Modeling Pricing for Configuring e-Service Bundles

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Abstract

To offer *online* bundles of independent *e-services*, software is needed that composes services of different enterprises into a bundle of services, satisfying a complex consumer need. In earlier research, a service ontology – a formalized conceptual model of services – has been developed for such software-aided service bundling. This ontology, however, did not include constructs to reason about the *prices* of services, while these are needed to realize and offer service bundles online. In this paper, we present an extension of the service ontology with pricing models for e-services. Examples from real-world services are used to illustrate how pricing models of services can be modelled by domain experts, and prices of service bundles can be calculated by software using the extended ontology.

Keywords: bundling, pricing models, ontology, service industries

1   Introduction

Due to the Internet's diffusion, more and more enterprises offer their services jointly as *e-service bundles* over the Internet. *E-services* are traditional services, being economic activities, deeds and performances of a mostly intangible nature (Grönroos 2000, Kasper 1999, Kotler 1988, Zeithaml 2001), which can be (partly) provisioned using the Internet. Examples include an email inbox, Internet radio, or even plain internet access. A service *bundle* is a set of more elementary services, possibly supplied by multiple suppliers. Consider for instance an email inbox and Internet access as a service bundle. Bundling is a well known economic principle (Grönroos 2000) for increasing revenues, decreasing costs and improving a company's competitiveness. It is defined as "the sale of two or more separate products in one package" (Stremersch and Tellis 2002).

In addition to the provisioning of e-service bundles via the Internet, these bundles are also *ordered* via the Internet. In many cases, there is no 'physical' salesperson present whose task it is to find the customer's needs, and then to find appropriate bundles of services satisfying such needs. Rather, this salesperson is replaced by a software component. Ideally, such a component would try to elicit the customer need, and then propose one or more alternative service-bundles satisfying that need. These processes of need elicitation and solution proposal is collectively referred to as 'automated reasoning'. As software

can reason only about **formalized** domains, we need a formal description of what services *are* to enable need elicitation and software-aided service bundling. In earlier research (Baida et al. 2005, Akkermans et al. 2004), a service ontology, termed *serviguration*, has been proposed that formally describes a shared view on what services are, and aims to compose cross-organizational service bundles out of more elementary (single) services. Ontologies are formal representations of a domain, and serve as an important tool in making domain knowledge machine-readable. (Borst et al. 1997) define an ontology as 'a formal specification of a shared conceptualization'. Once domain experts use the ontology to model services and dependencies between services, an automated process can generate service bundles, based on a set of customer demands. We presented evidence of the usefulness of the ontology in (Baida et al. 2004), where we used the ontology and an ontology-based software tool to conduct a software-aided business analysis for offering service bundles by networked enterprises in the energy sector.

So far, the *serviguration* ontology did not include a mechanism for software reasoning about *prices* of services. Such reasoning is important since price plays a significant role in determining the value for the customer, and also gives a perception of quality (Payne 1993). Additionally, pricing models facilitate reasoning about the suitability of service bundles for customers, since a price range can be a requirement for service bundles. A pricing model represents the way a company sets its prices (Daly 2002). Very often the price of a service changes when the service is sold as part of a larger service bundle. Therefore, when software composes service bundles, it needs to reason about the price of the *bundle* and of the bundle's *components*.

This paper presents a pricing extension to our *serviguration* ontology. In Section 2 we shortly review the service ontology. Section 3 presents existing work on service pricing models, which is the foundation for extending our serviguration ontology in Section 4. Section 5 exemplifies how the price of a service bundle is calculated with the extended ontology. Finally, in Section 6 we present our conclusions.

2   Serviguration ontology

The aim of the *serviguration* ontology (Baida 2006) is to support automated generation of service bundles satisfying complex customer needs. It includes two perspectives: a *service value* and *service offering* perspective. The service value perspective expresses customer *needs* and *demands* that should be satisfied by acquiring a service, in return for a certain sacrifice (including price, but also intangible costs such as inconvenience costs and access time). The service offering perspective describes the *services* offered by a *supplier*. This paper focuses on the service offering perspective, since mostly suppliers determine pricing models (possibly after a negotiation process).

The service offering perspective facilitates the *composition* of *complex* services out of more *elementary* services. Similar mechanisms already exist for composing complex *goods* as PCs and cars out of more elementary goods (see e.g. current practice of Dell and BMW). However, a service description (for composition purposes) differs substantially from the description of goods. Goods are described by - and composed based on - their *physical* characteristics. Services, on the other hand, have an *intangible* nature, and cannot be described unambiguously based on physical properties. Instead, for services we employ the

economic principle that when customers buy services/goods, they are interested in the *value* – the benefits – of these services/goods, rather than in the service/good itself (Teare 1998, Lancaster 1966). So, as we cannot describe services by physical properties, we describe them by the benefits (e.g., money, capabilities, experiences) that customers and suppliers exchange in a service, and use this description for matching needs and services.

We present the core ontological concepts of the service offering perspective in Figure 1 (see (Baida 2006) for a complete discussion).
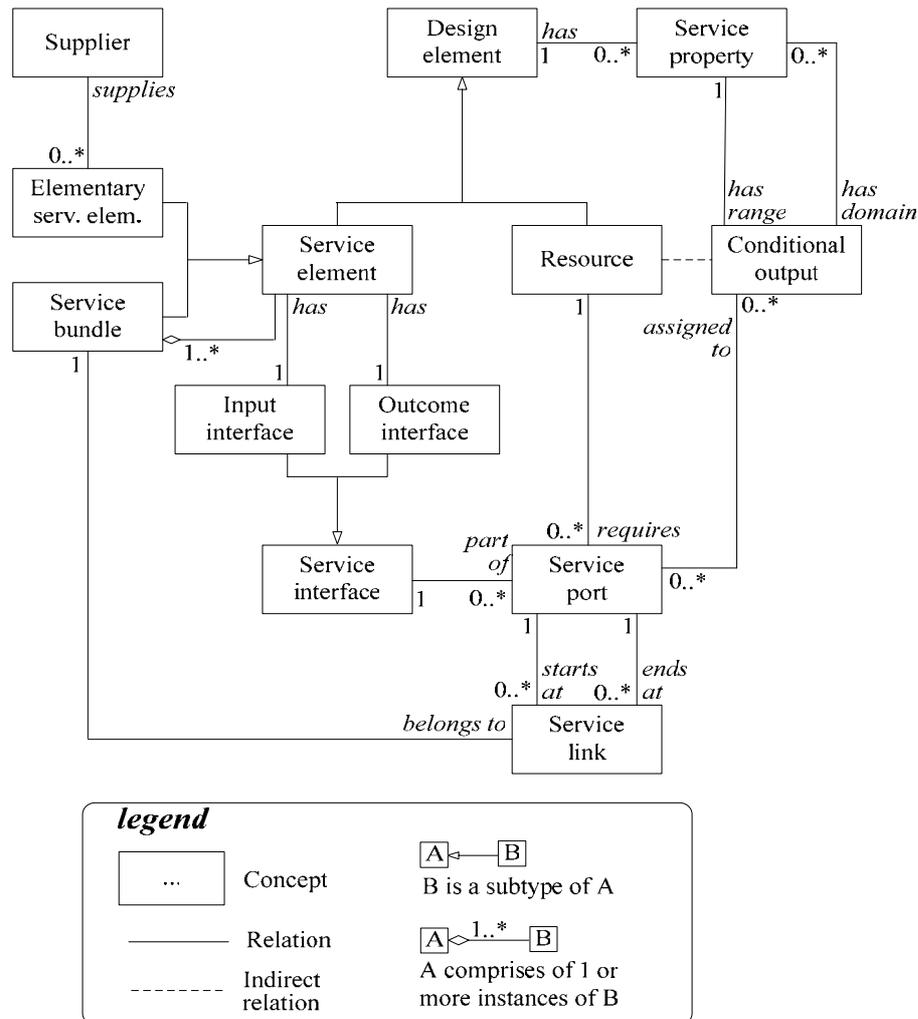

Figure 1: Main concepts of the service offering sub-ontology

Service elements represent what suppliers offer to customers. Such elements are often referred to as just *services*: economic activities, deeds and performances of a mostly intangible nature (Grönroos 2000, Kasper et al. 1999, Kotler 1988, Zeithaml et al. 2001). The concept service element is visualized in Figure 2. A service element can be a composite element, meaning that it is composed of smaller service elements. Once a smaller element represents a *non-separable* service element that is offered by *one* supplier, we call it an **elementary service element**. A **service bundle** is a complex service element, including one or more (potentially elementary) other service elements.
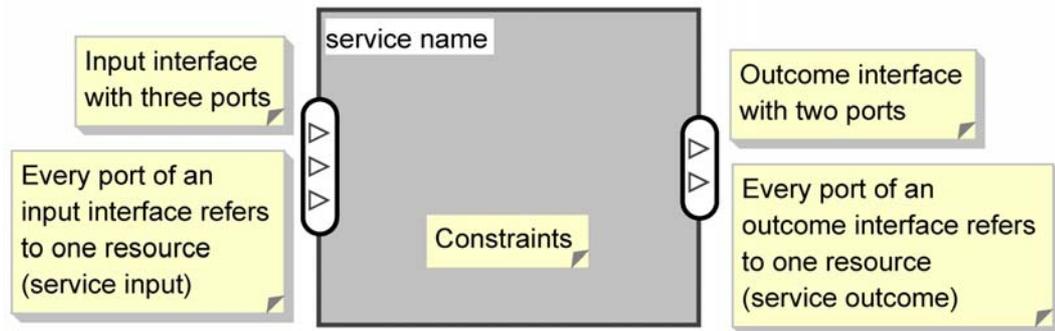
Figure 2: Service element

Because customers perceive a service as a bundle of *benefits* (Kasper et al. 1999), we describe services by the benefits that they present to customers, and by the benefits that customers have to sacrifice to consume the services (typically a fee but also intangible costs such as a long-term commitment).

Resources are the benefits that customers and suppliers exchange. Resources can either be required for the provisioning of some service element (service input), or be the result of a service element (service outcome). Inputs and outcomes may be tangible (e.g., a credit card) or intangible (e.g., the ability to perform worldwide money transactions). Since the outcome of one service may be the input of another service, inputs and outcomes are called **resources**. Several *types* of resources have been identified (e.g., information, experience, and capability) of which only the 'monetary resource' is relevant for this paper. **Monetary resources** are often money; alternatives are other value-papers.

Resources have certain **service properties** that encapsulate qualitative and quantitative information concerning the resource. Examples of service properties are download speed (for an Internet connectivity service) and amount (for a fee resource). Properties are expressed using a formula (which is a constant in its simplest form).

We specify that a service provides (or requires) a resource by attaching the resource to a service port of that service. While a resource may be related to multiple services, **service ports** allow us to determine the behavior of a resource when it is related to a specific service. Every service element has service ports of two types: input ports and outcome ports. Every service port is assigned exactly one resource (input resource or outcome resource). The notion of ports stems from the technical system theory (Borst et al. 1997). The set of all input ports and outcome ports of a service element form the element's **input interface**, respectively **outcome interface**. Every service element has exactly one input interface and one outcome interface.

A **service link** between two service ports models that one service port uses a resource that another service port provides. Since a service link can only exist in a service bundle (service ports of a single service cannot be linked because a service cannot provide a resource for itself), a service link also indicates that the service elements that it connects are part of a service bundle.

Figure 2 shows that a service element has **constraints**: descriptions that limit the permissible values for properties of service elements. The *serviguration* ontology includes constraints, referred to as **conditional outputs**. We call them conditional outputs because they include a condition, which determines the value

of some service property (the so-called 'output') They therefore have the form "IF…(condition) THEN a service property's value is…(output)". We distinguish between there types of output:

1. refers to one resource (e.g., the value of the service property *location* of resource *cash withdrawal* in a credit card service may be "NL" or "worldwide"); or
2. refers to two or more resources within one service element (the value of one service property depends on the value of another service property within the same service); or
3. refers to two or more resources in two or more services (the value of a service property depends on the value of another service property of another resource, assigned to another service).

In all three types the THEN part of a conditional output refers to the value of exactly one service property; they differ however in the IF part. In the first type, the IF part of the condition does not refer to any service property. This can be expressed as "IF (TRUE) THEN service property N =... ". In the second and third types the IF part of the condition refers to one or more properties of some resource(s). This can be expressed as "IF (service property X =...AND service property Y =... AND ...) THEN service property N =... ".

We refer to the IF part of a conditional output as 'domain', and to the THEN part as 'range'. A conditional output (see Figure 3) determines the value of exactly one service property (the 'range') of a resource. The value of that service property may be dependent on some other service property or service properties (the second and third types of conditional outputs), or on no service property (the first type of conditional outputs). These service properties are the conditional output's 'domain'.

How the service ontology can be used by software developers to actually design service bundles can be found in (Akkermans et al. 2004). In (Baida et al. 2005) we explain how this bundling process is triggered and driven by a given set of customer demands.
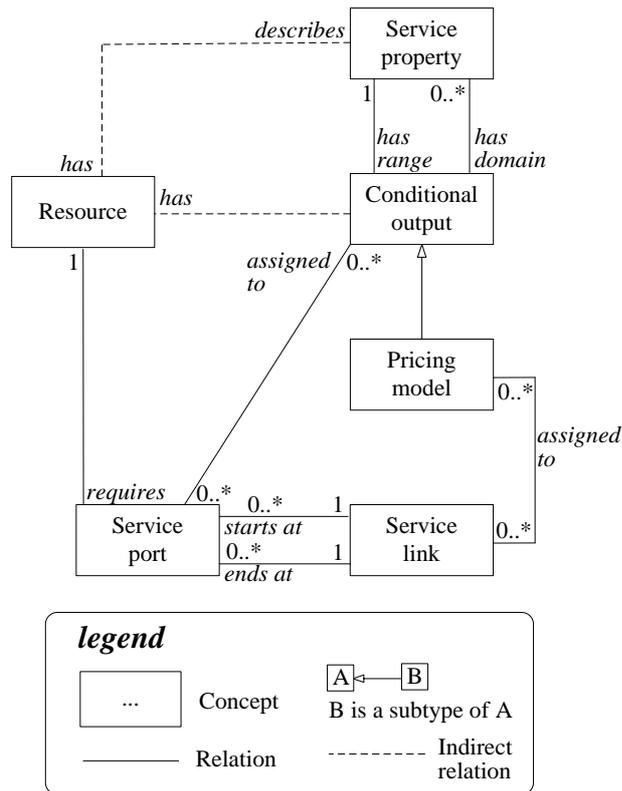
Figure 3: Service sub-ontology including pricing models of services

3   Pricing models for services

Earlier versions of the Serviguration ontology did not handle pricing models explicitly. There are at least three reasons why pricing models for services must be incorporated. First, the price charged for a service signals to customers the quality they are likely to receive (Payne 1993). Second, pricing models facilitate reasoning about offering services. For example, if a maximum price is a requirement for the design of an e-service bundle, more expensive solutions can be disqualified. Third, information on the price of a service is required for the actual selling of a service. It is common sense that if a service has no price tag, it cannot be sold.

To incorporate pricing models in the ontology for *elementary* and *bundled* services, it is necessary to understand what types of pricing models exist and how they are constructed. Amongst others based on (Berends 2004, Choi et al. 1997, Dewees 2002, Dolan and Simon 1996, Essegaier et al. 2002, Kotler and Bloom 1984, MacKie-Mason and Riveros 1997, OECD 1987, Simkovich 1998) we summarize that the four most broadly used pricing models for *elementary services* are:

1. *Flat-rate*: The user pays a fixed amount which is independent of usage.
2. *Usage-based*: The user is charged on basis of usage.
3. *Two-part tariff*: The user pays a fixed amount plus an additional usage based charge.
4. *N-block tariff* (with n = 2): A price per unit (p) is charged for any unit, up to a certain quantity q2, then the price per-unit changes to p2 for all units greater than q2. The n-block tariff with n > 2 is defined similarly.

The two most broadly used pricing models for *service bundles* are discussed in (Adams and Yellen 1976, Guiltinan 1987, Kasper et al. 1999, Kurtz and Clow 1998, Tung et al. 1997, Stremersch and Tellis 2002):

1. The price of a service bundle is equal to the sum of the prices of the services in the bundle, minus a *discount* applied to the *sum*.
2. The price of a service bundle is equal to the sum of the prices of the services in the bundle, minus a *discount* applied to *one or more of these prices*.

Hence, the pricing models of service bundles consist of a discount, and of the outcomes of the pricing models of the services that are part of the bundle (see also our literature survey (de Miranda 2005) for detailed information on pricing models).

4 Extending the *serviguration* service ontology with pricing models

4.1 Pricing models are constraints

A pricing model determines the value of a property of a monetary resource, expressing a required sacrifice for the provisioning of other resources (e.g. in commercial services). A pricing model includes an expression - a formula - that determines (limits) the value of a service property of a *monetary* resource.

This formula can use the values of service properties of (other) resources. Consider an 'electricity supply' service as described in the TrønderEnergi AS case study (Morch et al. 2005). This service element has two service inputs, lock-in and fee, and one service outcome, energy. A pricing model of this service element can be constructed as follows: price per kWh x electricity consumption (usage-based pricing model). The 'electricity consumption' amount can be derived from a service property of the energy resource.

Given that a pricing model determines the value of a service property of a monetary resource, this value is its range. Additionally, given that a pricing model can use the values of service properties of resources, these values are its domain. As a pricing model uses some formula to determine the value of a service property of a resource, it is a constraint on the values of service properties of resources. Such a constraint is called a conditional output. However, *a pricing model is a specific type of conditional output*, because it also has a relation that other conditional outputs do not have: relation with service links, facilitating that a price of a service may depend on the service's inclusion in a specific bundle (see Section 4.3). Consequently, the pricing model concept is a subtype of the conditional output concept.

4.2 Relation between pricing model and service port

A pricing model is related to a *service port* (via the pricing model's super-type *conditional output*). A pricing model influences the amount of monetary resources to be paid, and is therefore related to a service port, to which a monetary resource is attached.

A service element may have several service ports to which monetary resources are attached. One or more pricing models may be assigned to any of these service ports. The need for multiple pricing models per service port is motivated by the possibility that a service is available with multiple pricing models, and the

customer may choose his preferred pricing model (this is often the case in mobile telecommunication services – e.g. depending on the number of minutes you buy, you pay a different tariff). When a customer selects a pricing model, it becomes active.

One may question why not to assign pricing models to resources, rather than to service ports, given that a pricing model determines the value of a (service property of a) resource. This is not possible given that a resource can be associated with multiple service elements, while a pricing model of a service element is only applicable for that specific service element.

4.3 Relation between pricing model and service link

The relation between the pricing model concept and the service port concept is not sufficient to calculate the price of a service bundle, because some services may use a specific pricing model *only* when they are part of a specific bundle. To this end, a relation between the pricing model concept and service link concept is required. A service link is a connection between two ports (in a bundle), and also a relation between a service element (elementary or bundle, say service X) and a service bundle (say bundle Y), that includes that first service element. By adding a pricing model to a service link that connects X and Y, we model that this pricing model is used only when service X is part of bundle Y (e.g. when service X is sold at a discounted price in bundle Y). The service link then connects two monetary resources: that of service X and that of bundle Y. Consequently, it becomes possible to calculate the price of bundle Y based on the pricing model that is in the link between ports of service X and bundle Y (see Figure 4). Service X may use another pricing model when it is sold separately or in another bundle.
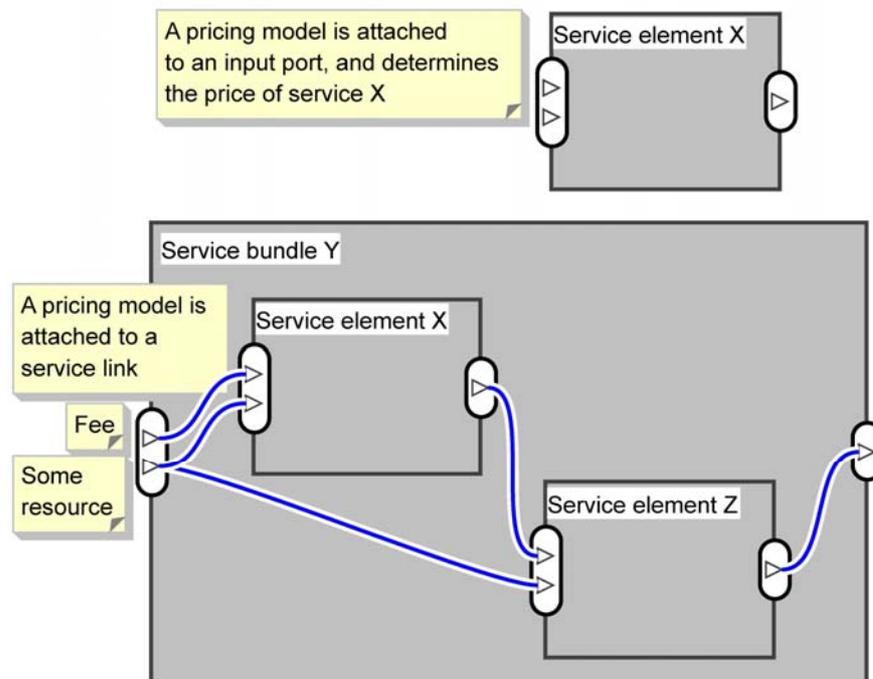

Figure 4: In the top image, a pricing model is attached to the input port of service X, to determine the price of the service. Once service X is included in service bundle Y (lower image), a different pricing model is attached to a link between ports of service X and bundle Y

In accordance with the service ontology, the input ports of the services within a service bundle need to be provided by the input interface of the bundle, unless they are *provided internally* within a bundle (e.g. in Figure 4, an input of service Z in bundle Y is provided internally by an outcome of service X). For all inputs that are not provided internally, service links connect input ports of the bundle with input ports of the services within the bundle. Calculating the price of a service bundle requires knowledge of (1) the prices of the service elements that are connected by a service link to (a service port of) the bundle, and (2) pricing models that are assigned to those links. The prices of the service elements that are not directly linked with the service bundle are *provided internally*, and do not influence the price of the bundle.

4.4 Pricing models in the service ontology: summary

We divided our discussion into two parts: a part that applies only to service bundles, and a part that applies to any service element (bundle or elementary). The relation 'a pricing model is assigned to a service link' is used for calculating the price of a bundle. By assigning pricing models to service links we can determine that a service has a specific price only when it is sold as part of a specific bundle.

We validated our extension of the service ontology in case studies from two sectors: energy and online music, and with several other real-world services (see (de Miranda 2005)). Our validation showed that our model is suitable to describe the pricing models of real-world services in various industries, and that it enables reasoning about the prices of services (elementary and bundled), needed for realizing an Internet-based service bundles offering. In the next section, we show how the price of a service bundle is calculated.

5 Calculating the price of a service bundle using the pricing model constructs

The prices of services are taken into account when ontology-based software configures service bundles. We show how this takes place using an example, summarized in Figure 5. For more elaborate examples see (de Miranda 2005).
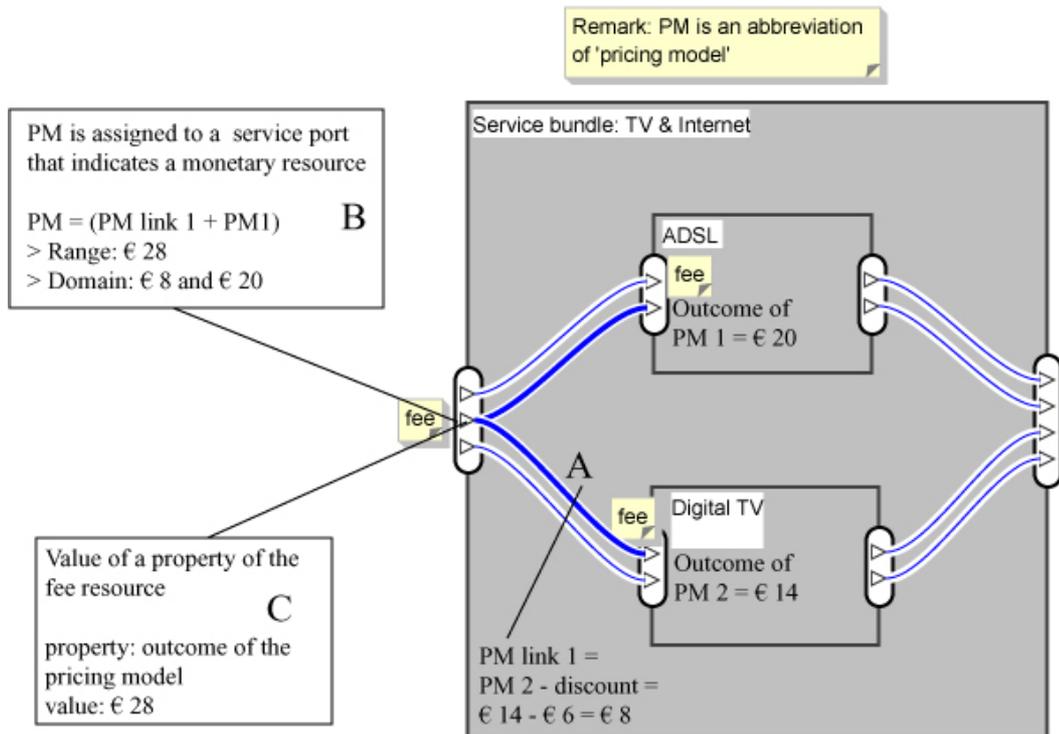
Figure 5: Example of the way to calculate the price of a service bundle

A service bundle and its two constituting elementary services (ADSL and Digital TV) are modeled as service elements, with input interfaces and outcome interfaces consisting of service ports. Lines between service ports in the figure are service links. Thick lines are service links that influence the price of the service bundle (i.e., they refer to service ports with monetary resources that are not provided internally in the bundle). For simplicity, the figure only displays the resources that are needed to calculate the price of the service bundle. Figure 5 shows the outcomes of the pricing models that are assigned to input ports that indicate a monetary resource (fee). There is also a pricing model assigned to the service link connecting the service element Digital TV and the bundle.

Our discussion on calculating the price of the service bundle is divided into three parts (denoted by letters: A, B and C in Figure 5). This discussion demonstrates which relations of the extended service ontology facilitate calculating the price of the service bundle.

- Part A: In this example, the service Digital TV is sold with a discount when it is part of the bundle. The discount (€ 6) is subtracted from the outcome of the pricing model of this service. The pricing model, with the discount applied, is added to the service link between the service Digital TV and the service bundle. Part A is supported by the following relation: a pricing model is assigned to a service link.
- Part B: The price of the service bundle is calculated by adding up the outcome of Part A with the outcome of the pricing model of the service ADSL. Their addition forms the pricing model of the service bundle, having as range the service property of the bundle's fee resource, and as domain the outcomes of the pricing model of the two elementary service elements. Part B is supported by the following relations: a pricing model is assigned to a service port that indicates a monetary resource, a pricing model has the value of one service property (of a resource) as a range,

and a pricing model has zero or more values of service properties (of resources) as a domain.

- ▪ Part C: The outcome of the pricing model of the service bundle is modeled as the value of a service property of its fee resource. This value is the range of the pricing model. Part C is supported by the following relation: a pricing model has the value of one service property (of a resource) as a range.

6 Conclusions

In this paper we presented an extension of an earlier published service ontology that facilitates online service bundling. The motivation for this extension lies in the fact that the service ontology had no constructs to model the prices of elementary e-services and e-service bundles, while these prices are needed for e-service realization. We successfully validated the extended ontology with industrial case studies. We also provided a graphical example to illustrate the way the price of a service bundle is calculated in accordance with the extended service ontology.

We gained insights into the types of pricing models of services and the way they are constructed by means of a literature study, showing that the four most broadly used pricing models of elementary (single) services are the flat-rate, usage-based, two-part tariff, and n-block tariff pricing models. Furthermore, two pricing models of service bundles were derived from the studied literature: (1) the price of a service bundle is equal to the sum of the prices of the services in the bundle, minus a discount applied to the sum, and (2) the price of a service bundle is equal to the sum of the prices of the services in the bundle, minus a discount applied to one or more of these prices.

We used services from various service industries to verify that the aforementioned pricing models are representative for real-world services. This served as input for the development of the extension to incorporate pricing models of services in the service ontology, and to validate our model. In this paper we described how pricing models of services are incorporated in the service ontology. The original service ontology facilitates the design of service bundles out of more elementary services, and it has been used for software-aided service bundling. The extended service ontology enables reasoning about the prices in this design process. Consequently, when software tools design service bundles that satisfy some customer demand(s), the price of each bundle can be calculated and be used as a criterion in the selection of a bundle to consume.

Future work
We are currently involved in the FrUX project (Freeband User eXperience, http://frux.freeband.nl), where the extended ontology will be implemented in another software tool, and serve for the creation of a prototype web-portal for offering service bundles in the health sector.

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12

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