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Integrating MDA and SOA for improving telemedicine services

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ABSTRACT

Through telemedicine, the health sector has seized the opportunity offered by development of information and communications technology (ICT) such as the business or industrial sectors, but ICTs are constantly evolving. To benefit from technological progress it is necessary to adapt the computer applications to these technologies, however this operation is costly to health facilities especially in developing countries. In terms of scientific research, this observation explains the development of model-driven engineering of computer systems such as the Model Driven Architecture (MDA) approach. MDA is a computer design approach for the development of computer systems that considers separately the functional needs of technical needs of an application. MDA mainly uses the models and their transformations whose traces allow MDA to capitalize expertise in terms of technology and to ensure some rapid modernization of applications to new technologies which results in a significant productivity gain. Today there is a huge requirement worldwide in the interoperable services, in particular with regard to their valuable contribution to the collaboration ability of remote information technology systems. Service Oriented Architecture (SOA) is an interesting architectural pattern in which software components contribute to the collaboration and sharing of services. In this way, the principles of SOA are intended to ensure interoperability between heterogeneous and distributed applications. Web services are at the heart of SOA, which splits functions into different services, accessible over a computer network that enables users to associate and reuse them in the exploitation of applications. Health applications have a strong need to communicate with the remote institutions in order to provide the most relevant services to patients and to collaborate with other medical partners to solve complex tasks. For this purpose, the proposed research work shows how the paradigms of SOA and MDA can be configured to implement medical software applications on an e-health platform. The case study concerns the Telemedicine in French-speaking Africa (RAFT) project in which the joint use of MDA and SOA facilitates knowledge combination and reuse in the management of applications supporting a medical collaborative work environment.

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1. Introduction

Telemedicine services are becoming more and more grow in health systems both in developed countries than in developing countries (Ekeland et al., 2012). Their operation requires to provide communication services via distance means

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promoting exchanges between collaborative actors and their heterogeneous and diversified resources (Doumbouya et al., 2014; 2015a, b, c, d). These services offer different features, but in some measures they are complementary to solve complex tasks (Sene et al., 2015; Kamsu-Foguem et al., 2015; Kamsu-Foguem, 2014a, b). To ensure better efficiency of telemedicine, the problem of interoperability of services provided by the information systems involved must be solve (Adebesin et al., 2013). This interoperability problem may create conceptual, technological or organizational barriers; these barriers may appear in the business, processes, services and data (Ducq et al., 2012). In those instances, solving the interoperability problem with the service is a major issue in the collaborative working (Lamprinakos et al., 2015). However, to overcome the technological aspects, it is important to place particular emphasis on conceptual modeling of a good abstraction level, especially with model driven approaches (Raghupathi and Umar, 2008). These approaches allow both to solve interoperability problems in the development and management of applications (Davies et al., 2014).

The network services have considerably affected and modified the collaborative work in information systems. This collaborative environment involves the usage of heterogeneous components whose interactions results in complexity. To answer this problem of heterogeneity and complexity, the integration of Model-Driven Architecture (MDA) (Model Driven Architecture, 2014) and Service-oriented architecture (SOA) (Sweeney, 2010) is an interesting avenue of research concerning information systems. The MDA approach proposes to define a business model independent of any technical platform and to generate a software application by its gradual transformation facilitating the business-information technology alignment. The SOA is an architectural principle allowing the communication (through the mediation) between different applications (independently of their environmental characteristics). Since the telemedicine acts are represented as applications to deal with complex medical situations, then the combination of MDA and SOA would facilitate communication and exchanges between these applications.

On the one hand, there is an increase of the means of communication between remote actors (e.g. main providers or specific users). On the other hand, there is too much data exchanged in network systems, in these exchanges the existence of related techniques can ensure good communications as regards the format of transmitted data (syntactic interoperability). However there are few means of implementation to ensure a proper understanding of the exchanged content (semantic interoperability). This applies in particular to the medical information systems in networks. According to the definition agreed upon by the World Health Organization, telemedicine is "*The delivery of health care services, where distance is a critical factor, by all health care professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for the continuing education of health care providers, all in the interests of advancing the health of individuals and their communities*" (WHO, 1998).

Thus, telemedicine must consider the technical and human issues related to healthcare and patients' rights. Currently in developing countries, telemedicine technologies are assets, particularly to compensate for the lack of qualified medical staff in remote areas and also to overcome the technical problems for some medical analyses and operations (Kamsu-Foguem and Foguem, 2014a, b). Therefore, the telemedicine acts also help to facilitate the diagnostic and therapeutic activities through teleexpertise and teleassistance systems from health professionals without forgotten the remote training (e-learning) offered by some information systems such as the Network for Telemedicine in French-speaking Africa, abbreviated RAFT (Réseau en Afrique Francophone pour la Télémédecine) (Bediang et al., 2014). The telemedicine can be considered as a factor in territorial development, because it contributes to encouraging measures that support the geographic distribution and continuity of medical services and the retention of healthcare professionals in remote areas.

The rest of the paper is divided into the 5 sections. Section 2 presents a state-of-the-art review of the application of the SOA and MDA in the e-health; Section 3 provides background information on the SOA and MDA as well as the descriptions of concepts and technologies for each one. Section 4 presents the proposed methodology to highlight the different steps of the desired features of target information systems. In Section 5 the outcomes of the projected application in the RAFT project for the management of crisis situation are illustrated. Section 6 focuses on the conclusion of the paper.

2. State of the art review of the application of the SOA and MDA in the e-health

Telemedicine applications are constantly growing; their integration with SOA and MDA is a major challenge to meet the requirements of interoperability, modularity and extensibility of associated health services. However, the current interoperability provided by the health information systems is not enough (Uribe et al., 2015). An important point of interoperability is to ensure availability of specified services (e.g. patient's information retrieval and updating) at any time without geographic constraints. In addition, these services must be modular in order to guarantee some independent functions for each act of telemedicine. The services can also be extensible to take into account the opportunities of evolutions in health care information systems. The achievement of these characteristics (interoperability, modularity and extensibility) is essential for the good realization of remote medical services. For instance, the reduction of access time in the utilization of electronic health records can considerably impact the treatment of patients. In the same vein, an interoperable, modular and extensible environment provides means to ensure the consistency, traceability and coherence of distributed information recorded.

The methodology presented by Raghupathi and Umar (2008) highlights the conceptualisation and development for a health clinic system to track patient information using MDA. In this case, the described methodology is based on MDA for the development of health information systems which do not necessarily resolve the systems interoperability aspect. The prototype is made in the form of an entire MDA methodology for the specification and implementation of medical

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