Survey on UML based modeling for Web Services

Ch Ram Mohan Reddy[1], R. V Raghavendra Rao[1]
D Evangelin Geetha[2], T V Suresh Kumar[2], K Rajani Kanth[2]
[1]*B M S College of Engineering, Bangalore, India.*
[2]*M S Ramaiah Institute of Technology, Bangalore, India.*
crams19@yahoo.com, bmsce.rr@hotmail.com,
devangelin@gmail.com, tvsureshkumar@msrit.edu, rajanikanth@msrit.edu

Abstract

With the development of growing interest in number of web services, it is required to map the services at early stages of development, i.e., analysis and design phase. It is interesting to use UML in various stages of the web services development process. In addition, the non-functional requirements also can be modeled using UML. Using model driven architecture at various levels (PIM & PSM), the technology independent models are mapped into multiple technology specific models. This will help to automate the entire development process. In this paper, we study and classify various UML based approaches that are used to model web services.

1. Introduction

The term "Web service" has been used very often, nowadays. In today's e-commerce environment, various commercial and other organizations provide their services through the web. In the current classification of product development, software product not only full fill functional requirements but also flexible for future enhancements. To make this happen architecture of the product must be designed by foreseeing the scenario. It may not be possible in all circumstances of product development. To fix this gap, the technology introduced called web services, which are made available on the web. The word web by the name of Web services does not mean that it is a Web application; rather it relies on Web technologies like Hyper Text Transfer Protocol (HTTP) [23]. The main idea and target of Web services are to enhance interoperability of a distributed system over networks, especially the Internet, mainly clients and servers, where both sides exchange XML messages. Web services can interact with and invoke each other, and be aggregated to form larger web services with additional functions. Web Service is the most flexible technology among the various technologies available in this genre. Web Service is a software use identified by a Uniform Resource Identifier (URI), whose interfaces and binding are capable of existence defined, labelled and revealed by extensible Mark-up Language (XML) based format and can be able to communicate with other parts of software product depending on XML parsing on Hypertext transfer protocol or any Internet based protocol[14,19].

The modeling of Web services with Unified Modeling Language [34] (UML) is presented in [11]. A general model based on Web service's standards (i.e. Web Service Description Language (WSDL) [40]. Simple Object Access Protocol (SOAP) [32], and Universal, Description, Discovery, and Integration (UDDI) [36] and their associations in UML are defined.

A service consumer is another or service within the organization or external to the organization. The service consumer uses the service registry to locate one or more services. Once a service is located, the consumer binds itself to the service provider in order to use the service. A service provider makes such services available for service consumers to use. The service registry /service broker acts as a common point to publish all service-related information. It stores information about the organizations and the services they provide. Further it also reserves information about how to access and use the service. The conceptual web service architecture is presented in figure 1.

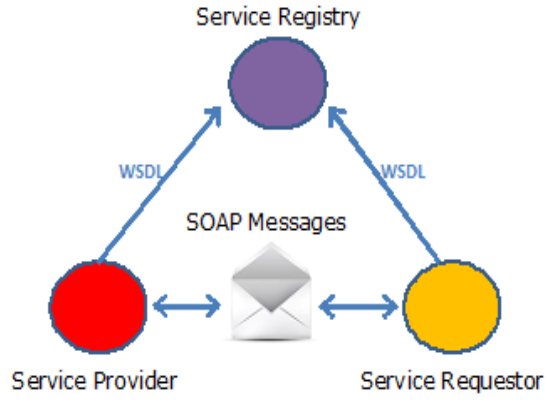

Figure 1. Web service architecture

UML is an easy to understand modeling language that has a proper meta-model, extension mechanisms defined, and that caters designing issues from different point of views. The UML is a graphical language for visualizing, specifying, constructing and documenting the artifacts of a software-intensive system. The UML provides a methodology to design system architecture, which includes various business sequences and functional requirements and also supports to design conceptual models such as database design, and development of reusable components.UML2 defines fourteen diagrams to fit out the Modeling of both static structure and dynamic behavior of systems, and help in managing the entire development process [29].

UML2 specifications are classified as Structural and behavioral diagrams. The structural diagrams are the ones that define the static view of the system. They represent the entities involved within the system and the relationship between them. Structural diagrams include: class, object, package, component, deployment, composite structure and profile diagrams.

The behavioral diagrams represent the dynamic view of the system, and depict how the entities behave and communicate in order to produce the desired behavior within the system under development. Behavioral diagrams include: use case, activity, state machine, and interaction diagrams. The interaction diagrams which include sequence, interaction overview, communication, and timing diagrams [22], [35]. The decision of choosing the UML diagram is usually based on the nature of the system; the domain, the functional, as well as the preferences of the modeller, since some UML diagrams might in some cases replace each other.

MDA uses Web Services as a platform for B2B products. MDA performs the task in two levels named as PIM and PSM. In first level in identify the Platform Independent Model (PIM) of the product. After initializing the required environment for the product MDA invokes level two functionality called Platform Specific Model (PSM). PSM will have complete information about the model of the architecture and also the information specific to the user requirements. MDA (Model-driven architecture) [29] is a software-development model suitable for current trend in product development. MDA is an additional enhancement to software development life-cycle. In this new approach, models are the main artifacts to develop software systems. The MDA introduces a sophisticated way of defining requirements. MDA consists of a platform-independent base UML model, and one or more platform-specific models." It provides a set of guidelines for model's transformation.

The MDA has two important concepts: Platform-Independent Model (PIM), Platform-Specific Model (PSM). The communication between PIM to PSM is transformation definition that can be built with Extensible Style sheet Language Transformation (XSLT). However, these languages are not adapted to performing the transformation in the space of MDA. . The MDA Process is presented in figure2 is taken from [4].

Based on the web service architecture shown in figure 1, here with submitting the corresponding use case, activity and sequence diagrams as figure 3, figure 4 and figure 5 respectively. Figure 3 describes five business scenarios or use cases about how web services are used. Figure 4 describes the activity diagram describing behavior of web service. Figure 5 describes to show the interactions between objects in the sequential order. Figure 6 describes the topology of the physical components within a system where the software components are deployed in a web service.

The extensibility mechanisms in UML2 help to describe additional information, especially to model the non-functional requirements. Hence, we have carried out a survey on the literature available on web services and UML. The outcome of the survey is presented in this paper.

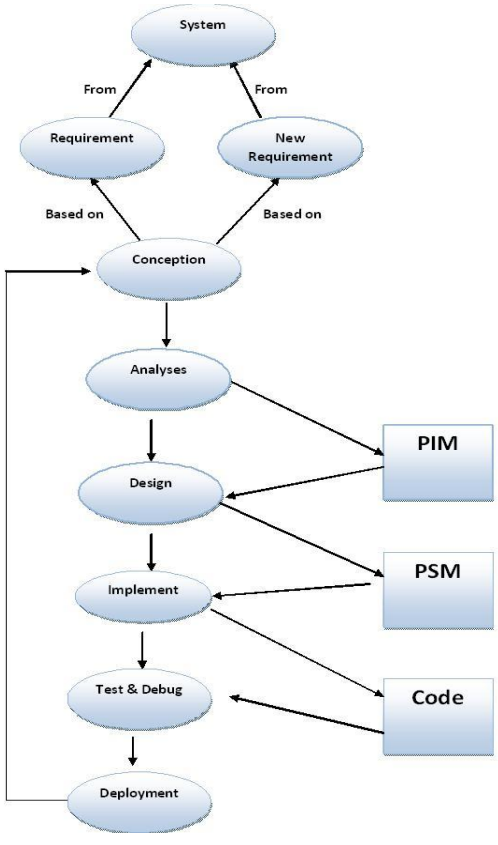

Figure 2. MDA software development life cycle

2. UML based modeling for Web Services

Considering the elementary web services to larger services and to integrate legacy components, which are not yet provided as a web service to composite web services is increasing today. Process oriented compositions of web services with UML are described in [33]. It presents Unified Modeling language – Web Service Compositions (UML-WSC) profile as an alternative for existing languages like Business Process Execution Language for Web Services (BPEL4WS) [6], which is a language for the formal specification of business processes and business interaction protocols. They propose (UML-WSC) profile, which is mainly based on activity diagrams. UML activity diagrams represent dynamic part of the composition, whereas, static part is represented by UML class diagrams. States are stereotyped as service states, transform states and object flow states. 'Object flow states' represent flow of XML messages, 'Transform states' represent structural transformation on messages and 'Service states' represent call operations. Stereotyped UML class diagrams are used to describe operations and parameters of available web services. In addition, they present a UML profile and guidelines for modeling composite web services. This work can be extended for all WSDL operations like solicit-response, notification, etc.

A UML extension for Web service's modeling defined in WSDL is described through a case study in [31]. In this paper, the WSDL Meta model is represented by a UML class diagram and the formation of WSDL descriptions from UML models. The Meta model describes all possible extensions for the concrete and abstract elements of WSDL.

UML-and rule-based approach for modeling web services is presented in [30]. The approach is called as UML based Rule Model Language (URML). URML defines business guidelines and constraints without depending on technology. A UML tool Fujaba is enhanced as the REWERSE Rule Markup Language (R2ML) is used for encoding rules and information transformations between R2ML, and WSDL is provided to achieve round-trip engineering of web services.

To model and build composite web services from already existing services, a UML extension is proposed in [15]. UML is a modeling tool for capturing the requirements. A case study on gas dispersion explains the flow of these events in a workflow with web services from vendors. The suggested solutions contain UML activity diagrams along with required extensions. The paper addresses the service composition patterns, but not provided an evolution mechanism to fine-tune the service. The paper focuses only on workflow modeling applied to web services but not on service modeling.

Some of the challenges using a model-driven approach which aims to facilitate the process of developing semantic services by exploiting various techniques of UML for designing service models are proposed in [24]. However, there are still a number of challenges that need to be addressed in order to make semantic services more relevant. To design a workflow of web service composition a well-known simplified modeling language such as UML is used. A model driven approach, which allows developers to design the workflow of web service using UML sequence diagrams is proposed in [12]. In this paper, web services are composed and optimized based on a tree-based heuristic optimization algorithm.

In [41], work focuses about visual modeling approach of an aspect oriented web service composition

using UML. A UML Tool has been used to design basic service's composition. This composition having two processes, i.e. first, static process deals with UML class diagram and second dynamic process deals with an activity diagrams. Now using aspect oriented web service composition designs required/necessary services, this can be integrated in plug and play mode. After the integration process, this design will become a complete model to fix all defines issues. UML profile is used to model aspects. This UML profile shows aspects, point cuts, web service interfaces and binding relationships. This paper is a first effort towards modeling of web service compositions using aspects. The paper uses UML profile, addresses control and data flow and provides modeling at the meta-model level. However, it does not provide any tool support and does not address web service composition patterns.

In Web Services composition, most of the works have been taken place in implementation and execution. From the past few years, many composition languages like BPEL, XLANG, WSFL, WSCI, etc., have been proposed. However, these languages are difficult to use in early stages of system development in requirement's specification as functional requirements to define web service interfaces. UML for service (UML-S) is an extension of UML 2.0 is proposed in [8, 9] to address the above issue. UML-S can be used in early stages of development, to specify web service's interfaces and their interactions. It allows developing composite web services using Model Driven Engineering principles. The work is explained by taking a case study, Hospital Service System. This case study is based on EU based project called Advanced Safety and Driver Support for Essential Road Transport (ASSET). However, a fully functional UML-S framework is yet to be implemented in order to provide new value-added composite services allowing Business-to-Business interactions at the early stages of development.

The reuse of existing classes, Interfaces and methods using existing object oriented system as web services in service oriented architecture is described in [20]. The authors designed a tool called softReuse by using existing technologies of java and c#. It also generates the documentation for the WSDL interfaces.

An empirical study has been done on usage of UML in industry, and the observations are presented in [28]. The paper presents a corpus of interviews with professional software engineers from various companies and identifies five patterns of UML use. The work reported here is based on the notion that understanding the nature of actual UML use is important to the discipline, and that understanding how software professionals 'use' UML can inform the development of software design notations and tools. There are a number of issues that challenge the effectiveness of UML as a lingua franca – but there are also practices that employ UML effectively in reasoning about and communicating about design, both individually and in collaborative dialogues.

The transformation rules between UML-S and low level code with Model Driven Engineering (MDE) approach is proposed in [10]. It comprises of UML-S class diagram, WSDL to UML-S class diagram, UML-S activity diagram, WS-BPEL to UML-S transformation with the help of merging patterns. However, the approach does not cover the modeling using UML at a broader level, and it does not address all the patterns, which are used in service composition. The WS-BPEL documents are written in XML format, it is difficult to understand the XML for non-exports. So, starting from UML may give a clear picture for the design and implementation of web services. To model Real Time Web Services, the process of translation main element of the UML sequence diagram of the elements of the WS-BPEL specifications is proposed in [27]. The authors mainly used the sequence diagrams for transformation. It is illustrated with the case study Aero Electric Management system. Not all the UML diagrams have been used.

As the number of web services is steadily increasing, the reusing of web services is also increasing which we called as composite web services. A UML profile and guidelines for modeling composite web service using UML activity diagrams is defined in [13]. Here composite web service models have been adapted into executable models by model transformations. It introduces a UML -based model-driven method for Web service composition. This method shows the possibility of using model transformation to get executable models from composite web services. By this, we can import descriptions of existing web services into UML diagrams by WSDL Further. This approach can be integrated in QoS requirements and Semantic Web Services.

The approach to convert the UML sequence diagram into a graph called sequence diagram graph (SDG) is proposed in [38]. Using UML models of any kind product are reflected for creating the test cases. The UML model sequence diagrams are used to generate the test cases by using a new representation called

sequence diagram graph (SDG) is generated. Once the sequence diagram graph is generated the node traversal in the graph generates a test case for system testing. It is illustrated with the case study BANK ATM System.

Web Service Composition is an emerging trend in the field of Service Oriented Architecture, where a new web service is developed using existing web services. There are a number of techniques for modeling web service compositions to specify the exact requirements, identify errors and eliminate the conflicts in the development of a composite web service at the design level. A study on UML based approaches for modeling web service compositions is presented in [21]. A comparison is made between models by taking several constraints and concluded that a good UML based modeling approach for web service is required to provide a valid composite web service.

Library management system is designed and implemented based on the web service proposed in [42]. In this system, the three-layer architecture is employed, applying model building language that UML carries on need's analysis and design, using various technologies and database optimization techniques to maximize the performance of the system. However, they cannot be able to predict the performance of the system at analysis phase.

As the available Web Services are huge in number, so there is an significance demand in combining and reusing existing web services. It results composition of web services. A model-driven methodology for designing of composite web services is proposed in [16]. The methodology considers a syntactic and semantic description of the interfaces of service candidates. It also processes QoS requirements form the developer and offerings from the service providers. The authors have identified how we can use models as the primary artifact by defining the characteristics of the required models and corresponding model transformation. Further investigations needed on suitable graphical service composition languages and accompanying tool-supported transformations to and from the lexical web service documents.

The author uses a well-known timed extension of UML, RT-UML, in order to model Real-Time web services. Implemented transformation rules that can change the RT-UML models into WS-CDL(Web Service Choreography Descriptive Language) documents capturing the time constraints; a method is proposed that uses RT-UML sequence diagrams to design web service compositions and OMG's model driven architecture to generate specifications in web service choreography description language, as well known as choreographies. The translation presented here is the most powerful tool for obtaining correct real-time web services. Future work focuses on extending the use of RT-UML diagrams in the generation of Web Services business compositions described by using the Web Services Business Execution Processes Language (WS-BPEL), RT-UML activity diagrams as well as sequence diagrams to capture complete behaviour of the compositions.

3. UML based Web Service Framework

A framework which is UML based is designed to model structural behavior of service-based systems in [17]. The framework follows an iterative process and provides functional and non-functional characteristics for service based systems. These system services are used for formal modification, and the design is redeveloped, which are used to identify new services. Query language is used to specify service characteristics. Hard constraints are given high priority than soft constraints to achieve QoS. However, the framework can be extended to support the creation and negotiation of service-level agreements during the development of service-based systems, service discovery based on behavioral composition, and verification of design models.

A framework and related tool for managing and designing the variations in web services are proposed in [7]. This work defined two concepts called variation point & variants to identify locations where variation will occur and variants are alternative solution, which can be made available at variant points. The above two concepts implemented in a framework called COVAMOF. This COVAMOF framework can be implemented in UML model through this paper.

The framework model called Colombo model to model services and service composition using UML is proposed in [1]. Since Colombo does not have any language, an XML document serves as a base. He proposed the transformation rules between UML and Colombo XML documents. An automatic composition algorithm for Colombo model has been applied to build a composite service that satisfies the user request. The implementation is done by creating a prototype of a CASE tool that would be used to facilitate the design of composite web services.

In current trend, frameworks are limited to Web Services, which can't use another framework. A

method to integrate UML models taking place in a quality evaluation framework for Web Services is proposed in [39]. ITac-QoS (iTac Tests and Certifies Quality of Services) is a quality evaluation framework for Web Services. It depends on UDDI server, and provides quality information's based on investigations. Each vendor produces the models of its own product, and it automatically merges different models using UML model of their product. Tests are generated from this model and result of their execution is translated to evaluate the quality of the Web services. The model produced after this merging represents the composition of the different web Services. A tool is implemented for model merging method.

4. MDA Approach for Web Service Platform

Web services based on the UML show how UML can be used to specify information related to the design services. The WSDM (Web Services Development Model) defines a set of tasks that shall be followed to develop the model for the selected web service. The WSDM consists of three tasks in its life cycle. The Web Services Requirements Analysis in the requirements analysis task (use case & class diagrams). The Web Services Design in the design task (Class diagram & State chart diagram) to represent the web service architecture for modeling the functioning of the web service. A comprehensive approach for the model-based development of Web services is presented in [37]. In this thesis, an approach for the development of executable web services is defined. The proposed approach is composed of a sequence of steps to produce a viable Web service source code. The work includes a specification of a platform for the implementation and deployment of Web services. The executable code is precipitated from UML models, which form the starting point in the code generation process. In this thesis, he has used state machine diagrams for the representation of Web Services behavior. Using other behavioral diagrams such as activity diagrams the above concept can be implemented.

Web services are very much important for the development of distributed applications with respect to service oriented architecture, because many features are provided by the technology. A new method for WS composition is proposed in [2]. It is based on MDA and consists of using UML to model web service's composition and to generate an executable model (BPEL process) through transformation rules. The process is as follows. First, Existing web services are located and discovered in service registry. The programmer imports the service description represented in WSDL and translates them into UML diagrams (Class diagram, Use Case diagram and Sequence diagram). Second, the sequence diagrams which are generated previously called scenarios are integrated into a single sequence diagram, which describes the behavior of a composite web service. Third, the MDA approach is adopted to transfer the resulting sequence diagram into a BPEL process. It is illustrated with the case study Travel agency. The advantage of this process is to import the service descriptions which are available in existing web services (i.e., WSDL) and represent them into UML diagrams, so that it can be understandable by even non-experienced users/clients. However, the web service composition on Transformation of the sequence diagram into BPEL process has to enlarge for semantic web services to offer better precision on existing services.

A UML design of PIM-level SOA-based architecture model is proposed in [25]. This work presented in this article are part of MIDAS framework for the development of Web Information Services (WIS) based on MDA and to implement the flexibility of the SOA development process using the model-driven methodology. In literature various methods discussed related to BPEL4WS with UML, since it is a widely accepted language for web service composition. [3, 18] provide UML 1.4 profile for BPEL 1.0 covering most of the aspects of Web Service Composition.

The concepts of MDA approach are platform-Independent model (PIM), platform-specific model (PSM), transformation language, transformation rules & transformation engines. Two of the applications of the MDA approach, i.e., a PIM using UML, another using EDOC is proposed in [4]. First, PIM is created using UML. Later, PIM is transformed using ATL to generate the PSM based on platform specific models (Java, Web Service & JWSDP). In second PIM is created using enterprise distributed object computing (EDOC), the business characters were explored without paying attention to implement details. Basically, EDOC provides a better representation of the functional and behavior patterns for a distributed system. Further, when the PIM meta-model and the PSM meta-model present elements with equivalent structures and behaviors, the mapping is even easier. However, this work can be extended for the composite web services.

With the development of Web services applied in the network management domain, it is required to define web services based information models in design phase. Based on MDA, [5] proposed mapping rules describing how to map the existing source UML

models into the target web services based models. An automatic transformation approach using XSLT was proposed to implement the mapping rules and experiments were made for verification. The proposed mapping rules improved the defects in related work. However, this paper could not be able to resolve all the issues in the current models which developers used manually.

The use of a graphical modeling language can be of great help in understanding the behaviour of systems in current generation products where the maximum number of systems uses xml notation for information transmission. In [26], UML as a graphical modeling language for XML web service's composition is used. This language has been defined by the OMG, the leading organization for object-oriented programming.

5. Conclusion & FUTURE Work

In this paper, we have done an exhaustive review on the literature available for modeling web services using UML. The extension mechanisms of UML help us to define the non-functional requirements. In future, the performance characteristics of web services can be modeled using UML and MDA. Using behavioural diagrams, such as activity diagrams is promising as well and could be investigated in future work.

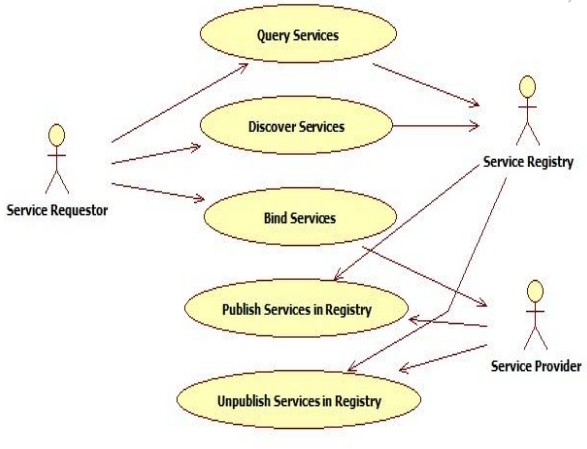

Figure 3. Web Service Use Case

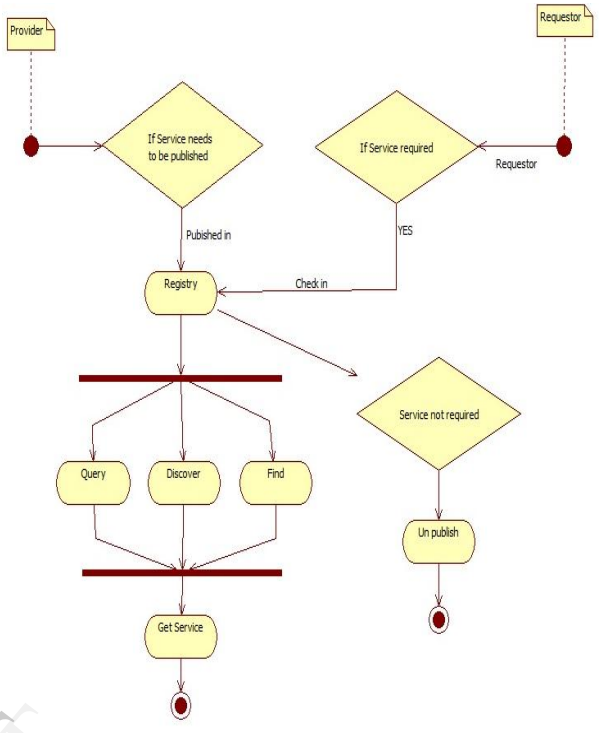

Figure 4. Web Service Activity diagram

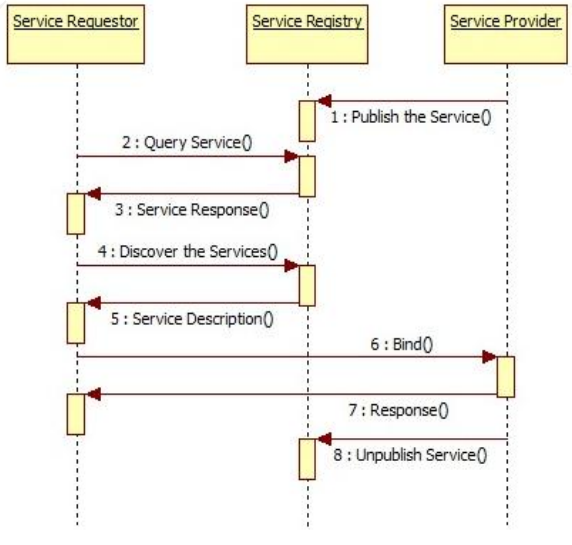

Figure 5. Web Service Sequence diagram

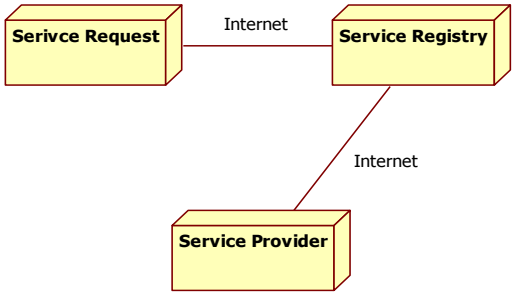

Figure 6. Deployment diagram for web services

6. References

[1] Amal Elgammal and Mohamed El-Sharkawi, Using UML to Model Web Services for Automatic Composition, Int.J. of Software Engineering, IJSE Vol.3 No.2 July 2010.

[2] Ayoub Sabraoui, Abdeslam Ennouaary,Ismail Khriss Uqar, Mohammed El Koutbi, An MDA-Based Approach for WS Composition Using UML Scenarios, Ninth International Conference on Information Technology- New Generations, pp. 306-313, IEEE, 2012.

[3] Amsden, J., Gardner, T., Griffin, C. and Iyenger, S. Draft UML 1.4 Profile for Automated Business Processes with a mapping to the BPEL 1.0. IBM alphaWorks Available at http://dwdemos. alphaworks.ibm.com/wstk/common/wstkdoc/services /demos/ uml2bpel /README.htm, 2003.

[4] B´ezivin, J., Hammoudi, S., Lopes, D. and Jouault, F. Applying MDA Approach for Web Service Platform. The 8th IEEE International Enterprise Distributed Object Computing Conference (EDOC'04), 2004.

[5] Bo Wang, Zhili Wang, Qiu Xue-song, MDA-based Network Management Information Model Transformation from UML to Web Services, Network Operations and Management Symposium (APNOMS), 2012 14th Asia-Pacific, 25-27 Sept. 2012.

[6] BPEL4WS V1.1 specification. http:// download.boulder.ibm.com/ibmdl/pub/software/dw /specs/ws-bpel/ws-bpel.pdf, last visited: May 2013.

[7] Chang-ai Sun, Rowan Rossing, Marco Sinnema, Pavel Bulanov, Marco Aiello, Modelling and managing the variability of Web service-based systems, C.-a. Sun et al. / The Journal of Systems and Software, pp. 502–516, ELSEVIER, 2010.

[8] Christophe Dumez, Jaafar Gaber and Maxime Wack, Web services composition using UML-S: a case study, pp. 1-6, IEEE, 2008.

[9] C. Dumez, A. Nait-sidi-moh, J. Gaber and M. Wack, Modelling and specification of Web services composition using UML-S, 4th International Conference on Next Generation Web Services Practices, IEEE, 2008.

[10] Christophe Dumez, Jaafar Gaber, Maxime Wack, Model-Driven Engineering of composite Web services using UML-S, Proceedings of iiWAS, pp.395-398, 2008.

[11] C. Armstrong. Modeling Web Services with UML. OMG Web Services Workshop 2002, 2002.

[12] Ching-She Wu and Ibrahim Khoury, Web Service Composition: From UML to Optimization, fifth International Conference on Service Science and Innovation, pp- 139-146, IEEE, 2013.

[13] David Skogan,, Roy Grønmo, Ida Solheim, Web Service Composition in UML, Proceedings of the 8th IEEE Intl Enterprise Distributed Object Computing Conf (EDOC 2004), IEEE, 2004.

[14] Extensible Markup Language (XML). http://www.w3.org/XML/, Last visited: June 2013.

[15] Grønmo, R. and Solheim, I. Towards Modeling Web Service Composition in UML, presented at The 2nd International Workshop on Web Services: Modeling, Architecture and Infrastructure (WSMAI-2004), Porto, Portugal, 2004.

[16] Grønmo, R. and Jaeger, M. Model-driven semantic web service composition. In Proc. 12th Asia-Pacific Software Engineering Conference (APSEC 2005), Taipei, Taiwan, pp.1-8, 2005.

[17] G. Spanoudakis and A. Zisman, Discovering Services during Service-based System Design using UML, Digital Object Identifier, IEEE TRANSACTIONS ON JOURNAL , 2009.

[18] Gardner, T. UML Modeling of Automated Business Processes with a Mapping to BPEL4WS, presented at 17th European Conference on Object-Oriented Programming (ECOOP), Darmstadt, Germany, 2003.

[19] Heather Kreger Web Services Conceptual Architecture (WSCA 1.0), IBM Software Group, 2001.

[20] Harry M.Sneed, Chris Verhoef, Stephan H. Sneed, Reusing Existing Object-Oriented Code as Web Services in a SOA, International Symposium on the maintenance and Evolution of Service-Oriented and Cloud-Based Systems (MESOCA), pp. 31-39,IEEE,2013.

[21] Irum Rauf, Muhammad Zohaib Z Iqbal, Zafar. I. Malik, UML based Modeling of Web Service Composition - A Survey, Sixth International Conference on Software Engineering Research,

Management and Applications, pp. 301-307,IEEE, 2008.
[22] J. Arlow and I Neustadt. UML 2 and the Unified Process. Addison Wesley, second edition. June 2005.
[23] J. Conallen. Building Web Application with UML. Addison Wesley, second edition, 2003.
[24] Jabu Mtsweni, Exploiting UML and Acceleo for Developing Semantic Web Services, 7th International Conference for Internet Technology and Secured Transactions (ICITST), IEEE, pp- 753-758, 2012.
[25] Marcos L´opez-Sanz, C´esar J. Acu˜na,Carlos E. Cuesta, Esperanza Marcos, Modelling of Service-Oriented Architectures with UML, Electronic Notes in Theoretical Computer Science 194, pp. 23–37, 2008.
[26] M.Emilia Cambronero, Gregorio Dıaz, J.Jose Pardo, Valentın Valero Fernando L. Pelayo, RT-UML for modeling Real-Time Web Services, Proceedings of the IEEE Services Computing Workshops (SCW'06), IEEE, 2006.
[27] M.Emilia Cambronero Gregorio Dıaz J.Jose Pardo Valentın Valero, Using UML Diagrams to Model Real-Time Web Services, Second International Conference on Internet and Web Applications and Services (ICIW'07), IEEE, 2007
[28] Marian Petre, UML in Practice, Centre for Research in computing, ICSE, USA, pp- 722-731, IEEE, 2013.
[29] Object Management Group (OMG). http://www.omg.org/, last visited: May 2013.
[30] Sergey Lukichev, Adrian Giurca, Gerd Wagner, Dragan Gasevic, Marko Ribaric, Using UML-based Rules for Web Services Modeling, pp.290-297,IEEE, 2007.
[31] S.Marcos, V.de Castro, and B. Vela. Representing Web Services with UML:A Case Study. In UNITN - The First International Conference on Service Oriented Computing. UNITN, December 2003.
[32] SOAP Version 1.2 Part 1: Messaging Framework (Second Edition). http://www.w3.org /TR/ soap12-part1/, Last visited: June 2013, W3C Recommendation 27 April 2007.
[33] Thöne, S., Depke, R. and Engels, G. Process-Oriented, Flexible Composition of Web Services with UML, presented at Int. Workshop on Conceptual Modeling Approaches for e-Business: A Web Service Perspective (eCOMO 2002), Tampere, Finland, 2002.
[34] Unified Modeling Language. http://www.uml.org/, Last visited: June 2013
[35] Unified Modeling Language: Superstructure, V2.3. Formal/2010-05-03, May 2010.
[36] UDDI Version V3.0.2. http://www .oasis – uddi-spec/doc/spec/v3/uddi-v3.0.2-20041019.htm, Last visited: June 2013, UDDI Spec Technical Committee Draft, Dated 19 October 2004.
[37] Wafi Dahman, Jens Grabowski, A uml based methodology for the development of web services, software engineering for distributed systems group, 2011.
[38] VinayaSawant, KetanShah, Automatic Generation of Test Cases from UML Models, International Conference on Technology Systems and Management (ICTSM),Proceedings published by International Journal of Computer Applications® (IJCA), pp.7-10, 2011.
[39] Vincent Pretre, Fabrice Bouquet, Christophe Lang, Automating UML Models Merge for Web Services Testing, Proceedings of iiWAS, pp. 55-62,2008.
[40] Web Services Description Language (WSDL) Version 2.0 Part 1: Core Language. http:// www.w3.org/TR/wsdl20/, Last visited: June 2013, W3C Recommendation 26 June 2007.
[41] Yang Xu, Shengqun Tang, Youwei Xu, Zukai Tang, Towards Aspect Oriented Web Service Composition with UML, 6th IEEE/ACIS International Conference on Computer and Information Science (ICIS), IEEE, 2007.
[42] Yujun Li, Hao Aheng, Tengfei yang, Zhiqiang Liu, Design and Implementation of a Library Management System Based on the Web Service, 4th International Conference on Multimedia Information Networking and Security, pp- 433-436,IEEE,2012.