Towards Semantic based Requirements Engineering

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Abstract: Requirements Engineering is recognized as a crucial part of project and software development processes. This is due to the fact that the different stakeholders involved in a development project have to establish common terminologies as well as goals, scenarios and requirements expressed using these terminologies. Within the Semantic Web initiative various standards emerged for the creation and use of terminologies, expressed in the shape of semantic networks, taxonomies and ontologies. We develop an approach for semantic based Requirements Engineering. We present an ontology for capturing requirements relevant information. Furthermore, we report about a tool for semantic based Requirements Engineering and its application in a real-world development project scenario from the E-Government domain.

Key Words: requirements engineering, semantic web, ontologies, software engineering
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1 Introduction

Requirements Engineering (RE) is recognized as a crucial part of the software development process. Recently, RE techniques were also applied to project development and management in a more general context beyond software development. The importance of Requirements Engineering was identified by several studies [Hall et al. 2002] as a critical factor for the success of project development. This is due to the fact that the different stakeholders involved in a development project have to establish common terminologies as well as goals, scenarios and requirements expressed using these terminologies.

Within the Semantic Web initiative, various standards emerged for the creation and use of terminologies, expressed in the shape of semantic networks, taxonomies and ontologies (e.g. RDF, RDF-Schema, OWL). As software and

project development projects become more distributed in the sense that spatially separated stakeholders have to be integrated in the RE and project development cycle[Riechert et al. 2006], these terminological knowledge representation standards can form a solid basis for the elicitation, representation, structuring and management of requirements relevant information. Semantic representations of requirements relevant information, furthermore, can be a crystallization point for the integration of various tools for project development (such as project management software and CASE tools).

In this paper, we present an approach for semantic based Requirements Engineering. After introducing crucial RE concepts (in Section 2) we present a semantic structure (i.e. an ontology) for capturing requirements relevant information (in Section 3). In Section 4, we report about a tool for semantic based RE and its application in a real-world development project scenario from the eGovernment domain. We conclude with directions for future work in Section 5.

2 Requirements Engineering

Requirements engineering is the part of software engineering and project development processes that deals with the requirements for a planned system. It is a cooperative and iterative process that tries to attain three goals (cf. [Pohl 1996], [Pohl 2007]):

- *Elicit and understand all relevant requirements:* RE must elicit the requirements from the relevant stakeholders or develop the requirements together with them, because they are usually not known in advance.
- *Reach agreement:* Agreement on the requirements is a prerequisite for the acceptance of a planned system. It is not given that individual stakeholders agree to all requirements expressed by other stakeholders. Therefore, RE must identify and resolve existing conflicts between the stakeholders, e.g. by discussions, votings, or decisions of distinguished stakeholders.
- *Documentation:* Different types of systems require different types of requirement specifications. For instance, safety critical systems such as a control system of an airplane require a strict and formal definition of requirements in order to ensure that the system cannot endanger human lives. Consequently, it is essential for requirements engineering to document the requirements according to the specific needs of the domain of the planned system.

A common RE approach for achieving these goals, is the use of goals and scenarios as intermediate steps for obtaining requirements. Goals describe the stakeholders intentions for the planned system (cf. [Pohl et al. 1998]). They support for example the resolution of conflicts because it is easier to reach an agreement

on an abstract goal level than on a concrete requirements level. Scenarios are exemplary descriptions of the usage of the planned system to reach a defined goal (cf. [Pohl et al. 1998]). They facilitate for example the elicitation of requirements by having stakeholders describe concrete examples of system usage. Goals and scenarios together substantially support the derivation of detailed requirements for the planned system in terms of functional as well as quality requirements (cf. [Pohl et al. 1998], [Pohl 2007]).

3 Requirements Engineering Ontology

In order to support the Requirements Engineering process semantically, we developed a *requirements engineering ontology* named SWORE - SoftWiki Ontology for Requirements Engineering. The aim of the cooperative research project

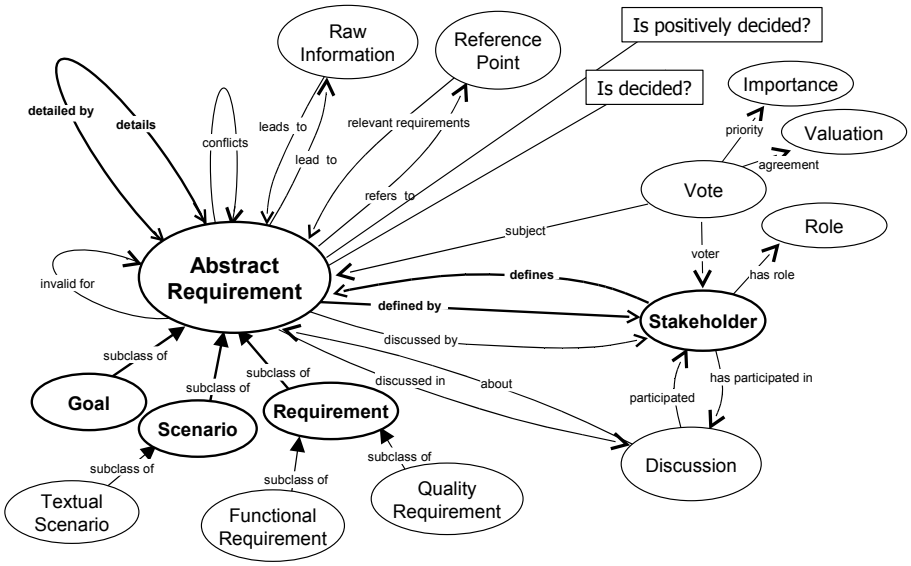

Figure 1: Visualisation of the RE Ontology Core (SWORE).

SoftWiki[1] (Distributed, End-user Centered Requirements Engineering for Evolutionary Software Development) is to support the collaboration of all stakeholders in software development processes in particular with respect to software requirements. Potentially very large and spatially distributed user groups shall

[1] See `http://softwiki.de` for a description of the SoftWiki project.

be enabled to collect, semantically enrich, classify and aggregate software requirements. The rationale is to provide a semantic structure, which will capture requirements relevant information and enables interlinking of this information with domain and application specific vocabularies.

Figure 1 visualises the core of the SWORE ontology, which we developed in accordance with standards of the Requirements Engineering community [Pohl et al. 1998, Pohl 1996, Pohl 2007, van Lamsweerde 2001]. Central to our approach are the classes *Stakeholder* and *Abstract Requirement* as well as the properties *details* and *defines*. Abstract requirements have the subclasses *Goal*, *Scenario*, and *Requirement*, each of which are defined by stakeholders and can be detailed by other abstract requirements.

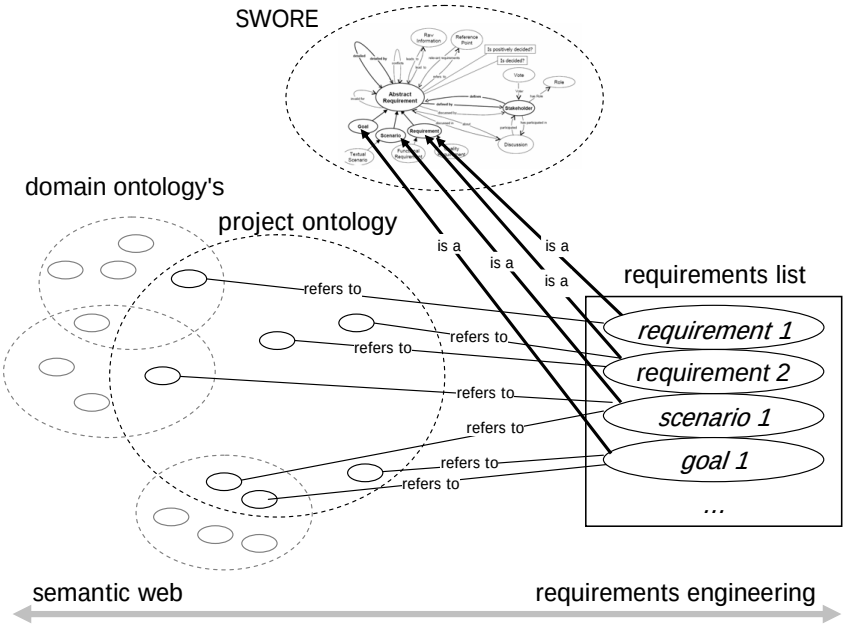

Figure 2: SWORE use and interlinking with domain ontologies.

This enables the specification of abstract requirements at different levels of granularity. (Elicit and understand all relevant requirements cf. Section 2) We emphasise the collaborative aspects of requirements engineering by integrating discussions amongst the stakeholders and voting (with the criteria of agreement and importance) in the model (Reach agreement cf. Section 2). In

the RE process this documentation is often relevant for future decisions (Documentation cf. Section 2). In order to interlink requirements with existing documents or resources, SWORE contains the classes *Raw Information* and *Reference Point* together with suitable properties. SWORE is available for download at: `http://softwiki.de/SWORE`.

The use of SWORE is visualised in Figure 2. A requirements engineering knowledge base will contain instantiations of the SWORE concepts. The innovation of using semantic representations in comparison with traditional RE tools is the possibility to reuse and reference existing information and domain ontologies. We expect the emerging of a multiplicity of domain ontologies, which describe knowledge specific to certain domains. These are very important for the RE process, since they facilitate the understanding between stakeholders and hence the annotation and referencing of requirements with such domain specific information is an integral part of the envisioned SWORE usage.

4 E-Government Use Case

An application and evaluation of the presented semantic based RE approach is currently performed in an E-Government use case. German citizens have to register their current place of habitation with the local community administration. For historic reasons a multiplicity of different applications was developed and is in use by individual administration offices. In order to facilitate automated data exchange between different community administrations and to provide self-service citizen services there are endeavors to homogenize and better integrate these individual applications on a local, regional and federal level.

The software application is implemented using the DotNetNuke Framework[2]. The deployment at local public offices is prepared. We main use is to demonstrate the SoftWiki concept. We identified several data sources to import into the ontology. All requirements are stored in the project management tool in-Step[3] in different granularities. The tool provides export functionality, without loosing references between the requirements. Stakeholder groups have been extracted from the documentation in particular the manuals of the application. Additional reference points have been linked into the side map of the web application.

The problem of better integrating these different applications, however, is not just a technical one, since different community administrations established different processes and information structures and hence have different requirements regarding information integration and exchange. In order to enable the different stakeholders to collaboratively work on requirements for the standardization, information, and process integration of the registration service, we adopted the semantic collaboration platform OntoWiki [Auer et al. 2006].

[2] `http://www.dotnetnuke.com/`
[3] `http://www.microtool.de/instep/en`

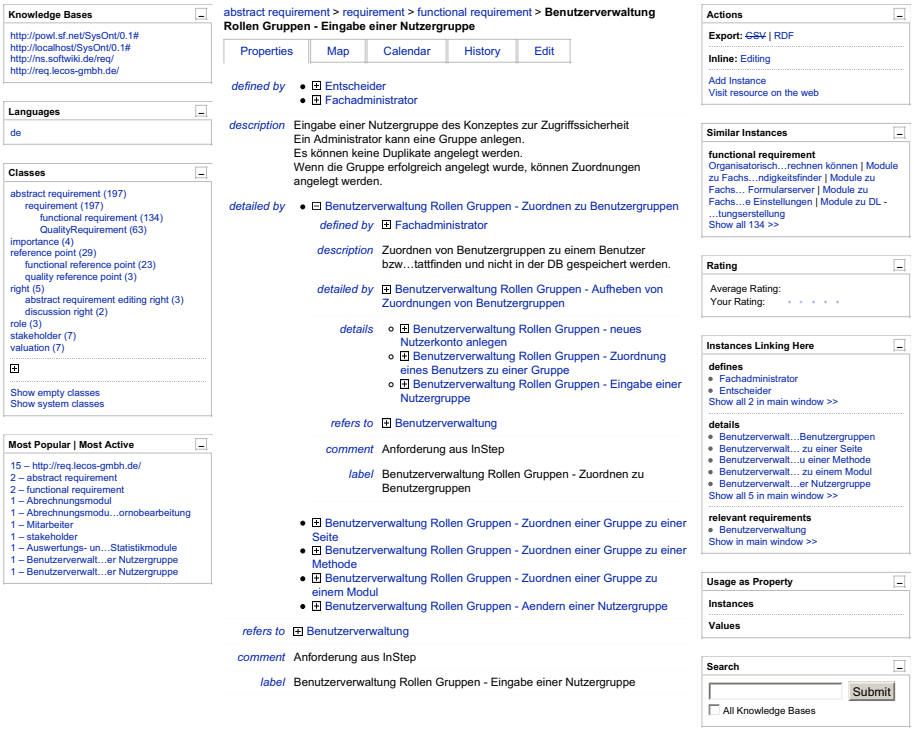

Figure 3: Functional requirement instance related to user roles and access control of the E-Government application.

OntoWiki is a Semantic Web application enabling a distributed user community to develop ontologies and collect instance data adhering to these ontologies. OntoWiki aims at making the browsing of knowledge bases and user contributions as easy as possible, while trying to provide means for coherent vocabulary development. OntoWiki is open source software and available at `http://ontowiki.net`.

In order to use OntoWiki for the Requirements Elicitation, we pre-loaded the requirements ontology (from Section 3) into OntoWiki. Subsequently, stakeholders of the RE process are enabled to create and interlink requirements and scenarios. OntoWiki also provides means to vote, discuss and comment individual pieces of information and hence to support the requirements agreement. Figure 3 shows a functional requirement instance related to user roles and access control of the E-Government application.

The use of OntoWiki allows to incrementally create a knowledge base of requirements relevant information. In the spirit of adaptive methodologies, On-

toWiki does not presume a rigid RE process, instead requirements can be refined, annotated, discussed and interlinked at any time until the requirements knowledge base reached a stable state which the stakeholder community agrees on.

5 Conclusions and Future Work

The application of Semantic Web technologies is beneficial for RE processes, since a crucial part of RE is the establishment of a common terminology by different (often spatially distributed) stakeholders.

We are currently in the process of gaining more experiences with RE stakeholder communities and plan to adopt the generic knowledge engineering tool OntoWiki more to the RE usage scenario. In particular, we want to develop interfaces to traditional RE and management tools, such as IRqA [4] and Doors[5]. The information exchange with such traditional tools is especially important, since we focus mainly on the early stages of requirements elicitation and RE processes with many, spatially separated stakeholders. Once an agreement is reached within a stakeholder community the gained information can be used inside traditional tools in order to support the remaining software or project development process.

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[4] `http://www.irqaonline.com`

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