OPEN PLATFORM FOR e-HEALTH SERVICES

Jaime Martín, Ralf Seepold and Natividad Martínez Madrid
Dep. de Ingeniería Telemática, Universidad Carlos III de Madrid, Avda. de la Universidad 30, 28911 Leganeś, Madrid, Spain

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Abstract: This paper reviews the state of art of e-health applications and technologies. These solutions usually are proprietary and lack interoperability between them. Our approach describes a system architecture that provides capabilities to integrate different telecare, telemedicine and domotic services in a smart home gateway hardware independent. We propose a rule system to define the user behaviour and monitor relevant events. Several use cases and data model for the system are presented.

1 INTRODUCTION

The World Health Organization uses the term e-health to explain the relations between institutions, public health, e-learning, remote monitoring, telephone assistance, domiciliary care and any other system of remote medicine care. Telemedicine is the delivery of healthcare services at a distance. So e-health is a broader concept that includes a range of services that are at the edge of medicine/healthcare and information technology. E-health services are experiment a great advance in the last years because ageing population, needle to optimize the health resources and Information and Communications Technologies (ICT) enhancements.

In spite of technical improvement, health care systems often lack adequate integration among the key actors, and also commonly fail to take certain social aspects into account which slow down the acceptance and usage of the system. Integrating ICT (e.g. telehomecare) in care, living and wellness is a citizens demand that it should be provide at affordable cost.

To achieve communicate to dependent people (elderly or disabled people) with relatives and medical people in telecare services, integrating electronic medical record transmission, is an example of integration challenge. Therefore, multimedia and communication services should be incorporated in the e-health system. Telecom companies are spreading use of Residential Gateways (RGW) to integrate different applications and a platform to manage several services remotely is needed. OSGi (formerly known as the Open Services Gateway initiative) specification provides an architecture for remote control of a platform and provides an execution environment for services supporting to start or stop a service, update it to change its behavior and deploy new ones. We propose an open system architecture based in OSGi that provide capabilities to integrate different telecare, telemedicine and automation services in RGW.

2 STATE OF ART

Current State of Art of telecare and telemedicine is detailed next briefly.

2.1 Related Research on Telecare and Telemedicine

Several residential telecare and telemedicine platforms approaches are founded currently in the literature. In (Bobbie et al., 2003) an electronic-prescription system for home-based telemedicine using OSGi framework is described. This article describes a health-prescription application running on a smart card that communicates with a Personal Digital Assistant (PDA). It uses OSGi as a cen-tral coordinating point among the devices. The OSGi environment is aimed to allow intercommunication between the card reader, the patient's PDA application and other devices but there's no detailed description about how the system is implemented.

Other telemedicine approach based on OSGi framework is presented in (Chen and Huang, 2005). The Service-Oriented Agent Architecture described enables healthcare services providers to support telecardiology services on demand. It proposes a unit runtime of telemedicine agents to permit the services

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to be managed remotely. The system implemented has an agent unit, which includes a vital signals acquisition module, can acquire ECG (electrocardiogram) data and forward ECG data to medical service center. It uses Web Services to all services communicate with one another but no mention to any Electronic Health Record (EHR) standard is done.

2.2 e-Health Technologies

Health patient data must be transmitted and saved in a standard known by the involved systems. An EHR refers to an individual patient's medical record in digital format. An EHR standards comparative study (Blobel and Pharow, 2006) describes HL7 and EN 13606 standards.

2.2.1 HL7

Health Level Seven (HL7) (Hutchison et al., 1996) is a widely applied protocol to exchange clinical data. Several versions are been developed by the HL7 organization, part of American National Standard Institution (ANSI) and founded in 1987. HL7 v3 is not reviewed in this article because it's a complex standard and there isn't an stable version (Smith and Ceusters, 2006).

The HL7 refers to seventh OSI layer (application) although also specifies a layer 6 presentation protocol made up of its own abstract message format and encoding rules. Concerning the lower layers, like session and transport services, is rather vague because HL7 authors intention was to support a wide variety of systems. The underlying HL7 operational model is that of a client-server system. HL7 distinguishes between two messages exchange scenarios: *trigger events/unsolicited messages* and *queries*. The communication paradigm in HL7 is the trigger event. For example, when a patient is admitted to a hospital, the admission system will propagate HL7 admission messages to the appropriate subsystems to inform them of the new patient's data. An HL7 message always contains all the information required to complete a transaction and is encoded in HL7 own rules. The standard allows defining site-specific extensions segments, like message extensions to exchange data with an appointment system. However, the use of these extensions can prompt serious interoperability problems.

2.2.2 EN 13606

Health informatics - Electronic Health Record Communication standard (EN 13606) is a European official standard of CEN (European Committee for Standardization) and ISO standard approved. The overall goal is define rigorous and stable information architecture for communicating part or all of the EHR of a patient. It's based on the HL7 RIM (Reference Information Model) from HL7 v3, a set of datatype definitions harmonized between HL7 and CEN. EN 13606 is flexible to represent the information structures transmitted thanks to the archetypes, a knowledge representation of the clinic information domain. Moreover, is robust face of changes in the specifications because the archetypes changes don't require implementing new underlying systems.

The openEHR framework (www.openehr.org) is consistent with the EN 13606 and it's beginning to be utilized in commercial systems throughout the world.

2.2.3 ISO/IEEE 11073

A brief description of novel standards for personal tele-health systems interoperability can be placed in (Schmitt et al., 2007). The standards goal, often also referred to as Medical Information Bus (MIB), or x73 standards, is to enable medical devices to interconnect and interoperate with other medical devices. The standards cover the upper OSI layers and use well-known IEEE standards like Bluetooth (802.15.1) or WLAN (802.11) in lower layers. Part of x73 standards focus on point-of-care medical devices communication are mainly designed for acute monitoring and treatment application in the hospital domain like Intensive Care Unit. Several x73 standard series are currently draft versions or further research projects and they have not been adopted by the industry yet.

3 e-HEALTH SERVICE INTEGRATED OPEN PLATFORM

Our proposal design attempts to integrate several smart home services to provide a scalable and interoperability e-health solution. We describe the platform below.

3.1 Overview

The system is divided in three basic subsystems: domotic, multimedia and e-health subsystem. In the home can exits different devices from each subsystem connected by wire or wireless to a RGW with an embedded OSGi framework. Blood-pressure monitor and personal scale are examples of integrated devices in the medical network.

The automation platform Lonworks (http://en.wikipedia.org/wiki/LonWorks) is choosed

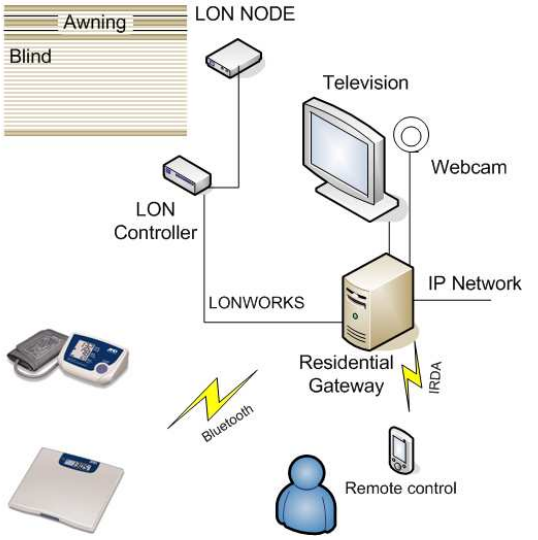

Figure 1: Smart Home overview, with domotic, multimedia and medical devices.

because provides a reliable and open protocol accepted as a standard for control networking in many countries. A typical Lonworks network includes sensors and actuators, for example light sensors or blind motor. As we'll see in Data Model section, RGW monitorizes environment variables from automation home network so when an important event occurs in the home and sensors detect it, an alert or alarm rises in the RGW. This event can be sent to relatives or medical people. The multimedia network typically includes a television, an IP camera or a webcam with microphone, necessary for the dependent person to communicate with relatives and carers. The RGW is able to physically interconnect all networks and devices, and to host the different services which can be managed remotely by the e-health or access provider. Multimedia services, like SIP audio/videoconference is provided to communicate dependent person with doctor/assistant during the medical televisit besides his relatives and friends.

3.2 Production System

A rule-based system to control and monitorize the user behaviour is presented in this section. It's a production system formed by a facts base and rules base. This system is implemented by Jess (http://herzberg.ca.sandia.gov), a rule engine and scripting environment written in Java language.

In certain cases, we need a priority range for these rules because it's possible that several rules happen at the same time. Alert mechanisms in actions should have a priority level because some situations could be critical o very critical and need a faster response. For example, if the patient has a lot of pain, it can notify to the assistant firstly and then to relatives. The assistant can then decided if an ambulance is required to attend the patient.

3.3 Use Cases

We can identify some important use case of the platform. Device management can be one.

A general administrator controls the RGW but can appear different administrator for each subsystem like e-health admin, which is allowed to configure e-health devices only. A solution to separate different RGW admin by virtualization is described in (Ibáñez et al., 2007). Every service offered by a device is part of a scene, i.d. a set of preestablished services by the admin. Non admin user, like relatives, friends, assistant or dependent person can directly customize the devices to adapt them according to their preferences. For example, a relative of dependent person can set the hours that blind is open to allow illuminate the room during periodic blood pressure check.

Telecare with assistant people of the dependent person can be another use case. This is often organized without considering the communication with the relatives and friends of dependent person. Problem is that the patients usually prefer to contact first of all their relatives and friends if they need anything. According to several studies, dependent people are reluctant to use many health care services because they do not personally know the operator or contact person in the service centre. So an objective of this work is to integrate these relatives and friends into the healthcare service provision, in an effort to increase the usability of the system. For example, in this use case the assistant initiates a SIP video call with the patient and with relative and check remotely the vital statistics like weight or blood pressure thanks to health care devices at patient home. These devices are wireless connected to RGW which recover the medical information, process data and save it in HL7 format.

4 DATA MODEL

Data model designed is divided in user management in one side and device management in the other side. An overview of data model it showed in 2. A generic User entity saves basic data, like name, surname, address, etc. Defined attributes in this schema should be compatible with HL7 PID (Patient Identifier Segment) fields. For example, Spanish second surname must be matched in Mother's Maiden

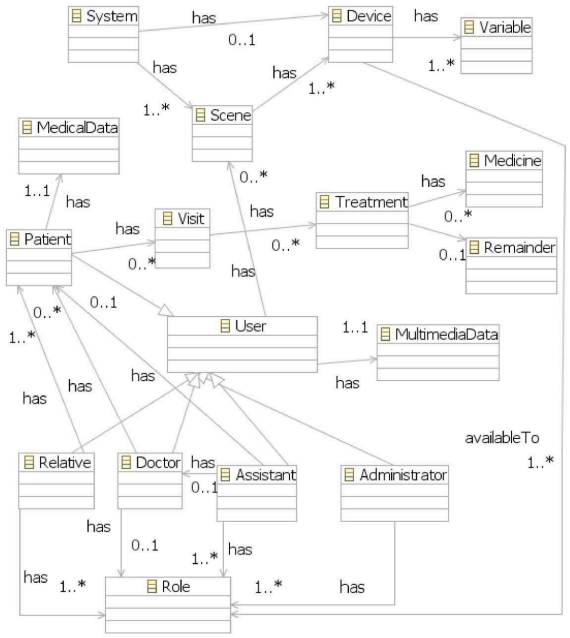

Figure 2: Platform Data Model.

Name (XPN) following the HL7 Spain recommendations (www.hl7spain.org). Relative, Assistant, Doctor and Administrator are entities which have different attributes and different roles according to permissions. A role defines a permission set that a user have to access to data and devices. In this manner, user type definition is separated from privilege definition.

5 CONCLUSIONS

We have seen an overview of some e-health applications and technologies. We propose a system architecture that provide capabilities to integrate different telecare, telemedicine and automation services in a smart home gateway based in OSGi platform. A production system is presented also to control and monitorize patient behaviour in his home. Separation between this production system and different services implementation in RGW allows a flexible and scalable functional system.

Future works should provide a basic implementation and test with some of the use case describes here. A prototype is interesting to check in a real home with dependent person and to observe the result to do future enhancements in the system design.

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REFERENCES

Blobel, B. and Pharow, P. (2006). Ehr standards-a comparative study. In Bos, L., Roa, L., Yogesan, K., O'Connell, B., Marsh, A., and Blobel, B., editors, *Medical And Care Compunetics 3*. IOS Press.

Bobbie, P. O., Ramisetty, S. H., Yussiff, A.-L., and Pujari, S. (2003). Designing an embedded electronic-prescription application for home-based telemedicine using osgi framework. In Arabnia, H. R. and Yang, L. T., editors, *Embedded Systems and Applications*, pages 16–21. CSREA Press.

Chen, Y. and Huang, C. (2005). A service-oriented agent architecture to support telecardiology services on demand. *Journal of Medical and Biological Engineering*, 25(2).

Hutchison, A., Kaiserswerth, M., Moser, M., and Schade, A. (1996). Electronic data interchange for health care. *Communications Magazine, IEEE*, 34:28–34.

Ibáñez, M., Martínez Madrid, N., and Seepold, R. (2007). Virtualization of residential gateways. In Seepold, R., Madrid, N. M., and Kucera, M., editors, *Proceedings of the Fifth International Workshop on Intelligent Solutions in Embedded Systems (WISES07*, pages 115–126, Leganés (Spain). Universidad Carlos III de Madrid.

Schmitt, L., Schmitt, L., Falck, T., Falck, T., Wartena, F., and Simons, D. (2007). Novel iso/ieee 11073 standards for personal telehealth systems interoperability. In *High Confidence Medical Devices, Software, and Systems and Medical Device Plug-and-Play Interoperability, 2007. HCMDSS-MDPnP. Joint Workshop on*, pages 146–148.

Smith, B. and Ceusters, W. (2006). Hl7 rim: An incoherent standard. In Hasman, A., Haux, R., van der Lei, J., and France, F. R., editors, *Studies in Health Technology and Informatics. Ubiquity: Technologies for Better Health in Aging Societies - Proceedings of MIE2006*, volume 124, pages 133–138, Amsterdam. IOS Press.