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Development and evaluation of SOA-based AAL services in real-life environments: A case study and lessons learned

Erlend Stav[a,*], *Ståle Walderhaug*[a,d], *Marius Mikalsen*[a], *Sten Hanke*[b], *Ivan Benc*[c]

[a] *SINTEF ICT, P.O. Box 4760 Sluppen, NO-7465 Trondheim, Norway*
[b] *Austrian Institute of Technology GmbH, Austria*
[c] *Ericsson Nikola Tesla D.D., Croatia*
[d] *Department of Computer Science, University in Tromsø, Norway*

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ABSTRACT

Intro: The proper use of ICT services can support seniors in living independently longer. While such services are starting to emerge, current proprietary solutions are often expensive, covering only isolated parts of seniors' needs, and lack support for sharing information between services and between users. For developers, the challenge is that it is complex and time consuming to develop high quality, interoperable services, and new techniques are needed to simplify the development and reduce the development costs.

This paper provides the complete view of the experiences gained in the MPOWER project with respect to using model-driven development (MDD) techniques for Service Oriented Architecture (SOA) system development in the Ambient Assisted Living (AAL) domain.

Method: To address this challenge, the approach of the European research project MPOWER (2006–2009) was to investigate and record the user needs, define a set of reusable software services based on these needs, and then implement pilot systems using these services. Further, a model-driven toolchain covering key development phases was developed to support software developers through this process. Evaluations were conducted both on the technical artefacts (methodology and tools), and on end user experience from using the pilot systems in trial sites.

Results: The outcome of the work on the user needs is a knowledge base recorded as a Unified Modeling Language (UML) model. This comprehensive model describes actors, use cases, and features derived from these. The model further includes the design of a set of software services, including full trace information back to the features and use cases motivating their design. Based on the model, the services were implemented for use in Service Oriented Architecture (SOA) systems, and are publicly available as open source software. The services were successfully used in the realization of two pilot applications. There is therefore a direct and traceable link from the user needs of the elderly, through the service design knowledge base, to the service and pilot implementations.

* *Corresponding author*. Tel.: +47 7359 0371; mobile: +47 9341 1597.
E-mail address: erlend.stav@sintef.no (E. Stav).
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The evaluation of the SOA approach on the developers in the project revealed that SOA is useful with respect to job performance and quality. Furthermore, they think SOA is easy to use and support development of AAL applications. An important finding is that the developers clearly report that they intend to use SOA in the future, but not for all type of projects. With respect to using model-driven development in web services design and implementation, the developers reported that it was useful. However, it is important that the code generated from the models is correct if the full potential of MDD should be achieved.
The pilots and their evaluation in the trial sites showed that the services of the platform are sufficient to create suitable systems for end users in the domain.
Conclusions: A SOA platform with a set of reusable domain services is a suitable foundation for more rapid development and tailoring of assisted living systems covering reoccurring needs among elderly users. It is feasible to realize a tool-chain for model-driven development of SOA applications in the AAL domain, and such a tool-chain can be accepted and found useful by software developers.

1. Introduction

The proper use of ICT services can support seniors in living independently longer [1,2]. While such services are starting to emerge, current proprietary solutions are often expensive, covering only isolated parts of seniors' needs, and lack support for sharing information between services and between different stakeholders. It is complex and time consuming to develop high quality services, and support is needed to simplify the development and reduce the development costs. By providing a knowledge base of elderly user needs, software development tools and out of the box software components, we can reduce the costs of delivering ICT services to seniors and as such increase the number and quality of services delivered [2].

In the seminal paper about health information systems from 2006 [3], Haux argues that it is necessary to explore new architectural styles that focus on trans-institutional access to patient data. Finally he concludes that: "informatics methodology and technology is expected to facilitate continuous quality of care in aging societies". The Service-Oriented Architecture (SOA) [4] architectural style is designed upon the ideas of cross-organizational information sharing and reuse.

This paper reports on the design, development and evaluation of a software platform for building assistive services for elderly users, with special focus on users with cognitive challenges such as mild dementia. The platform builds upon the concepts of SOA, and was developed in the context of the European research project MPOWER[1] [5] (October 2006–June 2009). The SOA approach facilitates reuse of domain services between disparate systems and incorporation of domain knowledge into software artefacts, and its flexibility facilitates tailoring and personalization of the systems to the needs of individual users or user groups. The main contributions presented in the paper are:

1. *A knowledge base of user needs*: The user needs knowledge base was developed through an extensive requirement phase including 143 persons including seniors professional care providers, family, and physicians.
2. *Model driven toolchain development*: Using a model-driven development toolchain, an architectural description including UML [6] use cases and information models for the target domain was specified.
3. *A set of reusable domain specific software services*: Based on the identified requirements in the domain, requirements for tool support and reusable services were derived. A set of 25 SOA services were designed and implemented according to the SOA for HL7 methodology [7] and task-centric approach described by Erl [8].
4. *Two pilot systems developed using domain software services*: To validate the usefulness of the SOA services, one information-sharing and one sensor-centric pilot system were implemented and deployed to real-life settings. The two pilot systems were built on top of the 25 domain services in order to reduce the development effort and time.

Evaluations have been conducted on both technical artefacts (methodology and tools), and on end user experience. Two evaluations were conducted on the developers: the use of model-driven development tools and the use of SOA in application development. The evaluation of end user experience was conducted in the period from February 2008 to June 2009. Five elderly (age 65–92) and their carers (formal and informal) in Norway have used the information-sharing system. The evaluation was conducted in three phases, as reported in [9]. The sensor-centric system was installed in a Polish nursing home and a usability evaluation was done in a three-month period from April to June 2009.

The main technical findings are that a SOA facilitates the development of domain services that may improve the overall system design and performance. However, the reusability of services varies between the functional areas, and this must be taken into account. From an elderly/patient and carer point of view, the pilot systems provided appropriate functionality and reasonable quality of service. For one user of the information-sharing system the activities of daily living were significantly improved.

This paper provides the complete view of the experiences gained in the EU IST project MPOWER with respect to using

[1] http://www.mpower-project.eu/.