The MPOWER Tool Chain - Enabling Rapid Development of Standards-based and Interoperable Homecare Applications

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Abstract

There is a need for new models for providing care to the increasing number of elderly in the world. Technological solutions are being developed to assist the elderly in their homes, and the caregivers managing the care. However, the development of these solutions is complex and expensive, and new techniques should be applied to reduce the development costs. Reuse of interoperable services is an effective solution that can be realised using a model-driven development process for the homecare domain. This paper presents the results from the MPOWER project where UML has been used to incorporate domain knowledge into tools that automises the technical implementation through model transformation and code generation.

Introduction

The world's population is getting older and the number of people requiring health-related care is increasing rapidly. The AAL-Report [1] states that the increase of elderly in general and people with dementia in particular in the societies will "have enormous economic and social implications in a number of areas: e.g. in employment and labor markets, in pension systems and in healthcare systems".

Researchers believe that utilising new technology in order to provide care at home, facilitating active ageing at home, and leveraging the informal care given by family and friends are prerequisites to maintain a proper level of healthcare services.

To make assistive devices and information systems interoperate reuse of existing components and services, and proper developer tool support is necessary.

Standards for information models for this domain are being developed by many standards developing organisations, but the tool support for using the standards as an asset in the development process is poor.

The MPOWER project [2] will investigate the use of a model-driven software development (MDSD) [3] approach in the development of a service oriented middleware platform for homecare services[4]. The overall goal is that the platform will enable developers to rapidly create and deploy standards-based homecare applications.

This paper presents the results from the work on service specification and tool support done in the MPOWER project. The primary focus for the work was:

- How can domain knowledge and standards be incorporated into model-driven development for services for homecare?
- How can a model-driven development tool chain implement standards-based Web Services for use in the homecare domain?

The main result from the project is a domain specific system model that is used directly in a Web Service Tool chain to generate web services[5] for homecare. The preliminary conclusions are that a MDA-compliant [6] tool can incorporate domain knowledge into the development process and make it easier for developers to create services that adhere to standards such as HL7. WSDL [7] files are platform specific design artefacts that can hold domain knowledge to be used by development tools for final implementation and deployment.

The reminder of this paper presents the method used for incorporating the user needs into a model-driven software development process. Then the results are presented

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using the before finally the results are discussed in terms homecare relevance and impact before future work is described and conclusive remarks are given.

Methods

In the healthcare domain, using Model-Driven Architecture[6, 8] approach has been presented in several articles [9-14]. The overall idea is to separate business (healthcare practices) from the system solution and the technological implementation of it by representing all relevant artefacts and their relationships in Unified Modeling Language (UML) models [15]. In practice, this means that the models are used directly in the implementation of and information system, either as system blueprints or as input to code generation engines that produce executable code.

Service Oriented Architecture (SOA)[16, 17] is currently the best practice approach to enable applications to expose information and services towards each other. To design SOA services, a formal language such as UML should be used to ensure correct and intentional specifications. A MDA-compliant tool with an UML extension such as the IBM UML Profile for Software Services [18] provides a formal framework from which executable SOA services can be generated.

Following the design principles by Erl [16] and SOA4HL7 [19], the services were modelled in UML as class diagrams, and using stereotypes from the UML profile for System Services [18]. Mikalsen et al demonstrates the use of this profile for interoperable healthcare services in [20]. The MPOWER services were modelled by five different organizations all across Europe over a period of three months.

Results

The MPOWER middleware services were specified to be implemented as web services, and the services modelled as stereotyped class models were automatically transformed into WSDL [7] models using a transformation script. To support the model-driven software development process described in the previous, three main process activities must be supported:

- UML Modelling, model transformation and code generation: Enterprise Architect (EA) from Sparx Systems was chosen as the primary UML modelling tool. The core UML model in EA can be extended using UML Profiles.
- Information Modelling: The tools recommended by HL7 were used for HL7 message modelling[21].
- Integrated Development Environment and Application Server: Java EE 5 bundle with Netbeans 5.5 and Java Sun Application Server 9 was chosen for web service implementation, deployment and hosting. For testing web services using SOAP transport, the SOAPUI NetBeans plug-in can be used.

Figure 1 shows the tools, activities and artefacts involved the engineering process. The MPOWER UML Service model is created in EA based on the User Scenarios and Needs document. HL7 messages are related to the service model and integrated during WSDL generation. The WSDL file is imported into NetBeans and a web service is generated along with a SOAPUI test project. Using the Netbeans IDE a web service is fully implemented and deployed to the Sun Java Application Server. The SOAPUI plug-in for NetBeans provide a powerful and easy-to-use test mechanism for web

services.

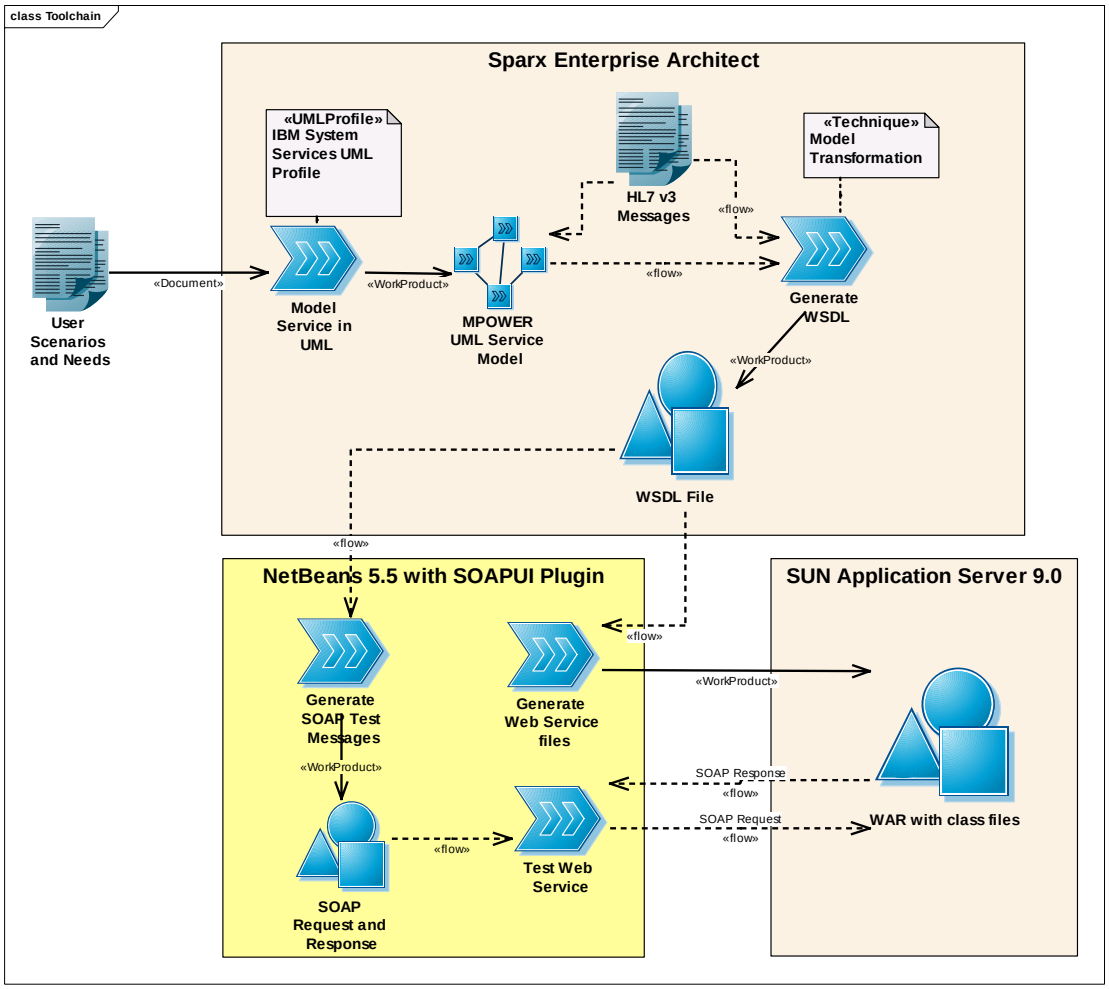

Figure 1: The MPOWER Tool Chain and Artefacts

Discussion

There is a need for tools that enable developers of homecare applications to rapidly implement a reusable and interoperable software system. Standards are being specified to improve interoperability, but the appropriate tool support for applying the standards is not readily available. The tool chain and process described in this article is applied in the homecare domain with focus on how to incorporate information models from the HL7 version 3 standard into the development process. This approach is relevant for most distributed healthcare system development projects and the results presented herein should be applicable.

Reusing interoperable services and models of services across projects and organisations will make development of new information systems easier and less expensive. Using a model-driven approach with UML provides a technology independent service specification, and services can be generated for the different platforms used in the homecare infrastructures.

Conclusion

The tool chain and process presented in this article can improve the development of interoperable homecare applications with respect to development time and functionality.

The MDA approach incorporates domain knowledge as CIM and PIM, which can be applied for PSM development in the form of web services.

References

[1] e. a. Steg H, "Europe Is Facing a Demographic Challenge. Ambient Assisted Living Offers Solutions," 2006.

[2] SINTEF ICT, "034707: Middleware platform for eMPOWERing cognitive disabled and elderly (MPOWER)," 2006.

[3] T. Stahl and M. Völter, *Model-driven software development: technology, engineering, management*. Chichester: Wiley, 2006.

[4] S. Walderhaug, M. Mikalsen, G. Hartvigsen, E. Stav, and J. Aagedal, "Improving Interoperability in Healthcare Using Model Driven Software Develoment for Healthcare," presented at MEDINFO Brisbane, Australia, 2007.

[5] World Wide Web Consortium (W3C), "Web Services Architecture," W3C 11 February 2004 2004.

[6] J. Miller and J. Mukerji, "MDA Guide Version 1.0.1," Object Management Group (OMG) omg/2003-06-01, 2003-06-13 2003.

[7] World Wide Web Consortium (W3C), "Web Services Description Language (WSDL) Version 2.0 Part 1: Core Language," W3C 23 May 2007 2007.

[8] S. J. Mellor, *MDA Distilled: Principles of Model-Driven Architecture*, 2004.

[9] B. B. Blobel and P. P. Pharow, "A model-driven approach for the german health telematics architectural framework and the related security infrastructure," *Studies in health technology and informatics*, vol. 116, pp. 391-6, 2005.

[10] K. S. Rubin, T. Beale, and B. Blobel, "Modeling for Health Care," in *Person-Centered Health Records, Health Informatics*. New York: Springer New York, 2005, pp. 125-146.

[11] V. Jones, A. Rensink, and E. Brinksma, "Modelling mobile health systems: an application of augmented MDA for the extended healthcare enterprise," 2005.

[12] C. Raistrick, "Applying MDA and UML in the Development of a Healthcare System," in *UML Modeling Languages and Applications*, vol. Volume 3297/2005, *Lecture Notes in Computer Science*: Springer Berlin / Heidelberg, 2005, pp. 203-218.

[13] K. Kawamoto and D. F. Lobach, "Proposal for Fulfilling Strategic Objectives of the U.S. Roadmap for National Action on Decision Support through a Service-oriented Architecture Leveraging HL7 Services," *Journal of the American Medical Informatics Association*, vol. 14, pp. 146-155, 2007.

[14] W. M. Omar, "E-health support services based on service-oriented architecture," *IT professional*, vol. 8, pp. 35, 2006.

[15] Object Management Group (OMG), "UML 2.0 Superstructure FTF Rose model containing the UML 2 metamodel," Object Management Group (OMG) 2005.

[16] T. Erl, *Service-Oriented Architecture Concepts, Technology, and Design*. Crawfordswille, Indiana, USA: Prentice Hall, 2006.

[17] OASIS Open, "Reference Model for Service Oriented Architecture 1.0," OASIS Open soa-rm-cs, August 2 2006.

[18] S. Johnston, "UML 2.0 Profile for Software Services," vol. 2007: IBM, 2005.

[19] A. Honey, A. Dutta, M. Kumar, and M. Christian, "SOA4HL7 Architecture Document," Health Level Seven August 16 2006.

[20] M. Mikalsen, S. Walderhaug, P. H. Meland, and O. M. Winnem, "Linkcare - interoperability accross levels and profession," presented at MEDINFO Brisbane, Australia, 2007.

[21] HL7, "HL7 Reference Information Model 2.16," vol. 2007, 2007.