Chapter XX
Sharing Ontologies and Rules Using Model Transformations

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ABSTRACT

Web Ontology Language (OWL), Semantic Web Rule Language (SWRL) and Model-Driven Engineering (MDE) are technologies being developed in parallel, but by different communities. They have common points and issues and can be brought closer together. Many authors have so far stressed this problem and have proposed several solutions. The result of these efforts is the recent OMG's initiative for defining an ontology development platform. However, the problem of transformation between Semantic Web ontology and rule languages and MDE-based languages has been solved using rather partial and ad hoc solutions, most often by XSLT. In this paper, we relations between the Semantic Web languages and MDE-compliant languages as separate technical spaces. In order to achieve a synergy between these technical spaces, we present ontology and rule languages in terms of MDE standards, recognize relations between the OWL and SWRL langauges and MDE-based ontology languages, and propose mapping techniques. In order to illustrate the approach, we use an MDE-defined architecture that includes the ontology and rule metamodels and ontology UML Profile. We also show how MDE techniques, such as model transformations, can be used to enable sharing rules and ontologies by using REWERSE Rule Markup Language (R2ML), a proposal for a general rule language. The main benefit of this approach is that it keeps the focus on the language concepts (i.e., languages' abstract syntax - metamodels) rather than on technical issues caused by different concrete syntax. Yet, we also provide transformations that bridge between both languages' concrete (XML) and abstract (MOF) syntax.

INTRODUCTION AND MOTIVATION

The Semantic Web is based on the use of ontologies that should provide an explicit definition of the domain conceptualization. Employing the rich AI research experience and being driven by practical needs for the use on the Web, the W3C has adopted the Web Ontology Language (OWL) as a standard ontology language (Bechhofer et al., 2004). Although the adoption of OWL means that Semantic Web applications can exchange their ontologies and tool vendors can develop reasoners and query languages over OWL, there is also a need to have some other mechanisms for defining knowledge. This is mainly manifested through advanced mechanisms for enriching ontologies by using rules. Thus, we should also define a standardized Semantic Web rule language that will be based on OWL to provide an additional reasoning layer on top of OWL. On the other hand, there are many Semantic Web applications that might use (OWL) ontologies whose business logic is implemented by using various rule languages (e.g., F-Logic, Jess, and Prolog) (Sheth et al., 2006). In this case, the primary goal is to have a rule exchange language for sharing rules, and hence enabling reusability of their business logics.

The above arguments motivated the research in the (Semantic) Web community to look at their different aspects. The most important proposal for the first group of rule language is Semantic Web Rule Language (SWRL) (Horrocks et al., 2004) that tends to be a standardized reasoning layer built on top of OWL. However, this is just one submission to such a language, while the research in Semantic Web services (e.g., WSMO and SWSL) introduces/relies on other rule languages besides SWRL such as SWSL-Rules or F-Logic (Sheth et al., 2006). In fact, this can be addressed by the second group of research efforts for Semantic Web rules manifested in the Rule Interchange Format (RIF) initiative (Ginsberg, 2006), which tries to define a standard for sharing rules. That is, RIF should be expressive enough, so that it can represent concepts of various rule languages. Besides RIF, one should also develop a (two-way) transformation between RIF and any rule language that should be shared by using RIF. Currently, there is no official submission to RIF, but RuleML (Hirtle et al., 2006) and the REWERSE I1 Rule Markup Language (R2ML) (Wagner et al., 2006) are two well-known RIF proposals.

Researchers have also been trying to integrate the ongoing software engineering efforts with the concept of the Semantic Web for a while (Kogut, 2002). The main question they want to answer is how to develop the Semantic Web ontologies enriched by rules using well-accepted software engineering languages and techniques in order to have a large number of practitioners developing and using ontologies in real world applications. Many researchers have previously suggested using UML in order to solve this problem. However, UML is based on object-oriented paradigm, and has some limitation regarding ontology development (e.g., properties in ontology languages are first-class concepts, while UML properties (i.e. attributes and associations) are defined in the scope of a class they belong to (Baclawski, 2002). Furthermore, UML classes and their inheritance cover behavioral characteristics of abstractions[1]. For a detail overview of differences between UML and ontology language, see (Baclawski, 2002). Hence, we can only use UML in initial phases of ontology and rule development. We believe that these limitations can be overcome using Model Driven Engineering (MDE) techniques (Kent, 2002). In addition, if we want to offer a solution consistent with MDE, we should also support automatic generation of completely operational ontology definitions with rules (e.g. in OWL/SWRL languages) that are model driven (Selic, 2003). Currently, the most important direction toward this goal is the one pursued by a dedicated research group within OMG that tries to converge many different proposals of solutions to this problem (ODMrfp, 2003). The result of this effort should be a standard language (i.e.,