A Value-based Foundation for Service Modelling

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Abstract

A broader use of e-services for cross enterprise collaboration requires the services to be analysed and designed with a clear business focus. From a business perspective, the e-services must support the primary values that an organization strives for. From an operational perspective, the e-services must be devised such that they support the day-to-day activities in the business. In this paper, we report on an effort to use value models and "service process models" as the foundation for analysis and design of e-services. Value models facilitate the exploration of new e-services, whereas service process models relate e-services to specific activities in an organization's business processes. We elicited a set of principles and models for analysis and design of e-services, and we discussed the experiences of practicing the principles in a project from the health sector. Having a well-defined alignment of software and business values provides benefits for service requirement gathering, service identification and service validation.

1. Introduction

The use of e-services [1] has started to evolve from point-wise use within single organizations towards intended large-scale use across enterprise boundaries. From a technology point of view, standardised technologies such as SOAP and WSDL pave the way for platform- and product-independent integration of systems. Trends such as process-based business engineering, promote the use of services from the business perspective.

As the number of e-services increases, the sheer extent of e-service use will increase the need for a structured approach for developing and maintaining the e-services. For example, managing hundreds of loosely coupled e-services can be simplified if the services are structured and documented according the business value they support. Having a well-defined alignment of software services and business values provides benefits for service analysis, service design and service validation. For instance, service analysis will be simplified by using a terminology that business people understand, service design will be simplified by understanding the business value of the proposed e-service, and service validation will be simplified as the business values will be the base for the validation.

Increasing the extent of service use and the number of actors involved, also put emphasis on finding a sustainable model for how services should be provided and evolved, i.e., service maintenance.

Any project facing the need to construct e-services will thus have to deal with problems related to the construction of individual services from a business and a technical perspective, as well with the future sustainability of the provided services and their interaction.

In this paper, we report on a work being conducted as part of the REMS project [2]. The main aim of the project is to develop a set of e-services that can be used to create, manage and transfer health care referrals between S:t Erik's eye hospital, primary care and private eye specialists in Stockholm. The project also examines new methods that can be used when analysing and designing e-services in the healthcare

region of Stockholm. As referrals are used as a mean to route a patient from a local physician to the correct level of specialist care, the problem domain is a complex mixture of actors, patient information and health care routines.

The contribution of the paper is to present a set of principles and models that contribute to key areas of service analysis and design. These principles and models are applied in the REMS project and encountered problems of applying them are listed and discussed.

The paper is structured as follows. In the next section, we give an overview of related research. Section 3 describes our modelling approach. In Section 4, we provide an example of value models and motivate the use of these models in relation to service analysis. Section 5 sets services in the context of a business flow, where we describe and motivate the use of the state-based processes. Section 6 describes how the modelling approach is applied in the REMS project, and Section 7 describes the problems encountered in applying the approach. Finally, in Section 8 we summarize our contribution and discuss subjects of further work.

2. Related research

The approach presented in this paper builds on the usage of value models, process models, and services, for integrating business and IT. Value models, in form of business models, have been used to analyze economic resource flows [3], and as a starting point for creating business process models [4], [5]. Research presented in [6] and [7] emphasizes that when addressing business-to-IT integration, the starting point is to analyze the business models of enterprises. A business model describes *what* is offered by an actor to another actor [7], rather than *how* these offerings are negotiated and fulfilled among the actors, as explained by a process model. In the examined health care domain, it is however important to not only capture typical economic flows of resources, but also "softer" values, such as trust and knowledge. Without such values it is difficult to explain reasoning behind certain health care activities and routines. Compared to the mentioned approaches, the value based modelling presented in this paper is an extension that enables capturing of the "soft" values in business models. Our approach also builds on aligning services with processes; this idea is both advocated in previous research [8], [9], and supported by technologies such as Business Process Execution Language (BPEL) [10]. However, our modelling approach differs in two aspects. First, we use state-based processes models [11], [12]. Secondly, we model the processes from two distinct perspectives: actor and information entity perspective. The use of state based process approach increases the flexibility of how the services can be combined. The use of actor and information perspectives support the design process by clarifying the interaction between the consumer and the provider of the service, as well the information created and transformed by the system. In [13], the authors describe a method for investigating the consistency between the value exchanges in a business model and the realisation of these exchanges given with a procedural model (that is, activity diagram). A similar approach can be applied in the context of our work for investigating consistency between a value model and a state-based process; however that issue is out of the scope of this paper.

3. Overview of the approach

To achieve a modelling approach aimed at both business and software a key concern is to use the shared concept of service. Both from a software perspective and from a business perspective a service can be defined as *a well defined offering that can be offered by a provider to a consumer*. In a business scenario the provider and consumer are commonly economically independent actors, while for e-services the provider is a software system and the consumer is either another software system or an (human) actor. Web services based on the web service technologies WSDL and SOAP are an example of e-services that are designed to be consumed by other systems.

The modelling approach presented in this paper consists of three layers: a business value layer, service process layer and an IT infrastructure layer. We outline this layered approach as the first principle in the REMS project:

Principle 1: *When designing services a layered modelling approach should be applied.*

Motivation: Each of the three layers in the modelling approach has a specific purpose with regards to the combined modelling of business and e-services (see Figure 1):

- The *value layer* depicts the economic resources (money, goods and service) exchanged between the main actors, as well as softer values (such as trust and knowledge). The purpose of this layer is to capture high-level requirements of providers and consumers, which can be used as a base for

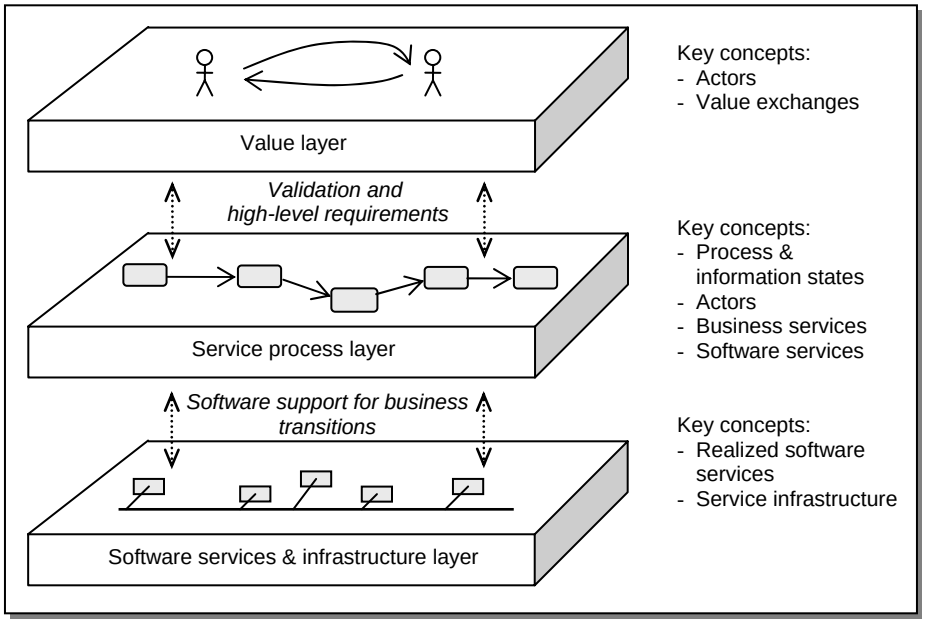

Figure 1. Overview of the layers in the modeling approach

identifying services (together with domain experts) and to justify existing services in terms of economic resource and softer values.

- A *service process layer* is used to model services in relation to business process state changes that occur in the business domain under study. The purpose of this layer is to map the use of services to certain points in the business process, and, thereby, better understand the relation between the different services. The resulting models can be used as a base for identifying new services (together with domain experts) or redesigning existing services. This layer depicts the use of both e- and business services. Furthermore, models in this layer can be drawn both from actor and information centric perspectives.
- The IT *infrastructure layer* is used to depict the collected set of implemented e-services as provided by the actors.

. These three layers are selected such that they complement each other during a top-down, as well as a bottom up design of services. For example, the value and service process layers can be used to identify e-services that will be implemented in IT infrastructure layer (top-down) while implemented e-services in the IT infrastructure layer and identified services in the service process layer can be validated and refined using the value models (bottom-up).

In this paper we concentrate our description to the two uppermost layers, that is, the value layer and the service process layer (see Figure 1).

4. Value based foundation

As we stated in Section 1, we strive to capture both vales such as money transfers and soft values such as security and trust. We formulate this as a second guiding principle:

Principle 2: *The value modelling approach should be able to capture both concrete value exchanges (economic resources) as well as values as perceived by the receiving actor.*

Motivation: To support the above given principle, we apply a value model consisting of three main components: *value objects*, *actors*, and *values*.

– A *value object* is a domain specific economic resource exchanged between actors. Value objects are exchanged in the form of dualities. This means that in a business context, an actor that provides something of value to another actor always gets compensation [12]. Examples of different types of value objects are: *goods*, *information*, *money*, and *services*.
– An *actor* is a business role that a legal entity, such as an organization or a person, takes when providing or consuming value objects. Some examples of actors are banks, brokers, suppliers, patients, physicians, primary care, etc.
– A *value* is an internal goal of the actor, related to the value object that is consumed. For example an operation (value object) can lead to a better eye-sight (value). Thus a value object can be seen as the

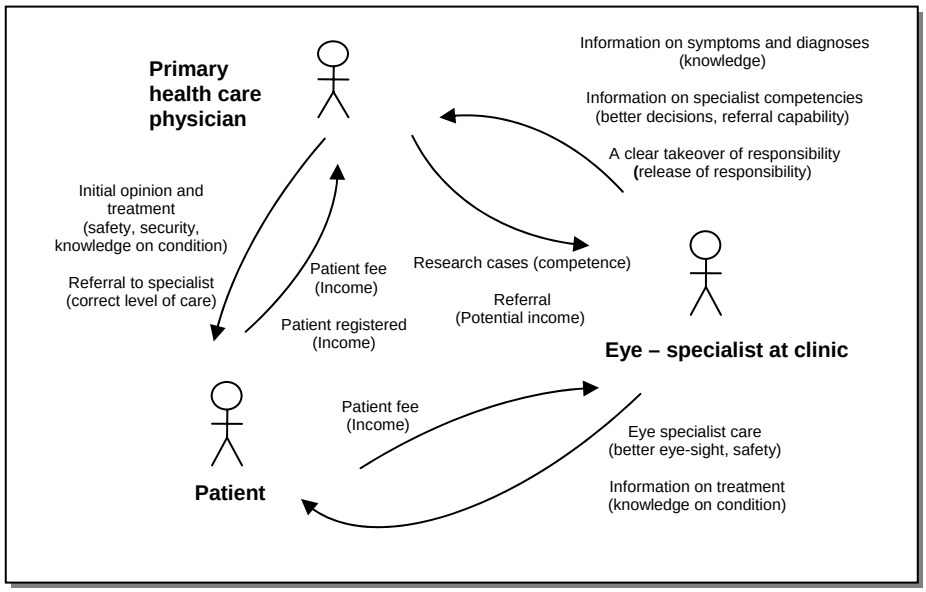

Figure 2. Main flows of value objects and, in parenthesizes, values perceived by actors

things that are transferred, while values are perceived by the receiving actor.

The differentiation between value object and values gives us an opportunity to model both "hard" economic resources and services transferred between actors, such as goods, information and services, as well as "soft" values. This differentiation is not done in other value modelling approaches, but the concept value has similarities with the concept value subject in [13]. However, value subject is defined as something that an actor owns, controls, or in some other way has an interest in, and will therefore include things such as house, eye and eyesight. Furthermore, "soft" issues such as trust is explored in the i* framework [14], which is used for goal modelling.

The use of values will enable a better understanding of why economic recourses are transferred. This also makes it possible to discern alternatives of value object provisioning giving the same values, i.e., discern alternative business models (describing alternative value objects exchange) that can fulfill the same (soft) values.

Furthermore, different actors can receive the same value object, but perceive different values. Thus, actors could be divided in different actors group (or market segments) according to the different values they perceive. In marketing this is called customer segmentation, and different marketing strategies can be developed for the different segments.

In Figure 2 we illustrate an excerpt of the value model defined in the scope of the REMS project. The figure depicts the exchanges of values among the patient, the primary care physician, and the eye-specialist at a clinic. Having a problem with the eye(s), the patient first contacts the local primary care physician, in order to get an opinion and a treatment, and if necessary, the primary care physician refers the patient to an eye specialist clinic. As Figure 2 depicts, the resources (i.e., value objects) that the patient gets, are the initial opinion and treatment, and the referral, if necessary. For the patient, those value objects provide the values of getting the right treatment level and safety. In return, the physician gets the patient fee and the possibility to register the patient visit, both yielding the value of income. The actual patient registration is an important value object, since it gives the primary health care unit the possibility of reimbursement for the expenses from the city council (the actor city council and the value object reimbursement are not shown in Figure 2).

In relation to this, an exchange of values occurs between the physician and the specialist eye-clinic. To be able to serve patients, the physician needs information on available specialists', important symptoms, diagnosis and upon referral, a clear signal when the responsibility for the patient is taken over by the specialist. In that way he or she obtains the values of necessary knowledge about symptoms, the basis for decision-making and release of responsibility. Further, if the patient gets referred, he is to be accepted by the

clinic, treated and provided with the information about his treatment process; those services give him the value of safety, possible improvement of his sight and knowledge of his condition.

The value model as shown in Figure 2 is used to set high-level requirement on the services and processes described in the next section.

5. Services in business flows

In this section, an approach of analysis and design services in a business flow is outlined. The approach is based on a set of principles initially outlined in the REMS project:

Principle 3: *The customer and the customer process should be in focus.*

Motivation: In business management, there has been awareness during recent years that organizations need to focus on the processes that create value for their *customers.* This is in order to see to that value is created as efficiently as possible and that unnecessary or redundant activities are avoided. Healthcare is by no means an exception and, therefore, there need to be a focus on the *patient* process [15], i.e., the process where various healthcare providers interact with the patient to increase his or her values. Other health care processes, or services, can then be adjusted in order to support the patient's process as efficient as possible.

An effect of following this principle is that we focus on modelling the patient's process.

Principle 4: *The services developed should be defined with a clear consumer and provider perspective.*

Motivation: The patient is the main consumer of the services. In order to describe which services that can support the patient's process, we relate the services to the patient's process. Further, it should be obvious which health care actors that provide the services to the patient. UML Use cases can be used for representing the services, and swim lanes for representing the providers, see Figure 3. The visualisation of the patient's process, the related services and the providers of the services, will facilitate discussions about alternative services or alternative providers of the services. Note that also health care actors (not only patients) can be consumers of services, provided by other health care actors.

To follow this principle we incorporate UML Use cases and providers' swim lanes as a representation of services interaction in our service process model.

Principle 5: *A state transition process modeling technique should be chosen to depict the interaction between processes and the services they utilizes.*

Motivation: When modelling processes, several categories of process modelling techniques can be used, for example, data flow diagrams, workflows, and state transition diagrams [11]. The data flow diagrams focus on visualising the input to and output from the activities, the workflow diagrams focus on the time ordering of activities, and the state transition diagrams focus on state changes produced by activities (or services). In the state transition diagram a state in the process thus represent a desired (sub) goal to be reached. The use of state transitions diagrams as the base for our service process model let us focus on what should be achieved rather than how. Services can then be "inserted" to aid state transitions. The process' states thus give a base for attaching, deleting and combining the services which will drive the process to its final state.

We adhere to this principle by making state transition diagram as the main tool in our service process model.

Principle 6: *Main information entities supporting the customer process should be identified, as well as their possible states.*

Motivation: Business (and healthcare) processes usually originate in some information entity supporting the process. Sometimes the basis for the business process can be considered as a collection of information structures. For example, a part of the health care domain focuses on handling referral documents as the key information entity. It is important to identify these main information structures supporting a business process, as well as identifying the information's main states. These states can be related to the identified business process states, e.g., a state change in the information state may trigger a state change in the business process. Furthermore, an information centric state model can closely be related to the core functionality of e-services, as will be shown in the case example.

Models that combine the above principles are shown in Figure 3 and 4. The processes are modelled by using high level state transition diagram (principle 5). The focus will be the patient's process (principle

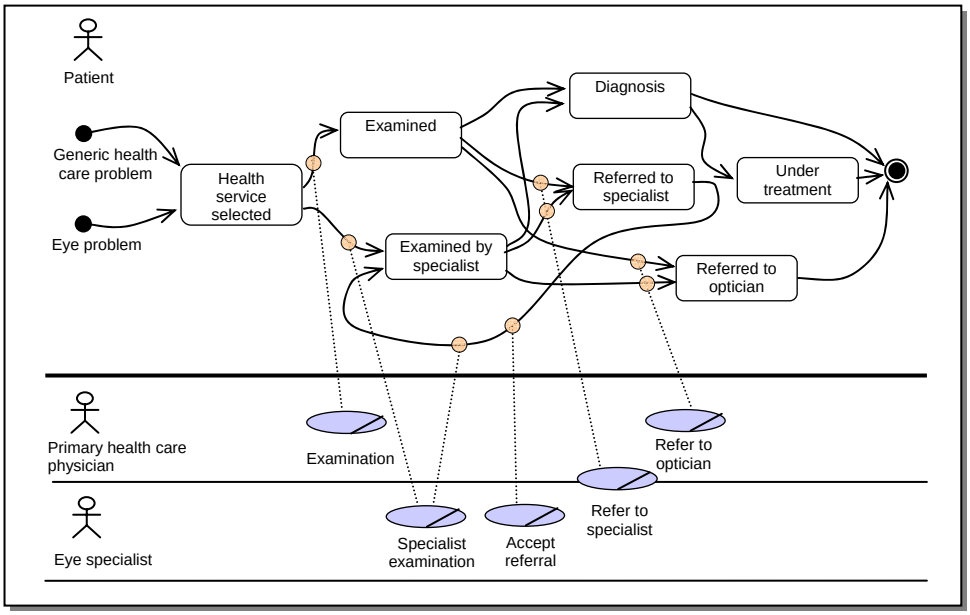

Figure 3. Process service model depicting the patient states and utilized services

3), see top of the model in Figure 3. At the bottom of the model use cases are used, representing interfaces to services. The actor who provides the service is shown by using "swim lanes" in the bottom of the model (principle 4). The interconnection of service interfaces and state transitions shows where a particular service can be applied to change the state.

The described process in Figure 3 is a simplification of the main states relevant for referrals in the eye care domain. The shortest path in the example is when a primary health care physician can issue a diagnosis and commence treatment directly (se the upper path of Figure 3). However when a referral to a specialist need to be sent the physician (or another specialist) needs to write the referral. Once the referral is received at the eye specialist clinic a specialist need to accept the referral.

Examining the handling of the referral in a more detailed manner can be done by taking an information centric approach to state modelling (principle 6), this is shown in Figure 4. In this service process model we depict the e-services that are activated in order to take a referral from a draft state into a state where the referral with an attached answer is returned to the physician. For reason of simplicity we only depict the case where the referring party is a physician and the receiver is a specialist.

The information centric service process model complements the patient centric model by adding additional states not depicted in the patient process. Furthermore it allows us to directly identify those e-services that are required to handle a referral. An example of added detail is the inclusion of a "Routed to receiver" state. The state transition from "Signed" to "Routed to receiver" is depicting the activity of finding the correct receiving specialist at large health care units, like the S:t Eriks eye hospital. To fully support the states each transition is supported with a corresponding service interface described by a use case.

6. Applying the modelling approach

The described approach on using value and state-bases service process models are applied in the health care project REMS as an instrument for identifying and refining e-services. As described in the introduction, the aim of the REMS project is to support the eye health care in the Stockholm region with IT support for health care referrals. Since a referral works as a "communication tool" between primary health care units, hospital (eye specialist clinic) and private specialists, the project work includes all of these actors in the e-service analysis. The following steps outline how the described approach is applied in the REMS project, this is thus a tried-out example on how to apply the approach in a concrete project put under the normal pressure of deadlines, user expectations and interest of key stakeholders:

1. *Value model creation*. As a starting point a value model was developed by the key stakeholders, that is, the representatives from the management at S:t Erik's Eye hospital and eye specialists at the clinic. At the outset, an initial value model depicting the exchanged *value objects* between the patients, the

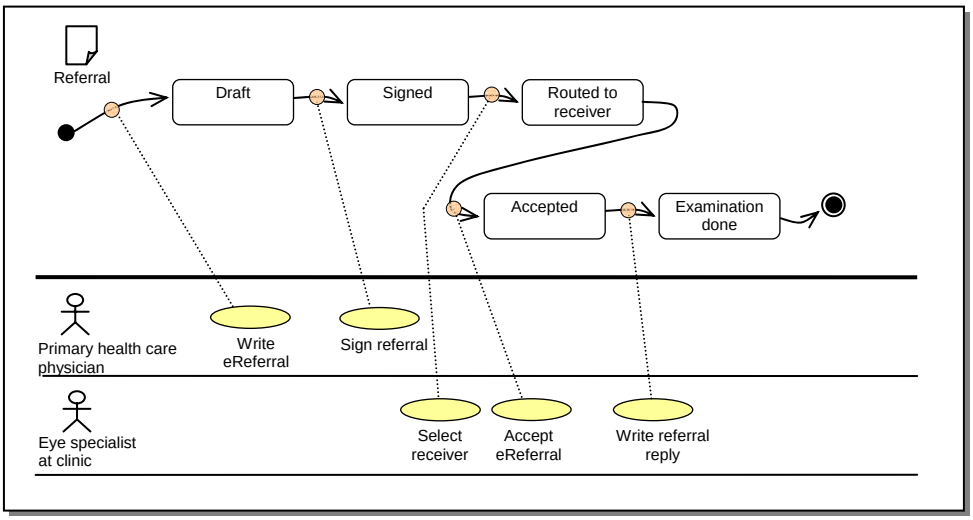

Figure 4. Service process focused on the referral states and corresponding software

primary health care and eye specialist was designed. Furthermore, the *values* that motivated each value object flow where modeled. The value model was later on structured by assigning (at least) one value to each value object, and by checking that exchanged value objects were a part of dualities as described in Section 3.

2. *Using the value model to set the scope for the first iteration.* Before commencing with the state-based service process modeling, the scope of further modeling was limited to the interactions of key actors that are depicted in Figure 1, as this was the planned scope for the first release of e-services. Furthermore, the focus was put on the handling of referrals.
3. *Model actor centric service processes.* One of the purposes of the project is to as far as possible take a patient centric view of the health care. It thus became natural to put the actor "patient" in the focus of the state based process, as shown in Figure 3. Using service processes from a patient perspective, made it possible to identify several business services that where needed during the patient interaction with the health care.
4. *Model information centric service processes and software services.* Based on the actor-centric process model key information entities where identified. For the key entity "referral" the possible states where analyzed using a state-based process (Figure 4). For each state transition an actor responsible for the transition and a e-service aiding the actor to "push" the referral to the next state was designed. Use case descriptions were used as a mean to document the requirements on each service.

The first release of software services became those that where directly related to the states of a referral (a subset of these is depicted in the bottom of figure 4). Upcoming releases, covering a larger domain scope, will require a re-visit of the value models for further refinement.

7. Encountered problems

The stated principles for analysis and design of services for collaboration were applied in the REMS project (described in section 1). The expected result of the project is a set of web-based software services that both are related to the patient process and are integrated in the IT environment. The services aim at not only support the eye clinic, private eye specialists and primary care, but also to support hospitals, primary care and specialist in the whole Stockholm region. The initial application of the principles has been promising. Figure 3 and 4 are excerpts of models developed in the project. However, some problems have been encountered, which are discussed below:

The difficulties of specifying values and value objects. Value objects belong to the operational concrete world of business, while values belong to the internal world of actors. However, values can be stated on different levels. For example, the value object haircut can be perceived as both the values: "a means for being more beautiful" and "a means for being more successful". The first value could also be a means for the latter value. Furthermore, sometimes value object and values

seems to be identical. A possible strategy for solving this problem is discussed in [6], where the values of economic resources (synonym to value objects) are enhanced in so called conversion processes. For example, an actor acquiring an education service (a value object) can convert the service to more skilled labour (value) by consuming the service. However, *guidelines are needed to specify the relations between values and between values and value objects*.

The difficulties of using the values as the base for identifying services. The use of values for motivating particular services is rather straightforward, but there is also a need to identify services starting from values, i.e., use values as an input for how to design the services. The value model as shown in Section 3, should be used as a basis for eliciting services in the given business context. A possible way for identification of services from the value models, are to focus on services as providers of concrete value objects (i.e. resources). Further, identifying services such that they support a group of related value objects might be one way to go from value exchange to services. Another approach is to use goal models as a mediator between value models at one side and e-services at another side. Top-goals could be created based on the value objects in the value model and a number of value enhancers. A value enhancer is a generic property of a value object that contributes to making it more valuable for an actor. To summarize, *a method for going from a value model to a set of services is needed.*

The difficulties of identifying the state of the process. Health care processes can be quite complex, without a clear goal of what to depict. Therefore, the process models can quickly be overwhelmingly complex. For example, by just slightly modifying the focus of the patients process shown in Figure 3 to include even more states not related to referrals will yield a quite complex state transition diagram. The solution to this problem is to clearly define the scope of the models; in this case the scope is patient states related to referrals. A possible way to solve this problem is to adhere to the practical scoping rules developed for UML use cases [16]. Further *guidelines are needed to elicit a coherent set of states to be represented in a service process model.*

8. Conclusion and future work

When analyzing a complex business environment with the goal to design process models and software services, it is easier to start by documenting current business activities and procedures than examining the business values proposed or expected by the key actors. However, obtaining software services "aware" of business aspects such as customer needs and economic resource flows, requires for starting the service analysis on a higher abstraction level then procedural. Following this, in this paper we have outlined a three-layered modeling approach that cater both analysis of high-level value flows and the coordination of services when realizing a business with IT. In particular, we set the focus to exploration of the two upper layers, that is, the value and service process layer, for which we defined and motivated a set of principles that guide their modeling.

The important subjects not addressed in this paper, as we argued in Section 7, are a stricter definition of the value model, as well as a method for alignment between values and services to improve traceability between the discussed models. The exploration of these subjects is in details addressed in our following study [19].

9. Acknowledgments

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10. References

[1] Piccinelli, G., Stammers, E., "From E-Processes to E-Networks: an E-Service-oriented Approach". In International Conference on Internet Computing. CSREA Press, Vol. 3, ,2001, pp 549-553

[2] R(REMisslusS) Project, http://www.rems.se, last accessed 2006-06-29

[3] Gordijn J., Akkermans J.M., "Design and Evaluation of e-Business Models", IEEE Intelligent Systems, special issue on e-business, 2001, Vol. 16, Iss. 4, pp 11-17.

[4] Andersson B., Bergholtz M., Edirisuriya A. , Ilayperuma T., Johannesson P., "A Declarative Foundation of Process Models", Proceedings of the 17th Conference on Advanced Information Systems Engineering (CAiSE'05). Porto, Portugal. LNCS, Springer Verlag, 2005.

[5] Schmitt M., Bertrand G.,"Risk Mitigation Instruments for Business Models and Process Models", REBNITA 05, Paris, France, August 29-30, 2005

[6] Hruby, P. "Model-Driven Design of Software Applications with Business Patterns". Springer (2006) ISBN: 3540301542

[7] Gordijn J, Akkermans JM, van Vliet JC: "Business modeling is not process modeling". In: Conceptual modeling for e-business and the web. LNCS, Vol 1921. Springer-Verlag (2000)

[8] Wald E., Stammers E., "Out of the Alligator Pool: A Service-Oriented Approach to Application Development", EAI Journal, March 2001.

[9] Klischewski R, Wetzel I, "Modeling Serviceflow", Proceedings of ISTA 2001, Kharkiv, Ukraine, June 13-15, 2001. Lecture Notes in Informatics, 2001, pp. 261-272.

[10] Juric, M., "Business Process Execution Language for Web Services", Packt Publishing (2006)

[11] Khomyakov M., Bider, I. "Achieving Workflow Flexibility through Taming the Chaos". Journal of Conceptual Modeling, Issue 21, August 2001.

[12] Bider, I. "State-oriented business process modeling: principles, theory and practice". PhD Dissertation, Royal Institute of Technology, Stockholm, 2002.

[13] Zlatev Z., Wombacher A. "Consistency Between e3-value Models and Activity Diagrams in a Multi-perspective Development Method". Proceedings of the OTM Confederated International Conferences: On the Move to Meaningful Internet Systems 2005, LNCS 3760, 2005, ISBN: 3-540-29736-7, p 520 - 538.

[14] Geerts G., McCarthy W.E. "The Ontological Foundation of REA Enterprise Information Systems". Tech. Rep., University of Delaware and Michigan State University, 2000

[15] Weigand, H., Johannesson, P., Andersson, B., Bergholtz, M., Edirisuriya, E., Ilayperuma, T.: On the Notion of Value Object. To be included in the Proceedings of the 18th International Conference on Advanced Information Systems Engineering (CAISE06)

[16] Yu E., Liu L., "Modelling Trust in the i* Strategic Actors Framework", Proceedings of the 3rd Workshop on Deception, Fraud and Trust in Agent Societies, Barcelona, Catalonia, Spain, June 3-4, 2000.

[17] Vissers, J. M. H., 1998. Health care management modelling: a process perspective, *Health Care Management Science*, 1, pp. 77-85.

[18] Cockburn A. "Writing Effective Use Cases", Addison-Wesley, 2000, ISBN: 0201702258.

[19] Henkel M., Johannesson P., Perjons E., Zdravkovic J. "Value and Goal-driven Identification of E-Services". Submitted to the 3rd International Conference on Interoperability for Enterprise Software and Applications. Madeira Island, Portugal 28-30 March 2007.