An Ontology-based MDA Framework for Service-based Software Systems Architecting

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Abstract. Model-driven Architecture (MDA) is a software architecture framework proposed by the Object Management Group OMG. MDA emphasises the importance of modelling in the architectural design of software systems. Ontologies are can enhance the modelling aspects here. We present a layered MDA-based modelling approach. We focus on service-based software and the Web Services platform.

1 Introduction

The recognition of the importance of modelling in the context of software architecture has over the past years led to model-driven architecture (MDA) [1]. MDA emphasises the importance of modelling for the software architecture design. MDA suggests a three-layered approach. The Computation Independent Model (CIM) describes a system from the computation-independent viewpoint, addressing structural aspects of the system. The Platform Independent Model (PIM) defines a system in terms of a technology-neutral virtual machine or a computational abstraction. The Platform Specific Model (PSM) consists of a platform model that captures the technical platform concepts and a model geared towards the implementation technique.

Our aim is to enhance MDA from syntactical (UML) to semantical (ontology-based) modelling. We develop a solution for a specific platform: service-oriented architecture and Web Services. Ontologies support a number of modelling tasks – from domain modelling to architectural configuration and service sintroperability. An ontology is defined in terms of concepts of a domain and usually hierachy relationships. It is a model available through the vocabulary of concepts and relationships. Ontologies are similar to languages notations such as UML. Ontologies, however, combine modelling with logic-based reasoning.

2 Layered MDA Modelling with Ontologies

MDA proposes three modelling layers, each with a distinct architectural focus. The CIM layer focuses on domain capture. The PIM layer focuses on architecture configuration and service process composition. The PSM layer focuses on interoperability and discovery support.

CIM – Computation Independent Model. Two viewpoints of domain modelling can be distinguished. Concepts are represented in form of hierarchies. Behaviour is represented in a process-based form. An OWL ontology can capture both. We distinguish two types of concepts: objects (static entities) and processes (dynamic entities). Three relationship types shall be distinguished: is_a (subclass relationship), has_part (component relationship), and depends (dependency relationship). The composition of objects and processes from a component perspective is an often essential information. Dependencies are useful to describe input-output relationships between objects and activities that process them.

PIM – Platform Independent Model. Architectural configuration addresses the interaction processes between different services. Since representing not only services, but also their configuration and assembly into processes is important here, we use the Web Service Process Ontology (WSPO), whose foundations were developed in [2]. This ontology will bring us closer to the architectural perspective than service ontologies such as OWL-S and WSMO [3]. Services (and processes) in WSPO are not represented as concepts, but as relationships denoting accessibility relations between states of the system. Concepts in this approach are states (pre- and poststates), parameters (in- and outparameters), and conditions (pre- and postconditions). Two forms of relationships are provided. The processes themselves are transitional relationships. Syntactical and semantical descriptions – parameter objects (syntax) and conditions (semantics) – are associated through descriptional relationships. This ontological representation in WSPO is actually an encoding of a simple dynamic logic (a logic of programs) in a description logic format.

WSPO provides a standard template for service process description. Syntactical parameter information in relation to activities and also semantical information such as pre-conditions are attached to each activity. WSPO can be distinguished from other service ontologies by two specific properties. Firstly, it adds a relationship-based process sublanguage enabling process expressions. Secondly, it adds data to processes in form of parameters that are introduced as constant process elements into the process sublanguage.

PSM – Platform Specific Model. Two concerns determine the techniques used at this layer: abstract service description for discovery and standardised service composition to processes. Abstract syntactical and semantical service description and discovery interfaces shall be supported. The Business Process Execution Language WS-BPEL can be the service composition language.

References

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