Value-Driven Service Matching

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Abstract

Today's economy is a service economy, and an increasing number of services is electronic, i.e. can be ordered and provisioned online. Examples include Internet access, email and Voice over IP. Just as any other kind of services, e-services often are offered in bundles, and many consumer needs require the construction of e-service bundles. For example, a need to communicate with family abroad, can be satisfied by Voice over IP, which also requires Internet access. The problem is how to compose an e-service bundle so that the needs of the consumer are met optimally and the suppliers can provide the services in the bundle in an economically sustainable way. This is a requirements engineering problem: matching consumer needs to (combinations of) solutions. In this paper, we propose a technique to match a consumer need with a multi-supplier bundle of commercial e-services. The technique is intended to be used by suppliers when they build a service catalogue that describes what they can offer with their technical infrastructure in terms of what consumers can buy. It is also of interest to brokers who match consumer needs to what is offered by various suppliers in their catalogues. The technique is illustrated by means of a case study in which we used the technique to structure part of the catalogue of a Dutch telecommunication company. The technique is related to goal-oriented RE but it starts from consumer values rather than goals, and it matches existing solutions to needs, rather than creating a new solution.

1. Introduction

In today's economy, the difference between products and services has blurred, and an increasing number of services are e-services, which are commercial services that can be ordered and provisioned on-line. E-services are rarely provisioned in isolation but are offered in bundles, such as Voice over IP (VoIP), which may be offered in a bundle with Internet access and chat services. This creates opportunities as well as problems for suppliers and consumers of services. Suppliers have the opportunity to allow or prevent bundling of their services with those of other suppliers, depending on what is commercially profitable for them to do. And consumers have the opportunity to pick and choose different components of a service bundle from different suppliers to maximize consumer value.

However, this also raises some problems. The problems for the consumer are as follows.

P1 Which bundles of services are currently on the market?

P2 With which of these bundles can I achieve my desires?

To solve these problems, the consumer must become aware of the desirable consequences that could be created by available services (e.g. communicate with family overseas), cross a semantic gap between these desirable consequences and available services in the market (e.g. VoIP and MSN chat services), and reason about the ability to achieve the desirable consequences with these services. The consumer may change her desires if she obtains more information about what is possible with service bundles currently on offer.

The problems for the suppliers are as follows:

P3 What services can I offer with my technical infrastructure, possibly jointly with other businesses?

P4 Given an individual consumer need, which bundle can I offer (possibly with partners) in an economically sustainable way?

To solve these problems, the supplier must translate the capabilities of its technical infrastructure in services that a consumer can buy, and, for each individual consumer need, reason about possible service bundles that can meet this need and optimize commercial profitability.

In this paper we propose an approach for suppliers to structure their services in a service catalogue, and for an e-business consultant or even a call center employee to find a match between a given consumer need and services offered in current supplier catalogues. Our approach matches consumer requirements of services to properties of services as listed in service catalogues. The problem is that consumer requirements are not given: they need to be elaborated based on what is available in service catalogues and on what consumers find valuable. We therefore borrow concepts from marketing theory, by which we can elaborate an initial and incomplete statement of a consumer need and a vague idea of a service that meets this need into a specific consumer demand for a specific service bundle offered by particular suppliers. The resulting match defines a network that connects the consumer with one or more suppliers, in which service delivery and payments are made explicit. By using the e^3*-value* techniques [13] to represent this network, we can estimate the commercial sustainability of this network for the suppliers.

In section 3, we define our conceptual framework, indicating where and how we borrow concepts from marketing. Section 4 shows how we use this framework to construct service catalogues, and section 5 then illustrates the matching process. Section 2 introduces the running example and section 6 winds up the paper with a discussion of topics for further research.

Just as goal-oriented RE methods such as KAOS [10, 20], i* [26] and Tropos [5, 6], we start from what the consumer wants to achieve. However, we elaborate desired consumer value, rather than consumer goals, which are one kind of consumer value, along with others such as fun, aesthetic value and excellence. Also, goal-oriented RE methods propose top-down decomposition of goals, until low-level goals are found that can be satisfied by IT solutions, some of which is still to be designed. In our method, we start from an initial incomplete idea of both consumer problem and IT solution, and we assume that the IT required to deliver the e-services already exists. In fact, the IT does not concern us here, we are interested in the e-services provided by the IT.

Our line of reasoning is similar to the reference model of requirements engineering proposed by Jackson [17] and Gunter et al. [14]: We want to find a service bundle S that will help the consumer to achieve her desires D in the consumer environment E. We cannot go as far as to be able to formalize this as $E \wedge S \models D$ but we do present an informal reasoning pattern that allows the intermediary to start from an initial incomplete reasoning of the form "S in consumer environment E leads to D" to a complete reasoning of the same form, where S has been elaborated into a service bundle that can be bought from suppliers, and D may have been evolved in a consumer desire that matches available services. We will not formalize any of the concepts introduced in the paper, but we try to be as accurate as possible as preparation for a possible formalization later. For now, we assume that the concepts defined in this paper are used by a human intermediary who helps a consumer meet a need.

2. Running Example

Our running example is a consumer who wants to communicate with family overseas at low cost and is considering to use VoIP from a telecom provider (KPN) or from an internet access provider (XS4all) or Instant Messaging (IM) e.g. as offered by Microsoft. Each of these services is bundled with a number of other services, such as number portation or the ability to make more than one call simultaneously (multiple concurrent connections). One of the questions to be answered by our techniques is which bundles are possible and relevant for our consumer. This example is based on a collaboration we have with one of these companies, the telecom provider (KPN).

3. Conceptual Framework

Services and properties. Commercial services are usually defined as economic activities of a mostly intangible nature [21]. However, as Holbrook [16, pages 5–9] observes, *all* services are interactions. And service consumption, we add, *always* consists of interacting with a physical good or with a person. For example, a taxi passenger (service consumer) interacts with a taxi (physical means by which service is provided); a listener (consumer) interacts with sound waves produced by a loudspeakers (physical means by which service is provided); a manager (consumer) interacts with a consultant (person delivering a service). We therefore distinguish the interaction that constitutes the service from the means by which this service is provided (figure 1). As defined at the start of this paper, the means of provision of e-services is information technology (IT).

The means of providing the service has properties, and we follow the usual distinction between functional properties and quality properties (also called non-functional properties). Functional properties, or *functions* for short, are useful pieces of interaction, and quality properties are properties of these interactions. Since a service consists of an interaction with means of service provision, we can therefore define any service as a set of functions and quality properties, called a *bundle* in service marketing. For example, VoIP is a bundle of functions such as *handle incoming voice calls, handle outgoing voice calls* (collectively called *handle synchronous voice communication*), etc. and it has quality properties such as *bandwidth* and *latency*. To avoid awk-

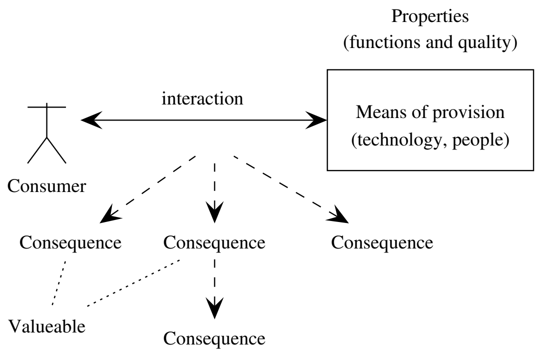


Figure 1. Properties, interactions made possible by them and consequences of those interaction.

ward ways of talking about services and how they are composed, we will sometimes refer to the functions and quality properties that make up a service as the *parts* of a service.

A quality property can have a *value* that may satisfy or violate a *criterion*, as set by the consumer. For example, the property *Bandwidth* can have value *10 Kbps*, which violates the criterion *at least 90 Kbps*. We will call a number like 10 Kbps a *data value* of a property, to distinguish it from the *consumer value* of the property (how much it is worth for the consumer that the property has this data value). We call a (quality property, criterion) pair a *quality*. What suppliers offer in their catalogues are services with qualities, as in the bundle *VoIP* = {*Handle synchronous voice communication, bandwidth = 90 Kbps, latency = 50 ms*}, where *Handle synchronous voice communication* is shorthand for the functional properties of VoIP.

The functions in a service may have a hierarchical structure, i.e. the interactions of one function may be part of the interactions of a more complicated function. This gives us a tree structure of functions often called a function refinement tree [25]. Quality properties may be attached to any node in this tree and then apply to this function and all its sub functions. The internal structure of a service in terms of functions and sub functions does not affect the matching process described in this paper and in what follows we abstract from it.

Supplier-side bundling. Bundling may involve more than one supplier if this is technically feasible and commercially desirable. For example, for KPN, we assume for the sake of the example that is not technically feasible to sell a VoIP service without the IP access service of KPN itself. XS4All on the other hand sells a VoIP service that can be used with an Internet access service provided by another supplier.

In general, qualities cannot be unbundled from the functions they are properties of, e.g. it is not possible to sell *bandwidth = 90 Kbps* without selling the function that this quality is a property of. However, in some cases, quality properties may be unbundled and provided by another supplier, such as anonymity. This can be the property of a service (e.g. the supplier does not know the identity of the consumer), but also a separate service (there exist anonymizers as separate services on the web). When this happens, the quality property is usually translated into a set of functions, i.e. useful interactions, in such a way that these functions can be supplied by another supplier.

Even when unbundling is technically feasible, a supplier may decide that this is not commercially desirable, if he believes that selling a service in a bundle will create more revenue. An example is triple play (Internet access bundled with VoIP, IP-TV, and IP-radio). This is known in economics as (mixed) bundling [7].

Technical and commercial reasons therefore motivate suppliers usually to put some constraints on possible bundles. Baida [2, pages 83–84] has identified a number of different kinds of supplier-side constraints, of which we here mention two, as they appear in our case study:

- S_1 has a *core/supporting* relationship with S_2 if S_1 cannot be provided (for technical or commercial reasons) without also providing S_2. The supporting service may be supplied by the same supplier as the supplier of the core service, or it may be supplied by another supplier. The core/supporting relationship is always asymmetric. This implies that a supporting service (e.g. Internet access) for a core service (e.g. VoIP) can be also be obtained in its own right, but not vice versa.

- S_1 *excludes* S_2 if the supplier of S_1 prevents the consumer to consume S_2, for example because S_2 is offered by a competitor, or because joint consumption is legally prohibited. The excludes relationship is always asymmetric.

Properties revisited: Avoiding Babel A property such as bandwidth may be called speed by a consumer, and the consumer may *no*t understand this property in the same way as the supplier. Even if the supplier uses the language of the consumer and refers to bandwidth as "speed" then this need not means the same as what the consumer understands by it.

Similarly, where a supplier applies the criterion *at least 4 Mbps* to the property *bandwidth*, the consumer may apply the criterion *fast enough to listen to music* to the property *speed*, and these criteria may not mean the same at all. In what follows we simplify by assuming that properties and criteria have the same meaning, and are described in the same language, by all suppliers and consumers. In future work we intend to lift this simplifying assumption.

Consequences and consumer values. Services are rarely valuable by themselves but are valuable for their consequences. For example, a VoIP service is valuable because it allows the consumer to talk to someone located elsewhere (the consequence). Applying the laddering theory developed by marketing [15, 22], our matching approach searches for consumer values that can be achieved by the consequences of service consumption. We then identify the service properties (functions or qualities) that make these consequences possible, and call these properties *benefits.* For the consumer it is also important to learn about consequences that are of negative value, such as background noise or delays. Service properties that lead to these negative consequences are *nuisances.* The consumer wants to find a bundle of properties that maximizes benefits and minimizes nuisances.

Note that the occurrence of consequences depends on the consumer and her context. For example, the consumer must be able to understand the data, hear the music, etc. and the context of consumption must provide enough paper, enough light, no background noise etc. to print the data, hear the music, etc. Consumer value too depends on the consumer and her context: What is valuable to one consumer is not so for another consumer, and what is valuable to a consumer in one context (listening to music at home) is not so in another (in the office). Our reasoning from consequences back to properties therefore has a similar structure as the reference model of RE [14]: In consumer context C we search for a bundle S of properties such that consumer value V is realized.

To determine whether consequences are valuable for a consumer we use the qualitative framework for consumer value of Holbrook [16]. The framework classifies consumer value along three binary dimensions, which yields eight different kinds of consumer value. We mention a few to explain the difference between our approach and goal-oriented RE: A service has *efficiency value* if it allows the consumer to achieve a goal. For example, a ticket booking service allows a consumer to obtain the right to be transported. A service has *quality value* if the consumer appreciates it for its own quality properties, such as a well-designed user interface or a reliable weather forecasting service. A service has *fun value* if it creates a fun experience for the consumer, such a playing a game; and it has *aesthetic value* if creates an aesthetic experience in the user, such as on-line music. The distinction between these last two is that the creating of fun value requires activity of the consumer whereas in the creating of aesthetic value does not.

Consumer needs, wants and demands. Borrowing some more terminology from marketing, we start our matching process starts with a (problem, solution) pair consisting of a consumer need and a consumer want. A *consumer need* is a consumer's desire to realize a consumer value, and a *consumer want* is an indication of the kind of service that the consumer thinks would partially meet this, without having a specific supplier in mind already [1, 19]. For example, an initial (need, want) pair offered by a consumer to an e-business consultant could be *(need: to communicate directly with remote people, want: VoIP)*. A need can result in a set of wants (in case each want satisfies the need only partially).

The next step in the matching process is to elaborate this into a (consumer need, consumer demand) pair in which a *consumer demand* represents the willingness of a consumer to buy a service (or a bundle of these) offered by specific suppliers, of which the consumer supposes that service(s) satisfies his need. The difference between a consumer want and a consumer demand is the difference between a vague solution idea and concrete solution offered by a supplier, as available on a market [4].

Consumer wants and demands cannot be found in a consumer catalogue, which contains only services that can be bought. Rather, they have to be elaborated for each particular consumer need by the consumer, salesperson or other kind of intermediary, based on the available supplier service catalogues and information elicited from the consumer. During this elaboration, additional constraints on service bundling may be encountered, this time motivated by what is technically feasible for the consumer or what is valuable for the consumer. The constraints apply to desired consequences. We have encountered four such consumer-side consequence relationships so far.

- Consequence C_2 has a *core/enhancing* relationship with consequence C_1 if it adds consumer value to C_1 and can be satisfied by a service that is offered as an optional feature of a more basic service, and which cannot be delivered independently from this basic service. For example, for one consumer, the ability to keep her current telephone number has a core/enhancing relationship with the ability to hear and speak at a remote distance; but for another consumer it may not have this relationship. In general, the enhancing feature may or may not be delivered by another supplier.

- Consequence C_1 has an *optional bundling* relationship with consequence C_2 if both consequences add consumer value to each other. The optional bundling relationship is always symmetric.

- Consequence C_1 may *exclude* consequence C_2 if desiring C_1 implies not desiring C_2. For example, if a consumer desires normal audibility of a conversation, she does not at the same time desire excellent audibility of this same conversation.

- Consequence C_1 *depends* on consequence C_2 if C_1 can only exist if C_2 exists, e.g. because C_1 is an attribute of C_2.

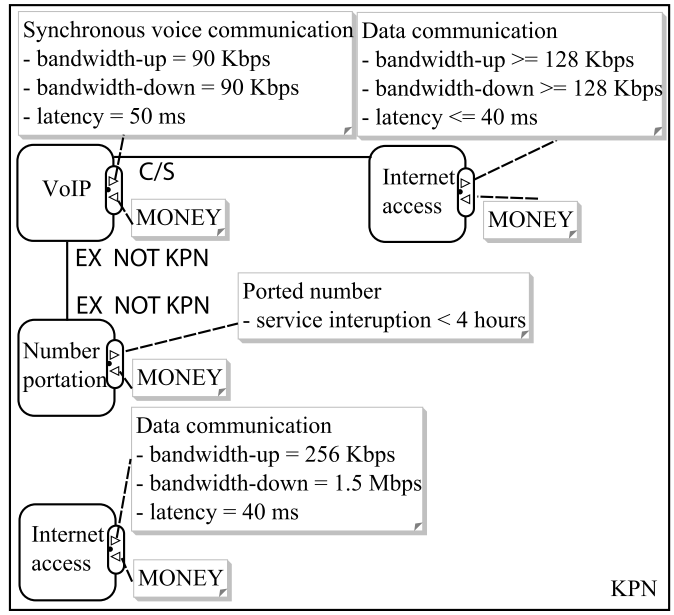
4. Service catalogues

A service catalogue of a supplier must describe which services are offered by the supplier, which functions and qualities are part of each service, how the service can be bundled with other services of the same or of other suppliers, and what the supplier-side bundling constraints are. To express this information, we use the e^3-*value* notation [13] and describe service catalogue entries as e^3-*value* fragments. This has also the advantage that we can represent what has to be offered in return for obtaining the service, usually money.

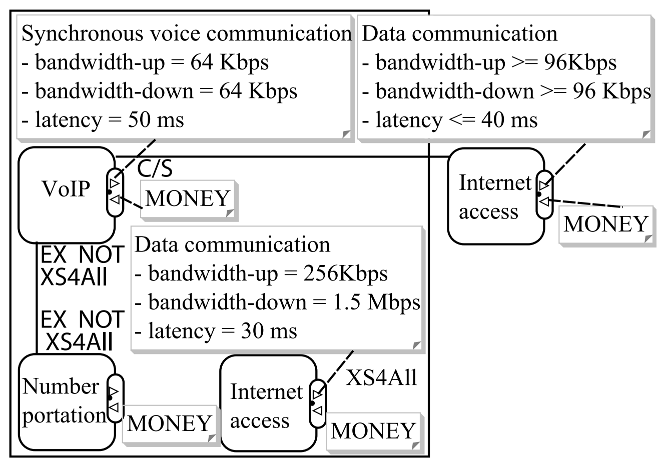
Figure 2 shows three partial catalogues. A supplier is an economic actor, represented by a rectangle with sharp corners in the e^3-*value* notation. We abstract from the means of service provision and merely represent service provision activities, represented in e^3-*value* as *value activities* by rectangles with rounded corners. Placement of a service provision activity inside a supplier rectangle means that this activity is performed by this supplier. For example, in the Skype catalogue entry of figure 2, *VoIP* is a service provision activity performed by Skype but *Internet access* is provided by an unstated supplier. Each service provision activity has a *value interface,* represented by an oval, through which the service is offered and through which something valuable is accepted in return. A value interface expresses atomicity: If it produces outcomes, it also accepts income. An e^3-*value* activity expresses no control, i.e. it does not show when events occur nor how they are triggered. It merely expresses that some economic transactions take place.

The service offered by a value activity consists of functions and qualities, which we show in a service catalogue entry by annotating the (outgoing) service arrow in a service interface with the functions and their qualities. One service may contain any number of functions and one function may have any number of qualities. As pointed out earlier, functions may have a hierarchical structure and qualities may be attached to any level in this tree. In our example, we abstract from this and do not decompose the functionality of services into more detailed functions.

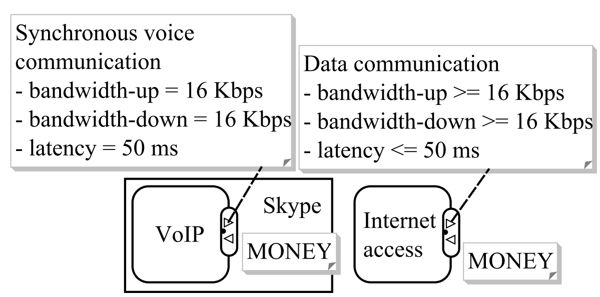
By representing service catalogue entries as e^3-*value* fragments, the matching process consists of constructing an e^3-*value* model from the value model fragments available in service catalogues, guided by the consumer need. From



(a) KPN



(b) XS4All



(c) Skype

Figure 2. Partial service catalogues of three suppliers

the supplier point of view, this construction is subject to supplier-side bundling constraints. These are represented in our catalogue entries by binary relationships on service provision activities. For example, in the KPN catalogue entry, *VoIP* has a core/supporting (C/S) relationship with *Internet access* by KPN. We now describe the three entries in more detail.

Figure 2(a) shows that KPN has a VoIP service, that provides synchronous voice communication functionality. The functionality of *synchronous voice communication* means that the VoIP service is capable of handling incoming and outcoming phone calls, to and from other telephone networks, such as POTS and GSM. The voice stream has a bandwidth of 90 Kbps, and has a latency of 50 ms. We assume that these numbers indicate the sound quality of the voice service.

The VoIP service does *not* provide data communication functionality by itself. This must be obtained and paid for by the consumer separately and for the sake of the example, we assume that the consumer has to buy a specific Internet access service from KNP too (e.g. due to technical constraints, see figure 2(a)). This is represented by the C/S relationship from *VoIP* to *Internet access*. This required Internet access service has also a bandwidth and latency, which should be chosen such that the Internet access can be used as a data transport service for the VoIP service.

The C/S relation is asymmetric (from VoIP to Internet access), because the Internet access service can be sold separately too. There is also an additional Internet access service, which targets consumers with high-bandwidth needs, and is offered as a stand-alone service.

KPN also offers a Number portation service. This service ensures that if a consumer obtains a VoIP service, a consumer keeps his existing phone number. Again, due to supplier-side technical considerations (and therefore not consumer-value considerations), the Number portation service works only with the KPN VoIP service (or other KPN voice services), but can not be used with services from other enterprises. Therefore, all bundles of VoIP and Number portation are excluded, except if the Number portation service is offered by KPN itself. Note that there is no C/S relationship between VoIP and Number portation, as VoIP can also be obtained without Number portation.

XS4All has a different service catalogue. First, the VoIP service itself has different qualities. But most importantly, XS4All offers its VoIP service in a core/supporting relationship with Internet access provided by any other supplier, provided that this Internet access satisfies certain quality criteria as listed in the catalogue entry: bandwidth-up at least 96 Kbps, bandwidth-down at least 96 Kbps etc. One particular instance of Internet access that the consumer could buy is the access provided by XS4All itself, and this satisfies the stated criteria. XS4All also offers a Number portation service that can be bought separately, and as with KPN, the Number portation service works only with the XS4All VoIP service, but can not be used with services from other enterprises. Therefore, all bundles of VoIP and Number portation are excluded, except if the Number portation service is offered by XS4All itself.

Finally, the Skype service catalogue is similar to the XS4All service catalogue, but lacks the Number portation service.

In general, each value activity provides a service that a consumer can buy independently from any other service, provided that the bundling constraints are satisfied. Each value activity is therefore priced separately (by the incoming money flow of a service). The price for the eventual service bundle will be composed from the prices of each of the component services of the bundle. Using various kinds of pricing schemes [12], a supplier can offer attractive prices for a service bundle, compared to single services.

5. Matching needs with services

Matching takes place in a three-step process, in which first desired consequences are collected based on consumer value, next services are selected based on their ability to produce these consequences, and finally bundling constraints are applied to construct service bundles that can actually be provided by suppliers. The first step requires considerable interaction between the intermediary and the consumer. The steps are:

1. Elaborate desired consequences.
    - Identify consumer wants, considering consumer-side consequence relationships.
    - Identify desired consequences that motivate these wants, considering consumer-side consequence relationships.
    - Prioritize consequences.
    - Elaborate wants, considering consumer values and consumer-side consequence relationships.
2. Identify benefits and the services that contain them.
3. Construct service bundles (considering supplier constraints).

The matching process for our running example is shown in figure 3. An experienced salesperson will have knowledge of a generic version of this tree, and build a particular instance of this tree for each consumer need. Automating the matching process, which we do in future research, contains the challenge of formalizing a generic version of this tree.

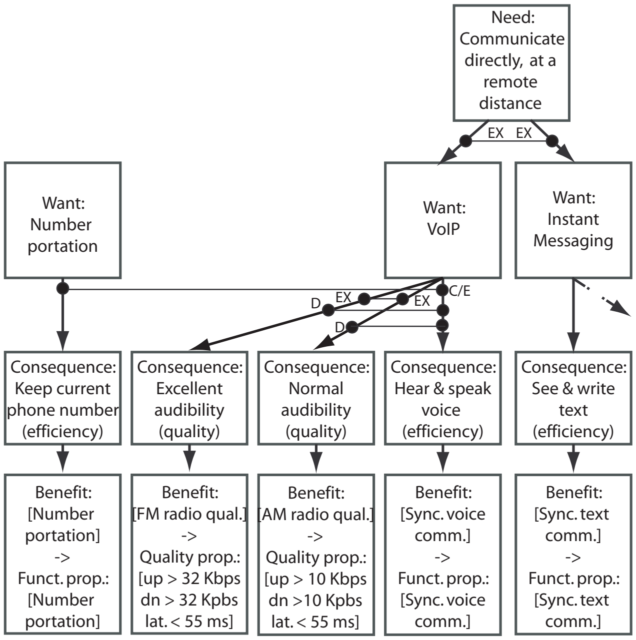


Figure 3. Reasoning process for matching consumer needs with available services.

5.1 Elaborate desired consequences

Identify wants. The matching process starts from one or more (consumer need, consumer want) pairs. For example, a consumer who has the need to communicate with someone else directly, but who is at a remote distance, may consider VoIP or Instant messaging as possible solutions(figure 3). The consumer is aware of desired consequences of each of these wants and based on these consequences, she wants only one of these solutions, but has not yet decided which. The exclusion relationship between consequences has therefore been lifted to consumer wants (figure 3). This particular consumer wants either VoIP or Instant Messaging but not both. The consumer wants are identified based on a basic knowledge of what kinds of services are on the market without applying detailed knowledge about who delivers what services, with which functionality and what quality attributes, and in which bundles.

Identify desired consequences that motivate the wants. To find out what services a consumer needs, we must know the consequences that this consumer wants to achieve. We therefore elaborate these desired consequences, using Holbrook's consumer value theory as explained earlier [16]. Some consequences of a want exclude each other, such as two different audio quality levels; and these two depend on the consequence *hear and speak voice*. Note that the intermediary discusses the desirable consequences rather than the functional and quality properties of services, because we need to understand the consumer values before understanding what services could realize these values. Note that in the running example the consequences realize Holbrook's efficiency and quality values. When we look for suitable services, these will be mapped to functions and qualities of services, respectively. We expect a less straightforward relationship when we consider consumer values like fun and beauty: These may be realized by both functions and qualities of services.

Prioritize consequences. The consumer is then asked to assign a priority to each consequence. We describe this process in detail elsewhere [11]. In brief, the prioritization mechanism is similar to the MoSCoW-list [3] as used in software engineering. First, all wants that do not result in must-have consequences are removed. The remaining wants are ranked using the number of should-have consequences. and if two or more wants have an equal number of should-have consequences, the number of could-have consequences determines priority. After prioritization, we are in a position to zoom in on consequences with high priority only.

Elaborate wants. The core/enhancing and exclusion relationships between consequences allow the intermediary to prune and elaborate the consumer wants and consequences. In our running example, for the same want, *Excellent audibility* and *Normal audibility* are mutually exclusive and the consumer must be asked to select a preference.

The next step is to find additional wants the consumer may have, given the want he has articulated so far. The typical question to ask is "if you want X, you perhaps want Y too". In the running example, *Number portation* is an enhancing want, i.e. for this consumer the consequences of number portation enhance those of VoIP.

Our running example does not contain an instance of optional bundling, but a hypothetical instance for VoIP would be a flight to the person who is far away. Such a want corresponds to a different need (to communicate directly, but not in a remote distance situation). Attempting to sell it to this consumer is an example of cross-selling of a solution to a different but related need that the consumer currently may or may not have.

The reasoning to find additional desirable consequences proceeds by kind of consumer value. For example, because the consumer has the efficiency value *Hear & speak voice*, the intermediary asks whether she is also interested in another efficiency value, namely to keep her current phone number. That in turn may lead the consumer to want Number portation.

Table 1. Wants and consequences

Want	Consequences
VoIP	Hear & speak voice, Excellent audibility
Number portation	Keep current phone number

Having elaborated the set of desirable consequences for this consumer, we must prioritize the elaborated set too, using the MoSCoW approach explained before. For the sake of the example we assume that this leads to the desired set of wants and consequences listed in table 1.

5.2 Identify benefits and the services that contain them

We now consult the service catalogues to find services that can realize the desired consumer consequences. As pointed out earlier, there is a usually a semantic gap between functions properties and qualities listed in the service catalogues on the one hand, and the consequences (in terms of economic value) the consumer is looking for on the other hand.

The gap is closed by someone who understands how service properties can create consumer consequences. As indicated earlier, if property P causes consequence C in the consumer environment, then if C is desired by the consumer, P is called a benefit. The intermediary therefore searches through the service catalogs for services with desired benefits P. A service of a particular supplier that contains P is then by definition a consumer demand.

In our examples so far, we have found the following.

- Efficiency consumer values map to desired functionality. For example, the efficiency value *Hear & speak voice* maps to the desired benefit *Synchronous voice communication*, which matches with the functional service property *Synchronous voice communication*.

- Quality consumer values map to service qualities. For instance, the quality value *Excellent audibility* imposes certain criteria on certain bandwidth and latency (desired benefits) and these can match with qualities of services.

We foresee that bridging the semantic gap between desirable consequences and provided service properties can be a business in its own right, as it requires knowledge how to translate subjective consumer values (Excellent audibility) into technical requirements (required bandwidth and latency). In fact, this task is usually done by a sales person.

Let us assume for the sake of the example that we have identified the demands listed in table 2. The VoIP service from Skype is not a demand of this consumer, because this service can not realize the required consequence Excellence audibility.

Table 2. Wants and selected demand

Want	Demand
VoIP	KPN: VoIP XS4All: VOIP
Number portation	KPN: Number portation XS4ALL: Number portation

Table 3. Service bundles

Bundles
[KPN: VoIP, KPN: Number port., KPN: Internet access]
[XS4All: VoIP, XS4All: Number port., KPN: Internet access]
[XS4All: VoIP, XS4All: Number port., XS4All: Internet access]

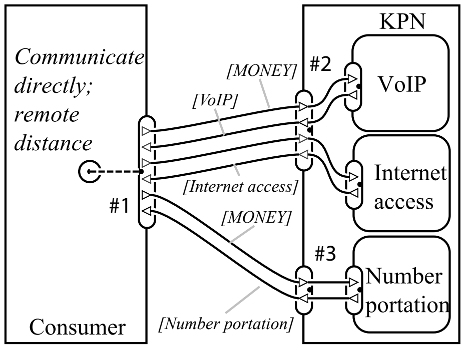
5.3 Construct service bundles

We should now apply supplier-side bundling constraints as listed in the service catalogues, in order to come up with service bundles that suppliers can actually deliver. The service catalogues tell us that VoIP requires Internet access, from the same supplier in the case of KPN, and from an arbitrary supplier that provides sufficient quality in the case of XS4All. The catalogues also tell us that number portation, which our consumer wants, always is bundled with VoIP from the same supplier as the supplier of number portation. This is a technical constraint imposed by suppliers and is not motivated by consumer values; the analysis in figure 3 shows that the consumer is not concerned with who provides number portation.

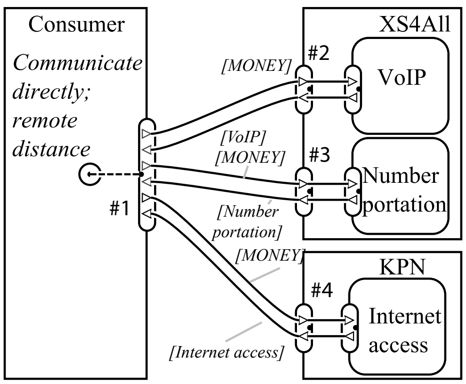
This resulting service bundles are listed in table 3. The service catalogues now allow us to assemble the selected services into e^3*-value* models. We have done this for the first two bundles.

Figure 4(a) represents the bundle *[KPN: VoIP, KPN: Number portation, KPN: Internet access]*. In e^3*-value* the consumer's value interface (annotated #1) models *consumer-side* bundling: To satisfy the consumer need *Communicate directly at a remote distance* (shown in e^3-*value* as a bulls eye), a bundle of services should be obtained, namely *[VoIP, Number portation, Internet access]*. This same bundle is also required by the consumer in figure 4(b), but suppliers bundle their services differently to deliver this service.

In figure 4(a) KPN offers all three requested services in two bundles, namely *[KPN: VoIP, KPN: Internet access]* as one bundle (interface #2). and *KPN: Number portation]* as another (interface #3). The number portation service is in a separate value interface because from the supplier point of view this service is an addition to the bundle *[KPN: VoIP,*



(a) Bundle 1: KPN delivers all services.



(b) Bundle 2: VoIP from XS4All, Internet access from KPN.

Figure 4. Two supplier-side service bundles.

KPN: Internet access] bundle. In other words, this bundle can be supplied without Number portation.

Figure 4(b) shows that from XS4All's perspective, VoIP and Internet access can be obtained independently from each other, as these services are in separate value interfaces.

Having constructed e^3*-value* models, we can do the standard commercial sustainability assessment of value networks that is offered by e^3*-value* [13] to analyze whether the service provisioning is sustainable for the enterprises. This introduces a final decision making process for the supplier network as well as for the consumer: The suppliers must assess whether they can earn money by participating in this service provision, but the consumer will assess whether she prefers one bundle over another based on price. From the consumer point of view, the bundles in table 3 are ordered according to (1) the desired functionality and (2) the influence of pricing upon desired functionality. In short, we take pricing into account by presenting the consumer with the prices of the service bundles generated according to the MoSCoW-prioritization method described in section 5.1. The basic idea here is that the consumer might change the priority assigned to desires, based upon what s/he has to give up for satisfaction of the desire.

6. Discussion and Further Work

Our proposed catalogue structuring and consumer need matching process offers a solution to the problems noted in the introduction, namely for a supplier to find out how its technical capabilities translate into marketable services, and how to match these to a given individual consumer need, and for a consumer to find out which service bundles are available and which of these can help her to achieve her desires.

The resulting value networks can be quite simple, as in our running example, but our earlier work has shown that they can be more complex, with multi-supplier bundling, supplier partnerships, and service components delivered by subcontractors [13].

Our matching approach is an example of problem framing because it frames the consumer need in terms of a certain solution idea (a consumer want). Problem frames have been proposed by Jackson [18] as a problem structuring technique, but they have been known for some time in empirical research of design cognition, where it appeared that designers frame a design problem in terms of possible solutions [8, 9]. Experienced professionals routinely use problem framing in their practice [23]. This contrasts with Simon's problem-solving approach [24] in which problem-solvers search for a path from problem to solution without initially being aware of a solution.

We have used our approach to help KPN structure their e-service catalogue. This provides an initial proof-of-concept of our solution, but further work is needed to provide more validation. We plan to do more action research with the business partners of the VITAL project [1] to establish the feasibility of this approach to structure service catalogues, and to do dry runs on example consumer needs provided to us by our business partners.

We have not yet investigated the possibility to apply optimization of the resulting value network to various criteria, e.g. commercial sustainability for suppliers or achievable value for the consumer. The e^3*-value* technique makes available standard net present value computations to estimate sustainability, but we need more work to adapt this to the situation where value networks are configured on a per-need basis, as we do in this paper.

The restriction to e-services has not played an important role in this paper and one intriguing question is therefore whether our approach is generalizable to services in general, or even to services and goods. However, even if our approach turns out to be generalizable we expect there to be a restriction to generalizability from a different source: Constructing a need-to-desired-benefits tree such as in figure 3 requires considerable domain knowledge. Any competent salesperson does this. A consumer needs tree con-

[1] http://www.vital-project.org/

structed by a car salesperson will be quite different from a tree constructed by a refrigerator salesperson.

This brings us back to the semantic gap between consumer values and desired service benefits. If we are to provide automated decision support for the matching process, we need to formalize the ability to construct a consumer need tree such as in figure 3, and this requires crossing this gap, which involves significant domain knowledge. We intend to investigate this in future work.

Additional topics for further research crop up when we ask how to operationalize a service bundle, once found. In order to provide the service bundle to a particular consumer, operational details such as help desk and billing must be decided. These operational aspects could be added as additional services to be bundled with the ones already selected, but this surely will affect the price and commercial sustainability of the bundle, so prioritization and commercial sustainability analysis will be affected by this.

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