General Adaption Framework: Enabling Interoperability for Industrial Web Resources

Olena Kaykova, University of Jyväskylä, Finland
Oleksiy Khriyenko, University of Jyväskylä, Finland
Dmytro Kovtun, University of Jyväskylä, Finland
Anton Naumenko, University of Jyväskylä, Finland
Vagan Terziyan, University of Jyväskylä, Finland
Andriy Zharko, University of Jyväskylä, Finland

ABSTRACT

Integration of heterogeneous applications and data sources into an interoperable system is one of the most relevant challenges for many knowledge-based corporations nowadays. Development of a global environment that would support knowledge transfer from human experts to automated Web services, which are able to learn, is a very profit-promising and challenging task. The domain of industrial maintenance is not an exception. This paper outlines in detail an approach for adaptation of heterogeneous Web resources into a unified environment as a first step toward interoperability of smart industrial resources, where distributed human experts and learning Web services are utilized by various devices for self monitoring and self diagnostics. The proposed General Adaptation Framework utilizes a potential of the Semantic Web technology and primarily focuses on the aspect of a semantic adaptation (or mediation) of existing widely used models of data representation to RDF-based semantically rich format. To perform the semantic adaptation of industrial resources, the approach of two-stage transformation (syntactical and semantic) is elaborated and implemented for monitoring of a concrete industrial device with underlying XML-based data representation model as a use case.

Keywords: adaptation framework; data transformation; industrial maintenance; industrial maintenance IS; interoperability; RDF; Semantic mediation; Semantic Web

INTRODUCTION

At the current stage of ICT development, there is a diversity of heterogeneous systems, applications, standards of data representation, and ways of interaction. All those systems were tailored for particular tasks and goals. The world is heterogeneous, and modern industry is looking for fast, global solutions related to Knowledge Management, Enterprise Application Integration, Electronic Commerce, Asset
Management, and so forth. However, in spite of advancements in data processing and acquisition, it is still difficult to automatically process and exchange data among the heterogeneous systems. Various industrial standards, which have been created and implemented by different consortia, appear not to be sufficient for growing interoperability demands.

Taking into account a great variety of possible types of information resources, data formats, and ways of data accessing and acquisition, an integration of such resources into a unified environment is an important development challenge (BMC Press, 2003; Khanna, 2004).

Basically, the integration tasks can be solved by adaptation of data from heterogeneous formats to some commonly accepted and semantically reached format (i.e., adaptation of heterogeneous applications and data originally represented according to a standard different from the common standard.

The integration process may include the following key functions (Apte, 2002; Sun Press, 2003):

- **Extracting, Transformation, and Loading.** For building data warehouse or operation data stores and giving to an end user/application a possibility to work with integrated data.
- **Data Replication.** To allow heterogeneous servers and databases to share data in real time.
- **Data Synchronization.** To allow sharing of data among servers and remote devices when connectivity is temporary.

Application adaptation is a special part of the general integration task. The data are generated by different applications with the following specific features:

- Application functions
- Application APIs
- Application interfaces

All variations of these features have an effect on the process of adaptation and the architecture of adaptation framework.

During the last several years, major efforts in solving the challenge of Enterprise Application Integration have focused on the domain of Web services; that is, loosely coupled Internet and intranet applications developed according to the requirements of W3C’s Web Services Architecture Working Group. So far, standardization efforts of W3C in this direction have resulted in SOAP (2000), WSDL (2001), and UDDI (2004) specifications. Industry currently supports these standards as a solid solution for a wide variety of tasks from the EAI domain. A service-oriented approach is actively used in modeling business-to-business tasks; Business Process Execution Language for Web Services (BPEL4WS, 2003) is used the most widely nowadays.

Semantic Web is a relatively new initiative within the W3C standardization effort to enable machine interpretable metadata on the Web. It provides standards and tools to enable explicit semantics of various Web resources, based on semantic annotations and ontologies. Integration in general is considered a killer application of Semantic Web technology, which particularly can be interpreted as heterogeneous data integration, Enterprise Application Integration, and Web service integration, among other interpretations. In contrast to ICT, the semantic technologies represent meanings separate from data, content, or program code, using the open standards for the Semantic Web. They are language-neutral, machine-interpretable, sharable, and

Copyright © 2005, Idea Group Inc. Copying or distributing in print or electronic forms without written permission of Idea Group Inc. is prohibited.
Representation of Web Application Patterns in OWL
www.igi-global.com/chapter/representation-web-application-patterns-owl/31197?camid=4v1a

Dynamic, Automatic, First-Order Ontology repair by Diagnosis of Failed Plan Execution
www.igi-global.com/article/dynamic-automatic-first-order-ontology/2837?camid=4v1a