Potential applications of ontologies and reasoning for modeling and software engineering

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Abstract. In the last few years SAP introduced Service-oriented Architecture as a blueprint for an adaptable, flexible, and open IT architecture for developing services-based, enterprise-scale business solutions. An Enterprise Service is typically a series of Web services combined with business logic that can be accessed and used repeatedly to support a particular business process. Aggregating Web services into business-level enterprise services provides a more meaningful foundation for the task of automating enterprise-scale business scenarios. At the same time, SAP Research was investigating in numerous research projects how ontologies, reasoning, semantic web services technologies, and advanced business process modelling technologies can be applied in order to improve technical foundation behind SAP SOA and business modelling. In this extended abstract we describe some selected business process composition and integration scenarios identified as potential candidates for application of business process composition techniques, semantic technologies, ontologies, and reasoning. We further identify some challenges linked to application of such advanced technologies in the context of modelling and software engineering.

Introduction

The advent of Service-oriented Architecture (SOA) and Web Services (WS) opened new possibilities for smooth Enterprise Application Integration (EAI), i.e., enabling of cross-system message flow automation, in A2A and B2B scenarios in a loosely-coupled manner. In principle, Web Services enabled enterprise applications can be used by anyone, from anywhere, at any time, and on any type of platform. Additionally, SOA opens also possibilities to innovate on top of already available *best practices business processes* implemented in existing enterprise applications. This can be achieved through adoption, extension, and composition of business processes across enterprise applications. Such composites can again be made available for composition or integration scenarios through SOA-enabling.

With respect to enterprise applications, there is obviously a relationship between Business Process Management (BPM) and SOA. BPM as a management discipline helps business organizations to standardize and continuously optimize the operational processes throughout the complete business processes lifecycle. BPM as a technology provides organizations with a framework of tools to compose, model, deploy, execute, and monitor processes that include human and system tasks or that span across different business applications and require a broad set of integration capabilities. From a technical point of view, a business process is a "collection of interrelated tasks, which accomplish a particular goal".[1] Hence, SOA is an enabler of BPM and at the same time, BPM provides value on top of a service-enabled enterprise application.

The lack of formally represented semantic meaning in the WS technology stack causes the tasks of discovering, selecting, composing, and binding Web Services being considered as manual steps performed by a human. The recent advent of the Semantic Web and Semantic Web Services (SWS) promises new standardized means to formally capture the representation of the semantic meaning of data and interfaces. This enables the machines to automatically reason and to draw conclusions about the "intended meaning". The so-called Semantic Web Services promise a higher degree on automation concerning discovery, invocation, composition, and monitoring of Web Services.

Similarly, the lack of formally represented meaning in the BPM technology stack causes the tasks of defining, classifying, discovering, selecting, composing, integrating and refining (adopting, extending) business processes as well as binding them to a SOA-enabled IT platform a challenging task requiring a broad set of human skills and expertise.

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[1] http://en.wikipedia.org/wiki/Business_process

Modeling at SAP

SAP introduced Service-oriented Architecture as a blueprint for an adaptable, flexible, and open IT architecture for developing services-based, enterprise-scale business solutions. In order to achieve this, service interfaces need to be clearly defined and stable, make use of interoperable (global) data types, and must follow clearly defined communication and behavioral patterns. Furthermore, the underlying business model (interaction between business objects) needs to be transparent to establish common ground in terms of relationships between business objects which play a role when calling services.

Services that fulfill the above criteria are called Enterprise Services and are published in an Enterprise Services Repository. Enterprise Service is typically a series of Web services combined with business logic that can be accessed and used repeatedly to support a particular business process. Enterprise services that SAP delivers are grouped in Enterprise Service Bundles (ES Bundles) based on specific business scenarios. This provides a meaningful foundation for the task of automating enterprise-scale business scenarios. The use of Enterprise Services or ES Bundles for integration/automation purposes can be seen as "service consumption". For instance, the usage of Web Services residing on top of Private Business Process Layer in order to create a composite application or usage of Web Services residing on top of Public Business Process Layer in order to create collaborative business process means service consumption (Figure1). Furthermore, it is possible to implement business applications (composites) on top of Enterprise Services and other third party services. Composites benefit from the reuse of existing assets and process flexibility. This means that it is possible to replace, remove, or rearrange steps in a process but also to implement new collaborative scenarios. The creation and packaging and publication of a composite application as ES bundle can be seen as "service provisioning" (Figure1).
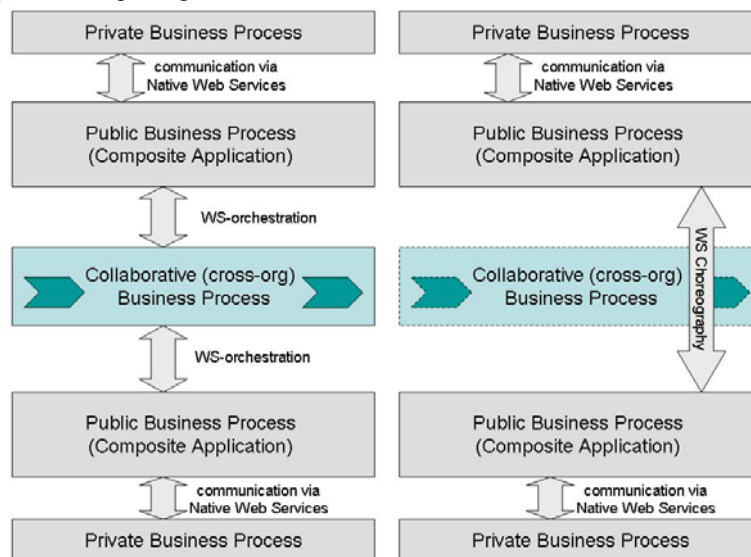
Figure 1 SOA-enabled EAI

BPM provides value on top of SOA by providing business value and business semantics to the Enterprise Services. BPM provides business process modeling capabilities identifies and classifies business scenarios, business processes and their variants and links them to integration scenarios. Thus, BPM helps to determine the granularity and required behavior of Enterprise Services and to give them business semantics. SOA is an enabler for BPM as it provides support for creating different types ob business processes, e.g., human-centric/system-centric composite business processes/applications as well as integration processes, and defines their accessibility and extensibility points.

In overall, SOA at SAP can already be seen as a convergence point between business and IT. The lack of formally represented semantic meaning in both BPM and SOA technology stacks causes all tasks to be performed within this infrastructure to be manual steps performed by a human.

Potential applications for ontologies and reasoning

In the last few years, SAP Research was investigating in numerous research projects how ontologies, reasoning, semantic web services technologies, and advanced business process modelling technologies can be applied in order to improve technological foundations behind SOA and BPM.

In order to give an idea about the scope covered within these projects, we give a short overview of the most relevant projects before we introduce two examples for potential application of ontologies, reasoning and business process composition technologies:

ATHENA (Advanced Technologies for Interoperability of Heterogeneous Enterprise Networks and Their Application) – main scope on Enterprise Interoperability, e.g., the concept Private/Public/Collaborative Processes as shown in Figure1 built one of the core concepts

DIP (Data, Information and Process Integration with Semantic Web Services) – main scope on Semantic Web Services Lifecycle (WSMO, WSML, WSMX)

SUPER (Semantics Utilized for Process Management within and between Enterprises) – main scope on Semantic Business Process Management, i.e, bridge the gap between Business Experts Perspective and IT Implementation Perspective (sBPMN, sBPEL, WSMO)

FUSION (Business Process Fusion using Semantically-enabled Service-oriented Business Applications) – main scope on Semantically-enabled Process-oriented Enterprise Application Integration (Private-Public Abstraction Layer for Data/Functionality/Behavior, EAI Ontology, Semi-automated Process Integration, SA-WSDL, BPEL)

MOST – Marrying Ontologies with Software Technologies (Semantically-enabled MDA - Ontology-driven Software Engineering, Guidance and Traceability in the Software Development Process and in Solution Domain (MOF, UML, BPMN, OWL, DSLs)

Example 1: Shipper Carrier Integration for delivery of goods

Let's assume shippers and carriers are SOA-enabled (in the sense of ES Bundles for the delivery step of let's say Order2Cash process), i.e. technically enterprise application integration is not a problem. Additionally, a shipper would like to automate the discovery, integration and selection of carrier services according to business rules that specify his preferences from the business perspective. This is obviously not possible without shared and common understanding of the business scope within the logistics domain of carriers and shippers and standardized means to describe the capabilities of the carriers and requirements of the shippers. We solved this problem by introducing a logistics ontology specified in OWL-DL and using SA-WSDL annotations to link WSDL to the concepts in the ontology. The complete solution is described in [1].

Example 2: Semi-automated process integration of enterprise and composite applications

Let's assume we have a SOA-enabled HR System providing an ES Bundle for a recruiting process. A department in a company would like to extend this process in order to introduce department specific recruiting procedures that a not supported by best practice process in the HR System. This can be done by developing a composite application on top of the ES Bundle provided by the HR System. However, all steps have to be done manually. We could semi-automate creation of a composite application with respect to the data and control flow tasks in the composite application by semantically annotating the input and output messages of the Enterprise Services and their behavior. The only steps that still need to be done manually are: the modeling of the new behavioral interface for the applicant and the internal workflow of the composite application. The integration of the data and control flow between the applicant interface, the HR System and the internal business process of the composite application is a guided semi-automatic process. The complete background used in this solution is described in [2], [3].

Challenges and future work

The above as well as many, many other examples show that application of ontologies, reasoning and advanced business process composition techniques in the area of integration and composition of enterprise applications is reasonable and feasible. However, there are only bits and pieces based on different conceptual assumptions and technologies. The challenge is to bring all loosely-coupled models and ontologies under an umbrella of a unified conceptual framework that combines the classical modeling techniques with ontological modeling in one hybrid meta-model. The framework must

address the business level as well as IT level and provide a link from business to IT that ideally supports round-trip engineering supported by guidance and traceability methodologies for both the software engineering process and the solution domain. SAP Research started to investigate these issues within the EU-funded project MOST (http://www.most-project.eu/).

Reference

[1] Andreas Friesen, Kioumars Namiri, Towards Semantic Service Selection for B2B Integration, Proceedings of The 6th International Conference on Web Engineering (ICWE 2006), Menlo Park, CA, July 2006

[2] Jens Lemcke, Andreas Friesen, Composing Web-Service-like Abstract State Machines (ASMs), Proceedings of the 2007 IEEE Congress on Services (ICWS/SCC 2007), July 2007, Salt Lake City, USA

[3] Jens Lemcke, Andreas Friesen, Considering Realistic Web Service Features for Semi-automatic Composition, In the Proceedings of the 3rd South-East European Workshop on Formal Methods (SEEFM 2007), November 2007, Thessaloniki, Greece, ISBN 978-960-89629-4-1