An Approach for E-service Design using Enterprise Models

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ABSTRACT

Today's organisations demand new business models for value creation and innovation. Such business models require collaboration with customers and vendors in agile and flexible networks. To realise such networks, organisations are embracing service oriented models and architectures, using e-services for business communication. A major issue for a service oriented organisation is to design and offer e-services that are adapted to the needs, wants, and requirements of customers and vendors. This is a challenging task as different customer groups and vendors will have different requirements, which may vary over time, resulting in a large number of e-services. In this paper, we suggest enterprise models as being adequate instruments for design and maintenance of e-services. More specifically, we propose an approach for designing e-services based on value and goal models. Such models will ensure that the constructed e-services will satisfy the needs and wants of customers. A project from the Swedish health care sector is used to demonstrate and evaluate the proposed approach.

Keywords: enterprise modelling, business model, value model, goal model, business process, e-service design, health care

INTRODUCTION

Organisations of today demand new models for value creation and innovation. The target of an organisation can no longer only be customers on the mass market. Instead, the individual customer will be put on centre stage where he/she takes on new roles in the creation of value and innovation together with the organisation. In other words, customers are no longer only consumers but active co-producers of value in a value network. In such networks, a flexible cooperation with multiple vendors and other business partners is needed in order to provide tailored solutions for each individual customer (Prahalad & Krishnan, 2008). The role of organisations will be to continuously reconfigure networks of customers, vendors, and other business partners.

In order to realise agile and flexible networks, organisations are turning to service oriented models and architectures. From an external perspective, services offer service consumers to focus on how to make use of the service for his/her specific business. The consumer simply does not have to deal with typical ownership responsibilities, like infrastructure management and maintenance. Thereby, the consumer can concentrate his/her resources on things that make his/her business successful. From an organisational internal perspective, a service oriented infrastructure will facilitate for an organisation to align its business and IT support. Thereby, an organisation that wants to change its business strategy can more easily do that by developing new

services and combining existing ones. This means that services provide many opportunities for organisations to become more focused, flexible, and agile.

As a consequence, many organisations are beginning to embrace service oriented approaches for their enterprise and IT architectures. In such service oriented approaches, e-services are used as a mean both for flexible integration of business and IT systems internally within an organisation, and for supporting external communication between organisations.

A major issue for a service oriented organisation is to design and offer e-services that are adapted to the requirements of customers and business partners. This is a challenging task as different customer groups and vendors will have different requirements, which may also vary over time, resulting in a large number of e-services. These e-services also have to be maintained and evolved in order to adapt to changing requirements. Thus, the organisation needs to manage a large, complex and continually evolving set of e-services. This task requires a set of instruments, including models and methods, for managing the complex environment. We suggest that enterprise models, in particular value models and goal models, are adequate instruments by offering a basis for analysing customers' and vendors' requirements as well as solution and e-service designs. A main advantage of value models is that they provide an easily understandable overview of actors in a value network as well as the resources and benefits they offer to each other, thereby enabling e-service design based on customers' and vendors' requirements. Furthermore, goal models provide a more detailed view by describing the goals of the actors in a value network, which makes it possible to relate and align e-services to these goals.

In this paper, we propose an approach for designing e-services based on value and goal models. As a first step, we use value modelling to capture high-level resource transfers between actors. Based on the resulting value models, we define top-level goals, which are then refined into a set of lower level goals. These goals are the base for identifying candidate e-services aligned with the goals. Finally, the e-services are refined into the desired granularity level.

The work presented here is based on experiences from a project in the health care domain, the REMS project (Henkel, Perjons & Zdravkovic, 2006). The main aim of the REMS project was to create a number of e-services that could be used to create, manage and transfer health care referrals between St. Erik's Eye Hospital (an eye specialist clinic), primary health care units, opticians, and private eye specialists in the Stockholm area. Health care referrals are one of the key instruments used when health care providers collaborate in the treatment of patients. The management of health care referrals spans geographical, organisational and IT system boundaries; thus, the project contains ample examples of complex business as well as IT interactions. A systematic approach, supported by an IT infrastructure, was thus required in order to design e-services that support the distribution and management of a large number of health care referrals, as well as support the desired business values and goals of the involved actors, including the patients.

The rest of the paper is structured as follows. In the following two sections, we discuss related research and present an overview of the proposed approach. Value models are described in Section 4. In Section 5, the linking of value models with goal models is described. The goal models are further refined into e-services, as described in Section 6. Section 7 describes how the identified e-services can be refined to a preferable granularity level. In Section 8, the application of the approach is described, as well as an evaluation of the approach used in the REMS project. Finally, in the last section, we summarise our contribution and discuss the subjects of further work.

RELATED RESEARCH

Identifying, designing and implementing e-services introduce many new challenges for business and IT architects. Compared to traditional information systems, service providers and users interact much more closely in order to create value. Instead of a single set of requirements on an information system, there are distributed requirements on e-services in networks of providers and users. Furthermore, e-service design is tightly interwoven with service use, as feedbacks from users contribute to the evolution of service oriented systems on an ongoing basis. These issues have been addressed in the new subarea of requirements engineering that investigate service design, as evidenced by for example the requirement engineering for services (REFS) workshop series (REFS, 2010). The main approaches in this new area make use of business processes, business functions, business models, and goals when designing e-services.

Many authors have considered *business processes* as a basis for designing service-based systems, see for example Piccinelli et al. (2002) and Papazoglou & Yang (2002). However, as these are focused on an operational processes perspective, they have omitted the connection between services and business values and goals that we address in this paper.

The notion of *business functions* has also been used to drive the development of e-services. The IBM research community has proposed the Component Business Model (CBM) for creating a structured representation of the business as an organised collection of business components (Cherbakov et al., 2005). In CBM the components corresponds to business functions. To support the exchange of information across a network of business actors each business component provides one or more business services. In comparison, the approach proposed in this paper is not driven by business functions. Instead, we use high-level business values as our starting point.

Recent research (Gordijn et al., 2008; Hruby, 2006; Andersson et al., 2005; Gordijn, Akkermans & Vliet, 2000) employ enterprise *business models* as a foundation to create IT systems. A business model describes *what* is offered by an actor to another actor rather than *how* these offerings are negotiated, contracted and fulfilled among the actors, as explained by a process model. In Osterwalder (2004) and Wieringa & Gordijn, (2005), an approach is suggested in which a business model is taken as a starting point for aligning business requirements with executable processes. The approach emphasises that IT solutions need to be derived from business models, validated with particular value propositions and exchanges, and accepted by all the participating actors. We utilise business models in our study, but the business model that we propose, called value model, in addition to the exchange of economic resources, also captures the concept of the actors' intended effects of receiving economic resources, see also the discussion in Weigand et al. (2006). This means that we make a difference between the *economic resource* transferred between actors and the *intended effect* experienced by an actor. Thus, in the approach proposed in this paper, value models are differentiated from business models by including both the exchange of economic resources and the intended effects that actors experience by receiving economic resources. Examples of intended effects are *increased knowledge* and an *increased feeling of safety*.

Several studies consider *goal-oriented* analysis as a starting point for the design of e-services. In Gordijn, Yu & Raadt (2006) and Gordijn, Petit & Weiringa (2006), the i* model for goal modelling and e3 value model for business modelling are combined in order to analyse and design e-service business models. According to Gordijn, Yu & Raadt (2006), the use of the i* model will reveal the strategic goals behind the value exchanges described in the e3 model, while e3 value model can be used for profitability analysis for the involved actors. In the approach

proposed in this paper, we utilise a goal-modelling method as a bridge between value models on the one hand and e-services on the other. Thereby, the goals are created based on a certain value model configuration, i.e. a certain configuration of customer and vendors in a value network and their resource transfers, and the created goals are then used to identify individual e-services. That is, the goals in the approach presented here are not strategic as in i*, and the purpose is not a general profitability analysis, as described in Gordijn, Yu & Raadt (2006). Another approach using goal models in presented in (Bleistein, 2006). In the approach several levels of both goal and context diagrams are combined to analyze requirements on e-business systems. A similarity with the approach we present here is that it starts with high-level goals and an analysis of the collaborating business partners. However no clear guidelines on how the levels are to be refined and how goals relate to the context diagrams are provided.

In Levi & Arsanjani (2003), e-services are coupled to goals using a modelling method, similar to the approach proposed in this paper. The method described in Levi & Arsanjani (2003) uses high-level business goals, identified by business executives, business owners and business modellers, which are decomposed into a hierarchy of sub-goals. Finally, e-services provided by existing software components can be identified that satisfies these sub-goals. The difference, compared to the approach presented here, is that there is no structured way to start the goal modelling, it directly starts with high-level business goals.

OVERVIEW OF THE APPROACH

The main aim of the approach proposed in this paper is to drive the design of e-services from a business value and goal perspective by using value and goal models. In order to do this, we utilise four distinct steps: value modelling, top-level goal identification, goal-driven identification of e-services, and e-service refinement (Figure 1). In each step, we apply a set of instruments to create the desired results:

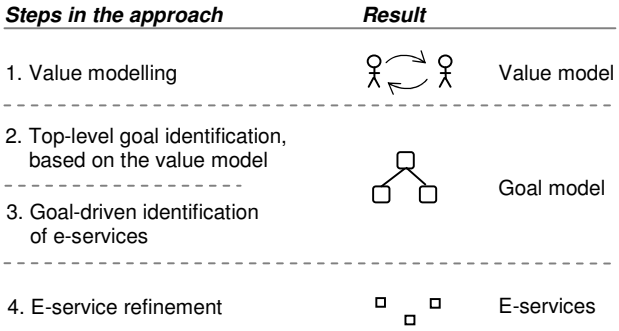

Figure 1. Overview of the approach

1. *Value modelling*: A *value model* is used to capture high-level economic resource transfers between actors as well as the different actors' intended effects, such as increased knowledge and increased safety, as a result of transfers of the economic resources.
   Result: A value model, depicting the main actors in the domain and their interchange of economic resources, such as money, business services, and products, as well as the intended effects that the actors strive for receiving economic resources.
   Provided instruments: Value modelling, including the modelling of actors' intended effects

2. *Top-level goal identification*: A goal model is used to further refine transfers in the value model. As a starting point for the goal model, we use a set of guidelines to derive top-level goals from the value model.
   Result: Top-level goals based on economic resources and intended effects which are described in the value model.
   Provided instruments: A set of guidelines, outlining the use of value enhancers to aid in defining top-level goals based on resource transfers in the value model
3. *Goal-driven identification of e-services*: The goal model is refined, leading to e-services as means to fulfil sub-goals. As an extension to the goal model, we introduce an *e-service level*, specifically enabling the identification of e-services that support goal fulfilment.
   Result: Refined goal models, with the top-level goal refined into sub-goals, forming a goal hierarchy. The bottom level in this hierarchy consists of e-services that fulfil the desired goals.
   Provided instruments: Goal modelling, with additional e-service goal level
4. *E-service refinement*: To aid the service analyst to select and structure the e-services that are the result of the goal modelling, we provide *granularity guidelines*. These guidelines aid the service analyst to refine the e-services to the desired granularity level.
   Result: Refined e-services, of appropriate granularity to be implemented.
   Provided instruments: Granularity guidelines, in the form of a list of top-down and bottom-up principles for selecting granularity levels

The proposed approach both adds concepts to existing models (for example intended effects, top-level goals and a service level in goal models), as well as providing methodical support for linking values, goals and e-services together.

VALUE MODELLING

Many different kinds of models exist for representing and visualising the architecture, actions, and environment of an enterprise. One recent type of model is the business model that focuses on actors, resources, and resource exchanges (Gordijn, Akkermans & Vliet, 2000; Wieringa & Gordijn, 2005; Weigand, 2006, Gordijn & Akkerman, 2001). A business model is different from other types of models used in enterprise modelling. In particular, a business model is different from process models, since it gives a high-level view of the actions taking place in and between organisations by identifying actors, resources and the exchange of resources between the actors. So, a business model focuses on the what in business. A process model, on the other hand, focuses on the how, as it deals with the operational and procedural aspects of business communication, including control flow, data flow and message passing (Gordijn, Akkermans & Vliet, 2000). In other words, a business model takes a declarative view, while a process model takes a procedural view.

Our approach to business modelling is in line with the e3-value language (Gordijn, Akkermans & Vliet, 2000; Gordijn & Akkerman, 2001). However, to cater for the analysis needs of the health care domain, we extend the e3-value language with the notion of internal resource and intended effects, which makes it possible to capture softer values like knowledge and safety. In the rest of this section, we give an overview of the important concepts in the value models we use.

Actor

An actor is someone who is able to participate in resource transfers and conversions (see below). An actor is typically a legal entity, such as a person or a company.

Economic and Internal Resources

A resource is an object that is viewed as being valuable by some actor. A resource is typically scarce, otherwise an actor would not consider it valuable. For example, ice would not count as a resource at the North Pole where it is abundant, neither would sand in the Sahara. Some concrete examples of resources are books, cars, movies, hair cuts, and medical treatments. However, resources can also be of a more social and psychological nature, such as status, beauty, pleasure, health state, honour, and a feeling of safety. To distinguish between these different kinds of resources, we identify two categories of resources: economic resources and internal resources. Intuitively, an economic resource is a resource that can be transferred between actors. More precisely, an economic resource is a resource that can be under the control of an actor, in the meaning that the actor may have legal rights on the resource. As a basis for analysing economic resources, we have identified the following categories:

- *Goods*, which are physical objects, like cars, refrigerators, and cell phones.
- *Information*, which is data in a certain context, like blueprints, referrals, and customer databases.
- *Services*, which are economic resources that encapsulate other resources and are used to increase the value of some other resource. Examples of services are hair cuts and eye treatments. A hair cut can increase the beauty and an eye treatment can give a better health state.
- *Money and vouchers*, which are media for exchange. A voucher is a certificate that can be exchanged for another specific economic resource, e.g. a good or a service. Usually, a voucher can be exchanged only with some pre-specified actor(s). Money can be viewed as the most general form of voucher without any restriction on economic resources and actors.

In addition to economic resources, there are also internal resources that, intuitively, cannot be directly transferred between actors. More precisely, an *internal resource* is a resource that is not an economic resource. Some obvious examples of internal resources are beauty, health state, honour, and glory. It is not meaningful to talk about legal rights on these resources, neither is it possible to transfer any of these resources from one actor to another. Another example of an internal resource is knowledge. At first sight, it might seem that it is possible to transfer knowledge from one actor to another. However, this cannot be done directly, but only through an intermediary economic resource, e.g. a book (goods) or a lecture (service). Internal resources are often desired by people for their own sake, e.g. someone might desire more knowledge without any intention to use it in a particular way. Someone else might desire knowledge in order to make money through lecturing or other knowledge services, i.e. he/she uses knowledge as an instrument for producing some other resource. Thus, internal resources can be seen both as ends in themselves or as instruments for other purposes. Economic resources, on the other hand, are only valuable as instruments for producing other resources.

Conversions

Resources can be used as instruments to produce or modify other resources. We define conversion as an action in which an actor uses some input resources to produce new or modify existing resources. For example, water and flour can be used as input economic resources in a baking conversion to produce the economic resource bread. Another example is an eye treatment (input economic resource) that is used to improve the health state (output internal resource) of a patient. That means that, in some cases, a conversion produces a brand new resource (bread), while in other cases the conversion modifies an existing resource (health state). In other words, a conversion can have two different results: a new resource or a modified resource.

Transfers

Transfers occur when actors want to acquire control of economic resources. Consider the question "What is transferred in a transfer?" This question may seem trivial, as the answer could just be "an economic resource". For example, if someone buys a book at a book store, then a book (goods, which is an economic resource) is transferred to him. Similarly, if someone borrows a book at a library, then again a book is transferred to him, but this book still belongs to the library. Thus, these examples indicate that the simple answer may in fact be too simple. There is clearly a difference between buying a book and borrowing one. If you buy a book, you are entitled to read it or use it for any other purpose, give it to someone else, or even destroy it. In contrast, if you borrow a book, you are still entitled to read it, but neither to give it away nor to destroy it. So, just saying that a book is transferred when you buy a book is not sufficient – we need to spell out how you are allowed to use the book. In other words, buying a book means to get certain rights on the book. Therefore, we define a transfer as an action in which the rights on an economic resource are handed over from one actor to another.

To summarise, an actor, for example a health care organisation or a patient, can increase and decrease resources by either conversions, in which an actor uses resources (economic or internal resources) to produce new or modify existing resources (economic or internal resources), or by transfers, in which an actor hands over the rights on a resource (economic resource) to another actor or receives the rights on a resource (economic resource) from another actor.

Intended Effect

It is often important to make explicit why an actor wants to acquire a resource in a transfer. To capture this, we introduce the notion of intended effect of a value transfer, which is an increase or decrease of an internal resource that the receiving actor wants to achieve by using the transferred economic resource in one or more conversions. Examples of intended effects are: better health state (where "health state" is the internal resource), increased knowledge on health condition (where "knowledge on health condition" is the internal resource) and increased feeling of safety (where "feeling of safety" is the internal resource).

Graphical Notation

Based on the above notions, we can now define a simple graphical form of value models. We base our notation on the e3 value language, which have a defined graphical notation. However we simplified this notation in order to limit the number of concepts to the ones presented earlier. This means that e3 concepts such as value interface and value ports are not used in our models. The simple graphical notation of the models makes them easy to introduce to key business

stakeholders. A value model is here shown by means of a directed graph representing actors, transfers, and resources (see Figure 2):

- Actors. Actors are represented by the nodes of the graph and are shown as stick person icons.
- Transfers. Transfers are represented by labels on the directed edges of the graph.

The label for a transfer consists of three parts:
- The economic resource being transferred
- The category of the economic resource (put within square brackets)
- The intended effects of the use of the economic resource in one or more conversions (put within ordinary brackets)

An example of a label for a transfer is:
- Eye treatment [service] (improved health state, increased feeling of safety)

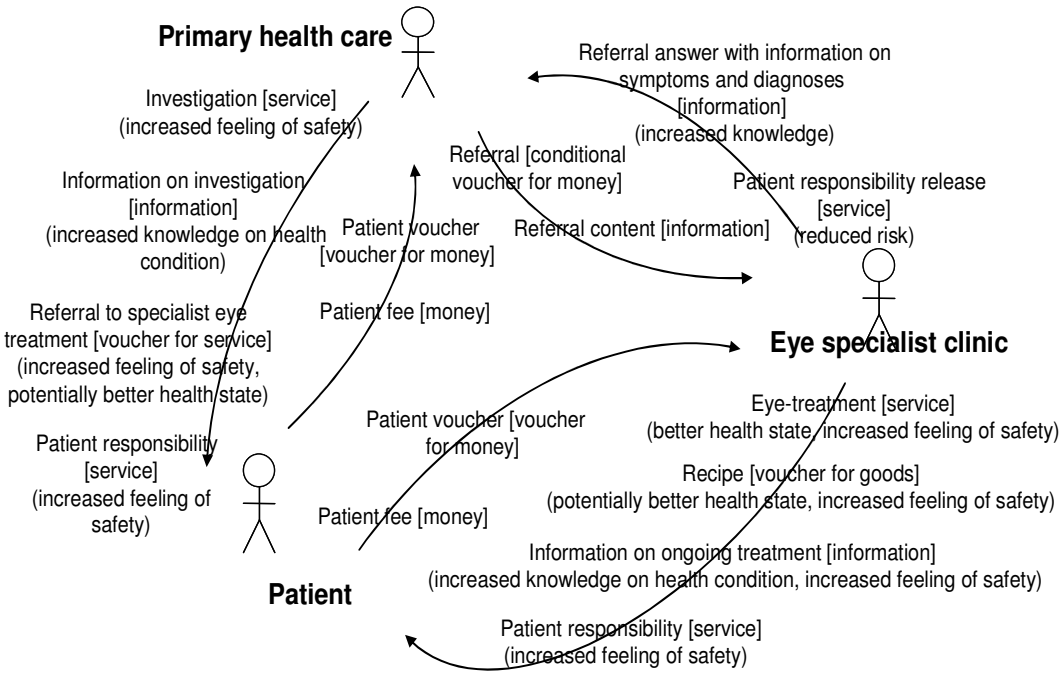

Figure 2. An excerpt of a value model created in the REMS project

If several conversions are needed in sequence in order to obtain the intended effect, we prefix it with "potentially". Note that the value model does not depict the ordering of the resource transfers, or the event that triggers the transfers. This kind of sequencing can be shown in a process model.

Referral Case from the REMS Project

The concepts presented above are applied to a real case from the REMS project. Figure 2 illustrates an excerpt of a value model defined in the scope of the REMS project. The figure is

explained below. First, the transfers between the primary health care and the patient are described, then the transfers between the patient and the primary health care, and so on. Note that we do not present any intended effects when the resource category is money or a voucher for money, since actors can receive money with many different intended effects.

From Primary Health Care to Patient

When a patient experiences an eye health problem, he/she will visit a primary health care provider. The basic resource this provider offers is an investigation service. The intended effect of this investigation is that the patient gains an increased feeling of safety, since the investigation will reduce anxiety as the patient knows that she/he will receive professional care. Note that a service can encapsulate other economic resources, such as information, vouchers, and other services, which can also be visualised as transfers in the value model. In this example, the investigation provides a basis for an information transfer, where the provider informs the patient about his/her health status. This information has the intended effect that the patient will gain an increased knowledge of his/her health condition. If the patient needs further treatment, either the primary care provider will carry out the treatment (a service, which is not shown in Figure 2) or the provider refers the patient to an eye care specialist at a hospital clinic who is able to provide advanced treatments. To do this, the provider provides a referral to eye specialist treatment, which is a voucher for an eye treatment (voucher for service). There are two intended effects as a result of the transfer of the referral to the patient. The first effect is direct: the patient will gain an increased feeling of safety, since the patient knows that the referral can be used for advanced treatment and this will reduce anxiety as the patient knows that she/he will receive professional care. The other effect is indirect: if the patient uses the referral, the treatment at the hospital clinic may improve the health state of the patient, i.e. another intended effect of the referral is a potentially better health state. Furthermore, when the primary care provider starts investigating the patient, the primary care gains a responsibility for the patient's health, i.e. the provider is responsible for carrying out the required actions in order to maintain or improve the patient's health state (depending on the diagnosis). The intended effect of this responsibility transfer is, again, that the patient gains an increased feeling of safety, since he/she knows that a professional health care provider has "promised" the health care system to carry out the required actions for the patient. Note that the responsibility will remain on the primary care provider until the responsibility is explicitly handed over to another health care provider, e.g. an eye specialist clinic.

Patient to Primary Health Care

When the patient visits the primary health care provider, the following resources are transferred from the patient to the provider: patient fee and patient voucher. The patient fee is the money that the patient pays when visiting the primary care, while the patient voucher is a voucher for money that enables further reimbursement for the expenses from the city council (not shown in Figure 2).

From Primary Health Care to Eye Specialist Clinic

The referral that the patient received is also sent from the primary health care to the eye specialist clinic. For the eye specialist clinic, the referral functions as a conditional voucher for money that gives the clinic a right to be reimbursed money from the city council. The voucher is conditional

since the clinic can only be reimbursed by the city council if the patient visits the clinic for treatment. Furthermore, the referral also contains referral content which is information that the eye specialist clinic uses to assess how urgent the patient's treatment is, as well as to plan and allocate resources at the clinic.

From Eye Specialist Clinic to Patient
When the patient visits the hospital clinic, he/she will receive an eye treatment service from the clinic. The intended effects of the treatment are twofold: a better health state and an increased feeling of safety. Furthermore, the treatment encapsulates other resources. First, it encapsulates an information transfer, i.e. information on the ongoing treatment, with the intended effect of increased knowledge on the health condition. Secondly, in some cases, the patient also needs certain medicine. The eye specialist clinic provider will then transfer a recipe, which is a voucher for goods; the patient can use the recipe at a pharmacy store and receive the needed medicine. There are two intended effects as a result of the transfer of the recipe. The first effect is direct: the patient will gain an increased feeling of safety, since the patient knows that the recipe can be used in exchange for medicine, which may improve his/her health state. The other effect is indirect: if the patient exchanges the recipe for medicine and also uses the medicine, the medicine may actually improve the health state of the patient, i.e. another effect of the recipe is a potentially better health state. Finally, when the eye specialist clinic starts the treatment, the clinic gets the responsibility for the patient's health, which gives the patient an increased feeling of safety.

From Patient to Eye Specialist Clinic
When the patient visits the eye specialist clinic, the clinic will receive the patient fee and patient voucher. The patient fee is the money that the patient pays when visiting the eye specialist clinic, while the patient voucher is a voucher for money that enables further reimbursement for the expenses from the city council.

From Eye Specialist Clinic to Primary Health Care Provider
When the eye specialist clinic starts treating the patient, it will explicitly take over the responsibility for the patient's health state from the primary health care. Therefore, the primary care provider will receive the resource responsibility release, with the intended effect: reduced risk. Furthermore, when the eye specialist clinic has treated the patient, the clinic sends a referral answer back to the primary care unit with information on symptoms, diagnoses and carried-out treatments. This information does not lead to any direct actions at the primary care unit. Instead, the referral answer is mainly used to increase knowledge about eye health care for the physicians and nurses at the primary health care unit.

VALUE-DRIVEN IDENTIFICATION OF TOP-GOALS

While value models are used to analyse the high-level transfers of resources among actors, goal models are applied to identify instruments in the form of e-services for: a) realising, and b) improving these transfers.

There are several reasons for choosing goals as mediators between resource transfers on one side and e-services on the other. First, goal models are easy to understand and introduce for stakeholders of an organisation, which together can develop such models (for example, in a

participative modelling session). Secondly, goal models enable stakeholders to be creative and innovative, since goal models do not focus on existing solutions. Instead, new and alternative means can be identified to fulfil goals. Thirdly, goal models can be used for measuring the goal fulfilment of processes and services. This makes it attractive to use goals for the management and evaluation of the business and supporting IT systems based on e-services.

Goal models have been used in requirements engineering to understand a problem domain and to map out the interests of different stakeholders. One of the most widely known languages for goal modelling is i* (Mylopoulos, Chung, Yu, 1999), which provides constructs for modelling goals, tasks, resources, and dependencies between actors. While i* holds a strong position in the academic community, there are also goal modelling languages with a more practical orientation. One of these languages is the Business Motivation Model, BMM (OMG, 2008). A basic notion in BMM is that of a goal, which expresses something a business seeks to accomplish, a desired state of affairs or condition. Examples of goals are being the market leader in an industry or having a profit of more than 1 million euros. Goals can be decomposed, i.e. one goal can be a part of another goal. The decomposition forms a hierarchy where top-level goals are broken down into sub-goals.

Furthermore, BMM includes the notion of *means*, i.e. instruments that can be used to achieve a goal. Means can take different forms, as they can be capabilities, methods, techniques, or even devices. When breaking down a goal into a goal hierarchy, the goals become more concrete further down in the hierarchy until the means are reached.

In the approach proposed in this paper, we use the BMM to identify potential e-services. The e-services that we model are aligned with the concept of means in the BMM, as they are seen as the IT instruments of the enterprise for achieving sub-goals in the bottom-level of the goal hierarchy.

In addition to the goal hierarchy (denoted as the *"sub-goals" layer* in Figures 5 and 6), we have distinguished the following novel layers to the goal model:

- *The resource layer* describes the starting point for the goal model.
- *The top-goal layer* is derived from the resource layer.
- *The e-service layer*, describing e-services that can aid in the fulfilment of bottom-level sub-goals.

The first layer, the resource layer, is directly created from the value model, by considering the transferred economic resources in the value model. The remainder of this section will describe guidelines for creating the second layer, the top-goal layer.

The second, top-goal, layer is created transparently from the first layer by considering the interests of the actors involved in a business model envisaged in the form of transferred economic resources. More precisely, the top-level goals are created from the requirements for each single resource transfer to a) obtain the intended effects and b) to exchange the economic resource with certain, desired features. This leads to two guidelines for identifying the top-level goals of an actor:

- *Intended effect guideline*, which guides the creation of top-level goals based on internal resources. These goals express the relationship between resource transfers and their intended effects; more precisely, they specify that the acquisition of a transferred resource should

result in a conversion of an internal resource. An example is "The eye treatment shall give rise to an increased feeling of safety".

- *Resource enhancer guideline*, which focuses on the features of transferred resources and guides the creation of top-level goals based on a number of resource enhancers. A resource enhancer expresses either a desirable feature of a resource or a desirable feature of the way in which the resource is delivered to the recipient. By applying the resource enhancers, we obtain a number of goals that concern the properties of an economic resource, as well as the adequacy of its delivery. Examples are "The delivery of the eye treatment shall be fast" and "The transferred information shall be correct and up to date".

Applying the described guidelines will result in a number of top-level goals for an actor. These goals reside on a high and abstract level, and as such cannot directly suggest any concrete actions to take. Therefore, there is a need to decompose these goals further until concrete means are identified.

It should be emphasised that when eliciting e-services an actor could use the two outlined guidelines independently and complementarily. In the latter case, the goals and sub-goals from the two guidelines may conflict with each other; it is then for the goal designer to decide which goal to include or exclude, using common prioritising techniques. Also, duplicated goals and e-services are easily removed. However, note that the two outlined guidelines can result in the identification of e-services on different granularity levels.

Intended Effect Guideline

The intended effect guideline is as follows:

For each transfer of an economic resource (ER) with an intended effect (IE), introduce the goal "ER should give rise to IE".

Using as an example the resource transfer for the giving of eye treatment by a specialist clinic to a patient (see Figure 2), and then by applying the intended effect guideline, we obtain the following top-level goals (see Figure 3):

- The eye treatment (ER) shall give rise to a better health state (IE)
- The eye treatment (ER) shall give rise to an increased feeling of safety (IE)

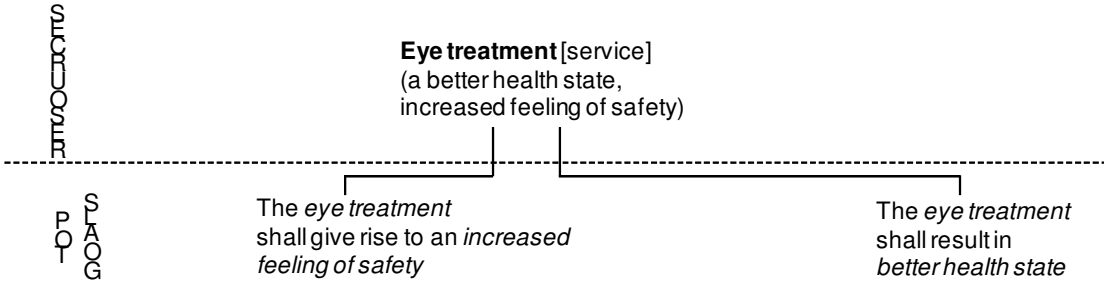

Figure 3. Identified top-goals based on the resource transfer "eye treatment" using the intended effect guideline

Figure 3 illustrates a goal model that is derived from the outlined example. The intended effect guideline is applied for discovering goals in the cases when the effect of the use of an economic resource is of high importance for the involved actors.

Resource Enhancer Guideline

The resource enhancer guideline is as follows:

For each transfer of an economic resource (ER), introduce a number of top-level goals based on the resource enhancers according to the table below.

A *resource enhancer* expresses either a desirable feature of an economic resource itself, or a desirable feature of the way in which the economic resource is delivered to the recipient, making the resource more valuable for an actor. The list of resource enhancers is open-ended, but in a number of case studies we have found the following to be the most fundamental ones: *fast*, *high quality*, *flexible*, *low cost*, and *secure*. This list also matches the critical success factors of business processes as suggested in Mende, Brecht & Osterle (1994), with the exception of secure.

When a certain enhancer is applied to a resource, or its delivery, the desired condition is formulated and viewed as a goal of an actor. Following this, in Table 1, we summarise the top-level goals for different types of resources, for each of the resource enhancers.

Some examples of goals obtained by applying the resource enhancer guideline given in Table 1 are the following:

- The information (ER) shall be correct and up to date (property of the resource, when the *high quality* enhancer is applied)
- The waiting time for the eye operation (ER) shall be short (property of the delivery of the resource, when the *fast* enhancer is applied)

Figure 4 shows top-goals that are derived from the example of the transfer of the economic resource *eye treatment* from the *hospital clinic* to the *patient* (this resource transfer is visualised in Figure 2). Figure 4 is only describing identified goals when one resource enhancer, i.e. *fast*, is applied to the service eye treatment. This results in two top-level goals, one for the delivery of the service and one for the property of the service (see Table 1). As with the intended effect guideline, the obtained top-level goals are further decomposed into sub-goals until e-services are elicited. We explain this process in detail in the following section.

Table 1. Resource enhancers and derived top-level goals for different types of economic resources

	Delivery of resource types	***Properties of the resource types***
Fast	▪ The delivery of the *information/goods/money* to the recipient shall be fast. ▪ The delivery, i.e. the waiting time for the *service*, shall be short.	▪ The enactment time of the *service* shall be short. ▪ N/A for *information/goods/money/voucher.*
High quality	▪ The delivery of the *information/goods/money/ service* shall be reliable, i.e. the goods/ information/money/service shall always reach the recipient and the recipient shall always be informed about delays.	▪ The *information* shall be correct, relevant, and up to date, and/or according to specifications. ▪ The *goods* shall be fit for their use, and/or according to specifications. ▪ The *service* shall be enacted fit for use and/or according to specifications. ▪ N/A for *money*.
Flexible	▪ The delivery of the *information* shall be customisable, i.e. information shall be delivered in different forms, e.g. paper, digital file sent via the Internet. Further, the presentation of the information shall be adapted to the needs of the recipient. ▪ The delivery of the *goods* to the recipient shall be customisable, i.e. different forms of delivery shall be provided, e.g. home delivery, delivery to the nearest post office. ▪ The delivery of the *money* can be in the form of cash, a check, or sent to an account. Further, the cash can also be delivered in different currencies. ▪ The delivery of the *service* to the recipient shall be customisable in space and time, i.e. different forms of delivery shall be provided, e.g. heath care services at home, at health care units close to home, as well as the waiting time being adaptable depending on needs and demand.	▪ The *information* shall be customisable to the needs of the recipient, e.g. an XML file will be more customisable than HTML (since the XML schemas can be changed). ▪ The *goods* shall be customisable to the needs of the recipient, e.g. a chair is adjustable to fit the user. ▪ The enactment of the *service* shall be customisable to the recipient. ▪ N/A for *money.*
Low cost	▪ The delivery of the *information/goods/ money/service* shall be provided at a low cost.	▪ The *information/goods/service* shall be provided at a low cost. ▪ N/A for *money*.
Secure	▪ The delivery of the *information/goods/ money/service* shall be provided with high confidentiality, high integrity, and accountability.	▪ The *goods* shall be safe in intended as well as unintended use. ▪ N/A for *information*, *money and voucher*, and *services*.

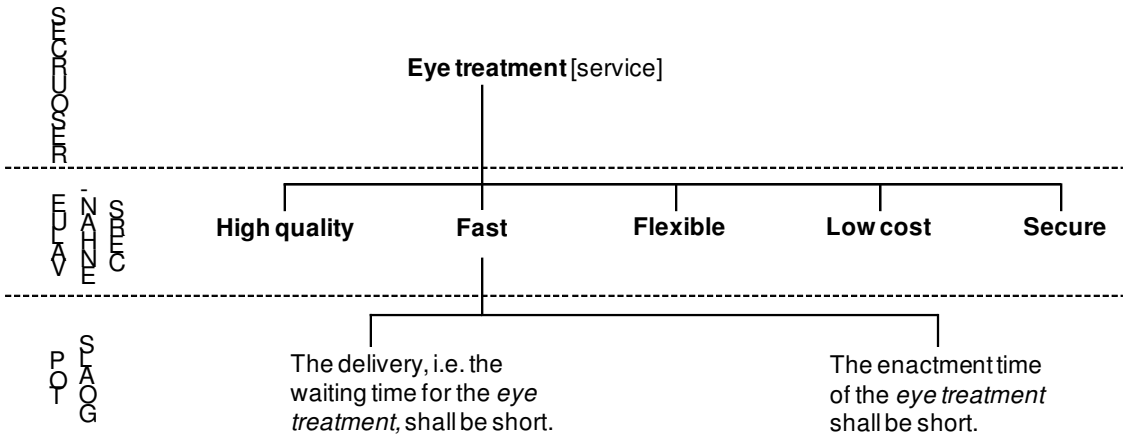

Figure 4. Identified top-goals based on the resource transfer "eye treatment" and the value enhancer "fast" using the resource enhancer guideline

GOAL REFINEMENT AND IDENTIFICATION OF E-SERVICES

The top-level goals identified through the analysis of exchanged economic resources serve as a starting point in the goal modelling session, carried out in a participative manner including different stakeholders. The goal modelling session is performed in two basic steps:

1. Refinement of the top-level goals into sub-goals, forming a goal hierarchy, thereby creating the sub-goal layer in the goal model.
2. Identification of e-services, based on the sub-goals, thereby creating the e-services layer in the goal model.

Each of the above steps requires input from the stakeholders, who are experts in the domain. As described in the following, a goal modelling session leader can guide the overall process.

During the first step, a top-level goal is further refined to create a goal hierarchy. If desired, the modelling of the goal hierarchy can be guided by the goal modelling session leader, by posing a set of guiding questions, see for example Liakos et al. (2006).

During the second step, candidate e-services are identified based on the created sub-goals. When the bottom-level sub-goals have been identified, it is usually straightforward for the stakeholders to determine candidate e-services that might support these goals. A key question to guide the identification of candidate e-services from bottom-level goals is "Can this goal be achieved using an e-service?".

An example of goal refinement in this manner can be found in Figure 5, where the top-level goal "The waiting time for the eye treatment shall be short" is refined. One of the sub-goal (see Figure 5) states that unused time slots in the hospital shall be decreased, and a sub-goal of this goal is to minimise the number of patients who do not use their allotted time slots. During the goal modelling session, means to achieve this bottom-level sub-goal were discussed. One possible way, as seen in Figure 5, is to introduce an e-service that reminds the patients via e-mail.

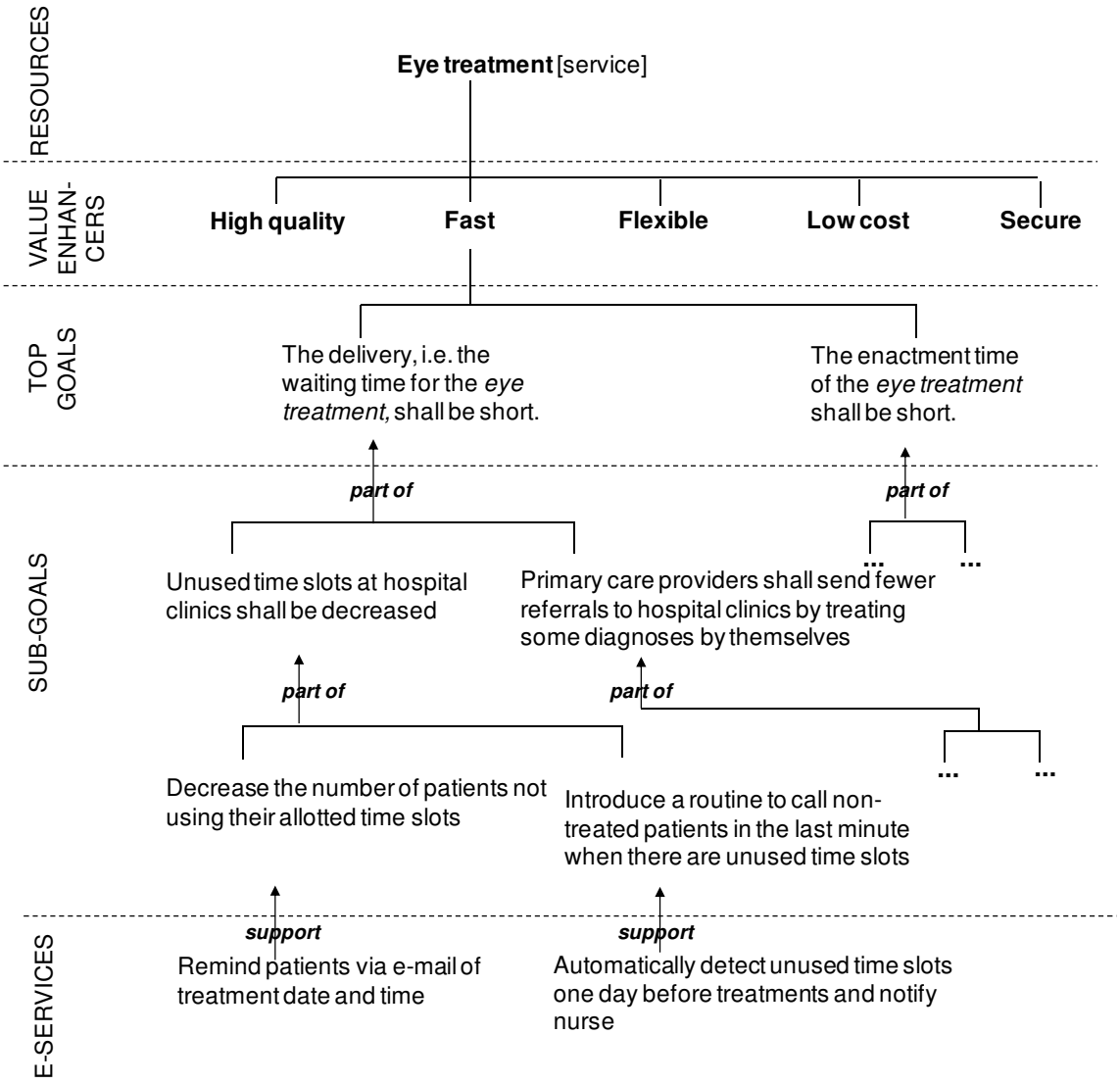

Figure 5. Goal refinement and e-service identification based on the top-goal "The waiting time fast for the eye-treatment shall be short".

Another example of goal refinement can be found in Figure 6, where the top-level goal "The eye treatment shall give rise to an increased feeling of safety" is refined. One of the sub-goal (see Figure 6) to this top-goal states that the patient shall have information about his/her own case before and after treatment. A sub-goal of this goal states that the patient shall be able to monitor the flow of his/her referrals and answers. One possible way of achieving such a sub-goal, as seen in Figure 6, is to introduce an e-service that makes it possible to search and view referrals via the Internet.

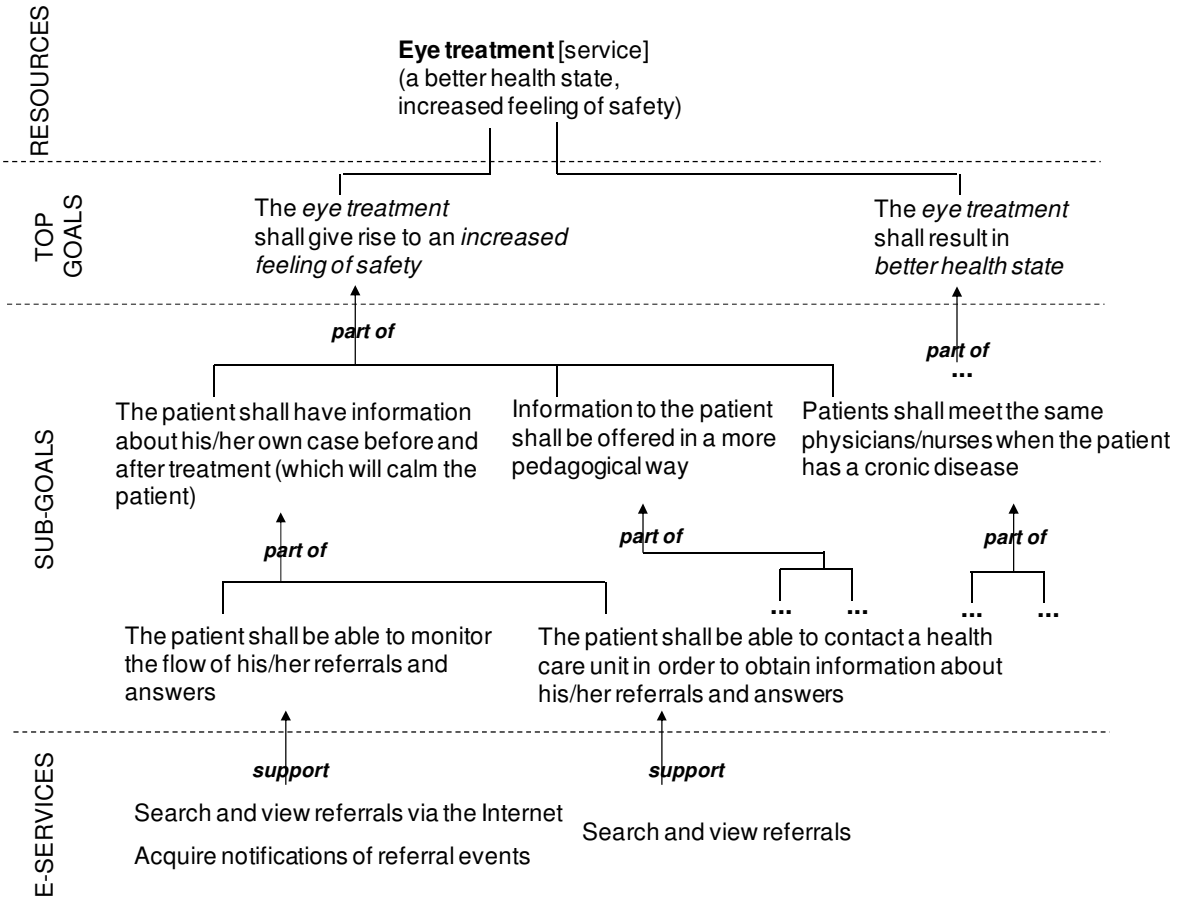

Figure 6. Goal refinement and e-service identification based on the top-goal "The eye treatment shall give rise to an increased feeling of safety".

Each identified e-service needs, upon implementation, to be coupled to a provider. A simple solution to identifying the providing actor is, by using the value model, to look at which actor provides the resource on which the top-level goal is based. For example, the reminder e-service introduced in Figure 5 is supporting the transfer of the eye-treatment resource from the specialist to the patient. It is thus natural that the specialist becomes the provider of the e-service. However, this simple selection of provider is not suitable in all cases. For example, actors might already have existing systems that can be easily extended to include new services, or the e-services might be provided by a third party. In the REMS case, the constructed e-services were provided by the eye-specialist clinic at St. Erik's Eye Hospital, because they already had e-services related to referral handling.

The goal refinement described in this section can result in a hierarchy of both quantitative and qualitative goals. In our approach we do not advocate the sole use of either of these types of goals. However, to measure goal fulfilment there is a need to introduce quantitative goals. One approach to combine qualitative and quantitative goals (referred to as objectives) is discussed in BMM (OMG, 2008). For example, the qualitative goal "The waiting time for the eye treatment shall be short" can be related to an objective: "The average waiting time for the eye treatment

shall be less than one month during 2011". By introducing such objectives in the goal hierarchy, it is possible to use the resulting goal hierarchy to measure the goal fulfilment in business terms.

The goal refinement presented in this section is resulting in a set of e-services. The identified e-services may need to be restructured to a granularity level of convenience, which is discussed in the next section.

E-SERVICE REFINEMENT

Before implementing the e-service that were identified during the goal modeling sessions there is a need to see to that the services are refined such that they are coherent in relation to each other, and that they are aligned with the existing infrastructure. For example, two similar e-services dealing with the same business concepts might be joined into a larger, more coherent, e-service. The technical infrastructure also needs to be examined. For example, there might be existing e-services that can be reused, or exiting legacy system that might be able to provide the needed functionality. Thus, the focus of the refinement is not to identify new e-services, but to adjust the identified services to better fit into a context of business use and technical infrastructure. Central to this refinement is the *granularity* of the e-services, that is, how much functionality they encompass.

Depending on how the goal-modelling sessions were carried out, the identified e-services will be specified on different granularity levels. There will simply be e-service candidates ranging from quite small features (such as "document the patient symptoms") to larger services (such as "prioritise and route the referral to a clinic"). Therefore, a discussion among the business and systems developers about a preferred granularity level needs to be performed. This discussion will be similar to identifying the granularity of UML use cases, which are important modelling artifacts in the Rational Unified Process. For example, Cockburn (2001) distinguishes between, and also presents guidelines for identifying, use cases on different granularity levels, i.e. kite, sea, and fish level.

During the discussion about the granularity level of the e-services, we recommend specifying on which criteria the choice of granularity level will be based. There are two basic approaches to defining the granularity level for the identified e-services: top-down refinement and bottom-up refinement. A top-down approach will use business level concepts as a guide to refine e-services. A bottom-up approach tries to align new e-services with the existing IT infrastructure. Typically, the bottom-up approach fits the desired functionality into the existing systems, while a top-down approach align the services with existing business concepts and processes Although a top-down approach is necessary during analysis to achieve a good overview of the complete set of e-services (Erl, 2007), a bottom-up approach is vital for the alignment with the existing IT assets within a organisation.

To refine the result of the goal modelling, we apply two guidelines: top-down and bottom-up. The top-down refinement guideline is as follows:

Use top-down refinement principles, as defined below, to refine the identified e-services according to business level concepts, such as business activities in a business process.

We have identified three *refinement principles* for the identified e-services from a top-down approach:

- *Process descriptions* – the e-services shall be refined according to process descriptions of an organisation or standardised process models presented by a standardisation body.
  For example, the services identified by the European health care standard Healthcare Information Service Architecture (HISA, 2007) are based on the process standard SAMBA (SAMBA, 2003). Examples of process steps in SAMBA are deciding referral, refer, renew health care mandate, and perform treatment. These steps can be seen as potential e-services. In Anzböck & Dustdar (2004), the use of pre-specified workflow transactions between two actors from the Integrating the Healthcare Enterprise (IHE) technical framework is recommended for the identification of e-services. Examples of such workflow transactions are patient identity feed, query registry, retrieve document, find personnel white pages, test results management.
- *Work assignment (task)* – the e-services shall be refined according to a definition of what constitutes a work assignment, i.e. an e-service is something that fulfils all the steps in a specified work assignment.
  For example, in Cockburn (2001), such a work assignment is defined as the steps that a user will fulfill before he/she will take a small ("coffee") break. For example, to refer a patient to an eye specialist is a work assignment, while a step such as finding an eye specialist and addressing the referral to an eye specialist are actions that are too small to constitute one work assignment. They should rather be seen as sub-steps in the work assignment "refer a patient to an eye specialist".
- *Sell/buy* – the e-services shall be refined according to a set of other e-service products supplied for the market.
  E-services may be designed for a product sold on the market, for example the health care market. Therefore, they need to be adapted for that market or for different market segments.

The bottom-up refinement guideline is as follows:

Use bottom-up refinement principles stated below to refine the identified e-services according to the existing infrastructure.

We have identified two *refinement principles* for the identified e-services from a bottom-up approach:

- *Legacy system* – the e-services shall be refined in order to adapt to the existing legacy systems and their functionality.
  The different e-services will work as wrappers for an existing legacy system (Cheesman & Daniels, 2001).
- *Reuse* – the e-services shall be refined so that they can be reused by other e-services.
  In this case, the least common denominator of the requirement from other e-services' use may direct the level of granularity.

To summarise, the above guidelines and principles are used to refine the e-services that are to be implemented. Services on a finer granularity level might be implemented as features (or functions) of other (larger) e-services. For the final implementation there is also a need to cover a finer detail of requirements than what can be done using the goal modelling. For example, non-

functional requirements need to be specified for individual services, such as scalability and performance. Another example of details that need to be added is user-interface design requirements. As the focus of the approach here is the identification of e-services, specifying these detailed equipments is out of the scope for the approach.

APPLICATION AND EVALUATION OF THE APPROACH IN THE REMS PROJECT

This section describes the application and evaluation of the approach proposed in this paper, as well as an evaluation of the resulting e-services.

Application of the approach

The approach for designing e-services based on value and goal models, has been applied in a health care project, called REMS (Henkel, Perjons & Zdravkovic, 2006). As described in the introduction, the aim of the REMS project was to create a number of e-services that could be used to create, manage and transfer health care referrals between several health care providers in the Stockholm region. The project resulted in a number of web-based e-services implemented in a prototype system, hosted by the S:t Eriks Eye Hospital.

The REMS projects was a joint research project with:

- researchers in information systems, responsible for applying the value and goal based approach for designing e-services
- system developers from an IT company, responsible for gathering requirement on, designing and implementing the e-services
- executives at S:t Eriks Eye Hospital, responsible for choosing e-services to implement, from a number of identified candidate services
- users of the prototype and e-services, i.e. physicians at an eye specialist clinic at at S:t Eriks Eye Hospital, physicians at primary health care units, opticians at optician companies and physicians at private specialist providers

The following steps outline how the approach for designing e-services based on values and goals was applied in the REMS project:

1. *Value model creation.* As a starting point, the researchers introduced value modelling to executives at St. Erik's Eye Hospital and physicians at an eye specialist clinic at the hospital. The executives and physicians developed an as-is value model based on their experiences of eye heath care in the Stockholm region. The resulting value model showed the economic resources that were transferred between patients, primary health care units, eye specialist clinics, opticians, and private specialist units, as well as the intended effects that motivated each economic resource transfer. Initially, there was a mix of economic resources, internal resources, and intended effects in the developed model. Therefore, the initial value model was re-structured by the researchers by transforming internal resources to intended effects, and assigning (at least) one intended effect to each economic resource transfer. The re-structured value model was verified by the executives and physicians at St. Erik's Eye Hospital.
2. *Goal model creation, including identifying candidate e-services.* The transformation of the developed value model into e-services using goal models, was carried out by a number of user representatives. That means that the modelling group in this step was larger than the group in

the first step, also including physicians from another hospital, primary care units and private eye specialist units, and opticians from different optician companies (in total six to eight persons in each modelling session). The starting point for the goal modelling session was the top-level goals generated from the value models. Each representative identified a number of sub-goals given the top-level goals. The identified sub-goals were then structured in a number of goal hierarchies, i.e. goal models, by the modelling group, one goal model for each top-level goal. The resulting goal models were refined by the researchers by further interviewing the different representatives. During these interviews also the candidate e-services supporting the goals were identified.

3. *Development of e-services prototypes*. From the identified e-services, the executives at S:t Eriks Eye Hospital need to choose the e-services to implement in the prototype. This choice was based on the goal models, and discussions with user representatives and systems developers. The final chosen e-services were: "Write referral", Send referral, including addressing", "Forward referral, including find available eye specialist", "Receive and review referral", "Re-sent referral", "Send referral answer". Finally, the e-service prototype was implemented by the system developers, and used by physicians at the eye specialist clinics, primary health care units, and private specialist units, as well as opticians at optician companies during a month period before two evaluation activities were performed.

Evaluation of the approach

After the implementation of the e-services, an evaluation of the value and goal based approach for designing e-services was carried out by the researchers. More specifically, the benefits and drawbacks of the value and goal based approach were evaluated. To structure the evaluation we focused on the ability of the approach to represent the entities of interest in a domain (*expressiveness*), and the degree to which the approach is able to support the design of e-services (*efficiency*). Note that the evaluation of the output of the approach, the e-services, is covered in the next section. In addition to the criterias mentioned above, the approach was intended to allow the active participation from stakeholders. Thus we also put emphasis on that the approach should be understood by the key stakeholders (*comprehensibility*). To summarise we have three evaluation criterias that were used to structure the evaluation; *expressiveness*, *efficiency*, *comprehensibility*.

The evaluation of the approach was carried out using semi-structured interviews. We interviewed the CEO of St. Eriks Eye Hospital, and two system developers, which have been responsible for gathering the requirements on the e-services, as well as carrying out the design and implementation of the e-services.

The result of the evaluation is described below by first presenting the value model creation part of the approach and then the goal model creation and e-service identification part. Note that the use of the service refinements criteria's is not covered in the evaluation since these criteria were not developed in full when the evaluation was carried out.

The evaluation of the value model creation part, showed several benefits and no direct drawbacks. According to the interviewees, the value model gave an easily *comprehensible* overview of the transfers of resources in the network of health care actors as a whole. The classification of economic resources into goods, services, money and information facilitates *efficient* identification and understanding of the transfers. Beneficial was also the possibility to *express* "soft" aspects such as the desire for safety and knowledge in the form of intended effects.

This fits well with the health care domain where such intended effects are essential. These comments points towards that the value model creation part of the approach offers *expressiveness, efficiency* and *comprehensibility*.

The evaluation of the goal model creation and e-service identification part of the approach, showed both benefits and drawbacks. A benefit that was pointed out was that the approach provided a clear, *comprehensible*, link between the values, goals and e-services, i.e. the approach shows how e-services support goals and values. Another benefit that was pointed out was that the *expressiveness* of the goal model supported prioritisation among e-services, when choosing e-services to implement among a number of candidate services. A third benefit was the use of a set of pre-generated top-level goals which was viewed as an *efficient* and inspiring means for the modelling group in order to identify sub-goals and e-services. However, the use of pre-generated top-level goals was also mentioned as a potential *efficiency* drawback, as they could hinder thinking "outside of the box". Another *efficiency* drawback that was mentioned was that there is no way to be sure that the goal models are complete, in the sense that it covers all possible ways to improve the resource exchanges in the value model. However, the use of both intended effect guideline and resource enhancer guideline seems to support the completeness requirement on top-level goals. A third drawback was that the approach did not *express* concrete means for the prioritisation of the e-services, by relating benefits or revenues to each goal in the goal model, and relating costs for development and maintenance to the e-services.

These comments point towards that the goal model and e-service identification part of the approach offers *expressiveness, efficiency* and *comprehensibility*, although the expressiveness could be extended by adding a prioritisation mechanism when choosing e-services to implement. The comments also indicated that approach might not be *efficient* when it comes to thinking "out of the box" and to ensure that the goal model is complete.

Evaluation of the resulting e-services

The goal fulfilment of the implemented e-services was also evaluated by interviewing users of the e-services. Since we had no practical possibility to compare the e-services with e-services designed using another approach, we opted for evaluating how well the implemented services fulfilled the goals stated in the created goal models. Thus, the evaluation is focused on the actual alignment of the goal models with the final e-services. If there is no such alignment, the approach would have failed to influence the design of the e-services.

Six persons that have used the e-prototype were interviewed: two opticians from an optician company, one primary care physician, one private eye specialist and one eye specialist from eye specialist clinic at St. Eriks Eye Hospital. The main result of the evaluation of the implemented e-services showed that the e-services helped the users to achieve goals as specified in the goal models:

- The e-services "Write referral" enforced the primary care physicians and opticians to specify the patients eye symptoms according to a predefined list of eye health issues and possible states of the issues. This supported the receiver of the referral, the physicians at the eye specialist clinic at St. Eriks Eye Hospital, to achieve better quality in the prioritisation of referrals. For example, patients with emergent needs could easier be identified by the specialists.

- The e-service “Forward referral, including finding available eye specialist” made it easier for the physicians at the eye specialist clinic at St. Eriks Eye Hospital to forward referrals to another eye specialists, according to a list of available eye specialists. This was necessary if another health care region or hospital should be responsible for the patient, or that eye specialist clinic temporary lacked resources. To forward referrals manually was a resource intensive activity, involving several persons at the eye specialist clinic.
- The e-service “Send referral answer” enforced the eye specialist to specify investigations and treatments carried out, as well as the result of the treatments, before sending the referral answer back to the primary care physicians or opticians that primarily wrote and send the referrals. Both primary care physicians and opticians stated that well specified referral answers were an important source to gain more knowledge about eye health care.

As a drawback the lack of system integration with external journal systems were mentioned. This caused some extra work for the users of the e-services, because they needed to copy some patient data between systems.

CONCLUSION

In this paper we have proposed and evaluated an approach that combines the use of value and goal models in order to design e-services. While value models capture high-level resource exchanges between actors, goal models enable a structured approach for defining concrete e-services. The approach consists of several novel contributions in the form of an enhanced value model, defined guidelines to derive top-level goals from value models, and finally a set of refinement guidelines used to structure the designed e-services.

An *enhanced value model* was used to depict actors, their transfers of resources, and the intended effects of these transfers. The value model enables us to represent, explore and relate traditional economic resources, such as goods and services as well as internal resources such as safety and knowledge. Internal resources are important in the health care sector to capture and refine the notion of values for patients.

A set of *high level goal derivation guidelines* that assist in the derivation of high level goals from a value model. To capture business goals pertaining to improvements on both economic and internal resources we defined two sets of guidelines, intended effect guideline and resource enhancer guideline. Applying these guidelines will result in a set of high level goals that are grounded in the value model, thereby linking goals to resource transfers in the value model. The high level goals can then be broken down into sub-goals and e-services than can be used to fulfill these sub-goals.

A set of *e-service refinement guidelines* was finally devised to structure the e-services that were identified during the goal modeling. These guidelines aid designers to select an appropriate granularity for the e-services that should be implemented.

The presented approach allows traceability between e-services, goals and resource transfers. Thus, the identified e-services can be motivated by their ability to support the goals in the goal models, and by their support of the resource transfers in the value model.

The approach was applied and evaluated in a case study in the Health care sector. The evaluation of the approach showed that the models were easy to understand, and allowed a clear overview of the actor’s transfers of resources as well as a clear link between resource transfers, goal and e-services. However it was pointed out by the interviewees that the approach could be

extended with instruments for the prioritisation of the resulting e-services, since there are seldom possible to implement them all.

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