The Configurable Nature of Real-World Services: Analysis and Demonstration

Ziv Baida
Free University Amsterdam
FEW/Business Informatics
1081 HV Amsterdam
The Netherlands
ziv@cs.vu.nl

Hans Akkermans
Free University Amsterdam
FEW/Business Informatics
1081 HV Amsterdam
The Netherlands
elly@cs.vu.nl

Amaia Bernaras
Parque Tecnologico de San Sebastian
Mikeletegi 53
20009 San Sebastian
Spain
amaia@miramon.net

ABSTRACT

A collaborative design of complex real-world services (ranging from plumbing services, transportation, network connectivity and events hosting to insurances and governmental public services) over the WWW requires services to be described as components, the building blocks of a configuration. Defining complex services then becomes a traditional configuration task, where services are seen as components. Reducing the process of defining complex services into a configuration task (as studied in knowledge engineering) implies that it can be supported by information technology, to be used either by service personnel or by customers via the Internet. Furthermore, to facilitate service configuration by customers, it is required that the customer value of services is linked to services – or *service elements* – that shall be configured. A subset of the service outcomes, very often intangible, reflects the customer value of a service, in supply-side terms. In this paper we describe the component-like nature of services, in the framework of a service ontology comprising of the customer value (demand-side terms) as well as a supply-side, component-based description of services. We demonstrate the process of configuring – or bundling – services with a case study on hosting a meeting.

Keywords

Collaborative eCommerce, Service, Configuration, Semantic Web technologies

1. INTRODUCTION

Current eCommerce is still mainly characterized by the trading of relatively straightforward commodity goods. Whereas the term *products* is often used to describe physical goods, according to the business literature it includes physical goods as well as *services*: performances of a mostly intangible nature [16]. Many industries offer complex compositions of goods based on customers' specifications. This is facilitated through a component-based description of goods, supported by a variety of product ontologies, e.g., UNSPSC and eCl@ss. These ontologies focus on physical goods – referred to as *products* – rather than on services. To enable similar eCommerce scenarios for services, a service ontology is required that supports a component-based structure of services.

Furthermore, a customer is typically not interested in a service as such (e.g., worldwide money transactions), but in the *value* of this service (e.g., the ability to pay worldwide). Consequently, service offerings (a supplier description of services) must be linked to the customer value perspective of a service. This enables a customer to configure a complex service by himself, based on what he considers to be of value.

Service is a loaded term in the IT world. It is used mostly to refer to Web Services: loosely coupled, reusable software components that semantically encapsulate discrete functionality and are distributed and programmatically accessible over standard Internet protocols [1]. Real-world services, on the other hand, are not software components, but business activities, deeds and performances of a mostly intangible nature [20, 13, 10]. Real-world services are the products of service industries; they can be compared with the physical products of traditional manufacturing industries. A car manufacturer sells cars (a physical, tangible product); similarly, a bank sells financial services, a hairdresser provides haircuts, a comedian provides entertainment and a government provides care for citizens. These are all services, or intangible products. In the business world they mostly represent how a business makes money, and why it exists as a business in a particular market. Since we refer to services in their business connotation, the business and economic sciences are the starting point of our research. Business literature is characterized by a broad consensus on what services are. We drew knowledge on services from the business literature, and combined it with work done in the field of knowledge engineering, to create a service ontology where services are described as components. The ontology acknowledges and emphasizes a component-based structure of services, and presents not only a supply-side description of services (in terms of service elements to be offered to potential customers), but also a demand-side description of the

service: its value for the customer. The service ontology can be used for (online) configuration of services, a process we call 'serviguration': service configuration. Various service elements can be configured to a more complete and value-adding service offering, possibly involving multiple service providers. In this paper we give a detailed analysis of a component-based structure of services, required to enable serviguration. We describe a service by its functionality, its required inputs, the outcomes it generates, its properties and constraints. Service elements can then be bundled, as long as their constraints permit it, and the required inputs are available. We use a case study to demonstrate how services can be configured in accordance with the service ontology, after they are described as components.

The remainder of this paper is organized as follows. We start with a short top-level description of the service ontology. In section 3 we present a component-based structure of services. Section 4 discusses a case study of hosting a meeting. Finally, in section 5 we present conclusions, and outline future research.

2. SERVICE ONTOLOGY

2.1 Top-Level Viewpoints

Using the service management and marketing literature as a starting point, we have developed a generic component-based service ontology [4]. The ontology incorporates both a customer perspective and a supplier perspective, and it includes unique characteristics of services (compared to goods), e.g., the intangible nature of services. It 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 point of view; it describes the service in terms of the customer's needs and wants, his quality descriptors and his acceptable sacrifice, in return for obtaining the service (including price, but also intangible costs such as inconvenience costs and access time). The *service offering* perspective describes a service from a supplier's perspective; 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 describes how the service offering is put into operation in terms of business processes that can be modeled using existing technologies as ebXML [2], WSFL [14] or BPEL [3].

2.2 Serviguration: Service Configuration

Three relationships between perspectives are sketched in Figure 1:

1. Service configuration, or *serviguration*: defining sets of service elements (a supply-side description of services, part of the *service offering* perspective), that satisfy the customer description of his desired service (*service value* perspective, in our terminology). Serviguration can be split into two sub-processes: (1) Transformation process between the customer description of the requested service (service value perspective), and the supplier's terms for describing the service; and (2) Defining zero or more 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.
2. The service process describes which business processes are required to put the service offering into operation.
3. The participation of customers (who are part of the service value perspective) in the service production process.

This paper focuses on the serviguration process, and specifically on the second sub-process: a task of configuring service elements. The service value and service process perspectives are not discussed further in this paper.

3. SERVICE OFFERING CONCEPTS

Configuration tasks ontologies [11] use components as the building blocks of configurations. Similarly, we claim that service elements (possibly offered by multiple suppliers) can be configured into a complex service (*service bundle*, in our terminology). Using configuration task ontologies to configure services requires a mapping between the service ontology and configuration tasks ontologies. We claim that such a mapping is feasible, due to the configurable nature of services. In the remainder of this section we present the concepts that play a major role in configuring services. We use a running example of an event hosting service, such as conferences, board meetings, executive courses, exhibitions, and more. Every type of event has its own characteristics. Our case study considers the service of hosting a meeting. Meetings can be hosted in various locations (e.g., meeting rooms), for differing numbers of participants, providing a broad range of equipment, as well as catering. A future scenario would include providing accommodation and possibly transportation for meeting participants.

In the remainder of this section we model elements of the service offering perspective which, unlike concepts within the service process perspective, cannot be modeled using business process modeling techniques, as the essence of value-oriented models is different from that of business process models. For a thorough explanation see [7].

3.1 Service Element

The service offering perspective centers around the concept *service element*.

Service elements represent what a supplier offers to his environment. We distinguish three types of service elements: a core service (the main business), a supplementary service with a supporting role (making the core service possible) and a supplementary service with an enhancing role (improving the service's value by adding extra features).

Core service. A core service describes how the supplier's business adds value to a value chain. This is the reason for the supplier's presence on the market. A firm may have multiple core services; it may offer banking facilities as well as insurances as its core services.

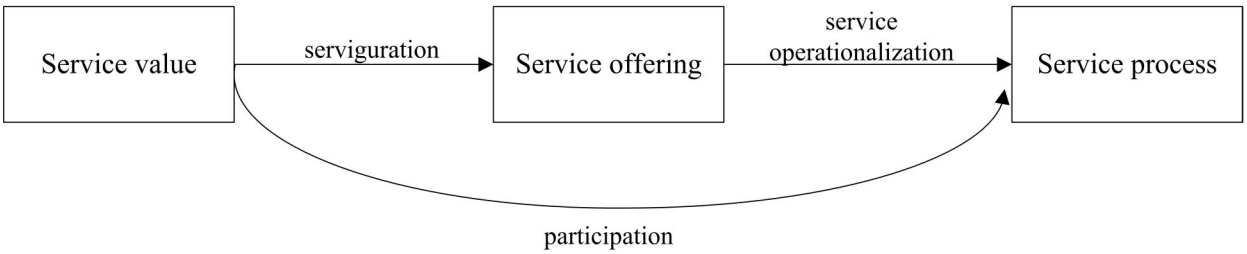

Figure 1: Three top-level ontological distinctions to be made in a generic service ontology: the customer-value perspective, the supply-side perspective, and the joint operationalization of these viewpoints in terms of the actual service production process.

Supplementary service. A service that accompanies the core service/product, ranging from finance to training. It may be of two types:

- *Supporting* supplementary services are needed in order to enable the core service consumption. In the absence of these services, the core service consumption is no longer possible.
- *Enhancing* supplementary services are often considered to be the elements of the service that define it and make it competitive. They increase the value of the service, or differentiate it from those of competitors [10]; the core service can nevertheless be consumed without them.

Supplementary services of both types are not offered to customers separately; they are always related to a core service, which stands for how a business makes money. A business can decide to offer a supplementary service independently, and then classify the service as a new core service in its service offerings.

To avoid confusion, note that the use of the terms supporting and enhancing services is author-dependent. The services that we refer to as supporting, respectively enhancing, are called facilitating services and supporting services respectively by [10].

Defining the type of service (core service, supporting supplementary service or enhancing supplementary service) is supplier-dependent. Catering will be the core service of a caterer, but an enhancing service of an event hosting company. A different event hosting company may consider catering to be a supporting, rather than enhancing service, since it does not offer the possibility of hosting an event without some catering service.

In our running example, hosting a meeting is the core service, the supplier's added value. We identify two supporting supplementary services: (1) planning (organizing) a meeting, and (2) room renting (a meeting cannot be held without having a location rented for it). We also identify two enhancing supplementary services: (1) coffee catering, and (2) equipment provisioning (e.g., video conference facilities, Internet facilities). Though practically every meeting requires some equipment, this is not a supporting service, since it is possible to hold a meeting without such equipment. In the remainder of this paper we concentrate on one supporting supplementary service element (room renting) and one enhancing supplementary service element (coffee catering).

A service element can be a composite concept, meaning that it is built of smaller components, each of which is a service element as well. A service element can thus be decomposed to smaller service elements, as long as the smaller service elements can be offered to customers separately or by different suppliers.

Components, as described in the knowledge engineering literature [11, 15, 5, 6], have constraints, properties and ports. As mentioned before, the component-based nature is inherent to services. As such, we can identify ports, properties and constraints for service elements.

Ports. Every service element has *ports* of two types: input ports and outcome ports. The provisioning of a service element requires core resources, and results in the availability of other resources. A port indicates a certain resource that is either a pre-requisite for carrying out this service element (input port), or the result (outcome) of carrying out this service element. A service element is characterized by its required inputs and by the outcomes it produces. The notion of ports stems from the technical system theory [6]; ports are used to abstract away from the internals of a service element. Inputs and outcomes may be tangible (e.g., coffee) or intangible (e.g., information, in a news service). Some service elements may produce outcomes that are pre-requisites for other service elements. In such a case an outcome of one service element will be the input of another. Since inputs and outcomes may refer to the same thing(s), we call them *resources*; every port stands for a resource.

As we will show later, the notion of two ports being *identical* is important for the configuration of service elements. Two ports are considered identical if and only if their associated resources are identical. The set of all input ports, respectively all outcome ports of a service element form the element's *input interface*, respectively *outcome interface*. Two interfaces are identical if and only if they include the same set of ports, and all their ports are identical. Note that based on this definition, two interfaces of different types (input and outcome) may be identical.

Properties. Service elements have certain properties, of-

ten referred to as *attributes* or *parameters*. We prefer the term properties, since *attributes* and *parameters* are loaded terms; they are often associated with primitive data types, as characters, strings or integers. A property, on the other hand, may be of a more complex nature. For example, the property "quality" may be defined by a set of criteria. We identify the following properties of service elements:

- *Type*. As explained earlier in this section, we distinguish three types of service elements: core service, supporting supplementary service and enhancing supplementary service.
- *Quality*. A customer identifies two main dimensions of quality: process quality and product quality. Although this is a generic statement, in accordance with [10] and other research, quality definition has to be verified by every business.
- *Productivity* refers to the rate of service production. Whereas it is common to measure productivity within manufacturing industries, this issue is not often dealt with in the service literature. The business literature defines productivity from a supplier point-of-view, as the rate between (1) the quantity and quality of the output, and (2) the quantity and quality of the input [18]. It measures the economic performance of a business. Our work is customer-oriented, rather than supplier-oriented. A customer is typically not interested in measuring the economic performance of a supplier; when discussing productivity, he's more likely to be interested in the rate between (1) the quantity and quality of the output, and (2) time. In some cases time may play an important role. For example building a new house according to plan A will last a year; building it according to plan B will last 16 months. In other cases the time is constant, and only the quality and quantity are relevant. For example, a movie has a fixed duration, but quality properties as the type of seats, location and bars availability, as well as quantity properties, e.g., the number of seats and the lounge size, will influence customers' choice for one cinema or another.
- *Sacrifice*. As explained in the previous section, sacrifice may be more than the price. It includes [10] the price of the service, as well as relationship costs (direct costs: investment in office space, additional equipment etc; indirect costs: related to the amount of time and resources that the customer has to devote to maintaining the relationship; and psychological costs: inconvenience, lack of trust, unpleasant sensory experience, such as noises and smells). The (financial) cost of a service is not a *constant* value, but a function, determined by the supplier. It may change as the service offering changes, as demand fluctuates or based on any criteria of the supplier.
- Domain-specific properties may be identified per service. We defined the set of generic properties *type, quality, productivity* and *sacrifice*, based on the business literature. At the same time we acknowledge the fact that these generic properties may not be enough for every real-world case.

Constraints. A constraint [11] on a service element is a description that limits the permissible values for properties or characteristics of a service element. A constraint may refer to properties, to resources (inputs or outcomes), to ports, to interfaces or to relationships between resources. We will provide examples of constraints in the following sections, after we have discussed the concept *resource*.

Two service elements are identical if and only if:

- All their associated ports (and thus resources) are identical
- They have the same set of properties (type, quality, productivity, sacrifice and possibly domain-specific properties)
- All their properties have the same values

Constraints need not be identical for two service elements to be identical, because they relate to the internals of a service element, whereas we adopt a customer-driven perspective: two service elements are identical if their external, "black-box" representation is the same. Often it is possible to achieve the same outcomes with different inputs. In such a case, the different options will stand for different service elements.

Suppliers will typically generalize their service offerings when publishing them (e.g., in service directories). For example, a supplier will publish a 'meeting hosting' service, rather than 'a meeting hosting service for 100 people, at the cost of ... Euro'. At a later stage, when an interested customer wishes to buy this service (or explore possibilities), a detailed service description is required. This is when different values of ports, resources, properties and constraints play a role, and a 'meeting hosting' service element is instantiated with multiple possible values, generating a number of 'meeting hosting' service elements.

The concept *service element* is visualized in Figure 2.

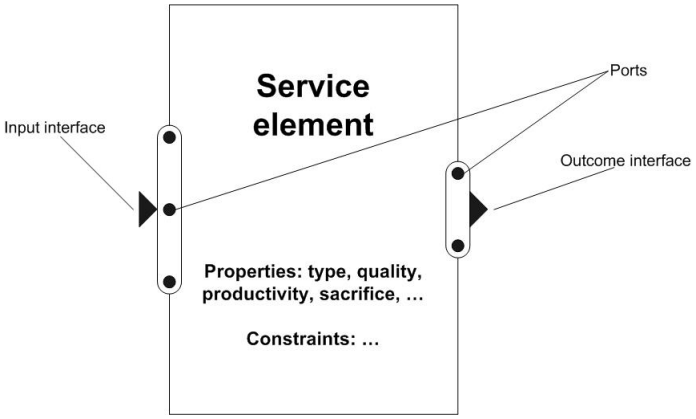

Figure 2: Service element

3.2 Resource

As explained before, *resources* can either be required for the provisioning of some service element, or can be the result of a

service element. 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 [17], hence resources on the service offering level are objects of economic value. The most trivial example is money, but also information (e.g., in a news provisioning service), capabilities (e.g., the possibility to receive a replacing credit card worldwide in case of card loss) and other types of resources have economic value.

- Resources on the service process perspective relate to *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.

There may be some overlapping between resources on the two levels (e.g., coffee is a resource on both perspectives in our case study), but they are conceptually different. In the rest of this paper we refer to resources on the service offering level, rather than the service process level.

We distinguish the following types of resources:

Physical goods: sometimes defined as 'those things that can be dropped on the floor'. The business literature determines that services are of intangible nature [10, 12, 13, 16, 19]. Quite often however interactions between customer and supplier result in the customer having something of a tangible nature, like airline tickets or a credit card. In other scenarios, the physical product has a central role, and services are added to it (like plumbing services and a new house). These services may look more tangible than services that are not related to physical objects, but in fact there is no difference in the tangibility of the service itself [12]. The tangible aspect of a service may be an accompanying physical good (often wrongly referred to as *product*), having a supporting or an enhancing role in the service offering. The concept *physical good* can be used to link the service ontology with existing product classifications, e.g. UNSPSC and eCl@ss[1], by means of an ontology *import* relationship.

Human resources: human resources may refer to the supplier (i.e., employees) or to the customer (own participation in the process). On the service offering perspective we model the human resources only where they reflect value (or costs, thus a negative value) for the customer. When human resources do not reflect value *for the customer*, we refer to them as *inherent* to the service, and we do not model them. They are however still resources on the service process level. We will explain this by means of an example. If a customer orders coffee catering, it is obvious that an employee will bring the coffee to the meeting room and serve it to meeting participants. This is inherent to the service, and thus not a human resource on the service offering level. We will model the *customer* as a human resource (on the service offering level) when he serves himself, after the coffee was brought to the room (self-service reflects lowering the costs of the service); and we will model the *employee* as a human resource when he stays in the meeting room to serve coffee upon request for a longer period (in return for a higher fee). It is of course up to the service provider to define when a human resource is inherent to his service, and when it reflects value/costs for the customer.

Monetary resources: mostly money, but one could also consider stocks or similar value-papers. Monetary resources are, like the earlier presented notion of *sacrifice*, not a *constant* value, but a function, determined by the supplier.

Information resources: information may be of economic value, for example in a news provisioning service or in a weather report service. Suppliers often value information about their customers, when trying to increase customer loyalty. Since suppliers are willing to reward customers for this information, it has economic value and is a resource.

Capability resources: the ability to do something is often of value for customers or suppliers. For example, when buying an insurance we pay for the ability to receive some service in case something goes wrong, but often we eventually do not need that service, because nothing goes wrong. Another example is a customer who uses the services of a free-of-charge Internet Service Provider (ISP). Such a customer provides the ISP with the capability to generate telephone connections (by dialing the ISP's phone number every time he connects to Internet), for which the ISP is rewarded by a telecom provider. Hence, the service can be provided free of charge, because a customer who uses the service provides a capability resource that is of (financial) value.

Experience resources: every service involves a service experience. The experience becomes a resource, when it reflects costs (e.g., the earlier mentioned psychological costs) or value for the customer (e.g., an added value of going to Euro Disney is having fun; a Gold credit card is a status symbol).

State-change resource: services are "activities... of bringing about a desired change in – or on behalf of – the recipient of the service" [16]. A variety of objects can be subject to change, e.g., a customer himself (e.g., haircut, transportation from A to B, medical treatment), a physical good (e.g., car repair, shipment of goods) or information (e.g., translation services). In some services the change can be related to a property of some resource (e.g., a car's state changes in a car repair service), whereas in other services the subject of the state-change is not a resource (in the sense of economic value), e.g., a passenger taking a flight undergoes a state change, but he is not a human resource because he doesn't reflect economic value. In such cases the economic value of a service, from the customer point of view, is a change of state: the customer *was* in Amsterdam, and now he *is* in Sydney. He pays for this change of state.

[1]UNSPSC and eCl@ss address products (physical goods) as well as services, but the emphasis is on (physical) products

This set of resources is derived from our experience with analyzing and modeling value-based transactions, e.g., services. It has been and will be tested on case studies, and if necessary updated.

A resource can be of one of the earlier mentioned types. Once a resource is associated with an input- or outcome-port, it becomes a **service input** or a **service outcome**. A service input is thus a resource that is a pre-requisite for a specific service element, and a service outcome is a resource that is the result of a specific service element. Those two terms make it easier for us humans to understand that resources may be required for providing a service, or be the result of providing a service, but in fact they are the same thing: a resource. The same holds on the service process level: a resource is called service input or service outcome only when it is related to some process.

Resources, like service elements, have constraints and several properties: type (physical resources, human resources etc), quality, productivity and possibly other, domain-specific properties. Identifying and defining relevant properties and constraints is a domain-specific task. We add three more properties for resources[2]:

- *State.* The change of state is a main characteristic of services, as we have explained. For example, in a room renting service element, the resource *room* has a state *available* as input, and a state *reserved* as outcome. Note that a service element does not have this property, since it is not the state of a service that changes.

- *Sharability.* A resource can be shared if it is still available for consumption, after being consumed already. When bundling service elements A, B and C (and possibly more) into service bundle X, service element A may have a service outcome that is required as a service input for service elements B as well as C (and possibly more). If this resource (outcome/input) is *sharable*, it can be used as an input by both B and C, and not only by one of them. A second scenario is that this service outcome of service element A is required by service element B, but will also be part of the outcome interface of service bundle X (implying that it can be consumed by an external entity). These two scenarios are depicted in Figure 3. Sharability is expressed by a number between 1 and infinite, standing for the number of times that this resource may be consumed. Sharability 1 means that a resource cannot be shared.

- *Compositeness* refers to whether and how two or more resources of the same type (possibly, but not necessarily resources of different service elements) can be united into and modeled as one resource, when they appear in the same interface. Resources may either not be united into one resource (e.g., tables of type A, and tables of type B – both physical resource – cannot be united into one resource), or they may be united by some formula. The formula may be simple (e.g., add the values of both resources) or a more sophisticated function. A common example for the compositeness property is the (financial) costs of services. If service element A costs 5000 Euro, and service element B costs 3000 Euro, the bundle may cost only 7000 Euro (the new price is calculated by a formula).

[2]In order to fully understand two of these properties, it is necessary to be familiar with the term 'service bundle', presented in section 3.4. For the time being, it suffices to say that a service bundle is a set of service elements, so that one service element may produce resources that another service element consumes.

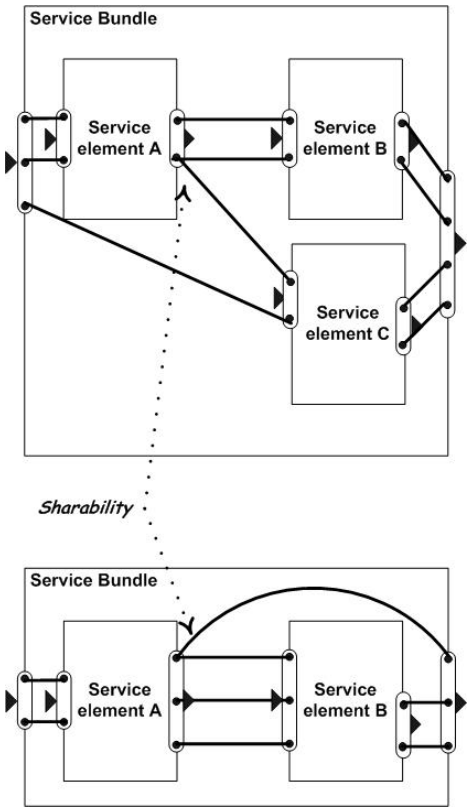

Figure 3: Resource sharability

Two resources are identical if and only if:

- They have the same set of properties (type, quality, productivity, state, sharability, compositeness and possibly domain-specific properties)

- All their properties have the same values

3.3 Service Outcome

Every service element eventually results in one or more tangible and/or intangible *service outcomes*. They are an observable, and thus an objective external representation of the supplier's service elements. By delivering service outcomes to a customer, the related service elements have been provided. Service outcomes are sometimes used to measure service quality.

3.4 Service Bundle

Service bundle is a set of core service(s) and possibly supplementary service elements, to be offered to customers. A

service bundle, being a composite service element, also has an input interface and an outcome interface, as defined for service elements. Service elements can be bundled in two ways:

1. Service elements A and B *can be bundled* if one or more outcome ports of A and one or more input ports of B are identical. Inputs of service element B, for which service element A does not provide identical outcomes, must be satisfied by the input interface of the service bundle. This type of a service bundle reflects a set of related service elements. Their relation may be of varying degrees. In the extreme case (see Figure 4a), the outcome interface of service element A is identical to the input interface of service element B; we call such two service elements *strongly connected*. In weaker cases only a subset of the outcome ports of service element A is identical to input ports of service element B; we call such two service elements *weakly connected* (see Figure 4b). Bundling services in this way requires defining the earlier presented notions of *identical ports* and *identical resources*.

2. Service elements A and B *are bundled* into a service bundle if (see Figure 4c):

   - The input interface of the service bundle is equal to the union of the input interfaces of A and B (taking the compositeness property of resources into consideration), and
   - The outcome interface of the service bundle is equal to the union of the outcome interfaces of A and B (also taking the compositeness property of resources into consideration).

   This type of a service bundle is less classic, but yet possible: a situation in which multiple services are provided together, although they are not related at all. Of course, there always exists some logic behind the bundling (e.g., lowering operational costs). We call such two service elements *independently connected*.

Note that although these examples and explanations refer to the bundling of two service elements, they can be generalized to the bundling of any number of service elements.

3.5 Service Offering

Service offering is not only the name of a perspective, but also a concept within that perspective. It should not be confused with *service bundle*. Whereas a service bundle stands for a set of one or more core service elements, plus zero or more supporting/enhancing service elements, a service offering is a set of zero or more service elements (of any type) plus zero or more 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. The service offering does not have to include all of the outcomes, associated with certain service elements, but only a subset thereof - the subset that is of interest for a customer at certain circumstances. Since a service offering includes outcomes that present what a customer is interested in (in supplier terms), we can use the service offering in the transformation process of customer input (service value perspective) into a supplier description of the service (service offering perspective).

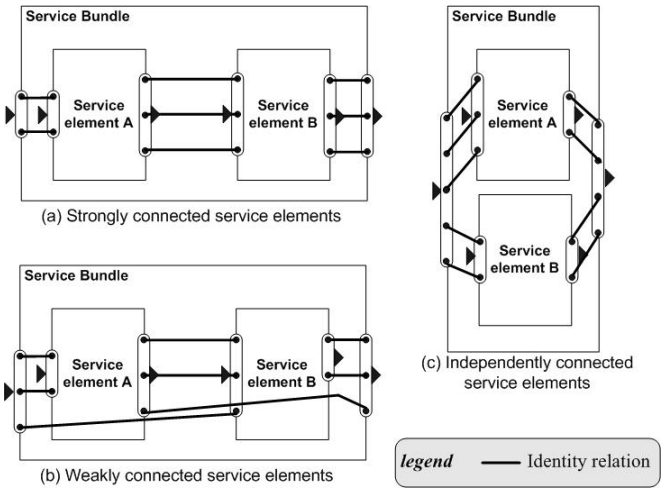

Figure 4: Service bundle

4. HOSTING A MEETING: A BUNDLE OF SERVICE ELEMENTS

Our running example includes the following five service elements; more service elements can be identified, but that is not necessary to demonstrate how our theory can be put into practice:

- core service element: hosting a meeting
- supporting supplementary service elements: planning (organizing) a meeting and room renting
- enhancing supplementary service elements: coffee catering and equipment provisioning

Hosting a meeting requires, like every service, the supporting service elements; the decision whether or not to choose enhancing service elements depends on the requested functionalities and quality requirements of the customer, and on the price he's willing to pay. In the following sections we analyze the service elements *room renting* and *coffee catering*. Each of them is actually a name for many service elements, since two service elements (e.g., two coffee catering services) with differing sets of properties (e.g., sacrifice, quality) are considered to be different service elements. Resource properties of secondary importance are omitted for simplicity. Where the valid values of properties are important, we mention it. Note that it is the supplier's task to decide which values are valid per property.

4.1 Room Renting

Like many other supporting service elements, room renting as a service happens "behind the scenes". For a customer who organizes a meeting, the existence of a space for the meeting goes without saying. A supplier, on the other hand, sees a more complex process behind it.

Room renting has the following **properties**:

Type: Supporting.

Quality: Is not considered in our running example. Examples would be regular or high quality, whereby high quality could imply mahogany tables (as a constraint).

Productivity: Refers to the maximum number of people that can participate in a meeting. Two resources determine the productivity of this service element: the room itself, and the setup (how tables and chairs are organized, e.g. in an O-shape or a U-shape). Productivity, expressed in a number (integer), is thus the maximum number of people in a room, considering the room setup.

Sacrifice: Price.

Room renting requires the following **service inputs**:

Payment. Type: monetary resource.

Room. Type: physical good. State: available. Productivity: number (as explained before, it depends on the setup).

Room renting results in the following **service outcomes**:

Room. Type: physical good. State: reserved. Productivity: number of people.

Room-setup. Type: physical good (a setup is an organization of tables and chairs). State: O or U (no other values are allowed for a meeting). Productivity: number.

Room renting has the following **constraints**[3]:

- Relation between the resources *room* and *setup* (some setups are not possible in specific rooms; the productivity of a room depends on the room setup).
- Price (sacrifice) is a function that depends on the supplier's pricing strategy, and takes quality and productivity issues into consideration.
- The value of service property *sacrifice* is equal to the value of service input *payment.*
- The value of the service property *productivity* is determined by the productivity of the resources *room* and *room-setup.*
- If we had considered the quality property, we would have had constraints on the service outcome *room* (various rooms may offer differing levels of luxury).

[3]We provide generalized, and thus not machine-readable example constraints; they can be further specified with concrete values. For example, if resource 'room' has value 'room X', then valid values for resource 'setup' are 'O' or 'U'.

4.2 Coffee Catering

A meeting can be held without coffee catering. Including this service element in a service offering will probably make the service more expensive. The customer may choose one of several predefined service quality levels.

Coffee catering has the following **properties**:

Type: Enhancing.

Quality: This is a composite property; it is composed of two properties: product quality (referring to the variety of products to be provided) and process quality (referring to the degree of required customer participation vs. employee doing the work). The possible quality values are:

Product quality: (1) Basic: coffee, milk, sugar and cutlery; (2) Regular: basic, plus water and cake; (3) Luxurious: regular, plus juice, tea and several types of cakes

Process quality: (1) Basic: catering is brought in, but not served (self-service); (2) Regular: catering is brought in and served; (3) Luxurious: catering is brought in, and served upon request (employee remains in room for a long period)

Productivity: Maximum number of people to be served.

Sacrifice: Price.

Coffee catering requires the following **service inputs**:

Room. Type: physical good. State: reserved. Productivity: number of people.

Customer/Employee. Type: Human resource. This resource depends on the chosen process quality. We model only human resources that are not inherent to the service: we do not model the employee who brings the coffee to the meeting room. Basic process quality implies that the customer has to serve himself (in return for a lower price), and is thus considered as a human resource. Regular quality is the standard service, in which an employee brings refreshments to the meeting room, serves it and leaves the room. In such a case we do not model human resources, because they are inherent to the service. Luxurious quality implies that the employee remains in the room for a longer period, to serve coffee upon request. This last part of the service is not inherent to the service (and reflects costs for customers); it is thus modeled as a human resource.

Payment. Type: monetary resource.

Coffee, milk etc. are *inputs* on the service process perspective, but not on the service offering perspective, since on this perspective they are invisible to the customer, as inputs. They are, however, modeled as *outcomes* on the service offering perspective, since they reflect – as outcomes – what the customer pays for. As input they reflect value (costs) for the supplier, and as outcomes they present value for the customer. Only the latter type of resource is modeled on the service offering level.

Coffee catering results in the following **service outcomes**:

Coffee. Type: physical good. Productivity: number of people.

Milk. Type: physical good. Productivity: number of people.

Sugar, water, cake etc: based on the chosen product quality.

Ability to freshen up. Type: capability. A coffee catering service during a meeting is not only about consuming beverages and/or snacks; it provides meeting participants with the opportunity to take a break and gain some new energy. Productivity: number of people.

Coffee catering has the following **constraints**:

- Process quality (basic, regular, luxurious) determines the service input of type human resource (valid values: customer, null, employee, respectively).
- Product quality (basic, regular, luxurious) determines the service outcomes of type physical good (coffee, milk etc).
- Price (sacrifice) is a function that depends on the supplier's pricing strategy, and takes quality and productivity issues into consideration.
- The value of service property *sacrifice* is equal to the value of service input *payment*.
- The productivity of the resource "ability to freshen up" equals the lowest productivity value of the resources *coffee, milk, sugar, cake* etc.

4.3 Bundling Service Elements

Since it is a supporting service element, *room renting* has to be part of every service bundle for meetings. Coffee catering is an enhancing service element – the decision whether or not to include it in a service bundle depends on the customer. When configuring these two service elements, we face two conceptually different levels of configuration. The first level reflects a high level decision regarding the services to be configured: (1) only room renting, or (2) room renting AND coffee catering. The second level is choosing which of the various room renting service elements and (possibly) coffee catering service elements to configure. As explained before, a coffee catering service element with product quality X, and a coffee catering service element with product quality Y are two different components – two different service elements. The same holds for room renting, or for any other service element. An important observation can be made regarding room renting and coffee catering: they can be weakly connected. A reserved room is an outcome of the service element *room renting*, as well as an input of the service element *coffee catering*. Figure 5 presents the first option for a service bundle: the bundle includes a room renting service element, but no coffee catering. It shows two different service bundles, with two different room renting service elements. The difference between them is limited to the productivity property (number of participants), but typically the price would be different as well. Figure 6 presents two examples of possible coffee catering service elements. In the first one, the process quality is set to *regular*, implying no human resource input. In the second one, the process quality is *basic*, implying that the customer is an input of type human resource. Finally, Figure 7 shows two of many possibilities to bundle a room renting service element with a coffee catering service element. This is where we see that both service elements can be weakly connected; an outcome resource of the room renting service element is also an input resource of the coffee catering service element. Both examples presented in Figure 7 combine weakly connected service elements. Whereas the coffee catering service element in Figure 7a requires two inputs, in Figure 7b it requires three inputs (next to two more inputs required by the room renting service element). The service bundle would consequently have four and five service inputs respectively. But since one input is satisfied internally, the service bundle eventually has only three and four inputs respectively.

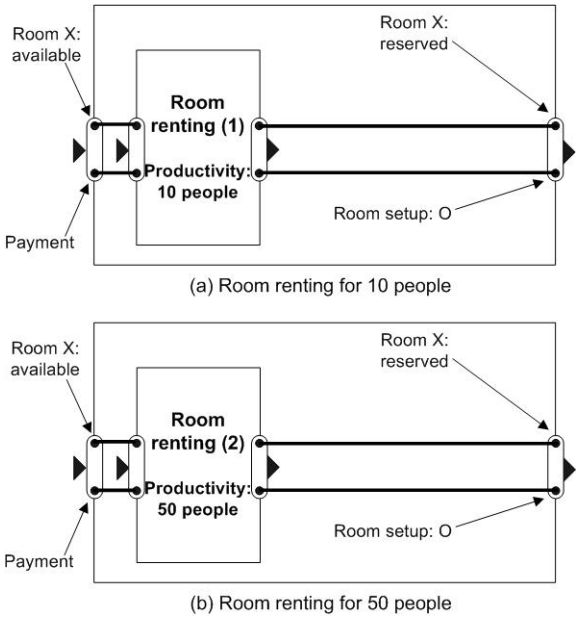

Figure 5: Service bundles, including a room renting service element only

4.4 Analysis

Even with only two simple service elements, room renting and coffee catering, a supplier can offer a broad variety of services; a room has to be suitable for a certain number of people, and can be organized in various ways (room setups). A further – very realistic – complication would be to include requirements on available equipment (e.g., network connectivity). Also a simple service as coffee catering may be offered in different setups (product and process quality); ample possibilities to configure a service bundle exist. Analyzing the meeting case with domain experts revealed that the service is much more complex than expected. The component-like analysis of the service offering is new to the business, and mapping a service offering into service elements and resources is a time-consuming task. It is required though to make implicit knowledge explicit, and to facilitate a machine-enabled scenario of offering services. Analyzing the meeting case study was a useful exploration activity to domain experts as well. It helped understand characteristics of the service, which were not explicitly acknowledged as such before. Mainly, domain experts concluded that two

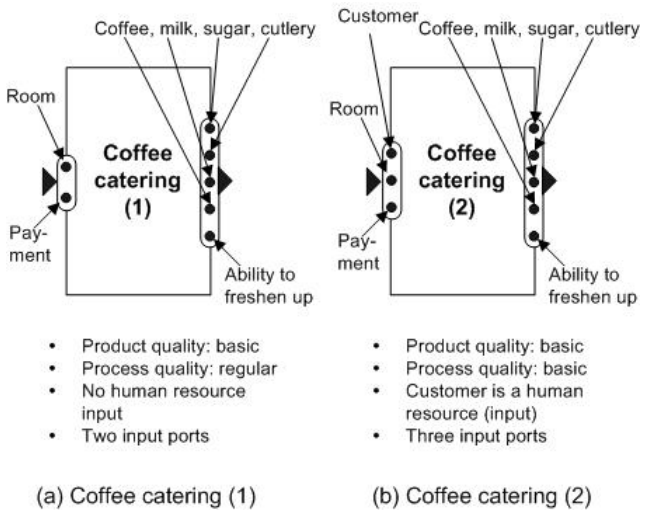

Figure 6: Two possible coffee catering service elements

quality dimensions are important for customers in organizing a meeting: product quality and process quality. This corresponds with the Nordic school for service quality [10], and not with the North American school [20], also used by [13] and by [16]. The process provided us with new insights on the service ontology. Mainly, the distinction between resources on the service offering level (stand for *which service is provided*) and resources on the service process level (relate to *how* the service is provided) was not yet clear at earlier stages.

5. CONCLUSION AND FUTURE WORK

We have created a generic ontology of real-world services, based on the scientific literature in service management and marketing. Such an ontology has to be component-based, in order to facilitate the online configuration of services. By expressing services as components with related resources, we make it possible for software to reason about bundling services: it becomes a 'traditional' configuration task. Since services are business activities that present value to customers as well as suppliers, a value element has to be dominant in a service ontology. The configuration of service elements into a service bundle is triggered by a customer's desire for some value, reflected by service outcomes. The sacrifice property of service elements represents the most common value from the supplier side. Together these concepts give us a good understanding of a service offering's value. In order to understand the business model behind such a service offering (or service bundle), one must use a business value analysis tool, e.g. by integrating the service ontology with a value ontology [8, 9].

Many product-oriented industries configure products based on a componential description of their (tangible) products. Services, being intangible products, can be handled in the same way. Whereas many ontologies exist for classifying tangible products (physical goods, in our terms), a generic service ontology for the support of service configuration is yet missing. This is the contribution of our service ontology. In this paper, we have shown how it can be put into practice.

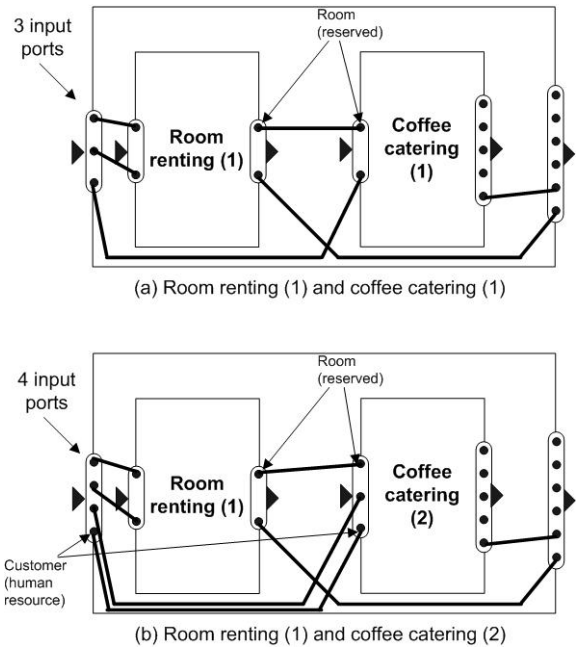

Figure 7: Service bundles, including room renting and coffee catering

The work presented in this paper is still in an ongoing stadium. Work is being performed on multiple fronts. First, the service ontology is in the process of testing for real-life suitability, based on case studies. The ontology is evolving through the learning process of our research. Second, we are working on the integration of the service ontology with a configuration ontology, developed by a project partner in accordance with [11] and [15]. Third, we plan to work also on integrating the service ontology with a value ontology, i.e. e^3*-value* ontology [8, 9].

Acknowledgements. This work has been partially supported by STW project VWI 4949 and by the European Commission, as project No. IST-2001-33144 OBELIX (Ontology-Based ELectronic Integration of compleX products and value chains). We thank especially Nieves Peña (LABEIN, Bilbao, Spain) for useful discussions on the topic of this paper.

6. ADDITIONAL AUTHORS

Jessica Aguado, (Parque Tecnologico de San Sebastian, Mikeletegi 53, 20009 San Sebastian, Spain, email: `jessica@miramon.net`) and Jaap Gordijn, (Free University Amsterdam, FEW/Business Informatics, 1081 HV Amsterdam, The Netherlands, email: `gordijn@cs.vu.nl`).

7. REFERENCES

[1] *Defining Web Services.* The Stencil Group, 2001. www.stencilgroup.com/ideas_scope_200106wsdefined.html, last visited August 2003.

[2] *ebXML website.* 2003. http://www.ebXML.org.

[3] T. Andrews, F. Curbera, H. Dholakia, Y. Goland, J. Klein, F. Leymann, K. Liu, D. Roller, D. Smith, I. Trickovic, and S. Weerawarana. *Business Process*

Execution Language for Web Services Version 1.1. 2003. http://www-106.ibm.com/developerworks/webservices/library/ws-bpel/, last visited August 2003.

[4] Z. Baida, H. Akkermans, and J. Gordijn. Serviguration: Towards online configurability of real-world services. *Accepted for publication in the Fifth International Conference on Electronic Commerce (ICEC03)*, 2003.

[5] P. Borst. *Construction of Engineering Ontologies for Knowledge Sharing and Reuse*. PhD thesis, Universiteit Twente, Enschede, NL, 1997.

[6] W. N. Borst, J. M. Akkermans, and J. L. Top. Engineering ontologies. *International Journal of Human-Computer Studies*, 46:365–406, 1997.

[7] J. Gordijn, H. Akkermans, and J. van Vliet. Business modelling is not process modelling, In: Conceptual modeling for e-business and the web (ECOMO-2000), Springer-Verlag, LNCS 1921, Salt Lake City, USA, October 9-12, 2000, pp. 40-51., 2000.

[8] J. Gordijn and J. M. Akkermans. Designing and evaluating e-Business models. *IEEE Intelligent Systems - Intelligent e-Business*, 16(4):11–17, 2001.

[9] J. Gordijn and J. M. Akkermans. Value based requirements engineering: Exploring innovative e-commerce ideas. *Requirements Engineering Journal*, in print, 2003. http://link.springer.de/link/service/journals/00766/contents/03/00169/.

[10] C. Grönroos. *Service Management and Marketing: A Customer Relationship Management Approach, 2nd edition*. John Wiley & Sons, Chichester, UK, 2000.

[11] T. Gruber, G. Olsen, and J. Runkel. The configuration design ontologies and the VT elevator domain theory. *International Journal of Human-Computer Studies*, 44:569–598, 1996.

[12] H. Kasper, P. van Helsdingen, and W. de Vries jr. *Service Marketing Management: An International Perspective*. John Wiley & Sons, Chichester, UK, 1999.

[13] P. Kotler. *Marketing Management: Analysis, Planning, Implementation and Control, 6th edition*. Prentice Hall, Englewood Cliffs, NJ, 1988.

[14] F. Leymann. *Web Services Flow Language (WSFL 1.0)*. IBM, 2001. http://www-4.ibm.com/software/solutions/webservices/pdf/WSFL.pdf, last visited August 2003.

[15] C. Löckenhoff and T. Messer. Configuration. In J. Breuker and W. V. de Velde, editors, *The CommonKADS Library for Expertise Modelling — Reusable Problem Solving Components, Chapter 9*, Amsterdam, The Netherlands, 1994. IOS Press.

[16] C. Lovelock. *Services Marketing, People, Technology, Strategy, 4th edition*. Prentice Hall, Englewood Cliffs, NJ, 2001.

[17] J. O'Sullivan, D. Edmond, and A. ter Hofstede. What's in a service? towards accurate description of non-functional service properties. *Distributed and Parallel Databases*, 12:117–133, 2002.

[18] I. Vuorinen, R. Järvinen, and U. Lehtinen. Content and measurement of productivity in the service sector. *International Journal of Service Industry Management,*, 9(4):377–396, 1998.

[19] V. Zeithaml and M. J. Bitner. *Services Marketing*. MGraw-Hill Companies, New York, NY, 1996.

[20] V. Zeithaml, A. Parasuraman, and L. Berry. *Delivering Quality Service: Balancing Customer Perceptions and Expectations*. The Free Press, New York, NY, 2001.