Web services composition applying MDA

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Abstract. Currently, Web services are available on Internet in a simple and easy way to use. However, a single service can not respond to a predetermined request by user. Thus, it is necessary to compose services, ie, organize them in a manner to achieve the goal automatically. The semantic web services increases the descriptions of web services using semantic annotations (eg ontology). There are different approaches to express the semantic aspect as OWL-S, WSMO, WSDL-S and a recent W3C recommendation SAWSDL (Semantic Annotations for WSDL and XML Schema). To address complexity, scalability and heterogeneity problems of Web Systems, the OMG has proposed the model driven approach MDA based on the concepts of models, metamodels and transformations. The method describes a process that guides the developer through various phases, starting with the models, and ending with a new compound that can be deployed and published.

Key words: Web services composition, semantic web services, MDA.

1 Introduction

A Web service is a standardized manner to integrate applications based on the Web using open standards XML [1], SOAP [2], WSDL [3] and UDDI [4] and Internet transport protocols. However, a single service can not respond to a predetermined request by user. Thus, it is necessary to compose services. The composition object is to combine the functionality of several Web services within a business process in order to respond to complex applications that single service could not meet. However, the creation of service from other services is far from being trivial task. To help developers create composite services, the middleware web services composition should provide abstraction and infrastructure that facilitate web services composition development and implementation.

Web service proposals for description (WSDL), invocation (SOAP) and composition (BPEL4WS [5]) that are most commonly used have no semantic descriptions. It is difficult to find appropriate services, since a large number of services is described only syntactically. The semantic web services description is used to improve search accuracy for existing services and automate parts of composing services process.

Several proposals have been used as OWL-S [6] and WSML [7]. In addition to these standards, there is a recent W3C recommendation SAWSDL [8] (Semantic Annotations for WSDL and XML Schema). The objective of SAWSDL specification is to develop mechanism that allow Web services descriptions annotation with semantic concepts extracted from ontologies representing knowledge in a specific domain.

Model driven development is the basic idea to automatically transform models from one area to another. Therefore provide a model that supports these transformations is of great importance.

The work described in this paper adopts the strategy MDA to develop Web services compositions.

The rest of the paper is structured as follows: section 2 describes the background to this work,. Section 3 presents previous and related works, section 4 presents synthesis for semantic web services composition in MDA; finally, section 5 sums up the main conclusions.

2 Background

Model Driven Development (MDD) [9] is an emerging technology for software development, promoting the role of models and automatic creation of code by predefined model transformations. A variant of MDD suggested by the Object Management Group (OMG) is the Model Driven Architecture (MDA) [10]. MDA provides an enabling infrastructure with standard specifications facilitating the definition and implementation of model transformations between Meta Object Facility (MOF) [11] compliant languages.

The application of model transformations is expected to improve the software development process in many ways, as it enhances productivity, portability, interoperability, ease of use, maintenance and reusability.

3 State of Art

Web services composition is not a simple task; it must be a way for Web services composition to describe organizational and temporal constraints that must be met by client application to lead better interaction process, which is trivial. The concept of models allows the reuse of these models, and thus it facilitates Web services composition. In this section we present some works that have MDA benefits.

3.2 Web Service Composition

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Authors in [12] examine functional requirements of service composition and introduce an approach for developing service compositions. The proposed approach uses UML to model composition. They use (OCL) to express transformation rules. Approach steps are abstract definition, scheduling, construction and execution.

The system starts with an abstract composite service, which specifies the constituent activities of a composite service. In the second phase, the service composition system determines how and when services should run and prepares them for execution. Next, the system proceeds with the Construction phase to construct an unambiguous composition of concrete services out of a set of desirable or potentially available/matching constituent services. Lastly, the service composition system prepares the constructed composed services for execution. This phase maps the resulting specification to an executable web service orchestration language (e.g. BPEL).

The authors in [13] propose a method that uses the UML activity model to design the web services composition, and MDA to generate executable specifications in different composition languages. The method uses UML manufacturers with a minimum set of extensions for web services. The most important step of the method is the transformation of WSDL descriptions to UML. This information is used to complete the composition models. The method is independent of the language composition of web services. The user can choose his preferred language of composition and its execution engine. The method has been implemented to support two languages that are Worksco and BPEL4WS with their execution engines. They use UML to capture the patterns composed of web services. These patterns express in UML activity diagrams with additional extensions that specify the flow control between the individual performing the service compound. Activity diagrams of UML are used for the composition of services. The service component is then exported as a WorkSCo or BPEL4WS. The process consists of three steps: in the first step they create a preliminary model for the new web services and identify the candidate web services. The modeller will extract the WSDL specifications to be used in the next phase. Its but is to modeler the details of the composition in UML activity models. Configure the execution engine to execute the new operation. The business model will be transformed into an XML document and will be entering the engine. The transformation was made by UMT. Prepare the new service deployment. Generate WSDL specifications.

A methodology to develop Web services and correspondence between a UML model and WSDL was proposed by authors in [14]. This methodology can be arranged by following these steps:

Discover Web Services: The developer uses a Web browser and a client directory to search candidates for Web service composition. He obtained a list of Web services and the locations of their descriptions (represented in WSDL).

Import Web Service Descriptions: The developer imports the service description and translated it into UML. The result is a UML model conforms to WSDL.

Model Composite Web Service: The developer uses a UML tool to review and integrate the models imported in the form of a composite model. This step consists in the service structure modeling and Workflow modeling.

Export Web Services Description: The composite Web service model is exported in order to obtain a WSDL document for the composite Web service.

Implement Composite Web Service: The Web service is made from a WSDL document.

Publish Composite Web Service: Finally, the composed Web service is published in a directory.

In [15], B. Bordbar and A. Staikopoulos present a case study and its implementation with Web services. They propose a metamodel for BPEL4WS, specify the correspondence between the activity diagram of UML and BPEL4WS and define transformation rules in OCL.

Kath et al [16] propose an infrastructure to implement the MDA approach and present experiments with EDOC and Web services. In their approach, they present a metamodel for Web services (WSDL), a correspondence between EDOC and WSDL, a metamodel for BPEL4WS and correspondence between EDOC and BPEL4WS.

Lopes and al [17] have presented an approach to developing a Web services following MDA and they have applied this approach in a case study (travel agency). They proposed to follow the MDA approach as follows:

1. The selection or creation of metamodels to build the PIM.
2. The selection or creation of metamodels for building the WSP.
3. The specification of correspondences between metamodels of PIM to PSM meta-models.
4. The generation of the definition of transformation from the specification of correspondences.
5. The application of the definition of transformations to transform a PIM into a PSM.
6. Verification of PSM: move to step 7 if it is incomplete, in step 8 it is complete.
7. The user intervention to complete the PSM.
8. The generation of source code, scripts, files for deployment

They used UML and EDOC models to generate the PIM, and ATL to define the transformation rules. Platforms for which they generate the Java code are Web services and JWSDP.

Lopes noted that the mapping from EDOC to WSDL is more accurate than that of the UML to WSDL because the EDOC elements are closer to WSDL elements. To show the importance of language processing in the MDA approach Lopes defined not only the changes to the Web services platform, but also to Java and JWSDP.

An automatic transformation of ISDL models into BPEL was proposed by Teduh Dirgahayu in [18] for the creation of a composite Web services can be made quickly and with low cost.

ISDL (Interaction Systems Design Language) is a modeling language-independent of language implementation. Its purpose is to support the design of the distributed system by providing generic design concepts and a textual and graphical notation to model the structure and behavior of systems. ISDL is used in high levels of abstraction.

The transformation process consider that ISDL is created using GRIZZLE, so it has a .grizzle extension, using an XML editor (butterfly XML IDE) the model is imported in a format ISDLXML, and using XLANG file it is converted to XMI which will be transformed into WSDL models, and BPEL by using the YATL transformation for MDA. These models are translated into BPEL and WSDL documents using XLANG.

Brahe and Bordbar [19] have presented an approach to support, and semi automates the process of composing services by transforming the models created by designers at a final executable workflow. This approach produces good quality applications in less time. The idea is to capture existing knowledge of the company and consider them as patterns parameterized reusable. These patterns are used as tools of transformation models. To support their approach, the authors have used domain specific modeling languages DSMLs designed for each company to capture the business process models in different levels of abstraction.

These authors have shown that a general modeling language such as activity diagrams or UML Business Process Modeling Notation (BPMN) does not model the business processes of companies using their vocabularies and terminologies as the DSML. In this approach MDA provides mechanisms for defining DSMLs and a conceptual framework for defining transformations between different DSMLs.

The process is as follows: the analysis of business processes creates the DSML model of business processes. The architect transforms this model to an architectural model by applying a predefined and automatic processing using the patterns set. In the same way the developer transforms the architectural model into an executable model.

Distribution Patterns describe how a distributed system will be deployed. A composition based on the distribution pattern using MDA was proposed by Barrett et al [20]. This approach takes as input interfaces of existing Web services and generates an executable composition based on a distribution pattern chosen by the engineer.

In the first step, Web services interfaces (web services to compose) are modeled in UML2.0. Links between these Web services models are determined in the second phase following a chosen distribution pattern. The third step consist to transform the model into a distribution pattern by a generator of distribution patterns, this instance is transformed into XML using XSLT / DOM and will be called a document instance DPL (distribution pattern language) that is validated in step 4 by a validation tool of distribution patterns to check if the chosen pattern in the second step is adequate. In the last step the executable code is generated from the valid document DPL using XSLT / DOM.

A model driven Approach to incorporate the prediction of performance in the process of composing services using BPEL was proposed by [21]. This approach is based on the use of P-WSDL (Performance-enabled WSDL), an extension of WSDL

3.2 Semantic Web Service Composition

Semantically described Web services make it possible to improve the precision of the search for existing services and to automate the composition of services. In this section we have present some works that uses semantic description to compose web services adopting MDA.

The authors [22] use MDA techniques to generate Web service OWL-S descriptions from UML model. This approach allows the creation of web services composed by specifying a semantic web service using the WSDL specifications. This compound is generated using a UML model and the generation of specifications and application following concepts MDA.

The authors in [23] defined transformations between UML and OWL-S and make composition of Web service on the basis of these transformations. The profile developed uses ontology UML profile (defined by Duric) to model the concepts of ontology. They use UML to describe a web services and to link inputs and outputs. Their profile supports code generation of OWL-S and WSMO but they do not support SWSF and WSDL-S.

Barrett based in his approach [24] in the context of composite Web services, so that it can support the semantic Web services. He followed the same steps, but added the condition that all Web services components are semantically annotated using OWL-S in [20].

Gronmo and al.[25] Present a model-driven methodology for designing composite Web services. The methodology considers a syntactic and semantic description about the interfaces of service candidates. It also processes QoS requirements from the developer and offerings from the service providers.

The methodology provided better documentation of the composition in the form of graphic models. They uses UML activity diagrams for model the composition. Class diagrams for the concepts of ontology and QOS requirements. Ontology concepts are grouped by package or each package represents domain ontology.

Phases 1 and 2

- The developer search in ontology register appropriate ontology concepts, the result is a lexical document that can be in OWL, WSMO, etc. Repeated the same work for the quality of service QOS. Use UML to represent the abstract composition model. Activity diagrams are used to capture composition data and control flow and Class diagrams represent QOS and ontology requirements. So it will output a list of candidate services for each task.

Phases 3and 4:

- The selection is based on semantic description and quality of service. We will have a graphic model and Transformations can be imported directly in the web services instead of tasks. The result is a concrete composition model. The model is used to generate the different WSDL descriptions.

The design of composite web services is achieved using the behaviour diagrams but they must be complemented by structural diagrams. This is the idea of Quintero et al [26] who have modeled services and the behaviour of services composition using UML diagrams. The PIM service can be mapped directly to. NET or J2EE. The application of a set of transformation rules on the composition model allows the generation of BPEL. The SW service model captures the internal structural needs of a Web services and structural needs of external Web services (ports and operations).

The authors consider that the SW model is necessary to have a complete specification to allow automatic generation of code. The composition of Web services can be specified by services aggregation. By adding the structural model, they allow the dynamic selection of Web services, automatic and complete generation of code and easy maintenance of composite Web services, ...

An extension of MIDAS [27] called MIDAS-S for the development of semantic Web services. This version contains new elements modeling semantic Web services using WSMO as a specific platform. The PIM is ODM (Ontology Definition Model),, with these models it is possible to define mappings to the ontology dependent models (PSM). The PSM WSMO models are needed to define the specification of WSML (environment, ontologies, goals, Web service). It is possible to generate PSM of OWL-S.

In another work Behzad et al [28] have proposed a model of transformation of OWL-S to BPEL using SITRA which is a framework model of transformation using java. The authors defined the metamodels OWL-S and BPEL, then they set the rules for conversion of OWL-S service to BPEL using SITRA to prove that it is simple to use, and at the same time it can make complex changes.

The authors in [29] treats framework MoSCoE: A Framework for Modeling Web Service Composition and Execution which is composed of three steps: abstraction, composition and refinement. It will enter service in UML state machines and the result is a sequence of functions and relationships required to achieve the goal of the service. The user can provide extra functional requirements. The service provider in MoSCoE publishes its service in providing OWL-S and WSDL specifications. MoSCoE manipulates the input data and automatically identifies a composition.

Tim and al. [30] propose architecture based on MDA for the composition of semantic web services through the use of the profile that extends UML activity diagrams and class. This profile is used in the change that facilitates the automatic construction specifications OWL-S from the UML diagrams. The conditions require the composition such as those on building controls are specified in OCL and transformed into SWRL during construction.

Authors in [31] have proposed a metamodel to facilitate the annotation in the semantic Web services and automatic generation of code. This metamodel is used to generate code for both approaches OWL-S, WSMO, SWSF and WSDL-S using the transformation rules.

The approach in [32] uses the SPecification and EXecution tool (SPEX), which facilitates the automatic generation of OWL-S groundings and associated XSLT transformations. They demonstrated through an example that explains the use of the SPEX.

UML-S [33] (UML for Services) is an extension of UML 2.0 that allows the modelling of web services and interactions. In UML-S class and activity diagrams are used to model web services and their interactions. It provides a profile based on class diagrams UML2.0. Transformation Rules between WSDL 2.0 and UML-S class diagrams. A profile based on UML 2.0 activity diagrams and Transformation Rules from UML-S to WS-BPEL 2.0 are introduced.

SAWSDL represents an extension of format description syntactic WSDL to define a mechanism that allows semantic annotation of describe web services in terms of concepts provided by domain ontology, and the addition of these semantic annotations included in the WSDL document. Instead of writing notes by hand or load ontologies this paper describes a simple process: SAWSDL descriptions are produced automatically from the original WSDL document. In this article [34] they address the modelling of semantic web services and especially on the use of SAWSDL; they present a process of transformation between models based on rules to SAWSDL.

2 Synthesis

In this section we summarize the different approaches mentioned above in summary tables describing the different ideas for each author, the tools used to model the PIMs, the target platforms to which the transformations are made, and the various tools used in each approach.

Table 1. MDA for Web services composition.

Approach	PIM	PSM	Tools
Orriens and al.2003	UML	-	OCL
Gronmo et al.2004	UML	WSDL	UMT
Skogan et al 2004	UML	BPEL4WS	-
Bordbar et al 2004	UML	BPEL4WS	OCL
Kath et al 2004	EDOC	WSDL and BPEL4WS	-
Lopes et al 2005	UML and EDOC	WSDL UDDI BPEL4WS	ATL
Dirgahayu 2005	ISDL	WSDL and BPEL4WS	YATL
Brahe et al. 2006	DSML	DSML	-
Barrett et al. 2007	UML	WSDL BPEL4WS	XSLT/DOM DPL
Bocciarelli et al.2007	UML	P-WSDL et BPEL4WS	-

Table 2. MDA for semantic Web services composition.

Approach	PIM	PSM	Tools
Gannod et al.2004	UML	WSDL OWL-S	-
Jaeger and al.2005	UML	OWL-S WSML	UMT
Barrett 2006	UML	WSDL BPEL4WS OWL-S	distribution pattern XSLT/DOM DPL
Gronmo and al.2005	UML	WSDL BPEL4WS Semantic description (OWL-S or WSML)	-
Quintero et al. 2006	UML et MOF	BPEL4WS	ATL
Acuna et al. 2006	UM L	ODM WSDL WSMO	MIDAS
Bordbar et al. 2007	UML	BPEL	SITRA
Timm et al. 2007	UML	OWL-S	OCL
Florian et al. 2007	UML	WSDL-S /OWL-S WSMO/SWS F	-
Timm and al.2008	-	OWL-S	SPEX
Dumez and al.2008	UML	UML-S WS-BPEL	-

2 Conclusion

Semantic Web Services technology is gaining momentum. However, new Web engineering techniques should be defined to enable the systematic development and promote widespread composition of semantic Web services. In this work, we have presented some methods for service composition modelling adding the semantic aspect and using MDA approach.

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