e-Services in a Networked World: From Semantics to Pragmatics

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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. Typically, e-services are offered as bundles consisting of more elementary services, offered by different suppliers, forming a network. This allows for best-of-breed solutions, in which the customer selects the best services from different suppliers to satisfy his need, and in which the supplier can focus on his core-competences. The research question is then how to compose such a multi-supplier service bundle. In this paper, we argue that first understanding of the context of the service is important. We propose a framework of ontologies, called e^3*family* , which can be used to reason about the contextual socio-economical aspects of e-services. This framework can be used to elicit customer's need, to compose service bundles satisfying such a need, and to reason about profitability of the found service provisioning network. We illustrate e^3*family* by presenting two of its core-ontologies: e^3*value* and e^3*service* .

1 Introduction

Today's economy, is a service economy, and an increasing number of services is electronic, i.e. can be ordered and provisioned online. As an example consider an Internet Service Provider (ISP). An ISP satisfies the customer need of 'communication at a remote distance' via a variety of alternative services. Core services include raw bandwidth, IP connectivity, and Domain Name resolution. Additional services may be offered, such as an email box, a chat box, Voice over IP (VoIP), or Instant Messaging (IM).

Although many customers deal with just one ISP for all their Internet-related services, this is not strictly necessary. The mentioned ISP services can *all* be provided in their own right, and so by different suppliers. For example, the customer may obtain raw bandwidth from supplier S_1, IP connectivity and Domain Name resolution from supplier S_2, and an email box from yet another supplier. Actually, *partnership*, being cooperating suppliers who jointly offer something of value to the customer which they never could have done alone, is frequently seen in eCommerce settings [27]. Partnering enables suppliers to satisfy complex customer needs, and allows customers to obtains a bundle of services which more closely satisfy customer's need, as compared to a single supplier bundle.

The online nature of e-services requires online ordering by the customer, and online provisioning of those services. Therefore, ordering and provisioning processes should be facilitated by computational support as good as possible. Note that traditional services, such a hair cut, or cleaning of a hotel room, do not have this online characteristic. Envisioned computational support is first about need/want/demand reasoning. Such reasoning aims at understanding the customer, ultimately in terms of desired positive and negative consequences by that same customer. Second, reasoning should be able to *configure* a bundle of services that satisfices these consequences. The bundle consists of elementary services, each of which can be provided by different suppliers. And third, reasoning has also a supplier perspective. For instance, a single supplier may decide for commercial or technical reasons, to offer a bundle of services only in combination, and not as separate units. A large Dutch telecommunication provider offers VoIP only in combination with raw bandwidth, whereas other providers do just the opposite.

In this paper, we argue that ontologies for e-services should focus on the perceived economic value and desired consequences of those services for the customer, the potential profit for the service supplier, and the ability to match desired consequences with available services in the market in the first place. In other words: the *pragmatics* of the service, in terms of customer goals enabled, and positive and negative consequences for the customer is important, in addition to goal satisfaction of the suppliers (usually profitability).

In the past few years, we have developed a series of ontologies, called e^3*family* to reason about service pragmatics. These ontologies are used during business development of e-service offerings, but are also used to compose multi-supplier service offerings online. In section 2 we will overview the e^3*family* ontology suite. Then, in section 3, we focus on the two ontologies of e^3*value* most relevant for e-services, namely e^3*value* and e^3*service* . The e^3*value* ontology is intended to model networks of enterprises, jointly offering services. Its main purpose is to support business development processes, so before business starts running. The e^3*service* ontology allows online elicitation of consumer needs and desired positive and negative consequences. Furthermore, e^3*service* can be used to match these customer oriented catalogs with available services, and finally allows to reason about possible service bundles from a supplier perspective. This paper ends with a discussion section.

2 The e^3*family* ontologies for modeling and reasoning about context

In the recent past, many approaches for understanding semantics of web-services such as WSMO [25], WSDL [6], BPSS [9], BPEL4WS [2], WSCI [3], and WS-Coordination [7] have seen the light. Obviously, these approaches are important to arrive at composition, orchestration, and monitoring of web-services in complex settings. We argue however for e-services, being commercial services which can be ordered and provisioned online, understanding of pragmatics of services is also needed. To that end, we have developed e^3*family* (see figure 1).

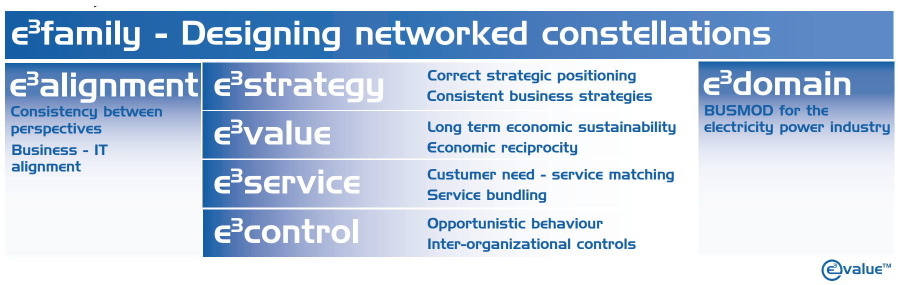

Fig. 1. The e^3*family* ontologies

Understanding of the pragmatics of e-services is about understanding the context of these e-services. This means that we are primarily interested *how* e-services contribute to reaching goals by parties, being customers or suppliers. In the field of Requirements Engineering, a significant amount of work has been done on goal modeling (see e.g. $I*$/Tropos [28, 8] and KOAS [19]) in general. Our ontologies allow reasoning about goals also, but more specifically related to e-services.

e^{3}value . The e^3*value* ontology [12] is one of the key ontologies in e^3*family* and represents a network of enterprises producing and consuming objects of economic value. The instantiation of the ontology can be represented as a graphical model, allowing for easy communication during workshops with executives.

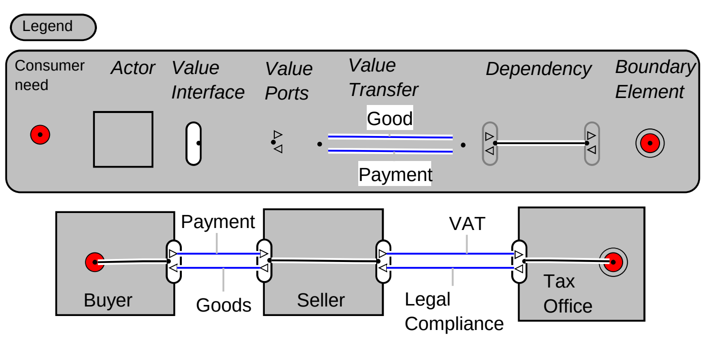

Fig. 2. An educational e^3*value* model

Figure 2 shows an educational e^3*value* model. The model states that the buyer (an actor) has a consumer need (bullet eye), and in order to satisfy this need, the buyer has to obtain an object of economic value (here: a good) for a seller (also an actor). However, the buyer has to pay for the good. In e^3*value* , the payment is considered as a reciprocal value object for the good; furthermore it is assumed that if the good is provided the payment always will be done, and vice versa. In other words: e^3*value* assumes an ideal world, in which all parties provide a reciprocal object (e.g. money) if they obtain another object (e.g. a good). Reciprocity is represented by the value interface, the rounded rectangle superimposed on the actors. Value interfaces include value ports, which provide or request value objects from their environment. Value ports are connected via value transfers. The seller, providing the good, has to pay Value Added Taxes (VAT) to the tax authority, to obtain legal compliance. This is modeled by connecting the two value interfaces of the supplier by means of a dependency path.

In the realm of services, we consider e-services as a kind of value objects. The ontology can be used to reason about profitability for the enterprises involved, or to reason about the economic utility of final customers. It is our claim that for a successful e-service network, *all* enterprises in the network should be economically sustainable. The e^3*value* ontology comes with software tool support for graphical modeling and model analysis such as profitability assessment and sensitivity analysis (see http://www.e3value.com/ and section 3).

e^{3}control . The e^3*value* ontology supposes an ideal world, meaning that economic reciprocity is always maintained. This assumption is convenient for the development of business models for e-services, as the main concern is first and foremost commercial viability of all the actors in the network. The notion of economic reciprocity relates to the idea of 'one good turn deserves another'; if an actor provides an object of value to its environment, it request an object of value in return, which at least has the same economic value to the actor as the provided object.

As soon as the e^3*value* model is agreed upon by the stakeholders, it is time to relax the constraint of economic reciprocity. We then assume that the world is not ideal anymore, meaning that some actors may obtain objects from their environment, and do not provide the reciprocal object in return. Such behavior is considered as fraudulent behavior. The e^3*control* ontology allows to model such ideal behavior, by relaxing the reciprocity constraint.

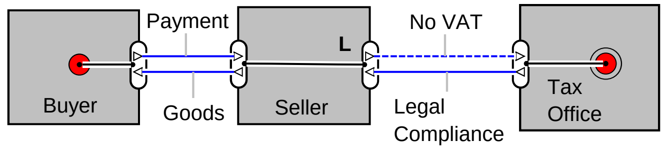

Fig. 3. An educational e^3*control* model

In figure 3 a sub ideal situation is modeled for the ideal e^3*value* model in figure 2. The dashed value transfer indicates that the seller does not pay taxes, which considered as sub ideal. We have experienced in case studies [17] that analysis of ideal e^3*value* models for sub ideality is often a first step towards the design of business processes between the actors in the network, as many solutions to avoid sub ideal behavior have a foundation in sound business processes. However, in the same case studies, we have found also solutions that are on the level of the e^3*value* model itself; as penalties and rewards can be used to reduce sub ideal behavior. To reason about solutions for sub ideal behavior, the e^3*control* ontology proposes a series of patterns, which are grounded in inter-organizational auditing and control [17].

e^{3}strategy . An e^3*value* model can also be used to reason about the strategic positioning of each actor in a service network. The e^3*strategy* ontology extends the e^3*value* ontology by modeling strategic motivations of actors that stem from environmental forces. The e^3*strategy* ontology models various forces between actors, based on the theory of Porter. Porter distinguishes five kinds of forces [16, 23, 24]: *bargaining power of suppliers*, *bargaining power of buyers*, *competitive rivalry among competitors*, *threat of new entrants* and *threat of substitutions*. Questionnaires are used to determine the strength of these forces, as exercised by actors on a focus actor. Understanding of these forces can drive redesign of the corresponding e^3*value* model, e.g. in terms of alternative partners, different services to be sold, of different customer groups.

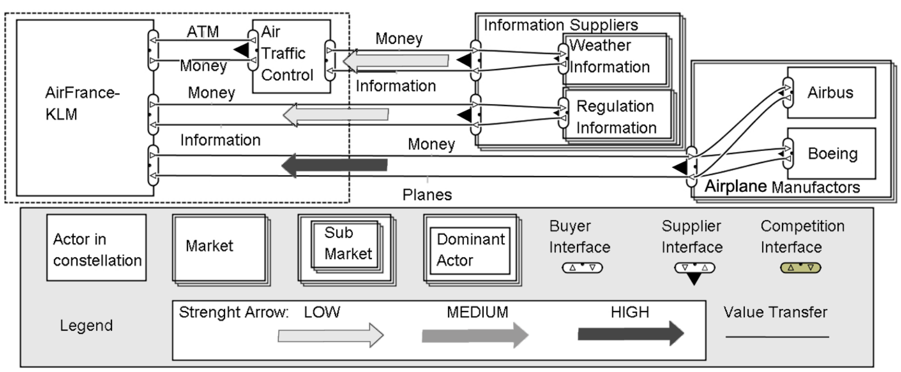

Fig. 4. A partly e^3*strategy* model

Figure 4 shows a fragment of strategy analysis for the Dutch aviation industry. Here, the forces exercised by suppliers on AirFrance-KLM are shown (by the arrows) and analyzed (see also [21]).

e^{3}domain . The ontologies which are part of the e^3*family* series are generic in the sense that the ontologies do not include knowledge about a specific industry.

We have experienced that, to enable the use of the ontologies for practitioners, at least industry specific guidelines on the use of the ontologies are needed, and also model fragments of their specific industry are convenient to increase re-use. For one specific domain, namely the domain of renewable energy, we have developed a specialization of e^3*value* [11], called BUSMOD. BUSMOD contains guidelines, specifically for the field on renewable energy, on developing e^3*value* value models, and comes with an extensive library of model fragments that can be re-used.

e^{3}service . Whereas the e^3*value* ontology is used to represent and reason about networks of enterprises exchanging objects of value with each other in general, e^3*service* focuses on services, and specifically e-services. In e^3*service* , we understand services as in marketing; economic activities, deeds and performances of a mostly intangible nature [20, 14], but with a focus on those services that can be ordered and provisioned (nearly) online. The e^3*service* ontology consists of a few sub ontologies, of which the customer [18] and supplier [1] ontologies are the most important ones. The idea behind e^3*service* is that customers and suppliers express their service needs and service offerings in different ways, and in a different granularity. The customer states a need, with associated desired positive consequences, and also acceptable negative consequences (e.g. a price to be paid for service provisioning), for the instance a need to communicate with family living abroad. Suppliers usually list their services in catalogs, and each service in the catalog can be ordered as a separate commercial unit. Examples include Internet access, VoIP, and an email box. The e^3*service* ontology allows for expressing these two different perspectives on services, and also assists in bridging the customer and supplier perspective. For instance, the need to communicate with family abroad may be satisfied by the service bundle Internet access plus VoIP, or by the bundle Internet access plus email box. Usually, there is a mismatch between the set of consequences as desired by the customer, and the services available in the market that can realize the requested consequences. For a specific service, the set of consequences can be too broad or to narrow. The e^3*service* ontology can first elicit the desired consequences by employing various marketing techniques (e.g. laddering [4]), and thereafter can configure a minimum multi-supplier service bundle, satisfying the requested set of consequences.

e^{3}alignment . All the fore mentioned ontologies take different perspectives on the same artifact: the network of e-service customers and suppliers. Although these perspectives separate concerns of different stakeholder concerns, they need to be aligned while exploring and operating networks of e-services. Moreover, as each e-service relies on ICT, there should also be alignment with the technical solutions chosen to provision the e-service at hand.

To this end, we are developing e^3*alignment* , a framework to reason about the alignment of strategy, business value, cross-organization processes, and ICT [22]. In brief, the e^3*alignment* approach explores an e-service network by considering each perspective iteratively, and refining each perspective if problems or stakeholder concerns are found in other perspectives.

Discussion The ontologies in e^3*family* all have different concerns. The e^3*value* ontology is used to reason about long term sustainability for all actors in the e-service network. Opportunistic behavior of actors is addressed by e^3*control* . The e^3*strategy* ontology evaluates the strategic positioning of actors in a network of service providers and consumers. Customer needs, desired consequences by the customer, bridging these to available commercial e-services in the market, and configuring multi-supplier service bundles is the focus of e^3*service* . All the ontologies focus on the context, or pragmatics of the service; how does service provisioning contribute to the goal (need satisficing, increase of economic utility) of a customer, and how does service provisioning contribute to the goal (profitability) of the suppliers. Finally, the e^3*alignment* ontology assists in keeping consistent all e^3*family* models for a case at hand, as these models refer to same artifact being a network of service suppliers and customers, consuming and providing services. Also, e^3*alignment* is the bridge to ICT oriented perspectives, showing how services are provisioned in practice, by using software and hardware components.

3 Reasoning about e-service networks: The e^3*value* and e^3*service* ontologies

To show the e^3*value* and e^3*service* reasoning about e-service networks, we use a case study. The customer wants to communicate over a distance. There are various ways to accomplish this, including via email or Voice over IP (VoIP). An important, usually positively valued customer-consequence for email is that the text can be sent and received. For VoIP, the consequence is to hear and speak voice. The customer considers payment as a negative consequence. From a supplier perspective, there are many parties offering services that may satisfy the fore mentioned need (partly), including KPN (Internet access, email), Google (email) and CozyHost (customized domain). The latter is a service that allows the customer to use a customized domain name (e.g. his own name) for email addresses.

3.1 The service catalogs

Reasoning about configuration of e-service networks supposes first service catalogs of suppliers. Our catalogs focus on the economic value aspect of services, in terms of valuable consequences for the customer, and on opportunities to bundle services. Bundling is important because then a more complex customer need could also be satisfied by a supplier, which would otherwise not be possible and thus missed as a commercial opportunity. So, our catalogs differ significantly from catalogs as they are used in the field on web-services.

We assume that suppliers all use the same terminology and structure for expressing their catalogs. Based on these catalog, we generate all possible service bundles. Bundle generation can be done on before hand, or on-the-fly on a per

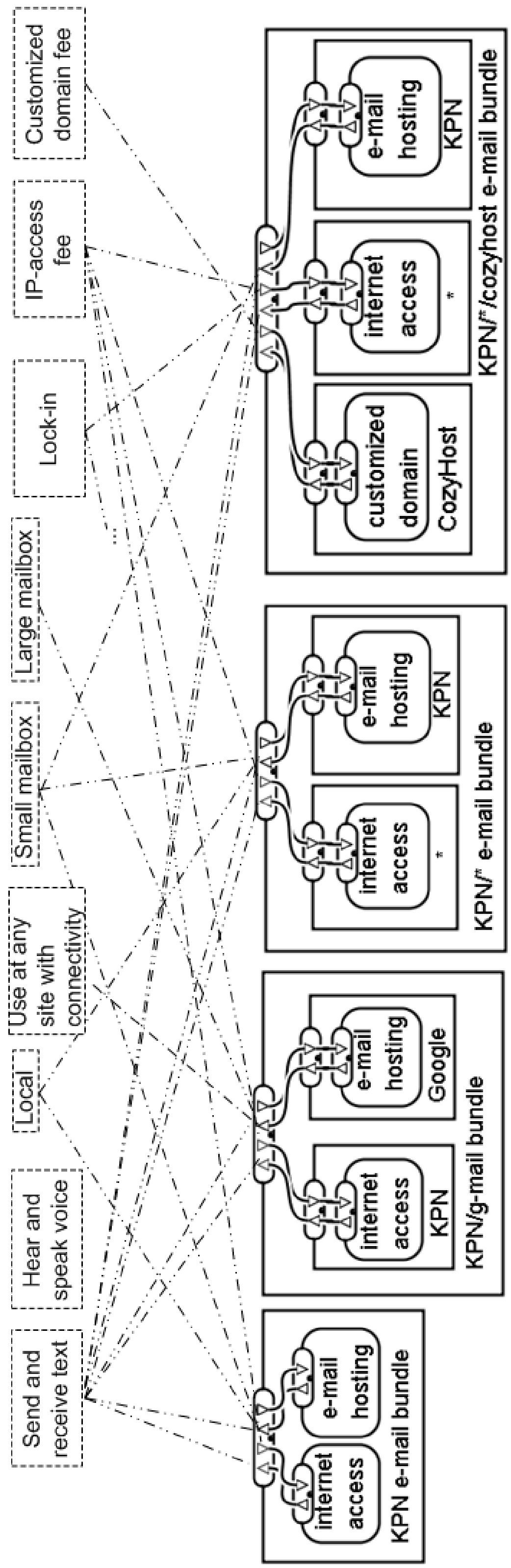

Fig. 5. Consumer catalog for e-mail example

need basis. A fragment of such a pre-generated multi supplier service bundle can be found in figure 5.

Figure 5 uses both constructs from the e^3*value* and e^3*service* ontologies. Services are seen as value activities that produce resources, such a a valuable service outcome, and require other resources (e.g. money). The resources are offered or requested via ports (graphically shown as arrows) to the environment. The notion of service interfaces (graphically shown as rounded rectangles) shows that if the incoming resources are transfered, the outgoing resources are transfered also, and vice vera. The e^3*value* ontology can represent partnerships; enterprises which jointly offering something of value to their environment. We use this feature to represent multi-supplier service bundles. For example, figure 5 shows that KPN and Google offer together a service bundle, consisting of internet access and email. The e^3*service* ontology adds the notion of consequences to resources offered or requested. For instance, email hosting of Google has the consequences 'send and receive text' and 'use at site with connectivity'. Furthermore, the e^3*service* ontology is capable of representing various kinds of constraints between elementary services. These constraints can be used to generate various multi-supplier services on before hand, or on-the-fly. As figure 5 shows the resulting bundles service only, the elementary services and their contraints are not visible (see [13] for more details).

3.2 Reasoning about customer needs and desired consequences

The reasoning about the customer need is summarized in figure 6. The customer start with a selecting a need from the catalog. Then the customer is presented with a series of wants and their consequences. A want is a (partial) solution for the problem indicated by the need. Therefore, the want corresponds to a service, without having a specific supplier in mind. Also, concrete properties (in case of Internet access for instance the bandwidth) are not filled yet. The presented wants should be seen as a bootstrap step to elicit other consequences, perhaps implied by related wants. It is reasonable to expect that the customer has already a notion of solution (want) for his need in mind; as often people are thinking in problem-solutions frames rather than just in problems.

Figure 8 shows a partial instantiation of the e^3*service* ontology, specifically the customer perspective of the ontology. The ontology itself is presented in figure 7. The need is to 'communicate over a distance'. There are two alternative wants: 'Email access', and 'VoIP'. Based on the selected wants, a first set of service bundles are generated.

The generated service bundles have consequences, which are presented to the customer. Consequences are expressed on a certain scale, for instance in case of an email size on an ordinal scale.

The customer then scores the presented consequences. This is a subjective process, as each customer has different preferences. Also, the customer decides whether consequences are perceived as positive or negative. The e^3*service* ontology only represents consequences themselves, and does say anything about their (positive or negative) value.

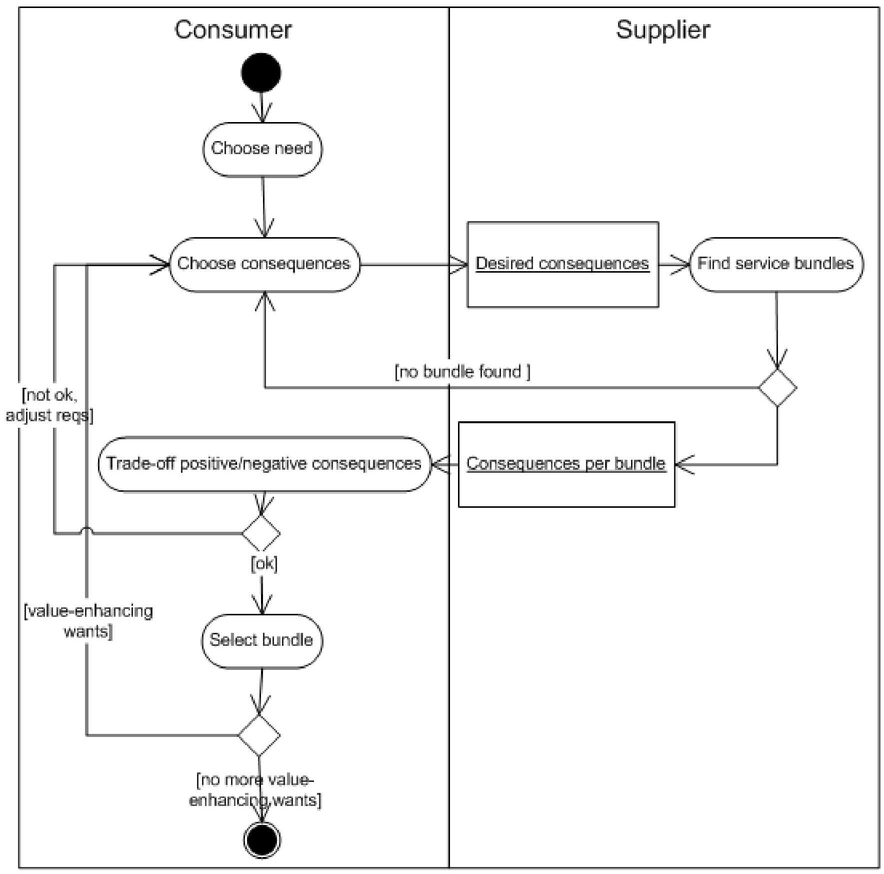

Fig. 6. The generic reasoning structure of e^3*service*

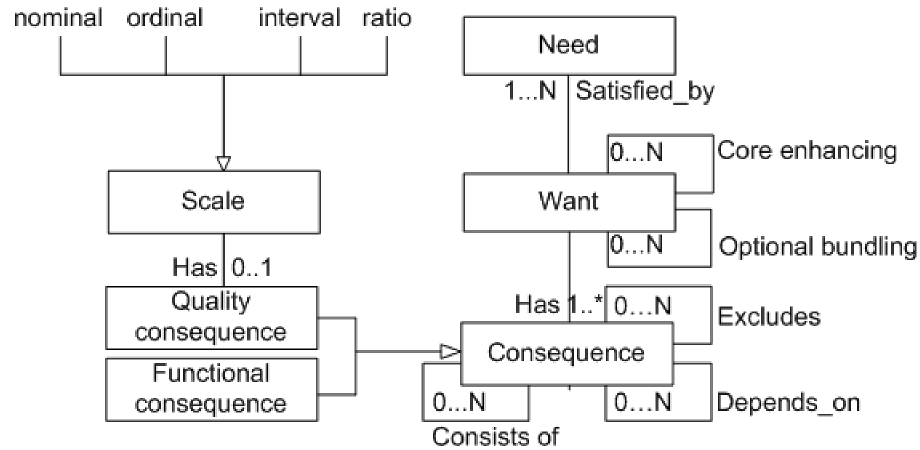

Fig. 7. The customer perspective of the e^3*service* ontology

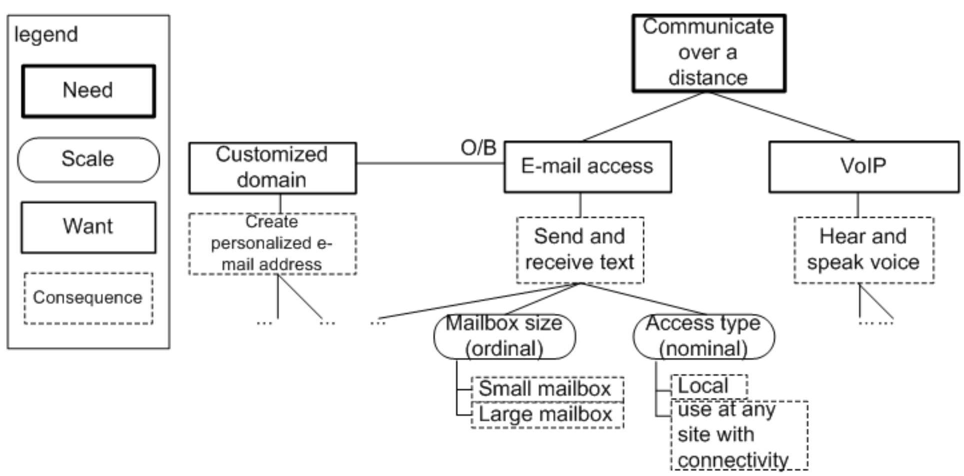

Fig. 8. Example instantiation of the e^3*service* ontology

It is possible that consequences result in other, more concrete consequences, and so on. The reasoning process elaborates such a series of consequences. This technique is in Marketing called 'laddering' [15].

Based on ranking methods, which are a combination of compensatory decision techniques from [10][5], and the non-compensatory decision techinque MoSCoW from DSDM[26], the customer then selects a set of desired consequences, initially a subset of the consequences of the consequences contained by the bundle. This set of consequences is then matched with the pre-generated multi-supplier service bundles as explained in section 3.1. Sometimes, the resulting services bundles contain fewer services than the initial proposal, and also different suppliers. In such a case, a better match between the desired consequences and the service bundles containing these is found.

These reasonings steps are repeated to find value-enhancing services and optional services. This refers to what in marketing is called up-selling and cross-selling. For instance, if an email box is selected as service, a value enhancing service could be a spam-filter. The e^3*service* ontology allows for such reasoning also.

During each iteration, the customer is asked to rank and prioritize the consequences. In other words, the process does not wait until the end before involving consequences. We have learned from our case studies that specifically negative valued consequences should be involved early in the process to discard many potential bundles, which are too expensive.

So, in sum, the reasoning process can be characterizes as as a series of bundle proposals, which are critiqued by the customer by ranking and prioritizing them, and the prioritization is used by the suppliers to come up with modified service bundles.

3.3 An e-service network

By ranking the consequences of the alternative service bundles, the customer selects a service that he orders and so should be provisioned. Figure 9 shows an example service network, as an e^3*value* model cf. the e^3*value* ontology. The standard reasoning techniques present in e^3*value* , such as profitability assessment can be used to analyze the network further.

4 Discussion and conclusion

We have presented in this paper a series of ontologies, all part of e^3*family* . The e^3*family* ontologies have in common that they all focus on the *pragmatics* and and the *context* of innovative IT, which can be offered as bundled e-services.

Concerning the context of e-services, the customers and suppliers are first class citizens. To find appropriate e-services for a specific customer, it is first important to understand the customer need more detailed. The e^3*service* ontology does precisely that; Needs are elaborated into desired consequences, which are prioritized. Reasoning steps are borrowed from marketing, and refer to laddering,

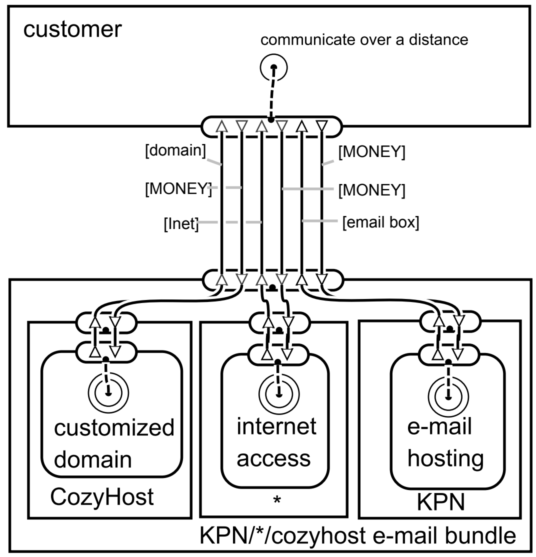

Fig. 9. Example service network

up-selling, and cross selling. Moreover, the reasoning is an interaction between customer and suppliers, in which the suppliers propose a solution, which is critiqued by the buyer, so that the supplier can offer a modified version of their e-service bundle.

A selected e-service bundle is typically provided by a few suppliers, operating as partners. For the partnership at hand, an e^3*value* model can be build. This model shows the actors involved, the service outcomes they consumer or produce and the reciprocal objects (usually money). One of the analysis tools of the e^3*value* is then to do a profitability assessment for all the actors involved. The partnership can only survive on the long term if all actors in the partnership can achieve economic sustainability. Such a profitability assessment is another example of understanding the context of e-services, rather than the e-services themselves.

The other ontologies part of e^3*family* have similar goals: e^3*strategy* reasons about appropriate strategic positioning of an actor in a network, e^3*control* analyzes fraudulent behavior of actors, and finally e^3*alignment* keeps the various perspectives on the same e-service artifact consistent.

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