Chapter IV
Building Semantic Web Portals with a Model-Driven Design Approach

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ABSTRACT

This chapter presents an extension to Web application conceptual models toward Semantic Web. Conceptual models and model-driven methodologies are widely applied to the development of Web applications because of the advantages they grant in terms of productivity and quality of the outcome. Although some of these approaches are meant to address Semantic Web applications too, they do not fully exploit the whole potential deriving from interaction with ontological data sources and from semantic annotations. The authors claim that Semantic Web applications represent an emerging category of software artifacts, with peculiar characteristics and software structures, and hence need some specific methods and primitives for achieving good design results. In particular the contribution presented in this chapter is an extension of the WebML modeling framework that fulfils most of the design requirements emerging in the new area of Semantic Web. The authors generalize the development process to cover Semantic Web needs and devise a set of new primitives for ontology importing and querying. The chapter also presents a comparison of the proposed approach with the most relevant existing proposals and positioned with respect to the background and adopted technologies.

INTRODUCTION AND MOTIVATION

Modern Web applications comprise distributed data integration, remote service interaction, and management of workflow activities, possibly spawned on different peers. In this scenario, a wider attention to the semantics of data and applications is mandatory to allow effective design and evolution of complex systems. Indeed, if semantics of data and applications is known, their integration becomes more feasible. Moreover, explicit semantic annotation of Web applications can facilitate content search and access, and foster a future generation of Web clients that exploit the semantic information to provide better browsing capabilities to customers.

The Semantic Web aims at bringing formal "semantics" to the human-readable information so as to make it machine-readable and allow better and easier automatic integration between different Web applications. To address this challenge, many semantic description languages arose, like RDF, OWL and WSML; some of them are currently W3C Recommendations. All these languages allow to formally model knowledge by means of ontologies: the resulting formal models are the starting point to enable easy information exchange and integration between machines.

These languages are suitable for reasoning and inference, i.e., to deduct more information from the model by applying logical expressions. This makes the modeling task easier since not all the knowledge has to be modeled. These languages are supported by a wide range of tools and APIs, that cover design of knowledge (e.g., Protégé (Noy et al., 2001) and OntoEdit (Sure et al., 2002)), provide storing facilities (e.g., Sesame (Aduna, 2007) and Jena (HP, 2007)), and offer reasoning on the data (e.g., Racer (Racer Systems, 2007) and Pellet (Sirin et al.,2007)). Based on these modeling languages, a set of querying languages have been devised too; among them, we can mention TRIPLE (Sintek & Decker, 2002) and SPARQL (W3C, 2007), a W3C candidate recommendation.

Unfortunately, although the theoretical bases and some technological solutions are already in place for Semantic Web support, the techniques and methodologies for Semantic Web application design are still rather rough. This leads to high costs of implementation for Semantic Web features, even if embedded within traditional Web applications. These extra costs are related not only to the design of the architecture and deployment of the Semantic platforms, but also to the repetitive and continuous task of semantic annotation of contents and application pages.

We claim that conceptual modeling and model-driven development can increase dramatically the efficiency and efficacy of the design and implementation of such applications, by offering tools and methodologies to the designer for specifying semantically-rich Web applications.

The model-driven approach to software development has been proven valid in several application fields and is currently one of the best practices of the software engineering discipline. Developing a Semantic Web application, as with any other kind of software system, is a complex achievement that requires the ability to master a broad spectrum of tasks, jointly performed by a number of persons with different skills for a long timeline. Software engineering and Web engineering (Ceri et al., 2002) demonstrated that following a well organized development process, centered on the appropriate modeling concepts, is essential to overcome the complexity inherent to such kind of developments.

This chapter aims at demonstrating how model-driven design can impact on specification, design, and implementation of Semantic Web portals as well. In the proposed approach, we leverage a conceptual modeling approach for visually designing the Web application domain model and hypertext model. Conceptual modeling works at higher abstraction levels with respect to direct implementation design, thus allowing to specify the application design with a top-down philosophy. The first design steps aim