On Developing Hybrid Modeling Methods using Metamodeling Platforms: A Case of Physical Devices DSML Based on ADOxx

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ABSTRACT

It has been acknowledged that model-based approaches and domain-specific modeling (DSM) languages, methods and tools are beneficial for the engineering of increasingly complex systems and software. Instead of general-purpose one-size-fits-all modeling languages, DSM methods facilitate model-based analysis and design of complex systems by providing modeling concepts tailored to the specific problem domain. Furthermore, hybrid DSM methods combine single DSM methods into integrated modeling methods, to allow for multi-perspective modeling. Metamodeling platforms provide flexible means for design and implementation of such hybrid modeling methods and appropriate domain-specific modeling tools. In this paper, we report on the conceptualization of a hybrid DSM method in the domain of network physical devices management, and its implementation based on the ADOxx metamodeling platform. The method introduces a hybrid modeling approach. A dedicated DSM language (DSML) is used to model the structure of physical devices and their configurations, whereas the formal language for knowledge representation OWL2 is used to specify configuration-related constraints. The outcome of the work is a hybrid, semantic technology-enabled DSM tool that allows for efficient and consistency-preserving model-based configuration of network equipment.

Keywords: Domain-specific Modeling, Metamodeling Platforms, Modeling Methods, Modeling Tools, Semantic Technology

INTRODUCTION

One of the challenges faced by OSS (Fleck, 2003) is the increasing need for consistent management of physical network equipment. In large companies, maintenance of thousands of devices is a complex, error-prone and time-consuming task. Proper device configuration and identification of errors among myriads of network device types cannot be done without

DOI: 10.4018/ijismd.2015010103
an adequate tool support. State-of-the-art technologies enable vendor independent equipment type identification and access to the attributes of the component types. However, they fail at providing a consistent support to the user by answering questions that involve sophisticated, configuration related constraints.

Model-based approaches, such as MDA (Kleppe, Warmer, & Bast, 2003) and DSM (France & Rumpe, 2005), deal with increased system and software complexity by raising the level of abstraction to models. Modeling methods provide necessary concepts to systematically capture relevant domain knowledge in terms of models. A modeling method usually contains 1) a modeling language (ML) used to describe the domain in terms of models, 2) mechanisms and algorithms (M&A) which, in general, process the knowledge in models and 3) a modeling procedure (MP) defining the steps, results and roles for modeling (Karagiannis & Kühn, 2002). Metamodeling platforms such as ADOxx (ADOxx, 2013) provide flexible means for the implementation of modeling methods for arbitrary modeling domains, in form of tailored domain-specific modeling tools.

The system complexity in the domain of network physical devices management can be greatly reduced by capturing the semantics of physical devices and their specific configurations in models using DSLs and visual modeling tools. Whereas the adequate definition of a domain-specific ML is important for successful capturing of network equipment information structures, it is equally important to define domain-specific M&As to check and ensure consistency of models, considering the specific semantics of the domain. In addition, a MP should guide users through the network management configuration process by pointing out possible and allowed next steps by considering the given specifics of ML and M&A.

In this paper, we report on the conceptualization of such modeling method, and its implementation using the ADOxx metamodeling platform. The method has been constructed within the EU project MOST, in order to build a novel modeling tool that leverages ontology technology to enhance the modeling. We first provide an overview of the case study. Following the introduction of the case study, we introduce the main concepts of the PDDSL method. The first part focuses on the method conceptualization. The second part elaborates on the method implementation using ADOxx. We further discuss the lessons learned, both from the conceptualization as well as from the implementation viewpoint. Further, results of the case study evaluation are provided, to underpin the applicability of the introduced modeling method and related prototype tool. Finally, an overview of the related work is presented, followed by the conclusion and the future work outlook.

THE CASE STUDY: CONSISTENT PHYSICAL DEVICES MANAGEMENT

Consistent management of the repository of physical network equipment is important prerequisite for efficient network management. Let us take as an example the usual situation in the telecommunication companies when one of the physical device cards is broken and requires replacement. Figure 1 represents a particular configuration of the Cisco 7603. It contains two cards. The card in slot 1 is a supervisor2 of type Supervisor Engine 2, required by the device to work properly. In slot 2, two additional cards hotswap and supervisor720 are inserted.

Let us suppose that the main supervisor card is broken and requires replacement. The person responsible for this device receives a notification about the problem and begins to resolve it. The process of finding a valid replacement requires deep knowledge about every sub-component of the physical device (what kind of cards can be used as a replacement for a broken card, what kind of constraints a particular card has, etc.). As shown in Figure 1, the device type Cisco 7603 requires at least one card in Slot 1, either of type Supervisor Engine 2 or Supervisor Engine 720. Furthermore, Slot 2 allows three types of cards to be inserted: Catalyst6500, Hot...
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