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Service Systems Through the Prism of Conceptual Modeling

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We seek means of further improving the process of service innovation by providing conceptual framework that would uniformly model information about a service system. Since value co-creation is achieved through knowledge-based interactions, such a framework should be a connection-oriented one. We propose uniform approach to context-sensitive relationships modeling and representation, based on semantic conceptual modeling, suitable for modeling both service system interactions and information about a service system itself. Its application is illustrated on digital libraries domain. The proposed representation may be combined with goal-driven development methods to allow closer interconnection of goals and value proposition. The paper presents application of an original conceptual reference model of service system, which may provide more elaborated background for service innovation process.

Key words: service systems; conceptual modeling; semantics; value proposition; service decomposition; goal-driven

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1. Introduction

Service systems have been defined as value-co-creation configurations of people, technology, value propositions connecting internal and external service systems, and shared information (language, laws, measures, and methods) (Spohrer et al., 2007). Since value co-creation mostly involves some sort of communication, which in turn requires reasonable level of understanding between communicating parties, using conceptual modeling as a tool capable of describing the domain of interest in comprehensible and unambiguous terms might prove beneficial in both service systems design and innovation.

Conceptual modeling can be described as the process of conceptual understanding and rendering the modeled part of reality. The modeler tries to find out which objects of interest the system should keep and provide. Conceptual model should be totally independent of intended implementation and intelligible for users (Duzi, 2001). We use specific semantics-oriented approach to conceptual modeling called HIT data model (Zlatuska, 1986), (Duzi et al., 1987). Although the benefit of models containing semantics lies above all in the presence of definitions of modeled concepts, the better the quality of definitions, the more likely readers of the model are able to understand correctly the modeled domain. Here the HIT data model comes in, offering method for writing quality concept definitions, thus improving the techniques of conceptualization. According to (Godsiff, 2009), better conceptualization of value co-creation is needed. Therefore, we are convinced that the usage of this semantics-oriented conceptual modeling technique is appropriate.

This article introduces specific service-oriented conceptual modeling approach based on slightly amended service system definition, which is given in part 2. Next, we are going to concentrate on modeling context-sensitivity, attention and certainty. Further, reference conceptual model of service system behavior is presented along with an example of its population with existing service system deployed in digital libraries domain. This model conforms to the recommendation to create modeling tools for service systems proposed in (IfM and IBM, 2008). We conclude with a brief proposal of presented reference conceptual model with goal-oriented techniques combination, which might provide inspiration for further work with value proposition.

To get closer to introduction of our service-oriented conceptual modeling approach, however, as it is primarily focused on relationships instead of objects, let us begin with a brief introduction to context-sensitive relationships modeling and representation. But a motivation is needed, to be sure we do not loose reader's attention, and thus we start with a slight amendment of Service System definition.

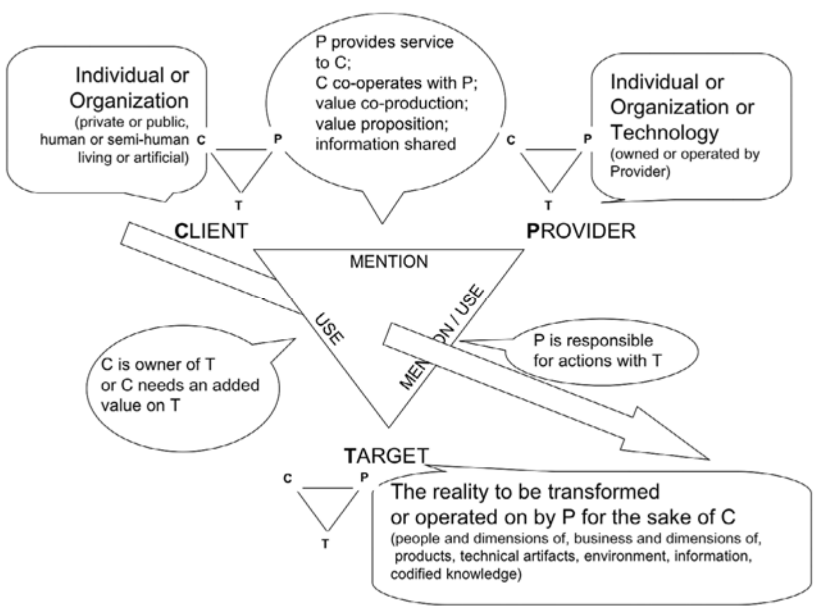
2. Service System Understanding

We define service system in compliance with Jim Spohrer definition given in (Spohrer et al., 2007). Our extension lies in a special focus on context and time aspects. The roles of client, provider and target are spread on agents involved in a service system according to a given point of view—a context. This distribution may further change during time of service lifecycle. Detailed explanation of this approach may be found in (Stanicek, 2009). Here is a brief excerption of these ideas.

Definition 1 (Service System): *Service system is a composite of agents, technology, environment, and/or organization units of agents and/or technology, functioning in space-time and cyberspace for a given period of time. There is always a lot of contexts from which the service system could be evaluated, explicated and comprehended. There exists at least one context from which the roles of Client, of Provider, and of Target could be recognized on agents or environment.*

The nature of Service System is a recursive one as is shown on Figure 1.

Figure 1 Service System Recursive Nature



The small C-P-T triangles depict this recursive nature. Any agent playing a role in the service system triangle Client-Provider-Target could be

- human being,
- group of human beings in a way organized,
- any of the previous items coupled with a technology and possibly with a piece of environment, simply a kind of organization,
- virtual, i.e. artificial, agent made from SW and/or HW components,

- any of previous items in a combination.

The Target, moreover, could be an agent or a piece of environment including a technology.
The time period of the service system "life" is not a trivial one compared to actions performed within a service provision process.

The following characteristics exemplify the nature of service system:

1. The Client-Provider connection covers the following sharing and actions between both agents
   - information sharing,
   - knowledge sharing,
   - work sharing,
   - risk sharing,
   - product sharing,
   - negotiations between them,
   - value proposition establishing,
   - repetitive reviewing the previous items.

2. The Client-Provider connection is about consultation, negotiation, planning, ideas and plan development, simply its nature is *mention* mode.

3. The Client-Target connection expresses a kind of ownership which could be
   - the Client owns the Target,
   - the Client owns rights to use and/or manipulate the Target,
   - the Client owns problem the solution of which could be performed by operating on or transforming of the Target.

4. The Client-Target connection expresses that the Client uses in a way the Target. This connection is about life, about putting into practice. Its nature is *use* mode.

5. The Provider-Target connection expresses a kind of competence. It could be
   - the Provider knows and is able to operate the Target,
   - the Provider knows and is able to transform the Target,
   - the Provider understands the Target and is able to plan for operation on or transformation of it.
   - The Provider improves in a way the Target for its better utilization by the Client which means a benefit for the Client.

6. The Provider-Target connection is about project or program of projects the goal of which is to improve Client's using of the Target. Thus its nature has to be both, the *mention* mode and the *use* mode.

Service system is a very fruitful concept. Lot of business situations could be better understood using this concept. Typical situation in which service system concept brings better understanding is project management and program management, where program is meant as a portfolio of projects connected by one set of shared goals. Another such situation is a complex information support of a company or of a group of co-operating companies.

Thinking deeply about a particular business situation, one challenging question arises: what is better to describe as one service system with several contexts, and what is better to describe as two or more service systems, each with one context, in some way connected or co-operated together. In other words, the question is: are there criteria according to which we can decide which of these two ways (one complex service system or several simpler service systems) is better, or is it a pragmatic decision only? This issue is challenging but very complex and unsolved, currently. One possible approach to this problem, of course not complete one, we propose in the next sections.

3. Reasons for Context-sensitive Relationships Modeling

Let us illustrate the previously introduced context and time aspects on the smallest service system (Maglio and Spohrer, 2007), which centers on an individual as he or she interacts with others. Imagine human being as a system evolving in time – many of the qualities and interactions that were important in childhood are quite different from those important to adults. Next, consider the same human being in situations typical for a specific environment, like working in a city versus taking a mountain vacation. In all cases, the individual remains the same, we just pay different amount of attention to his/her/its different attributes, relationships and interactions, simply to different connections. If we fixed our perception of what the individual is in one chosen context at the beginning, we would probably have troubles in later interactions with him or her.

In accordance with the previous illustrations and (Stanicek, 2009), we argue that in cases such as service systems modeling, it is beneficial to concentrate on relationships rather than objects. We perceive objects just as individual entities that can be mutually distinguished, but we cannot tell anything more about them. All features and attributes are assigned to an object by making relationships between the object and corresponding attributes values. The reason for this (maybe complicated-looking) approach lies in the ability to construct compound objects differently in various contexts. This ability may prove useful, e.g., when determining relevant part of information presented by service system to a particular service client, because every service client is unique and may have different expectations what he or she would like to get. The concentration on relationships is not exclusive to our work – the relationships and interaction of system components seem to take on a key role in a viable system (Barile and Polese, 2009), and the ability to organize relationships delineates the efficiency of viable firm government (Barile, 2008).

Context sensitivity enables consistent perception of information provided by several sources – such as service client, partner or individual services. Imagine a situation when service provider receives two contradictory statements from its two service clients. Using context-sensitive approach, the provider is able to uniformly process each statement in the context of relevant client.

Furthermore, the same individual may play different roles in different contexts. The same individual may act as service provider in one service system, as well as client or target in another. If we facilitate this in modeling process, the resulting model may more naturally capture the reality of modeled system, thus allowing users of the model to concentrate on the modeled service system rather than on understanding a set of different models of the same system.

Two special aspects characterize our perception of things and of our environment in almost any context. These are attention being paid to and certainty with which we believe perceived phenomena. Attention could be imagined as a mental energy assigned to particular phenomenon in a given state of affairs. Mathematical truths are absolutely certain, physical truths are certain in our physical world, some economical and social rules are enough plausible, some business assumptions and hypotheses are less plausible. These two characteristics have to be modeled in service system description in general: in other case models of service systems get stuck on a level of machines and no added value will be produced by this new approach.

4. Context-sensitivity, Attention, Certainty—How to Model It

A service system could be very complex. Moreover, it could be very dynamic. It looks almost impossible to grasp all the complexity and dynamics in a kind of model being on one hand comprehensible and on the other hand useful.

The first question is: *What to pay attention to?* Not aiming at any particular domain, we can say the answer is each '*object*' distinguishable from any other things which is relevant to the focused domain and a pragmatic purpose in a given state of affairs.

Let's try to say what we can see when focusing on particular domain. Simply, this is '*objects*' and their '*connections*'. Then we recognize objects' and connections' changes in time, i.e. we are interested in '*operations*'. So as connections give us sense of structure, operations give us sense of behavior. To understand an object in a particular domain means to connect it into a network of known connections. Lot of such connections will be connections to other objects, other connections will connect our object to operations enabling it to understand its behavior. We can say we give semantics to an object by connecting it into a (semantics) network of known connections.

As the object could be anything we can perceive in the physical world or we can think of in the cyberspace (the space of the content of our brains and of electronically stored data), a connection and an operation can, particularly, be a focused object. Object such as *connection* or *operation* can be understood using other connections and operations to explain it. This is the recursive nature of cyberspace. We often refer to this particular property as to self-reference.

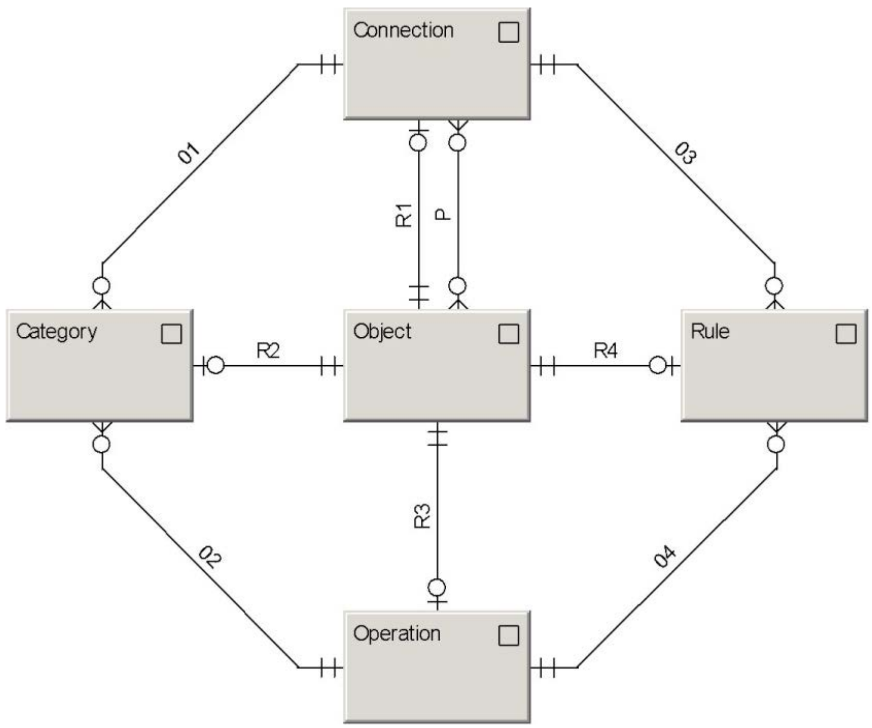
Objects can be collected into sets grouping them by common properties. This process is known as categorization and produced sets of objects are '*categories*'. A *category*, again, can be the object in focus, thus it can be self-referentially described by a model consisting of *objects*, *connections*, *operations*, and *categories*. Categories help us to distinguish between complex tangible or intangible things from the structural point of view.

But complexity is not contained in structure only. There is a complexity of behavior. '*Rules*' are the means helping us to distinguish kinds of behavior. Behavior satisfying a given set of rules is called admissible behavior with respect to this set of rules. So as category, a *rule* can be focused on and can be modeled as a focused object by a model consisting of *objects, connections*, *operations*, *categories,* and *rules*.

When speaking about or thinking of an object we '*mention*' this object by '*using*' connections, operations, categories and rules. There is a lot of possibilities how to *use* objects in the physical world: we can drink water, touch a tree trunk, go by car, exercise muscles, etc. The only objects usable in the cyberspace are: *connections*, *operations*, *categories*, and *rules*. And what is 'connection' or 'operation' or 'category' or 'rule'? These terms denote categories, again.

The situation can be synoptically expressed by a generic conceptual model – see Fig. 2 (Stanicek and Prochazka, 2004).

Figure 2 Diamond of Attention Focusing



The so called r-edges R1, R2, R3, and R4 in the model express the self-reference: a *connection* is represented by just one *object* for the purpose of *mentioning* it, and so does *operation*, *category*, and *rule*. The edge P says that a *connection* is a finite sequence of *objects*. Edges 01 and 02 express that a *category* is defined using a *connection* by an *operation*. The operation computes whether an element belongs to the category or not and does it dependently on a given connection. Edges 03 and 04 express that a *rule* is specified using a *connection* by an *operation*, again. The operation evaluates whether the rule is satisfied or not and does it dependently on a given connection.

Thus, any situation in any domain can be modeled by this 'Diamond of attention focusing' model – see Fig. 2 – for the purpose of understanding the situation and the playground of a service system. What is important is that a unique approach to the service system modeling is taken which can deal with any type of agent and which is plausible at any time point of the service system life-cycle.

Previous argumentation gives one possible answer to the first question "W*hat to pay attention to?*". However, we know that some parts of a given domain are more important than others, i.e. we pay more attention to them. There exist lots of possible points of view from which we can judge the situation and evaluate the service system behavior and service system structure. Finally, some facts are demonstrative ones, so we believe these facts with no doubts (math facts, e.g.). However, other facts are plausible ones to some measure or they are doubtful at all.

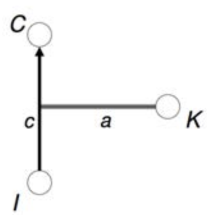
Thus the second question is: *How to distribute attention?* In other words: what is the semantics of what was seen using the 'Diamond of attention focusing' conceptual model; or: what can we recognize? Again, not aiming at any particular domain we can say we recognize '*items*'. An '*item*' is each '*object*' from Fig. 2, and vice versa. Some of these items are in a sense prototypes or marked items. They serve as hooks to which other items can be hooked. We are used to hook such items that are in a sense similar to the given marked item. Lakoff in (Lakoff, 1990) calls this process categorization and he speaks about prototype categories. We will refer to these 'hooks' as to '*categories*'. Then the most important thing we can recognize is whether a given *item* belongs to a given *category*. In alignment with Lakoff's approach we recognize a measure of certainty *c* with which the given item belongs to a given category. The measure of certainty *c* ranges over the real numbers interval <-1, 1>. If the item *I* belongs to a category *C* with c = 1, then we say it definitely belongs to this category. If the item *I* belongs to a category *C* with *c* = -1, we say it definitely does not belong to this category. If the measure of certainty is *c* = 0, we cannot decide about the item *I* and the category *C*. This means we know nothing about *I* with respect to *C* in a given state of affairs. But we know that in other state of affairs this can change. The fact that *I* belongs to *C* with a measure of certainty *c* we call elementary fact or *CI-connection* and we denote this by a triple (*I*, *C*, *c*). Note that while *item* is a synonym for *object* of the diamond from Fig. 2, the *category* is the same object as in Diamond of attention focusing, only defined in other way, and the *CI-connection* is a special case of general *connection* of this Diamond.

We referred to a state of affairs when explaining *CI-connection (I, C, c)*. Note that we didn't use this not clear and considerably vague concept in definition. But to continue and to explain the attention which we pay to a particular *elementary fact* (*CI-connection*) depends on this vague concept 'state of affairs'. Let's introduce a term '*context*' which we consider for a moment intuitively to be a particular state of affairs. Our recursive definition continues as follows: we say that the *CI-connection* is *manifested* with an *attention a* in a *context K*. The *manifestation* is a pentad (*I*, *C*, *c*, *K*, *a*) and it is the basic cognitive operation. We call it *elementary belief*. It is a special case of general *operation* of the diamond from Fig. 2.

For example, a price of a room in The Lake View Hotel in Beijing is in category 'cheap' with certainty more than 0.8 in the context of hotel room prices in most world capitals. This fact is manifested with much bigger attention when you are arriving to this hotel than in a situation you have never been to Beijing and do not consider visiting it in the next two or three years. But in the context of a rural Chinese inhabitant the same price is in category 'very expensive'.

A question remains: and what is the "context" exactly? We finish our recursive definition this way: The *context* is a sequence of *manifestations*, the so called "T-s", see Fig. 3. This means that a *context* is formed by a set of elementary beliefs. The *context* rules us to evaluate situations in the world—in physical space or in cyberspace. In this sense the *context* is analogous to the *rule* of the diamond from Fig. 2.

Figure 3: Elementary Belief: Manifestation of Elementary Fact in a Context



Each *CI-connection* or *category* or *manifestation* or *context* can be, similarly as in the Diamond of attention focusing, an *item*. Hence, the recursive concept of 'T' enables to model anything which can be classified in a category within a context. Potentially infinite hierarchy of more and more complex items (i.e. objects) and more and more complex contexts can be obtained, all of them measured as a whole or part by part by a measure of certainty and by paid attention. Note, that the most simple *contexts* are contexts of the form {(*I*, *C*, *c*=1,   , $a=a_{max}$)}, where *I* is an *item*, *C* is a *category*,   is the *empty context*, and a_{max} denotes maximal attention that can be paid to the fact that $I \in_{c=1} C$. More theory on these "T-s" will be found in (Stanicek, 2009).

The "T-s" help us to model certainty, attention and context-sensitivity. Together with the Diamond of attention focusing this help us to model connections and to build or to re-build objects in particular contexts based on these connections.

5. Reference Conceptual Model of Service System Behavior

Taking into account the holonic nature of service systems, i.e. the fact that service system can be viewed as a part of another bigger service system and at the same time this service system can be viewed as a whole composed of smaller service systems, and taking into account the fact that we, human beings, are also service systems, we can conclude: when modeling service systems, we need to be able to record

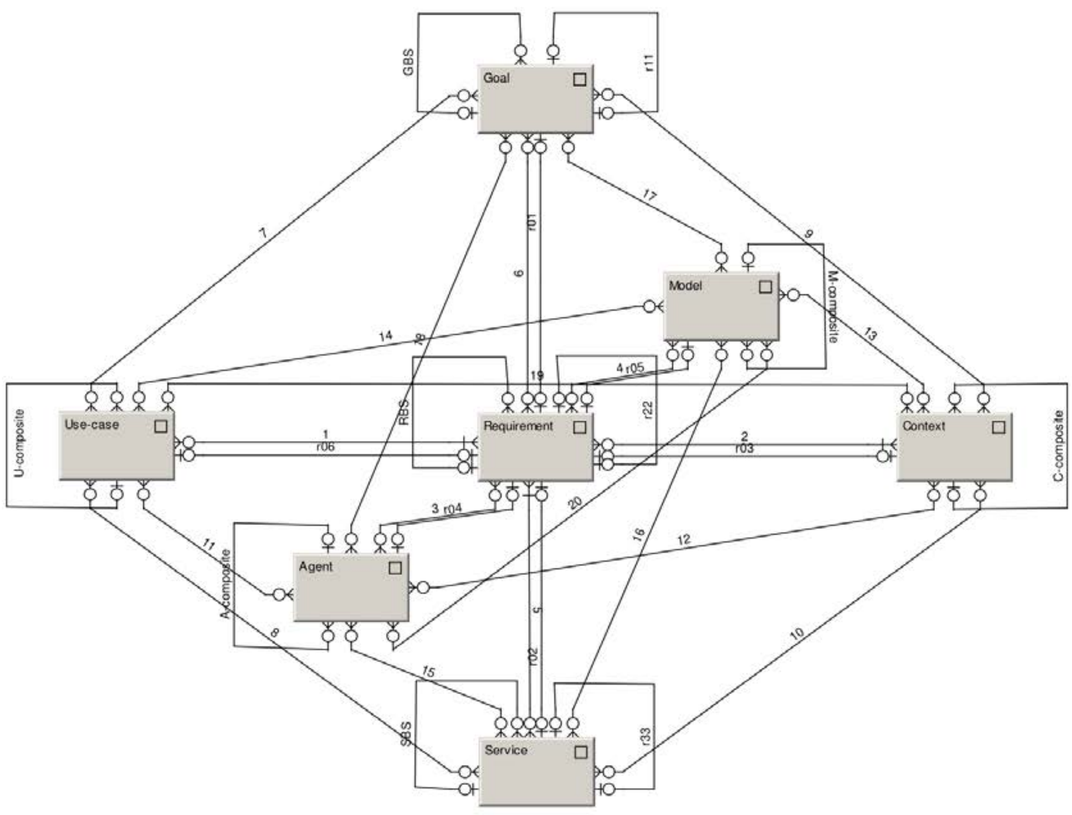
- connections
- contexts
- certainty
- attention
- composites of the previous mentioned

and to be able to revise such models, accordingly to world changes.

Provided that service systems are primarily business systems, we are interested in such models of service systems, in which *services* are sought to fulfill a set of *requirements*, where the sets of requirements are heading to some *goals*. The whole "game" is played within a *context* with a set of *agents* (natural or artificial ones) involved in, can be described by some *use cases*, and anything of the above mentioned can be remembered again in a form of *models*. This led us to development of a generic conceptual model for service systems.

The diagram of this model is shown on Fig. 4. This model conforms with previously presented service system definition and provides uniform top-level view that can be applied to any service system. We believe that thinking about service systems by means of this model can help us perceive particular service systems uniformly in terms of one framework, which may be rewarding, for example, in composition of complex service systems from several others. Since complete model description is outside the scope of this paper, we are going to focus on the most interesting parts. The model with complete semantics will be published in book (Stanicek, 2009) as "Diamond of Predictive Behavior".

Figure 4 Diamond of Predictive Behavior



The features of a service system that are accentuated by this model, could be summarized as follows: *Service system has to be autonomous, co-operative, composeable, and adaptive. To be useful, its behavior has to be predictive and oriented in various contexts. This means it has to be able to identify and deliver services achieving given goals in conformity with particular requirements and domain or context specifics. It should "understand" use-*

cases describing typical or important situations. It should "communicate" and "co-operate" with agents in the game involved. And finally, it should "remember" relevant structural connections and behavioral operations in a form of such models which are context-sensitive, attention aware and certainty-sensitive (Stanicek, 2009). Fig. 4 depicts such a generic model which we propose as a reference model of service system.

We start the description with *Requirement* category, the other categories from Fig. 4 follow immediately. Names of categories are written in form "(#category name)" for the sake of unambiguity.

Since service systems are built upon provider-consumer interactions and we want to maintain these interactions (and therefore whole system) *viable*, one possible option is to support predictive behavior by the model. We believe that realizing and meeting requirements is key element of predictive behavior, therefore we need to capture requirements in the model: *Object from the category (#Requirement) is every singular documented need of what a particular product or service should be or do.* It is a statement that identifies a necessary attribute, capability, characteristic, or quality of a system in order for it to have value and utility to a user.

In order to further support system prediction, it is desirable to assign requirements to goals that will be fulfilled by particular set of these requirements. *Object from the category (#Goal) is every formulation of a required state-of-things more or less definite.* By the term "definite" we mean that it is possible to clearly recognize whether the required state is achieved, there is a possibility to measure parameter values of the required state and it is possible to determine a time point of the desired state achievement. The less definite formulations belong to *needs*. Formulations expressing orientations only belong to *goals*. Really definite formulations belong to *objectives*. The *needs – goals – objectives* hierarchy is maintained by the *GBS* (goal breakdown structure) connection in the model (see Fig. 4).

Since survival of modeled system will depend on its ability to satisfy its requirements, we are interested in modeling the phenomenon of requirement satisfaction – and in case of service systems, we perceive this requirement satisfaction as the act of successful delivery of a service: *Object from the category (#Service) is a complex answer to a goal expressed in terms of accomplishment of appropriate requirements arising from a registered need/goal/objective.* Abstracting from the Clients benefits we can speak of *solution*. So, service is a solution bringing benefits to its Client. Note that according to Wikipedia, *solution* is a product, service, or combination of both which is said to solve a business or consumer's problem. *Service* can be connected to the above mentioned *goal* through appropriate *model* or through appropriate *use-cases* or through *agents* or through *contexts*, or, simply, through a set of *requirements*. Service can be composed of other services. Service can be both planned and already existing in the modeled system.

The three categories *Goal*, *Requirement* and *Service*, along with their interconnections, capture the information about recognized goals, which the system tries to achieve through formulating requirements, which can be fulfilled by specific services. These categories capture the more intangible aspects of modeled system and they form the vertical axis of model diagram (see Fig. 4). Let us now describe the tangible aspects of a service system.

As requirements should be addressed to somebody or something, a service system should be aware of its partners, clients or other important entities. Therefore we introduce *Agent* category: *Object from the category (#Agent) is every agent acting on the market, which is autonomous and co-operative in a sense of holonic approach and to which attention can be reasonably paid.* We are interested in partners who are customers or suppliers or cooperators or other way involved in the "life process".

Next, we need to keep track of current, past and planned states of requirements elaboration, to further support predictive behavior. We need some kind of "memory" of the service system, which can be seen as a collection of populated models. Examples of such models include conceptual models, organizational models, process models, business models, deployment models, and others. *Object from the category (#Model) is every formalized model (with prescribed properties) or record or description enabling to remember anything important from the point of view of any element or any part of the described Diamond of predictive behavior.* Usually the record is done in terms of business potential of the service system technologies utilization.

In order to more appropriately describe requirements and eventually formulate value-proposition, we need *Use-case* category: *Object from the category (#Use-case) is every fixation and combination of the functional requirements that adds value to relevant business. Use-cases*, stated simply, allow description of sequences of events that, taken together, lead to a system doing something useful. In other words, they express a contract on system behavior.

Every action takes place in some environment or context. This context is usually crucial for appropriate interpretation of information and knowledge associated with the action or whole situation. *Object from the category (#Context) is every domain or application field of human proceedings that can be supported by a service system.* Domains are chosen pragmatically according to their business potential. Domain or application field can be recognized according to existence of a conceptual data model describing this application field.

The categories *Agent*, *Model*, *Use-case* and *Context* form the horizontal "plane" of the model diagram (Fig. 4) and represent more "tangible" entities involved in service system behavior. Next, let us combine this model with previously introduced context-sensitivity. We can assign contexts for example to individual service systems and then naturally compose more sophisticated service systems by combining information from relevant contexts. Another application of contexts may be modeling of intersection of several service systems. Two service systems can intersect in their targets, service providers and service clients. Then we are able to look at the intersecting agent, which is always the same for both service systems, in context of any of the systems and thus see the important features of this agent that are relevant just for that particular system. Finally, using contexts, we can naturally work with an agent playing the role of service client in one context and the role of service provider in another.

As was already mentioned, the presented model describes a uniform framework for thinking about service systems. We are convinced that such a tool helps its users to focus attention on important aspects common for most of service systems. In the next part, an example of concrete system will be given, as well as its mapping to the presented framework.

6. Framework Application

This chapter illustrates the previously introduced framework application to already developed and deployed service system operating in digital libraries domain. The system provides service of measuring the utilization of electronic information resources (such as journal collections) in university environment (Smerda and Findeisova, 2009). The acquired information is then used by university librarians for determining which information resources are actually utilized, hence the university should purchase them for another time period, and which resources are used so rarely that another purchase would only mean a waste of money.

Let us now describe this service system in terms of introduced framework; however, we shall not describe all aspects of the system in full detail.

Need (category #Goal)

First we have to understand what problem is to be solved. Sometimes we start with requirements, in other cases we start with needs. This is the second case.

N1: University periodically rents access to many electronic information resources, such as journal collections, which are then made accessible to students, teachers and other university staff. Since purchasing access to such resources is an expensive transaction and some resources are getting even more expensive, university librarians would like to ensure that purchased resources are utilized efficiently. However, the librarians are not provided with sufficient feedback from resources utilization, which would enable them to make more accurate estimates.

Requirement

To understand deeper the librarian needs, requirements are collected. Some of them could be:

R1: Electronic information resources utilization is reported periodically and/or on demand.
R2: Reports should reflect real behavior as closely as possible.
R3: Reports are to be made accessible to every university librarian.
R4: Reporting service must not gather any personal information or otherwise invade privacy of any electronic information resources user.
R5: Reports are detailed up to individual departments, institutes and other units.

Goal

The requirements together with needs description form a basis for goal formulation. The goal has to be formulated such way that the value proposition of the service can be easily derived in terms of customer benefits.
G1: University librarians are provided with relevant information to be able to decide which electronic information resources are worth purchasing.

Objective (category #Goal)

Goal has to be materialized into one or several objectives which are specific, measurable, acceptable, realistic and time limited. A reduced example is:

O1: University librarians are daily provided with relevant reports on electronic information resources utilization.

Service

The service delivered by this service system is represented by the following value proposition:

S1: *Using this service, university librarians are able to save money spent for renting of electronic information resources by their university, in accordance with the actual usage of information resources by university people.*

In addition, a more detailed variant of value proposition containing references to other model elements can be given: *Currently, university librarians are not provided with sufficient feedback from the usage of electronic information resources rent by the university, and consequently they are forced to make decisions based only on their qualified estimates (N1). This system gives to university librarians the ability to decide which electronic information resources would be valuable to rent (G1), based on the amount of actual usage of information resources by the target university department or institute (R1, R2). The system measures and generates reports on the amount of specific network traffic between target and information resource providers (O1). Since NetFlow standard does not provide the actual information being transmitted, user privacy is not compromised (R4). Produced reports are periodically published on university Intranet (R3). Moreover, experienced librarians may employ provided information to discover illegal use of an electronic information resource.*

After presenting this intangible axis (Requirement – Goal – Service), we are going to describe the more tangible environment of it. We start with *agents* and then continue to *domain*, *use-case* and *model*.

Agent

Involved agents include university subjects, whose accesses are to be measured, information resources, information resources providers, involved university librarians and finally the system itself. One possible distribution of agent roles is the following:

1. service client – university librarians responsible for information resources management
2. service provider – university department of digital libraries
3. target – collection of service systems, whose utilization is being measured. In the measured systems, service providers are the providers of electronic information resources, service clients are the university people accessing those resources and finally the targets are the information resources. This example illustrates service system recursive nature mentioned in service system definition amendment.

Context

In practice, it is not convenient to describe a context by providing a list of elementary beliefs. We simply use description in natural language. The domain of modeled service system can be composed of the following particular contexts:

C1: Efficiency of particular electronic information resources available at the university.
C2: Previous experience of university librarians with using particular information resources.
C3: Utility of particular electronic information resources for students.
C4: Utility of particular electronic information resources for professors.
C5: Economic requirements of the university.

The information related to the first context is likely to be derived from or at least influenced by the contents of the remaining contexts. Usually, there is no single "correct" distribution of contexts across a non-trivial domain; however, discovered contexts help us to model the "interface" of modeled system to its environment. In addition, the quality of this "interface" strongly reflects the viability of the modeled system.

Use-case

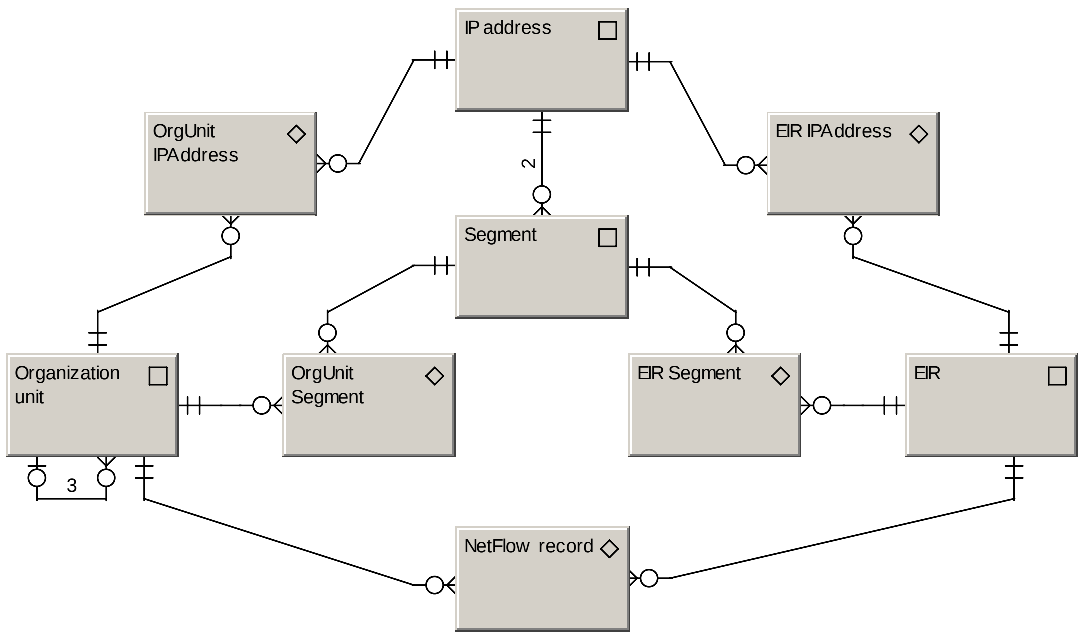
More specific system behavior definition can be made by providing a collection of use-cases. Possible use-case for the presented system follows:

U1: University librarian decides which electronic information resources purchase should be renewed for another time period. He or she evaluates the amount of utilization of all information resources in question. Based on this evaluation, the librarian is able to select those resources that have been utilized by the university during the last period because they are very likely to be utilized again.

Model

Although the system can be described by models of various types, conceptual modeling is our primary concern in this paper, thus we present only a part of conceptual model of digital libraries domain (see figure 5). The model describes entities such as EIR (every Electronic Information Resource) and Organization unit (every unit whose accesses to EIRs are to be measured). However, the core of the model lies in NetFlow record entity, which models every connection with the following semantics: *The tuple (frequency, amount) of access of given (#Organization unit) to given (#EIR)*[1]. Please be aware that all remaining connections have similarly defined their semantics in the original model. The IP address and Segment entities capture information technically necessary for correct assignment of NetFlow record source and target to EIR and Organization unit.

Figure 5 Utilization of Electronic Information Resources Conceptual Model



Since service systems often involve provider and client cooperation in order to create value, and mutual cooperation is more likely to be successful, when solution is described in terms comprehensible for both, provider and client, conceptual models appear to be more important for service system design compared with product design. Conceptual models capturing semantics assist in consistent understanding of service domain to provider and client. Another benefit of modeling with semantics lies in easier management of service system changes during system evolution in time.

7. Goals Modeling for Service Systems

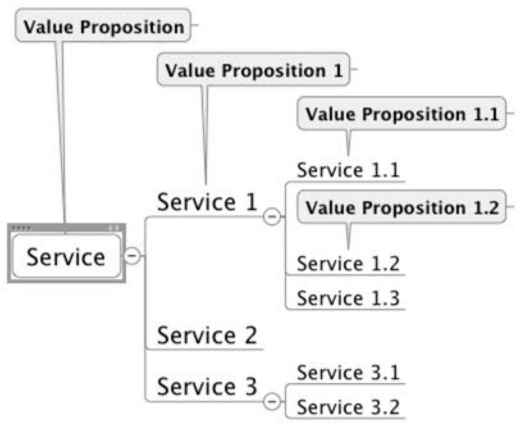
There are established goal-oriented requirements engineering techniques (Lamsweerde, 2001) and goals are being used for identification of individual services in the goal-service modeling method patented by IBM (Ang et al., 2008). These approaches conform to our proposed conceptual framework, as it allows describing goals refinement as well as requirements and use-cases derived from individual goals (see Fig. 4).

Customers are not buying goods or services but value propositions (Gummesson, 2007) (Vargo and Lusch, 2004). According to (Maglio and Spohrer, 2008), the key to understanding the nature of sharing arrangements among entities within service systems lies in the distribution of competences and the value propositions that connect entities. These statements illustrate the importance of value proposition and we believe that further elaboration of modeling the semantics of value proposition using tools such conceptual modeling and reference conceptual model of service system behavior (Fig. 4) in combination with goal-oriented methods may prove fruitful.

[1] names of descriptive sets and entity sets are enclosed in parentheses, entity sets are marked by the symbol #

Goal-refinement graph provides useful connection between (verbose) value proposition and individual services. The graph can be transformed into so called *service breakdown structure (SBS)* (see Fig. 6), inspired by *work breakdown structure (WBS)* defined in project management (PMI, 2008). Explicit connection of services and goals with partial value propositions adds structure to information provided by value proposition. SBS enables for instance traceability of value proposition parts that may be affected by unavailability of a particular service. SBS is modeled in the reference model of service system behavior as self-referential connection of (#Service) category (see Fig. 4).

Figure 6 Service Breakdown Structure



The main difference of service breakdown structure from work breakdown structure can be described as follows: WBS is a hierarchical decomposition of the work that is to be done, its elements are deliverables and activities; on the other hand, SBS is a value proposition-oriented hierarchical decomposition of the service that is to be delivered, its elements are services and value propositions. In other words, SBS defines how particular (sub)services participate in delivering of intended service (the root node in Fig. 6) from the perspective of value proposition. The same subservices might be involved in provision of other services as well, therefore a concrete SBS describes the participation of individual subservices only in the context of a particular root service.

To conclude, we believe that SBS can provide means for systematic recording of value propositions, which may be utilized by semi-automatic tools assisting for instance in further composition of services, matchmaking of services (service brokering), and finally monitoring service compliance with particular service level agreements (SLAs).

8. Conclusion and Future Work

According to presented findings, conceptual modeling can provide common language for service provider and client. Goal-oriented methods bring the possibility of linking parts of value proposition with corresponding partial services. The nature of service provision, i.e. value co-creation, requires that service provider and client understand each other, in other words, they speak in terms of mutually shared conceptual system.

We have introduced amended service system definition focused on context and time aspects and described context-sensitive relationships modeling approach, which leads to modeling framework (reference conceptual model of service system) that provides uniform top-level description of service systems. In future, we plan to compare this model to other known reference models and frameworks, such as (Alter, 2008). We have illustrated the framework application on utilization of electronic information resources service example. We believe that thinking in terms of this framework helps to concentrate on different aspects of service systems, especially complex ones.

The reason for application of conceptual modeling to the domain of service systems originates from the high complexity of this domain. Plain description of a service system leaves too much room for intuition and experience of the description reader. Consequently, the produced service system description is often misunderstood. The reference conceptual model of service system behavior presented in this paper reduces the amount of vagueness by providing basic concepts that a service system description can be built upon. Next, this reference model allows more explicit work with contexts than usual. It also supports services composition and decomposition by means of service breakdown structure. These two features provide knowledge useful for improving service reusability.

Finally, we have proposed combination of goal modeling techniques, introduced framework and service breakdown structure, which leads to interconnection of value proposition and corresponding hierarchy of services. Further research will be focused on modeling value proposition semantics in order to systematically support verification of the fact that modeled system fulfills given value proposition.

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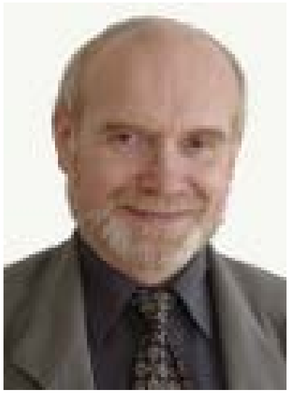

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