WSMoD: A Methodology for QoS-Based Web Services Design

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ABSTRACT

Web services are increasingly used as an effective means to create and streamline processes and collaborations among governments, businesses, and citizens. As the number of available Web services is steadily increasing, there is a growing interest in providing methodologies that address the design of Web services according to specific qualities of service (QoS) rather than functional descriptions only. In this paper, we present WSMoD (Web Services MOdeling Design), a methodology that explicitly addresses this issue. Furthermore, we exploit general knowledge available on services, expressed by ontologies describing services, their qualities, and the context of use, to help the designer in expressing service requirements. Ontologies are used to acquire knowledge among the entities involved in service design and to check the consistency of the Web service. The discussion of a QoS-based Web service design within a real case study bears evidence of the potentials of WSMoD.

Keywords: design methodologies; knowledge-based design; model-driven applications ontologies; quality of service; Web services

INTRODUCTION

Web services provide added value to e-services over the Internet by overcoming the limitations of existing component models. Web services take advantages from the universal resource identifier (URI) model to support open naming and addressing systems. They exploit XML features to supply rich descriptions of involved concepts, such as WSDL descriptions to service interfaces, UDDI to service lookup, SOAP to service interoperability, and Ws-BPEL to service orchestration.

Web services are the building blocks of the service oriented architecture (SOA), a paradigm focused on the composition of loosely coupled systems. In this architecture, a service provider publishes its Web services in a registry that can be searched by a consumer who can then access...
to a service, which has been found directly by means of XML-based messages. The increasing availability of Web services offering similar functionalities (for example in bookselling or hotel reservation domains) creates new opportunities in discovery and selection activities. In fact, the selection of a Web service can not only be related to what operations are offered, but also to how those operations are provided. Consequently, quality of services is becoming a crucial issue for the selection of Web services that fulfill customer requests better.

In this novel scenario, business requirements support the discovery of Web services and the development of new ones. In fact, Web service design should start from business needs and business processes instead of application features as in traditional software design. Such business requirements should drive the identification of the needed features, potential suppliers, technological, organizational, and social constraints. Therefore, the development process requires a change in the overall approach.

In this article, we present WSMoD, a Web service modeling design methodology for quality of service (QoS)-based Web services. The approach of the methodology consists in considering non-functional aspects derived from business requirements, as well as functional requirements, and incorporating and refining them throughout the design process. In this article we use the term functional to mean the operations that a service is expected to provide, and the term non-functional (or sometimes with the general term quality) to collect all the other characteristics associated with a service, related to QoS, user profiles, and delivery channels. The advantage of managing qualities, users and channels along the design process is twofold: Achieving at the end of the process, a ready-to-implement specification, and reducing the risk of delivering unsatisfactory services. In fact, the knowledge of the technical, organizational and social characteristics of the environment in which the service will be deployed allows the designer to effectively evaluate and customize the design of the service.

WSMoD extends the model driven architecture (MDA) proposed by (OMG, 2004), whose development process is divided into three steps: (i) first, a platform independent model (PIM) is created, expressed in UML; this model describes business rules and functionalities of the application, and exhibits a high degree of platform independence; (ii) then, a platform specific model (PSM) is produced, mapping the PIM into a specific platform; (iii) finally, the application is generated. The proposed extension is in two directions. The first one, according to the well-known software engineering principle “divide et impera,” adds in the definition of the platform independent model a specific methodological step for the definition of the non-functional requirements. Users and channels, which support the interaction between Web services and users, should be considered first-class concepts in the analysis and design of new services. The second extension concerns the platform independent model to represent quality aspects and the specific context related to user profile and channel constraints. This kind of context is still independent from a specific deployment platform, so that it can be adapted to different providers offering new Web services. The goal of this extension of platform independent model is to improve the design of software applications by avoiding modelling choices that are not deployable in real provisioning environments.

Ontologies have the role of providing a formal organization of knowledge that can be exploited to rationalize decision and evaluation processes. We use an ontology-based approach to understand, discover, classify and reason on qualities related to user constraints, user preferences, technological features (such as devices and networks), and domain peculiarities. Our final goal is to end up with a rich service description that includes service functionality and qualities, and a platform independent model of the service architecture that incorporates the quality constraints.

The WSMoD methodology has been developed within the MAIS project (Per-
The MACE Approach for Caching Mashups
www.igi-global.com/chapter/mace-approach-caching-mashups/66963?camid=4v1a