Chapter 13
Attaining Semantic Enterprise Interoperability Through Ontology Architectural Patterns

Rishi Kanth Saripalle
University of Connecticut, USA

Steven A. Demurjian
University of Connecticut, USA

ABSTRACT

Enterprise Interoperability Science Base (EISB) represents the wide range of interoperability techniques that allow the creation of a new enterprise application by utilizing technologies with varied data formats and different paradigms. Even if one is able to bridge across these formats and paradigms to interoperate a new application, one crucial consideration is the semantic interoperability to insure that similar data is reconciled that might be stored differently from a semantic perspective. In support of this requirement, usage of ontologies is gaining increasing attention as they capture shareable domain knowledge semantics. The design and deployment of an ontology for any system is very specific, created in isolation to suit the specific needs with limited reuse in the same domain. The broad proliferation of ontologies for different systems, which, while similar in content, are often semantically different, can significantly inhibit the information exchange across enterprise systems. This situation is attributed, in part, to a lack of a software-engineering-based approach for ontologies; an ontology is often designed and built using domain data, while software design involves abstract modeling concepts that promote abstraction, reusability, interoperability, etc. The intent in this chapter is to define ontologies by leveraging software design pattern concepts to more effectively design ontologies. To support this, the chapter proposes Ontology Architectural Patterns (OAPs), which are higher-level abstract reusable templates with well-defined structures and semantics to conceptualize modular ontology models at the domain model level. OAP borrows from software design patterns inheriting their key characteristics for supporting enterprise semantic ontology interoperability.

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1. INTRODUCTION

In today's world, the design, development, and deployment of a new enterprise application is no longer taking the prior approach of developing the application from scratch; rather, the emphasis is on the ability to construct a new enterprise application through the usage of existing resources such as enterprise applications, systems, servers, databases, etc., that are brought together to yield a system of systems. Enterprise Interoperability Science Base (EISB, Popplewell et al., 2012) has been promoted in order to address all of the different interoperability concerns including data, process, knowledge, cloud and Web services, rules, objects, APIs, etc. Two related interoperability of issues of particular interest are the ability to deal with: data in varied formats (e.g., XML, JSON, RDF (Allemang & Hendler, 2011), relational database, etc.) and the need to resolve semantics among enterprise systems of data (e.g., in a geospatial application, grid north vs. true north vs. magnetic north and these must be resolved if different do not use consistent formats). Ontologies have emerged to play a pivotal role in the World Wide Web (WWW) to promote the Semantic Web (Allemang & Hendler, 2011) by attaching semantics to electronically represented information thereby assisting users (humans and agents) in various ways such as semantic Web agents, semantic information extraction, semantic search, etc. Currently, ontologies are highly employed in the wide variety of enterprise applications for knowledge representation and reasoning (Baader, McGuinness, Nardi, & Patel-Schneider, 2007), software modeling and development (Demurjian, Saripalle, & Behre, 2009; Kuhn, 2010; Saripalle, Demurjian, & Behre, 2011), semantic information extraction (Wimalasuriya & Dou, 2010), biomedical and clinical informatics (Smith & Ceusters, 2006), databases (Gali, Chen, Claypool, & Uceda-sosa, 2004), geospatial semantics (Janowicz, Scheider, Pehle, & Hart, 2012), etc.

The primary goal of the ontologies is to capture semantics of a domain and tag the semantic concepts to electronically represented information, which in turn will ease *semantic interoperability* for enterprise applications to support both data and knowledge interoperability in EISB, assuming that the exchanging systems (e.g., computer systems, software applications, database records etc.) must come to an agreement on domain semantics in order to build an enterprise application. For example, various ontologies have been developed for capturing knowledge semantics on various aspects of a given domain for easing semantic interoperability issues in enterprise applications. For instance, in the business domain, the semantic Web has influenced various aspects of existing implementations such as: Simple Object Access Protocol (SOAP) (SOAP, 2007), Web Service Description Logic (WSDL) (WSDL, 2001), Service Oriented Architecture (SOA) (Bell, 2008), etc. In all of these approaches, the domain semantics captured in an ontology are tagged to business/service information represented using these standards, facilitating semantic compatibility between interacting enterprise services and easing knowledge interoperability (Nagarajan, Verma, Sheth, Miller, & Lathem, 2006; Burstein & McDermott, 2005). Researchers have also designed and implemented OWL-S (OWL-S, 2004), a semantic Web enabled Web-service model that incorporates all of the aspects of a software Web service lifecycle using ontology frameworks. For example, in the financial enterprise, lack of standard ontologies for capturing the semantics related to the financial domain have created a major bottleneck for information exchange/integration, knowledge extractions, financial reporting, Web services, etc., due to semantic ambiguity in the represented financial knowledge (Makela, Rommel, Uskonem, & Wan, 2007; Hu, 2010). Currently, Object Management Group (OMG) has taken an initiative to develop Financial Industry Business Ontology for capturing semantics related to the financial domain (FIBO, 2012). As another example, in the government domain, semantic technologies such as linked data, semantic Web, ontologies, etc., have become a crucial component for