Standards and Initiatives for Service Modeling - The Case of OMG SoaML

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ABSTRACT: *Service modeling is a key element of any service-oriented system. It is the foundation on which core service-related tasks such as service discovery, composition, and mediation rely. During the past years standardization bodies such as W3C, OMG and OASIS have been working on standardizing various aspects of services such as service functionalities, behavior, quality of services, etc. At the same time, initiatives from academia focused on developing ontologies and formal languages for specifying services. In this paper we give a brief overview of relevant initiatives and standardization activities in the area of service modeling, and, as an example of the use of such standards, guide the reader through the use of the OMG Service oriented architecture Modeling Language (SoaML) in a concrete service-oriented scenario in the manufacturing domain.*

KEY WORDS: *service modeling, standards, SoaML*

1. Introduction

The *service-orientation* paradigm has emerged during the last decade for distributed computing and e-business processing. It utilizes *services* – autonomous, platform-independent computational elements that can be described, published, discovered, composed, and accessed over the Internet using standard protocols – as fundamental elements for developing applications/solutions. In recent years, various forms of service-oriented metaphors have appeared, the most important being Web services, e-Services, Grid and Cloud services, and Semantic Web Services. With the IBM's introduction of *service science* (Spohrer et al, 2007) as an interdisciplinary approach to the study, design, and implement services systems (complex systems in which specific arrangements of people and technologies take actions that provide value for others) the service-orientation paradigm received new dimensions in supporting the service innovation process. Irrespective of such dimensions, being able to describe and model services is a key requirement for all service-related tasks.

There exists a plethora of service description efforts[1] that mainly differ on the information they capture about services. This can be related to IT or business aspects of services, or the whole service ecosystem. With this paper, we focus primarily on standardization efforts for service descriptions and provide a brief survey of the most relevant initiatives in this area. We then use the OMG Service oriented architecture Modeling Language (SoaML) to provide a concrete example in the manufacturing domain for service modeling using a standardized approach.

The remaining of this paper is organized as follows. Section 2 provides an overview of activities of the most relevant standardization bodies in the area of service modeling. Section 3 provides an example of using the OMG SoaML, and Section 4 provides a summary of this paper.

2. Service Modeling – Overview of Standards and Initiatives

The World Wide Web Consortium (W3C)[2] develops standards to "ensure the long-term growth of the Web." W3C has been actively involved in standardization activities related to service descriptions.[3] W3C sees service descriptions as an important part of accessing a service, and therefore the W3C standards in this area focus on the access aspect of services. Probably the most important standards for service description proposed by W3C are WSDL and SAWSDL:

- *Web Services Description Language (WSDL)* (Chinnici et al, 2007) provides a model and an XML format for describing Web services by separating the description of the abstract functionality offered by a service from concrete details (e.g. binding, concrete transport protocols) of a service description such as "how"

[1] A comprehensive list, albeit incomplete, of service description efforts is available at http://www.w3.org/2005/Incubator/usdl/wiki/D1
[2] http://www.w3.org/
[3] http://www.w3.org/standards/webofservices/description

and "where" that functionality is offered. The number of publicly deployed WSDL services is estimated to around 28000.[4]

- *Semantic Annotations for WSDL and XML Schema (SAWSDL)* (Farrell and Lausen, 2007) defines set of extension attributes for the WSDL and XML Schema definition language that allows description of additional semantics of WSDL components. It provides mechanisms through which concepts from semantic models (e.g. ontologies), typically defined outside the WSDL document, can be referenced from within WSDL and XML Schema components using annotations.

W3C is presently active in standardization of service descriptions through the Unified Service Description Language (UDL) Incubator Group[5] which aims to define a language for describing general and generic parts of technical and business services.

The Object Management Group (OMG)[6] develops enterprise integration standards. Its core standardization activity in the area of service descriptions is the *Service oriented architecture Modeling Language (SoaML)* (OMG SoaML, 2009). SoaML defines a UML profile and a metamodel for the design of services within a service-oriented architecture. It supports a wide range of modeling requirements for service-oriented architectures such as specification of systems of services, service contracts, individual service interfaces, service implementations, etc. Section 2 provides further details on the elements of SoaML in a concrete application scenario.

Organization for the Advancement of Structured Information Standards (OASIS)[7] produces standards for the information society in a variety of areas such as security, Web services, conformance, business transactions, supply chain, etc. In the area of service descriptions OASIS has developed two specifications that, although do not prescribe a concrete language for representing aspects of services, clarifies the elements of service-oriented architecture and their relationships:

- *Reference Model for Service Oriented Architecture* (MacKenzie et al, 2006) provides an abstract framework for understanding significant entities and relationships between them within a service-oriented environment
- *Reference Architecture Foundation for Service Oriented Architecture* (Estefan et al, 2009) provides an architecture that follows from the concepts and relationships defined in the OASIS Reference Model for Service Oriented Architecture. The architecture describes a possible template upon which a SOA concrete architecture can be built.

OASIS has been active in standardizing various aspect of SOA[8] in areas such as business processes (e.g. WSBPEL).

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[4] http://webservices.seekda.com/browse
[5] http://www.w3.org/2005/Incubator/usdl/
[6] http://www.omg.org/
[7] http://www.oasis-open.org/
[8] http://www.oasis-open.org/committees/tc_cat.php?cat=soa

The Open Group[9] develops standards in the enterprise integration domain. Relevant to service descriptions, The Open Group has developed *SOA Ontology*[10] which contains a formal definition of the concepts, terminology, and semantics of SOA in both business and technical terms. The ontology is expressed in the Web Ontology Language (OWL), but with explanatory text including UML diagrams and examples. It covers aspects such as actors and tasks, services, contracts, service interfaces, compositions, policies, events.

The Open Geospatial Consortium (OGC)[11] is developing standards for geospatial and location based services. Although its focus is on geospatial aspects of services, some of its specifications such as WFS and WPS are generally applicable to services:

- *Web Feature Service (WFS)*[12] provides a standardized interface allowing requests for (geographical) features across the Web using platform-independent calls. It provides generic operations such as query and retrieval of features based on spatial and non-spatial constraints, or creation and deletion of new feature instances.
- Web Processing Service (WPS)[13] provides standardized interfaces that facilitates the publishing of geospatial processes and clients' discovery of and binding to those processes. It defines WPS defines operations for returning service-level metadata, description of a process including its inputs and outputs, and executing the process.

Service Ontologies. Several service ontologies in the area of semantic Web services have been developed by the research community and were submitted for standardization primarily at W3C. These include:

- *OWL-S*[14] is an OWL ontology for service and contains three main parts: the service *profile* for advertising and discovering services; the *process model*, which gives a detailed description of a service's operation; and the *grounding*, which provides details on how to interoperate with a service, via messages.
- *Web Service Modeling Ontology (WSMO)*[15] is a conceptual framework and a formal language for semantically describing relevant aspects of Web services in order to facilitate the automation of discovering, combining and invoking electronic services over the Web. It includes Ontologies, Web services, Goals, and Mediators as core elements.
- *Lightweight Semantic Descriptions for Services on the Web (WSMO-Lite)*[16] provides a lightweight set of semantic service descriptions in RDFS that can be used for annotations of various WSDL elements using the SAWSDL annotation mechanism. These annotations cover functional, behavioral, nonfunctional and information semantics of Web services.

[9] http://www.opengroup.org/
[10] http://www.opengroup.org/soa/standards/ontology.htm#_The_Open_Group_2
[11] http://www.opengeospatial.org/
[12] http://www.opengeospatial.org/standards/wfs
[13] http://www.opengeospatial.org/standards/wps
[14] http://www.w3.org/Submission/OWL-S/
[15] http://www.w3.org/Submission/WSMO/
[16] http://www.w3.org/Submission/WSMO-Lite/

Although such ontologies for services have not been standardized, research for the development of ontologies is ongoing. An analysis of some of the service ontologies that have been developed primarily by the research community can be found in (Sorathia et al, 2010).

3. Service Modeling with SoaML

The SoaML specification provides UML extensions to support the modeling of services as required in SOA. The main extensions are the following. *Participants* are components that play the role of service providers or service consumers (or both) through their ports. *Services Architectures* define how the Participants work together by providing and using services between them. *Service Contracts* describe interaction patterns between two or more service entities. *Service Interfaces* define the operations provided and required by a service. *Service data* specify the information exchanged between service consumers and service providers. Finally, *Capabilities* specify a cohesive set of functions or resources provided by a service.

The rest of the section focuses mainly on Service Architectures and Service Contracts. We will exemplify our presentation with a case study in the domain of Manufacturing. A Boom Dealer is selling crane boom trucks, but uses the services of a Manufacturer. The Manufacturer will create the necessary metal pieces from raw material and assemble them on site. Raw material (i.e. steel plates) and the coating of metal pieces are provided by third parties. Moreover, it is possible that some pieces are too big for the Manufacturer to build (because of a lack of adequate equipment for instance). In that case a third party will create the metal piece for the Manufacturer.

We follow the SoaML methodology developed during the SHAPE project (Elvesæter et al 2011), and which provides guidelines for using BPMN and SoaML to specify an SOA, both from the business and the IT perspective. We concentrate here only on some aspects of SoaML.

A top-down approach for specifying SOA and using SoaML will start with Services Architectures. A Services Architecture is a high level specification of how Participants work together by providing and consuming services. It is modeled as a UML Collaboration, stereotyped <<ServicesArchitecture>>. It specifies the different Participants that take part in the service, and the relations between them. Those relations are expressed through collaboration

uses. For instance,

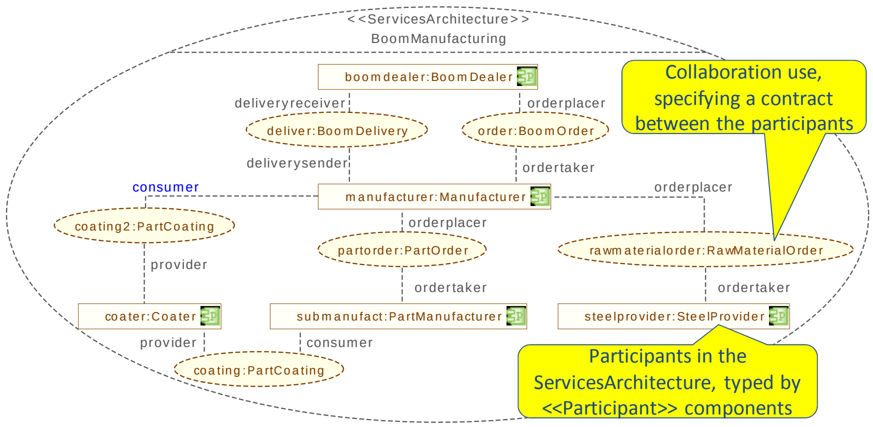

Figure 1 shows the Services Architecture for the *BoomManufacturing*, with the following Participants: *BoomDealer*, *Manufacturer*, *PartManufacturer*, *Coater* and *SteelProvider*. Those Participants interact with each other through the services identified by a number of collaboration uses. Each of those collaboration uses is in turn typed by a Service Contract.

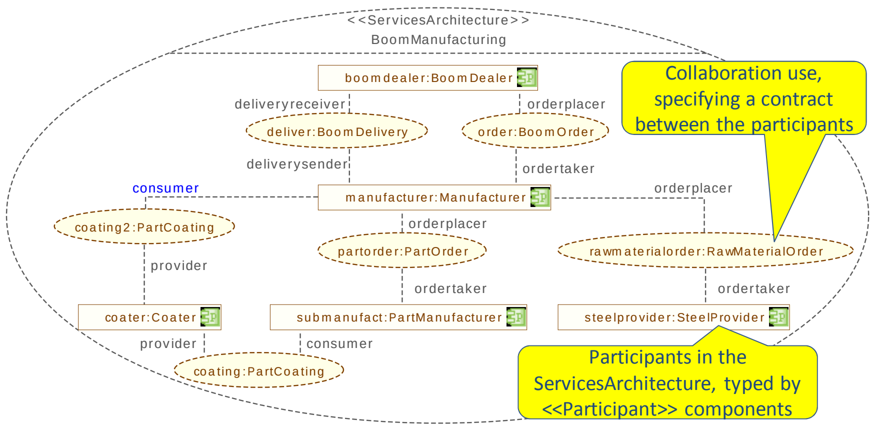

Figure 1 - Services Architecture for a Boom Manufacturing

The next step of the methodology is to specify the Service Contracts. They specify how the service is to be consumed and provided, by defining the role each Participant will play in the interaction, with interfaces and behavior. A Service Contract is modeled by a UML Collaboration stereotyped <<ServiceContract>>. It specifies the interfaces each Participant must implement in order to abide the service contract. A UML behavior can also be specified, as state machine or message sequence chart. Figure 2 shows the two Service Contracts used between two Participants. The *BoomDealer* will play the role *orderPlacer* in the *BoomOrder* service, while the *Manufacturer* will play the role *orderTaker*.

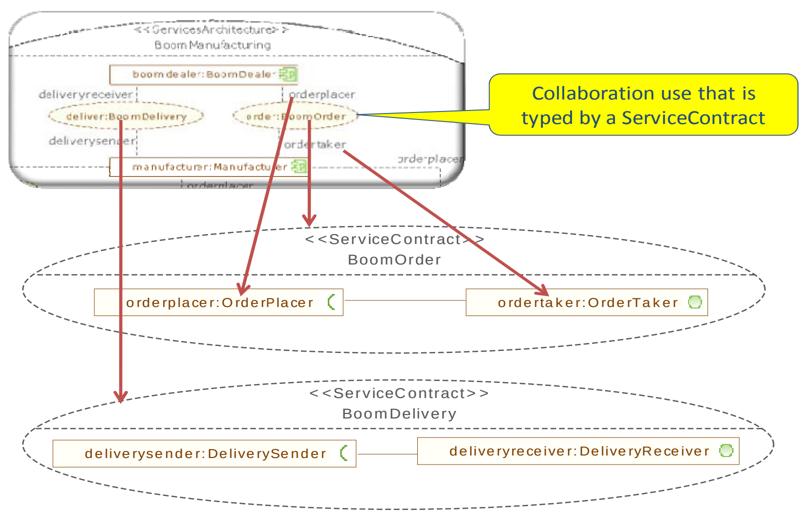

Figure 2 - Collaboration uses and Service Contracts

The Service Contracts are further refined by specifying the provided and consumed interfaces. The interfaces are respectively stereotyped <<Provider>> and <<Consumer>>, and define the operations and service data associated to them. For instance Figure 3 shows the two interfaces specified with the *BoomOrder*. The role *orderTaker* is typed by a <<Provider>> interface, and defines the operations *quote* and *orderConfirmation*.

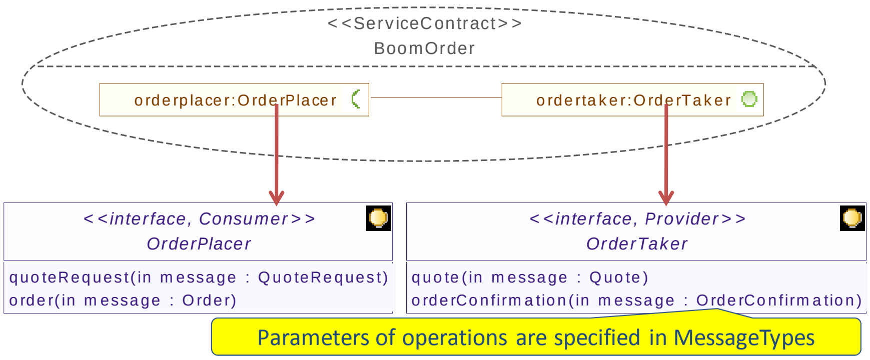

Figure 3 - Service Contracts and Interfaces

The parameters of the operations are specified as Message Types, which is a document-centric service specification[17]. This means that XML documents will be exchanged between participants of a service. In SoaML this is modeled using a classes stereotyped <<MessageType>>. Figure 4 shows the service data to the interfaces presented earlier, with the corresponding Message Types.

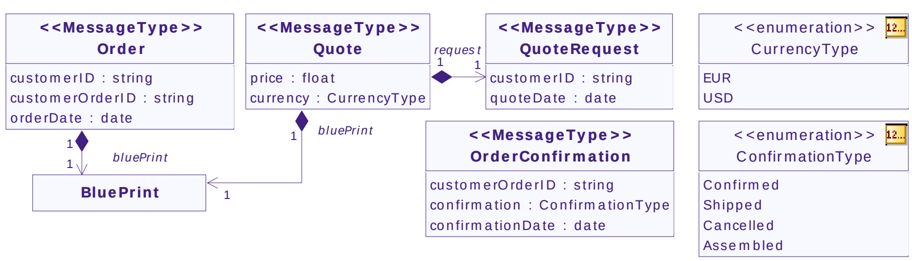

Figure 4 - Service Data

For more details on the elements of SoaML and their use we refer the reader to the SoaML specification at http://www.omg.org/spec/SoaML/.

[17] SoaML supports as well RPC-centric service specifications, but are not tackled in this article.

4. Summary and Outlook

A variety of initiatives and standards for service description have emerged during the past decade focusing on providing means for capturing information about services. This can be related to IT or business aspects of services, or the whole service ecosystem. In this paper we gave a brief overview of standardization efforts for service descriptions and provided a brief survey of the most relevant initiatives in this area. We used the OMG Service oriented architecture Modeling Language (SoaML) to provide a concrete example in the manufacturing domain for service modeling using a standardized approach.

There is no doubt that standards in the area of service modeling will continue to develop, with some of the existing standards currently being revised and new standards being proposed. With the emergence of the service science discipline, service modeling is seen a key requirement for all service-related tasks and will therefore animate the service science landscape during the coming years. On a short term, it would be interesting to follow the development of the Unified Service Description Language (UDL) in the context of W3C, and investigate and harmonize the various ontologies proposed for modeling services.

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