Collaborative Ontology Development in Real Telecom Environment

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Abstract: In this paper, we discuss the use of ontologies for semantic business process management. In particular, we address system and process integration challenges encountered in the real world, based on the example of the telecom domain: Internet-based telephony service (Voice over IP). Various aspects of ontology development are covered including relations to industry standards, ontology creation methodology and practice determined by telecom-specific aspects. Based on the use case example and the YATOSP framework, we ar-gue that the economical justification of the development of domain ontologies, due to their complexity and numerous dependencies, is not straightforward.

1 Introduction

Although it is already more than a decade that ontologies and related technologies have drawn the attention of researchers and practitioners a relatively poor adoption rate in the real business can be observed. By business adoption we mean the application of ontologies in real, say, production environment and exploitation within everyday business process management in both design and run time. Some recent analyses [He07], [Ob03], [FGD02] deal with the issues related to ontological prospects and possible applications in the world of loosely interoperable systems.

In the paper we bring into the light the real world example from the telecom industry – creating a domain ontology on the basis of available telecommunications standards, on the one hand, and, the business knowledge represented by practitioners from the industry, on the other hand. We argue that this collaborative approach, reinforced by using a complex use case, such as the Internet telephony in our example, may lead to the creation of a well business-adoptable ontology. The use case is discussed in the aspect of ontological engineering for the demanding, fast changing telecom environment. The paper is organized as follows: in the first section the example use case: the Voice over IP service (VoIP) and the telecom business process of handling it is presented, together with some general specification of the heterogeneous IT environment in which it is to be implemented. Then we focus on the ontology development lifecycle and intro-duce the telecommunications, industry-wide standards and the YATOSP concept – a new telecom ontology and process framework which is addressed in the aspect of real ontology development, followed by a showcase of collaborative work on ontology creation. We conclude with addressing ontology adoption constraints observed in the telecom use case, in relation to [He07].

2 Telecom Business Process

Before we start penetrating the methodology of collaborative ontology development we would like to describe in greater detail the process of deploying the VoIP service. The handling of this process from the perspective of a telco provider involves various business departments and IT systems. This complexity makes it a good example of motivation to build ontologies and work towards implementing semantic integration of IT systems, on the one hand, and, on the other hand, it is a practical use-case that may help in analyzing the telco environment and creating a business-adoptable ontology.

2.1 Voice over IP

VoIP (Voice over IP) telephony service, is a modern service realized in a complex telecommunication IT environment through many different IT systems. With this service customers can establish and answer IP calls provided that they have a broadband internet access with a minimum bandwidth of 256kbit/s.

2.2 Heterogeneous Environment

To handle the process of deploying VoIP telephony, and efficiently support the fulfillment, assurance and billing processes the provider – Telekomunikacja Polska (TP) with over 10 million subscribers must have a very advanced IT infrastructure A short architectural characteristics of the TP infrastructure (only most important systems) in the customer care domain may be viewed as follows:

- Contact Center (handling phone calls, e-mails, faxes etc.), it is a very advanced solution including Interactive Voice Response system, Automatic Call Distribution and Computer Telephony Integration.
- Centralized Customer Relationship Management (CRM) system which incorporates data of all TP customers from all segments. CRM is responsible e.g. for customer data management, customer interaction management, after sales and order management
- Centralized billing system, which is responsible for accounting and payment processes of TP customers' services.
- Order Management system which is responsible for technical realization of service orders for internet products.
- Enterprise Application Integration (EAI) layer, which connects all systems in an integrated environment.

Managing such a complex IT infrastructure is a big challenge, especially because of the high cost and the long duration of implementing changes in business processes executed in such an environment. The need for creating new business processes or introducing new services results in significant changes in many, of the above mentioned, systems. Development of new releases of the integrated environment involves many resources and takes plenty of time. This situation is very disadvantageous in nowadays' extremely competitive telecommunication market, where every enterprise must be able to quickly change processes and resources to address market opportunities and competitive pressures. The industry's mainstream response to the above needs and challenges is the Service Oriented Architecture (SOA) [SOA07], which intensively exploits web services (WS) technology [Kr01]. However, although it is widely adopted in IT systems integration, it seems not to address all of the current, abovementioned IT infrastructure and systems integration shortcomings, and thus it cannot to be treated as the final answer. The promising solution in this field should be the adoption of semantically enabled integration systems based on a domain ontology.

2.3 The Voice over IP activation process

To further justify the need for implementing a new approach to IT systems' integration we describe below the details of the activating procedure of the VoIP service.

The process of activating the VoIP service for a particular client begins when a customer calls the TP Contact Center called 'the Blue Line', then the call center agent verifies the data provided by the customer in terms of technical and formal issues. The agent subsequently creates a particular case in the CRM system and passes it to the Back Office for further processing. The Back Office agent is responsible for placing of this order in the Order Management system. Then the Order Management system processes the order: generates a service contract for the customer, and sends requests with the configuration of this service to the particular Service Platform and to the Billing system.
Having described the example process and the implementation problems that arise from the today's IT architecture we may pass on to the basis of the future semantically-enabled solutions and show the proposed way of constructing an applicable domain ontology.

3 Ontology Development

The motivation standing behind the commitment of TP to the telecom domain ontology stack is the general presumption concerning semantically-enabled business process management: bringing business processes to the business level. In particular even quite basic business involvement (teamed by knowledge engineers) in the ontology creation process brings uncountable benefits in areas such as knowledge transfer among divisions and teams, product knowledge standardizing, rise in awareness of bottlenecks in time-to-market improvement, workflow management and, last but not least, the business processes management review through the whole services and products division.

Unlike most research approaches the case presented in this paper reveals the business side of ontologies adoption in practice. The following sections describe the process of ontology creation in TP, involving business units managers, bringing communication issues through terms mapping and telecom standard compliance and concluding with remarks on the process efficiency, goals and ontologies adoption prospects within a real telecom enterprise.

Before passing on to the details of TP ontology creation experience as part of the telecom domain ontology framework in the SUPER project[1], we summarize ontology development principles assumed for the whole project. Related methodologies and literature is referenced as are the related telecom domain industry standards.

3.1 YATOSP

A unique example of semantic reference framework in the area of the telecommunication business processes is the YATOSP (Yet Another Telecom Ontology, Service and Process framework), which is based on the Tele Management Forum (TMF)[2] standards and experiences gathered from telco enterprises. The motivation of the initiative has risen from the quickly changing environment of enterprises which face a huge amount of data and provide more and more complicated business activities that imply even more composed business processes. In [Su06] there are reasons pointed out for undertaking the initiative: deregulation, globalization and dramatic communications breakthroughs, among others, which are shifting enterprise boundaries in fundamental ways. The YATOSP represents a Semantic Framework for telecommunication services and processes. The work on developing the YATOSP will be heavily based upon the TMF NGOSS framework which is described in detail below. It is going to provide a set of reference processes. Eventually we will be able to semantically annotate custom business processes. If successfully accomplished, the YATOSP framework is expected to serve as the reference framework for process automation with the use of semantics. In-company processes would be identified and annotated with proper generic standard processes what may ensure easy process discovery, composition and monitoring. TP is one of the use case partners contributing to the development of the YATOSP framework. In further

[1] See part 6 - acknowledgements
[2] www.tmforum.org

sections the underlying industry standards are briefly depicted and subsequently we reference our industry-side experiences and contribution.

3.2 Related standards

The development of generic ontologies for the telecommunication domain is based upon the TMF standards. Having been founded by the major telecom market players and contributed to by experts in the domain, the forum commits its efforts to practical solutions of improving the management and operations within the information and communications services. In following sections we briefly introduce standards used in the framework used for ontology creation.

3.2.1 NGOSS

NGOSS (Next Generation Operations Support Systems) is the TMF initiative to drive efficiency in and cost out of the operation of the telecom networks [TFn04]. It enables service providers to change the way they think about their business and operations, since they are positioned with a repeatable process for automation of complex operational tasks and it gives vendors the most effective open interfaces in the industry today.

NGOSS is a comprehensive, integrated framework for developing, procuring and deploying operational and business support systems and software. Through its integrated system of business and technical elements, it allows Operations / Business Support Systems (OSS/BSS) to become interoperable like never before.

It is available as a toolkit of industry-agreed specifications and guidelines that cover key business and technical areas including, among others:

- Business Process Automation delivered in the enhanced Telecom Operations Map (eTOM™)
- Systems Analysis & Design delivered in the Shared Information/Data Model (SID)
- Solution Design & Integration delivered in the Contract Interface and Technology Neutral Architecture (TNA)

This approach enables all players in the OSS/BSS supply chain to use elements appropriate for their business but with the confidence that they all fit together with a reduced level of ‘integration tax’.

Although NGOSS addresses several areas, in this paper we would like to focus on the eTOM, and SID which are described in detail below.

3.2.2 eTOM

The Enhanced Telecom Operations Map® is the ongoing TMF initiative to deliver a business process model or framework for use by service providers and others within the telecommunications industry [TFe04]. The eTOM describes all the enterprise processes required by a service provider and analyzes them to different levels of detail according to their significance and priority for the business. For such companies, it serves as the blueprint for process direction and provides a neutral reference point for internal process reengineering needs, partnerships, alliances, and general working agreements with other providers. For suppliers, the eTOM outlines potential boundaries of software components to align with the customers' needs and highlights the required functions, inputs, and outputs that must be supported by products.

The eTOM Business Process Framework represents the whole of a service provider's enterprise environment. The Business Process Framework begins at the Enterprise level and defines business processes in a series of groupings. The Framework is defined as generically as possible so that it is organization, technology and service independent and supports the global community. At the overall conceptual level the eTOM can be viewed as having the following three major process areas:

- Strategy, Infrastructure & Product covering planning and lifecycle management.
- Operations covering the core of operational management.
- Enterprise Management covering corporate or business support management.

In the scope of the YATOSP and the usage scenario in TP we focus only on the business processes from the area of operations.

3.2.3 SID

The Shared Information/Data (SID) model provides a common language for communicating concerns of four major groups of constituents represented by four NGOSS Views [TFs04]. Combined with the eTOM business process and activity descriptions it is possible to create a bridge between the business and Information Technology groups thereby providing definitions that are understandable by the business, but are also rigorous enough to be used for software development. In short, The SID provides the NGOSS information model that is a representation of business concepts, their characteristics and relationships, described in an implementation independent manner.

The benefit of using the NGOSS SID and its common information language is that it enables benefiting from cost reduction, quality, timeliness and adaptability of enterprise operations, thus allowing an enterprise to focus on value creation for their customers.

3.3 Ontology Development Lifecycle

Having introduced standards that constitute the foundation of YATOSP framework we focus subsequently on ontology development-related issues, i.e. design lifecycle and methodology lying behind our work.

In [HJ02] the role of ontology commitment is underlined and clear distinction made: on the one hand, there is the ontology itself, which specifies concepts used in a domain of endeavor, concepts whose existence and relationships are true by definition or convention. On the other hand, there are empirical facts about these concepts and relationships. They are not part of the ontology, although they are structured by the one. They are subject to context, observation, testing, evaluation, or modification. An ontology commitment is seen as the agreement by multiple parties (persons and software systems) to adopt a particular ontology when communicating about the domain of interest. It was clearly pointed out that in the case of lack of ontological commitment, it is difficult to converse clearly about the domain and benefit from knowledge of others. That is why the development of an ontology should proceed with ensuring that its potential users will find its characterizations to be sufficiently complete, correct, clear, and concise. The most important implication is that working towards ontological commitment should not be an afterthought, but an integral aspect of ontological engineering. This contention underlies the collaborative approach to ontology design. With a collaborative approach to ontology design, development is a joint effort reflecting experiences and viewpoints of persons who intentionally cooperate to produce it. Chances for relatively wide acceptance are enhanced if these persons are diverse in the contributions they make. This helps to reduce blind spots in the ontology and enrich its content. As we try to show in the later sections this aspect of collaborative approach is implemented in the telecom ontology building initiative.

3.3.1 Principles of YATOSP Ontology Design Lifecycle

The ontology lifecycle and design methodology is described in detail in [TO06]. That approach has been accepted by the SUPER project forum for generic telecommunication framework (YATOSP) development. The telecom case, which we consider, is concerned with the development of two vertical ontologies that are the generic representation of the Telecommunications Business Domain in the scope of the SUPER project. The methodology that has been accepted to develop these ontologies is based on Methontology [GFC04]. The Domain Ontology provides, according to [SSSS01], vocabularies concerning domain concepts together with their attributes, relationships among the activities in that domain and elementary rules governing that domain. The Process Ontology is called Domain-Task Ontology and describes the terms related to generic tasks or activities, which are provided by specializing the terms in the top-level ontologies. It is possible to put all in one, global domain ontology which also includes processes. In the described case, the separation of the vocabulary of the physical or abstract entities (Domain Ontology) and the processes was considered, as a more convenient solution.

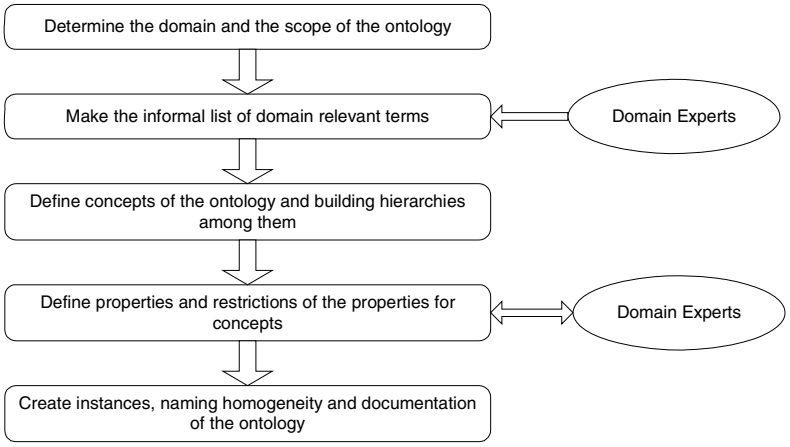

Fig. 1 Ontology development steps (to be performed cyclically)

An assumption was made to perform the above steps iteratively in the purpose of improving the quality of the ontology in each step. It is heavily recommended to use quality measures like version controlling and validation. The integrity of the ontology must be revised for each fixed version. It is a good practice to make an exhaustive list of terms from the domain with the help of domain experts. The terms are used as concepts of the ontology, attributes or instances. We assume the On-To-Knowledge methodology [SSSS01] for this phase of the development process. On-To-Knowledge recommends obtaining a list of main domain concepts and relations together with their natural language descriptions by means of brainstorming sessions with domain experts. Each term will be described by its name, with a description of it, attributes and some remarks of the ontology engineer that are focused on the modeling.

Three different methods can be used to define the hierarchy of the concepts: top-down: where the general concepts are first specified, going down in the hierarchy until one reaches the most specific concepts of the domain, bottom-up which is the opposite strategy, that means the lowest level concepts are specified first and then the concepts are generalized and a combination of which is a mix of the previous two methods.

In the following section we depict the ontology lifecycle in practice, presenting terms mapping for TP use case ontology development.

3.4 Telecom Ontology – Terms Mapping

For the design of telecommunication ontologies several rules were established to construct the hierarchy of terms, i.e. regroup synonyms together, avoid cycles, comparability of brother concepts, number of children between 2 and 12.

The comparability of brother concepts, means that the concepts of the same level must be at the same level of detail. In most of these cases, the number of children of a concept should be higher than one and less or equal than 12. A concept with only one child has no reason to exist as the hierarchy is used to distinguish between child concepts. A concept with 12 children could in most of the cases be modeled with more hierarchy levels. The above rules are only guidelines and should be applied in functions of the domain and objectives of the application.

Let us consider the example concerning 'ontologizing' the use case, i.e. the VoIP process. Figure 2 presents the rules of preparing ontological inputs based on the eTOM and SID standards. The example explains rules of extracting standard objects forthe purpose of creating ontology inputs. The rules are general and use case-independent. In the first step the relevant use case process activities are associated with the area defined in the eTOM. In this particular example (the VoIP process) the areas are: Customer Relationships Management, Supplier/Partner Relationship Management, Service Management & Operations and Billing. In the next step, accordingly with the chosen activity, the eTOM and SID concepts are identified, and then relevant ontology concepts are created. We seek after the appropriate eTOM concept in the eTOM area, determined in the previous step. According to the eTOM area, an appropriate SID domain is identified. Then the SID concept from the domain is found.

Once the first version of the concept hierarchy is defined, attributes should be assigned to each concept. The attributes whose range will be determined by instances of other concepts will form relationships inside of the ontology model. If more flexibility is needed, an intermediate concept can be created to model the relation.
Once the ontology concept is created, the description of attributes and relationships is possible. The process repeats for all determined use case activities.

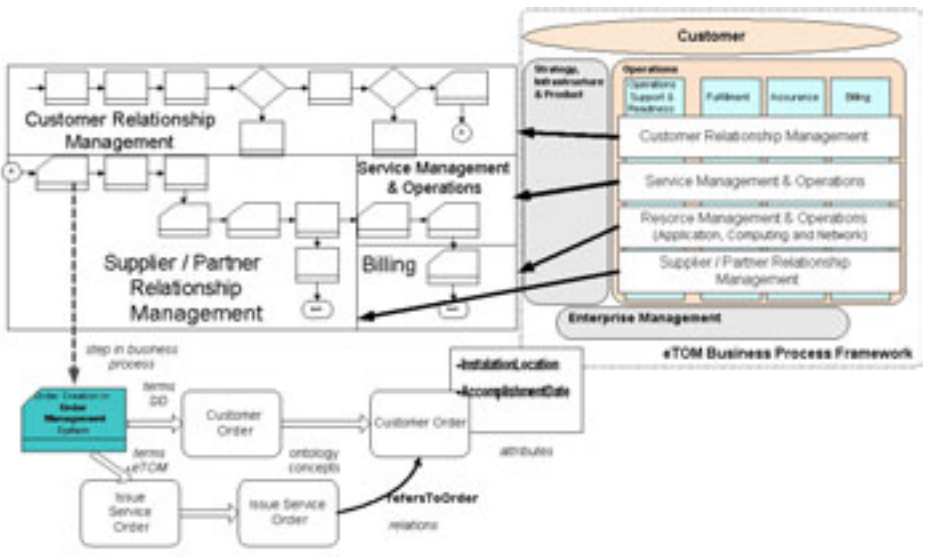

Fig. 2 Terms mapping based on eTOM Business Process Framework (Level 1 Processes).

3.5 Collaborative Development

The process of the development of the YATOSP framework is distributed among project partners. Furthermore, the tasks related to the development of the ontology are divided among ontology engineers and domain experts. The former are employees of the Research & Development Division of the telco company and the latter are specialists from business divisions. The R&D specialists work on standards for the generic part of the ontology and telco use cases that are expected to be useful in the specialization of the ontology. Use cases are chosen from telecom practice with help from business specialists.

The group of R&D specialists analyzes the standard documents concerning eTOM and SID (Fig. 3). The ontology input is extracted from those documents and aggregated subsequently in one destination resource by another group of R&D specialists. Additionally, those specialists who work on telecom use cases feed the ontological inputs with concepts from the "real" world. After the ontological inputs, prepared in natural language, are integrated, they are distributed among business specialists from the Sales Division for verification. Business specialists correct ontological inputs and afterwards they give feedback to the integration point. They are also responsible for delivering, to the use case specialists, the telecom documentation, such as process and product documentation, process maps, product catalogues. Working on those and additional documents from the IT, such as the data model, the High Level Definition and the Low Level Definition of systems architecture, allows use case specialists to develop the process in a generic BPMN notation.

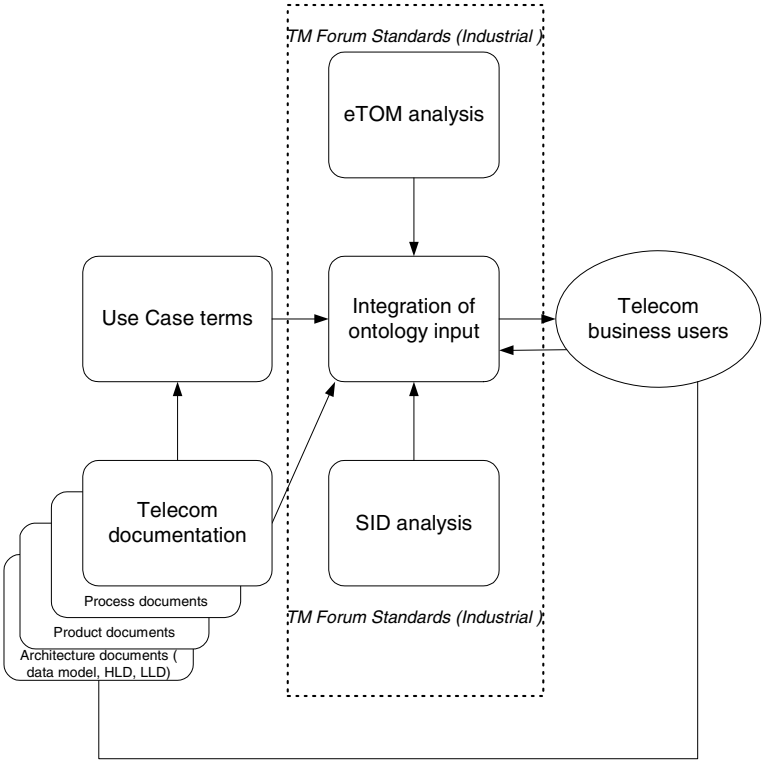

Fig. 3 Preparation of ontological input.

The integrated ontological input is eventually applied to use case processes in order to check the ontology. Integrated ontological input in natural language is transferred to ontology engineers who prepare the formal shape of the ontology, such as the WSML notation, and define mappings to other existing ontologies etc.

To summarize: the use case team may be asked for info, may ask for info and may provide info on its own as the result of a prototype analysis. Business experts may provide requirements and documentation, and may be asked for verification of deliverables. The list of deliverables may include: the list of terms, the definitions of terms, activities, attributes and relations, as well as process patterns.

4 Collaborative Environment

In addition to the experiences described in the proceeding section we would like to present our position regarding the observations concerning collaborative ontology development as well as our opinions on deploying semantically-enabled technologies in the telco environment.

In [He07] Hepp argues, that there exist serious difficulties on a social and technical level that suspend the development of ontologies and eventually constrain the space of possible ontologies. Furthermore identifies the bottlenecks, which we bring up here and compare to real world experiences of the telecommunication business.

Firstly, as Hepp asks: *is it possible for the ontology to be built and maintained fast enough to reflect quickly evolving domains?*

IIn the case of telecom ontologies sources of domain knowledge are distinguished by a significant changeability. Determinants are twofold: real in-company telecom process dynamics from the one hand, and telecom industry standards (such as TMF NGOSS) on the other hand. Both evolve quickly and are dependant on each other. In the business professionals' opinion deployment of ontologies in business processes area would require higher maturity of processes throughout the enterprise as a precondition. Furthermore a change in business and operations model would be needed, i.e. for example the separation of services and infrastructure.

The second problem Hepp points out relates to resources consumption: *is it reasonable to build a particular ontology from the resources point of view? i.e. does the gain in automation made possible by the ontology justifies the resources necessary to yield the ontology? Or, in technical terms, do the problems being solved with the aid of the ontology outweigh the problems that we must master in order to create it?*

As far as telecom ontologies are concerned, there is a huge amount of work to understand a variety of telecom systems and relationships among them, to fully identify data mappings, and analyze required processes and product documentation. The knowledge and logic are hidden right there. There is no easy way of unveiling them, but the idea of transferring the domain logic into ontology seems to be critical for innovative and responsive systems. Now logic has to be updated in many places independently, each change in product implies modifications in multiple environments of IT systems, processes and documents. In the case of ontologies there are mechanisms that allow the handling of changes in systematic way and managing them efficiently. Once again collaboration of different partners seems to be a key to success.

Moreover it is important to mention, that creating a common domain ontology may lead to the opening of the today's silo-resembling departments of the telco providers and more efficient sharing of business knowledge among them. This, together with the automation provided by the semantic-enabling of IT systems, could have a significant, positive impact on rapid product development and deployment and, in this way, result in the shortening of the time-to-market factor.

Regarding communication between creators and users (perspicuity), Hepp asks: *can the individuals using an ontology for annotating data or expressing queries easily grasp the intensions of all ontology elements as intended by the ontology creators?*

The communication between creators and users is important from the very beginning. Practitioners, such as the employees of the Sales Division and the Customer Relationship Division, process analysts, their managers, etc. should be involved in the process of the

development of the ontology. The advantage is twofold: on the one hand their help is indispensable in understanding the telecom subject and preparing ontological inputs. On the other hand, assisted by ontology engineers, they can learn to understand ontologies, as knowledge bases, already in the early stages. Subsequently they would constitute the core-team who might train other users.

5 Conclusions

In the paper we discussed the domain ontology development process applied a real use case from the telecommunication industry – the VoIP telephony service. Since the SUPER project is in early stages there are few results obtained to date, nevertheless even those already observed in TP work unveil multiple practical aspects of developing business process ontologies from not only technical, but also legal, social, organizational and economic sides.

In the paper we aimed at depicting both, problems and advantages, of the development of ontologies in a real-enterprise, preceded by an introduction to ontology engineering, founding standards and project framework.

Key factors	**Results to date**	**Problems identified**
TMF standards / lean operator	- TP is committed to standards, including active contribution and adoption - TP achieved intermediate level of the process ontology creation (covering VoIP area)	- determine the level of details to which the ontology should be drilled down from the perspective of the real business
Use case	- clear definition of area of application obtained; - established real IT platforms for the purpose of the use case	- determine and define business goals with respect to processes' activities; - apply above goals to real IT infrastructure services in TP - span the use case to mobile environment if possible
Integration of R&D and real business	- TP established cooperation among R&D and business units, e.g. sales and services - business terms verification process (internal - TP) - established and working	- analyze possibilities of incorporating semantically-oriented approach to the new product launch in TP, discussion with business and technology units

Table 1 Summary of results and problems

We characterized TP contribution to the development of the ontology stack within the YATOSP and presented the two-lane collaborative ontology development process [Table 1]. The telecom domain ontology is founded on TMF standards for business processes in the telco industry (lean operator) and domain experts' knowledge existing currently across companies in scattered 'knowledge islands'. Based on other real ontology adoption researches [He07] we distinguished threats and limitations and argued about possible ways to overcome them. A general remark is that the eventual success of semantically enabled business process management is the matter of enterprise maturity and its readiness to adapt and evolve to this approach to managing processes throughout the company.

Further work is focused on deploying in the IT environment of TP a prototype of the VoIP service. This prototype will make use of Semantic Web Services and ontologies designed within the YATOSP framework in the described, collaborative way.

6 Acknowledgments

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