions and requirements regarding a service usually contain many 'soft' statements, leave many things implicit, and often necessitate a significant interpretation and transformation step into the provider's ontological vocabulary and the components that the service provider can actually deliver (for example, a 'round-table' meeting with video facilities results in a U-shaped room setup rather than a proper round table). Finally, the electronic support system task is to come up with a feasible design that takes all these elements and constraints into account [10].

This is just one service example, and not even the most complicated one. We are also working in the area of smart buildings and their Internet-enabled energy management. Here, the service is having maximum comfort at lowest possible cost. Building users are connected to an agent-based electronic power market that allocates energy resources over time in an optimal way; essentially, in their service provisioning agents carry out control tasks [29]. To make such a market work, agents deal with a lot of background and context knowledge, including building physics and climate models, weather data and forecasting (to compute the need for energy resources dynamically) [4, 17, 18]. Users are effectively involved in forms of demand-side bidding, but this background knowledge is typically not possessed by end users. They are mostly interested not even in the energy resource allocation, but only in the resulting benefit, say, comfort, and there is a big transformation step between the two (there is empirical evidence from our field experiments that end users even have difficulty in correctly stating their comfort need, as it involves much more than just temperature). Such a local markets approach to energy management is especially attractive, in terms of energy and cost savings, if it on its turn is linked to real-time dynamic pricing schemes (in contrast to the common fixed tariffs), deriving from a national or regional power exchange market. Thus, an energy service such as demand-side energy management is ultimately based on multiple interconnected electronic markets involving a process of collaboration of several companies as well as end users in very specific ways.

Thus, service provisioning is generally very much a constructive, design-like activity. From the knowledge systems literature it is known that such synthetic tasks are hard, but there are ways to reduce them to more tractable tasks under certain assumptions on the knowledge structures of a domain [8, 28, 26]. In particular, configuration is a simpler constructive task, based on the availability of a set of predefined components, connections, and associated parameters and constraints [24, 22, 15]. Many industries, from the automotive to the software sector, have been historically moving to product configurability through a predefined component-based approach so as to enable more efficient and quality-stable production. The service sector will be no exception.

Therefore, we suggest that an important part of a paradigm for the electronic support of real-world services is a generic component-based description of services and what they contain, in other words a *service ontology*, such that electronic design and production of services can be simplified to a configuration task. This is what we will call 'serviguration'. In a collaborative eCommerce scenario, then, the ideal is to have an intelligent support system that:

1. contains ontological descriptions of the service bundle contents;
2. translates customer needs and preferences into terms suitable from the service provider viewpoint;
3. can deal with all the associated constraints in automatically constructing the requested service in a configuration-like way, supporting the composition of more basic goods and services into a compound end-product or end-service.

One major challenge is to come up with a service ontology that is sufficiently generic to be useful across many application domains. We discuss below how such an ontology might look like.

3. WHAT IS A SERVICE?

In order to understand what real-world services are, we should not so much look at the literature originating from the IT area, but rather at the work done in the economic and business sciences. Since the late 70s a wealth of research on service marketing and management has been carried out in the business sciences. This literature gives a general framework on what services are and in what sense they are different from physical products. Researchers and writers such as Normann, Sasser, Lovelock, Grönroos, Heskett, Gummesson, Berry, Parasuraman, Zeithaml and others provide a set of concepts that are, in our view, suitable as input material for an ontological description of what services (viewed as componential objects) are. Good recent overviews are [23, 14, 19].

An important observation for ontology work is that the service area in business science seems fairly mature in that it shows a consensus on many points. Representative definitions of what a service is from the literature often contain the same recurring elements. For example:

- Zeithaml and Bitner: "... services are deeds, processes and performances ..."
- Kotler: "... any act or performance that one party can offer to another that is essentially intangible ..."
- Grönroos: "... activities ... of a more or less intangible nature that normally ... take place in interactions between the customer and service employees and/or physical resources or goods and/or systems of the service provider, which are provided as solutions to customer problems".

These business definitions of the term *service* represent the core of what we call *real-world service*; no limitations are

posed on whether the service is provided in the "physical world", via Internet or in any other way.

Other important elements for a service ontology based on accepted concepts in the business science literature are the following:

- The 7P/8P model for services. To characterize services, an extension of the famous 4P marketing model (Product, Price, Place, Promotion) for products is helpful. The additional Ps that are special to services are: Process (describing the method and sequence of actions of service operationalization), People (customer participation and service employees), Productivity and quality (creating outputs that customers value, and keeping customers satisfied), and Physical evidence (to show that the often intangible outcomes of services are actually delivered).
- Service blueprinting and mapping. Because process is a key component of services (in contrast to goods), ways of modelling service processes are highly important. Evidently, process modelling as known from the IT area is very useful here.
- Service bundling and packaging. Typically, a service does not stand on its own, but in many cases there is a whole bundle of related services (sometimes called the service flower) needed to achieve customer satisfaction. The component-based and configuration-like nature is thus inherent to services.
- Managing the customer value equation. In contrast to the product (as well as IT) literature, service researchers (along with experiential marketing researchers such as Holbrook [16]) have given much better thought as to what constitutes customer perceived value and (also, intangible) cost. An important ontological distinction to be made is that services are seen differently depending on whether we take the service provider's or the customer's viewpoint.

Hardly any of these generic concepts concerning real-world services show up in current eCommerce product classifications or Web Services standards. (Hence, Web Services, however necessary and useful they are, cannot now really be seen as services in the sense of the business science literature; they are currently rather restricted to I/O interface specifications, ignoring the essential customer-value perspective of real-world services.) Generally, physical product-related approachess do not scale up to services, because many new ontological distinctions and concepts enter the picture. This has direct consequences for any service ontology.

Further requirements on any generic service ontology are that its components should be mappable onto configuration task ontologies (e.g. [15]). This is feasible, because as mentioned above, the component-based and configuration-like nature is inherent to services. In addition, a service ontology should be consistent with ontologies that describe value creation in eCommerce, e.g. the e^3-*value* ontology that expresses and analyzes eCommerce business models as networks of economic value exchanges between actors. A service is one type of value activity that involves customer and supplier. Due to lack of space, we do not discuss this aspect further and refer to work published elsewhere [12, 13]. In the following sections we will see how these informal concepts from the service business literature can be further developed into a (semi-)formal generic service ontology that meets these requirements.

4. TOP-LEVEL ONTOLOGICAL VIEWS

We have developed a generic component-based service ontology, based on the service management and marketing literature. The ontology includes unique characteristics of services (compared to goods), and incorporates both a customer perspective and a supplier perspective. It also allows the customer to configure compound services, based on his/her specific requirements and expectations.

On a high level of abstraction, a service ontology must embody three interrelated top-level viewpoints or perspectives, as sketched in Figure 1: *service value, service offering* and *service process*. The service value perspective describes the service from a customer's perspective; the service offering perspective describes it from a supplier's perspective; the service process perspective describes how the service offering is put into operation.

Adding value is the *raison d'être* of every business. The *service value* perspective captures knowledge about adding value. First and foremost, it represents a customer viewpoint on value creation: it expresses customer needs, expectations and experiences and is driven by a customer's desire to buy a certain service of a certain, often vaguely defined quality, in return for a certain sacrifice (including price, but also intangible costs such as inconvenience costs and access time). The *service offering* perspective in contrast, represents the supply-side viewpoint: it provides a hierarchy of service components (a core service and supplementary services) and outcomes, as they are actually delivered by the service provider in order to satisfy customers' needs. The *service process* perspective encapsulates knowledge about putting the service offering into operation in terms of input, process and outcome. It describes how the service is actually carried out. In contrast to the usual production process of physical goods, customers often take active part in the service production process (the *participation* relation in Figure 1). We will discuss the ontology using the running example (briefly discussed previously) of an online events organizing service, where conferences, exhibitions and meetings can be organized.

4.1 Serviguration: Service Configuration

Three relationships between perspectives are sketched in Figure 1: (1) the service value is translated into service offerings (service configuration or *serviguration*); (2) the service process is an *operationalization* of the service offering; (3) the *participation* of customers (viz., the service value perspective) in the service production process.

Serviguration takes the *subjective* service value information as input, and provides one or more service offering configurations as output, expressed in *'objective'* supplier terms (i.e., in terms of what actually can be delivered to the customer). The serviguration process can be split into two sub-

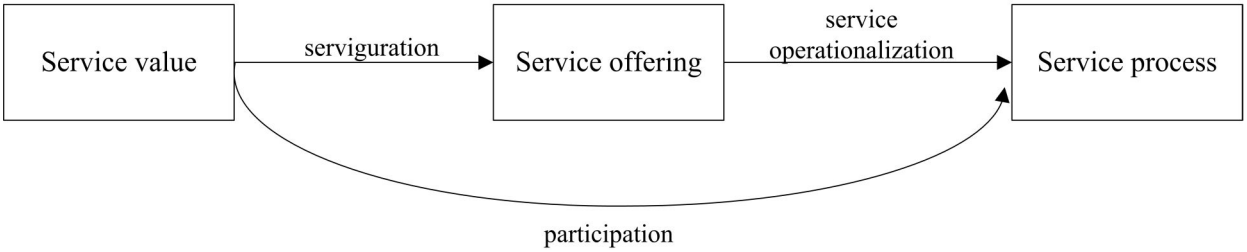

Figure 1: Three top-level ontological distinctions to be made in a generic service ontology: the customer-value perspective, the supply-side perspective, and the joint operationalization of these viewpoints in terms of the actual service production process.

processes: (1) transformation process between the customer description of the requested service (service value perspective), and the supplier terms for describing the service (service offering perspective); and (2) defining sets of service elements (service offering perspective) that satisfy this supplier description of the requested service, and thus also the customer description of his requested service. Our research concentrates on the second sub-process.

The service value perspective captures customer information of three types: (1) a high-level description of the requested service (e.g., organizing a conference); (2) requested quality criteria; (3) acceptable sacrifices (price and other costs). Acceptable sacrifices and requested quality must match of course. The quality criteria deserve some more attention. The quality of a particular product or service [14] is whatever the customer perceives it to be: 'quality is in the eye of the beholder'. It is generally accepted that the quality of a service is a function of the comparison between the (customer-) perceived service and the customer's expectations regarding the service [3]. These subjective and imprecise notions are made more concrete by using generic service quality criteria from the service literature. Developments in service quality research have been classified by [5] into two schools: the Nordic school and the North American school. The North American school, (Parasuraman, Zeithaml and Berry) centers its approach on the customer, the only true judge of service quality, conceptualizing the act of service as the customer's opinion as to overall superiority or excellence of a service. Service quality is measured by five criteria that together form the SERVQUAL model [30]: tangible service outcomes, reliability, responsiveness, assurance and empathy. The Nordic school [14] distinguishes three aspects of quality: technical (outcome-related), functional (process-related) and reputation. These are further refined by seven criteria of perceived service quality: professionalism and skills, attitudes and behavior, accessibility and flexibility, reliability and trustworthiness, service recovery, serviscape (describing the – physical, if existent – environment of encounters between customers and service employees [14]), and reputation and credibility. Both schools discuss the same issues, but put the emphasis on slightly different things. These generic criteria can be seen as determinants of a service quality level that would satisfy the customer. The list has to be made concrete per domain, by using domain-specific knowledge. For example: the term reliability has different interpretations and levels of importance in event organizing and in medical insurances. Customers have differing needs, past experiences, expectations and perceptions of the term quality, resulting in the subjectivity of their quality requirements. Nonetheless such information is translated to objective supplier notions by businesses in every service act. Every time a customer calls a business and says s/he wants 'a high quality service', 'a beautiful hotel room', 'a good meal' etc., the service personnel maps those notions into objective, supply-side domain-specific terms. The mapping of subjective customer information into 'objective' supply-side terms is thus done by service personnel daily, based on the interpretation of those notions in their domain. By capturing their knowledge (a knowledge acquisition task), this mapping can be made explicit for use by a configuration tool.

The serviguration process translates this information into service offerings, through a domain specific mapping between on the one hand (1) the service definition, (2) the quality criteria and (3) the acceptable sacrifice, and on the other hand the provider's available service offerings. For example, if a customer wishes to organize a luxurious conference in a unique environment (service value perspective), s/he will be offered a fancy room or lounge with a view on a beautiful bay (service offering perspective). If a customer requires a personal treatment (high level of empathy, service offering perspective), s/he will not be offered a standard service, but a customized one with more personnel at his/her service (service offering perspective). In our online events example we can use domain-specific knowledge to map the type of event (conference, exhibition, press conference etc.) with a type of room and with a room setup (how tables are organized), the type of necessary communications with available equipment, and the level of requested service with specific catering possibilities and hotel arrangements.

4.2 Operationalization

The *service process* perspective describes how the service offering is put into operation: it expresses which business processes are required to carry out a service, resource allocation (inputs) and results (outcomes). Processes can be described using traditional Business Process Modeling techniques. Operationalization is mostly supplier-centered; customers are often mainly interested in the outcomes of the process, and not in how the process is designed. Significant parts of the service process are usually even invisible to customers (e.g. the cleaning of a hotel room or the preparations needed for the catering for an event). Nevertheless, customers can be part of the process. A process may re-

late to one supplier or involve multiple suppliers, working together in a value constellation.

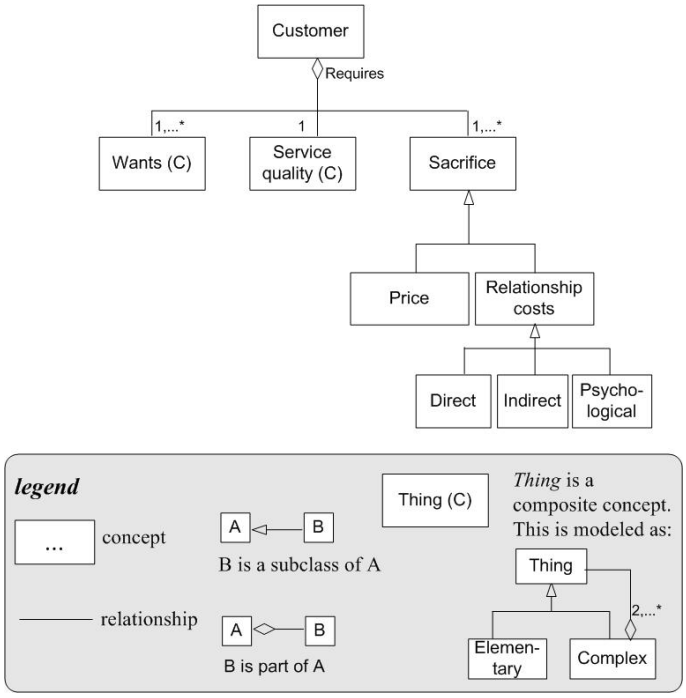

Figure 2: Service sub-ontology representing the service (customer) value perspective.

5. SERVICE ONTOLOGY

In this section we explain important concepts within all three perspectives that together form the service ontology. They are presented in Figure 2, Figure 3 and Figure 4. Notions that appear in multiple figures are explained only once in a legend. Some cardinalities, as well as relationships of secondary importance are part of our service ontology, but were omitted from the figures for the sake of clarity.

5.1 Service Value Perspective

The sub-ontology representing the *service value* perspective is sketched in Figure 2.

Wants. The starting point for the discipline of marketing – whether it refers to services or not – lies in the human needs and wants [20]. The term *need* refers to what humans need and want (to buy), and is quite straightforward. A formal definition is given by Kotler, who distinguishes needs, wants and demands:

- A human *need* is a state of felt deprivation of some basic satisfaction.
- *Wants* are desires for specific satisfiers of these deeper needs.
- *Demands* are wants for specific products that are backed up by an ability and willingness to buy them.

Needs are often vague; the need for "financial security", for example, can be interpreted in many ways. Customers concretize their needs by transforming them into wants and demands, for example based on their exposure to services and to marketing campaigns. In many cases, when a customer is interested in some service, he has already transformed his needs into wants and demands. He has, as a matter of fact, already found a solution for his problem (need). We model the concept *wants* in the service ontology. *Demands* are a type of *wants*; they are not modelled separately. *Example*: feel safe (need); worldwide payment facilities (want); credit card service (demand).

Service quality. Service quality is the degree and direction of the discrepancy between a customer's expectations and the perception of the service [3]. Customer expectations embrace several different elements, including desired service, predicted service and a zone of tolerance that falls between the desired and adequate service levels [2]. Expectations are based on word of mouth communications, personal needs, past experience and external communications from service providers [30]. The service quality is very important for the serviguration process, because it describes the service offering in customer terms. As shown in section 4.1, at least two widely accepted generic methods for defining service quality exist. Quality definition is though domain- and market-specific. A case study we preformed about event hosting showed that customers distinguish process quality and product quality. *Example*: high level of reliability; highly individualized service; fancy conference location.

Sacrifice. The customers long-term sacrifice includes the price of the service as well as relationship costs. These can be direct (e.g., investment in office space, additional equipment), indirect (related to the amount of time and resources that the customer has to devote to maintaining the relationship) or psychological costs (e.g., lack of trust in a service provider; unpleasant sensory experiences such as noise) [14]. The sacrifice a customer is willing to accept must match the quality of the requested service; otherwise no service can be offered. *Example*: time spent waiting to be served; travel costs; switching costs (from one supplier to another).

5.2 Service Offering Perspective

The *Service offering* perspective (see Figure 3) describes how a business intends to add value. Following subsections shortly describe important concepts within this perspective. A more thorough analysis of a component-like structure of services, specifiying the role that these concepts play in the serviguration process, will be published in a separate paper; in the present paper our aim is to sketch the ontological framework that can be used for, but is not limited to service configuration.

Service element. A service element can be a *core* service (the main business) or a supplementary service with a *supporting* role (making the core service possible) or an *enhancing* role (improving the core service's value by adding extra features). Service elements are described in our ontology as components, the building blocks of a configuration. Components, as described in the knowledge engineering literature [15, 22, 6, 7], have constraints, properties and ports. Describing service elements as components, we also identify ports, properties and constraints for them. *Example*: or-

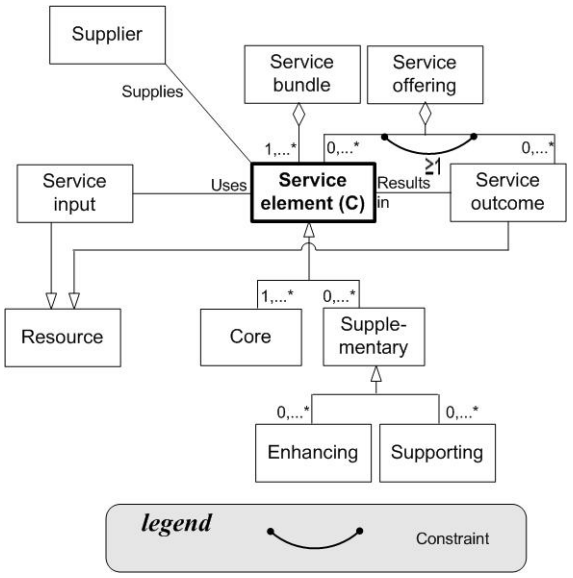

Figure 3: Service sub-ontology representing the service offering perspective.

ganizing a conference (core service); online payment service (supporting supplementary service); hotel reservations for conference visitors (enhancing supplementary service).

Resources can either be required for the provisioning of some service element/process (service input), or can be the result of a service element/process (service outcome). The natural way to understand this term is in the sense of resources for carrying out a business process. This is however not the case here. We make a distinction between resources on the service offering level and resources on the service process level:

- Resources on the service offering perspective describe *what is being offered (which service)*. Services involve the transfer of value [25], hence resources on the service offering level are objects of economic value.
- Resources on the service process perspective describe *how* the service is being offered. They are related to the actual service production and consumption process, and typically include the means required to produce the service, e.g., information, service personnel and machines, as well as mostly tangible outcomes of a service, e.g., a train ticket.

Example: furnitures (resource of type *physical good*), news report (resource of type *information*).

Service outcome and service input. Once a resource is associated with a service element (or a service process, on the service process level), it is refered to as *service input* or *service outcome*. The provisioning of a service element always requires some inputs (assuming that value is provided in return for value); and every service element eventually results in one or more service outcomes. They are an observable, and thus an objective external representation of the supplier's service elements. *Example*: the ability to freshen-up is an (intangible) outcome of the coffee catering service element; a room (to hold a meeting) is a tangible outcome of a room renting service element.

Service bundle is a set of core service element(s) and possibly supplementary service elements, to be offered to customers. A service bundle, being a composite service element, also requires service inputs, and results in service outcomes, as defined for service elements. *Example*: a service bundle comprising of (1) hosting a conference (core service), (2) coffee catering and hotel accomodation (enhancing services) and (3) online payment (supporting service).

Service offering is not only the name of a perspective, but also a concept within that perspective. It is a set of service elements and service outcomes (with the constraint of having at least one service element or service outcome). Both *service bundle* and *service offering* describe what a business offers to its customers. The difference between a service offering and a service bundle is that the latter does not include a direct reference to service outcomes, associated with the service elements. The service offering, on the other hand, may include service outcomes without service elements. The need for the notion service offering, next to the notion service bundle, stems from customers' inclination to assess a service based on some observable outcomes. *Example*: a service bundle comprising of conference hosting (service element) and the participants' ability to exchange novel research ideas (service outcome).

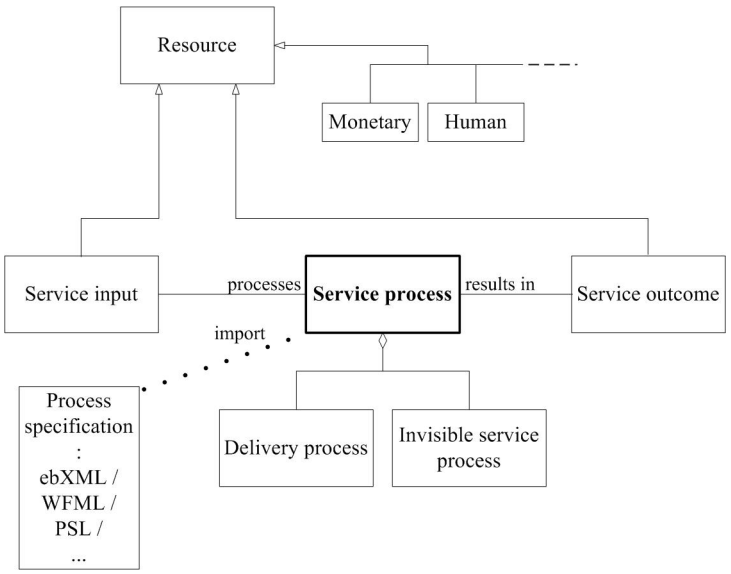

Figure 4: Service sub-ontology representing the operational service process perspective.

5.3 Service Process Perspective

The *service process* perspective is presented in Figure 4.

Service process. Service process is the core of the service process perspective; it includes all the business processes required to facilitate the service offering. The service process may be specified using existing technologies as ebXML

[1] or WSFL [21]. *Example*: hosting the conference itself, preparation and post-conference activities.

Delivery process. The business literature identifies delivery process as a third component of the service offering, next to the previously mentioned service elements and physical goods (a type of resource, in our terminology). Since there is a broad consensus in the service literature, claiming that service production and consumption cannot be separated ([23, 20] and more), we represent the service delivery as part of the service process concept. It is the part of the service process, which is visible for the customer. *Example*: the conference itself, hotel check-in.

Invisible service process. All parts of the service process to which a customer is not exposed. The customer is mostly not interested in how they are executed, but only in their result. *Example*: preparing a location for a conference; room cleaning.

Service input. Inputs are resources used to produce service outcomes. They can be tangible or intangible; some of them are consumed (e.g., food), whereas others continue to exist after the process terminates (e.g., conference room). *Example*: the supplier's employees; the customer (a conference cannot be held without visitors); physical goods (e.g., conference rooms, beamers, tables etc.).

Service outcome. The service process results in service outcomes. These may be tangible or intangible. For further explanations see section 5.2. *Example*: conference visitors received the proceedings (tangible outcome of type 'physical good'); novel research ideas can be exchanged (intangible outcome of type 'capability').

6. DISCUSSION AND CONCLUSION

We have outlined a generic ontology of real-world services, based on the scientific literature in service management and marketing. The motivation for such a service ontology lies in the fact that current eCommerce is still mainly characterized by the relatively straightforward trading of commodity goods, whereas significant additional steps are needed to enable more advanced business scenarios involving collaborative eCommerce concerned with real-world services. To achieve this, first of all a component-based description of services and what they contain is needed, such that electronic design and production of services can be simplified to an online configuration task: 'serviguration'. Second, a configurable service approach must be linked with a clear conception of customer value over the Internet. We have discussed the key concepts of a service ontology that satisfies these requirements.

Ongoing efforts related to the Semantic Web and Web Services contribute some necessary, but not sufficient, steps on the way to advanced forms of collaborative eCommerce focused on service design and production. Existing technologies for web services include WSDL and DAML-S. DAML-S is an initiative of the Semantic Web community to facilitate automatic discovery, invocation, composition, interoperation and monitoring of web services through their semantic description [11]. The Web Services Description Language WSDL is an XML-based industry standard for describing web-accessible services. It provides a communication-level description of the messages and protocols used by a web service. Important concepts in real-world services such as supplier and customer do not exist in WSDL. DAML-S points to them but doesn't define them. Value-creation interactions between service providers and customers and the associated benefits and costs are, as we have explained, at the heart of any service ontology, and thus are an indispensible part of any real-world service description. However, such notions of value exchange are not part of WSDL or DAML-S; both lack a good definition of the actors involved in a service and of the economic nature of their interaction. Thus, DAML-S and, to a much lesser extent, WSDL can be used to represent a part of the service activity, but do not provide a definition of the generic *content* and *value* aspects of real-world services in a configurable way, as this is not their goal. This is the contribution of this paper.

7. FUTURE WORK

The presented service ontology will be further developed and refined, and will serve as a support baseline for some industrial demonstrators and case studies in Semantic Web-enabled eCommerce, including online events design, demand-side bidding (briefly discussed in this paper) and Internet radio. We are also working on integrating the service ontology with a value ontology, i.e. *e^3-value* ontology [12, 13] and with a configuration ontology, developed by a project partner in accordance with [15] and [22].

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