Chapter 2
An Ontology-Based Method to Construct a Reference Model Catalogue for the Energy Sector

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ABSTRACT

Within this contribution we will introduce a first approach on an ontology-based method for constructing a domain specific reference model catalogue for the energy sector. First of all we will motivate and introduce a reference model catalogue for the energy sector as well as requirements for building such a catalogue. Based on the requirements, we will focus on describing a method which meets these requirements and show how to apply the method.

INTRODUCTION TO SMART GRIDS

The German energy industry is undergoing a process of structural changes due to changing regulations and technical advancements (see e.g. Appelrath & Chamoni, 2007; Brinker, 2009; Kurth 2009; Haas, Redl, & Auer, 2009; Starace, 2009). On the one hand, laws have been approved to encourage competition in the German energy sector like the legal unbundling as described in the German Energy Industry Act (Energiewirtschaftsgesetz EnWG) (Deutscher Bundestag, 2005). On the other hand, technical advancements lead to new products and services like Demand Side Management (DSM) and Automated Meter Reading (AMR). With the upcoming distributed generation, the legal requirements imposed by federal regulation and the resulting unbundling, things have changed a lot. Due to new generation facilities like wind power plants or fuel cells, energy is fed into the grid at different voltage levels und by different

DOI: 10.4018/978-1-60960-126-3.ch002

producers – former customers having their own generation can now both act as consumers and producers (also referred to as prosumer) which feed into the utilities' grid. Therefore, the communication infrastructure has to change.

Current application landscapes for utility companies were built to address requirements of the past de facto monopoly environment. Today, companies in the energy industry face more competition and have to provide new products and services at lower costs. This requires current application landscapes to become more flexible and to be able to adapt faster to the evolving requirements resulting in structural business changes. Therefore, adequate IT-infrastructures supported by appropriate architectures, like service-oriented architecture, are needed (Uslar et al., 2009). Both utility companies as well as software manufacturers have to deal with these changes and need to adapt their application landscapes or software products. In this context, requirements analysis plays an important part.

The energy sector comprises several activities like generation of electricity, gas, fuel or district heating. To reduce the complexity within this contribution, we only address electricity and gas when referring to the energy sector, as they form a major part of the German energy sector (45% of the energy consumption), see BMWi (2008b). In addition, electricity and gas have (with regard to business transactions) several processes in common despite of their physical differences.

Current national (like E-Energy, see www.e-energy.de) and international (like the European Technology Platform on Smart Grids, www.smartgrids.eu) initiatives and discussions in the energy sector reveal that the network is developing towards a so called "Smart Grid" with multiple devices and actors continuously exchanging data to provide user-oriented flexible services and products while operating a self-healing, economic, ecologically friendly and secure network. According to Electric Power Research Institute's report to the US National Institute of Standards and Technology (NIST) the term "Smart Grid" is defined as a process of the modernization of the electricity distribution system to monitor, protect and automatically optimize the operation of its interconnected elements (EPRI, 2009). The drivers for Smart Grid are the same for most of the developed countries, however, implementations differ. Within this contribution, we use the NIST definition (EPRI, 2009) and its application in the US which is different form the European one of the Smart Grids European Technology Platform (ETP), see ETP (2009).

Smart Grid requires the application of standards for being able to cope with heterogeneity and enable interoperability in an economic and technically feasible way. In addition, existing knowledge, often described in functional and standards reference models, should be used to design efficient processes and identify required functionality.

Identifying suitable reference models as well as standards is not easy as a variety of models and standards exists. Here reference model catalogues as defined by (Fettke & Loos, 2002) provide an overview on existing models and support the identification of relevant sources.

The main contribution of this work is to provide an ontology-based method for constructing such a domain specific reference model catalogue for the domain of the electric Smart Grid.

The remainder of this chapter is structured as follows: After describing the background of our research in the next section, the energy reference model catalogue with its components, construction process, modeling requirements and implementation will be introduced. The following section will describe in detail our ontology-based construction method and show examples of its application. Then, we outline the evaluation of our methods and give an overview of related work before we conclude the chapter presenting our conclusion and future research issues.

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