Using Web Services for Medication Management in a Smart Home Environment

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Abstract. The Smart Home is a house equipped with technology to assist especially the elderly and persons with special needs. Smart Homes rely on Service-Oriented technology usually OSGi. Web Services (WS) receives little emphasis on Smart Homes, but they can be very useful for some applications. That is the case of management of medication as this task can become very difficult and involve different, remote parties. Several solutions have been proposed for applications like medications management but their lack of interoperability limits them. This paper presents a solution that integrates current systems and provides interoperability by using WS. The secure transfer of sensitive data among subsystems is achieved by using secure WS for communication purposes as shown by our prototyped implementation.

Keywords: Smart Home, Web Services, OSGi, Medications.

1 Introduction

The Smart Home (SH) is a house equipped with technology like sensors and actuators with the purpose to help the resident in performing their activities of daily living. SH research has focused on using these homes to help the elderly and person with special needs to stay home longer and live more independently. SHs have relied on the Service Oriented Computing (SOC) approach to simplify its design, shorten the development time and reduce the cost [1]. Different Service Oriented Architectures (SOA) has been developed. Two widely used SOA are Web Services (WS) and OSGi services. Both architectures are platform independent, rely on well defined standards and can be deployed over networks. WS has become very popular and most research in SOC has focused on WS. OSGi has become a widely used standard for applications that use embedded devices such as SHs. This paper shows that WS are very useful for certain SH applications especially remote applications and those involving third parties. The use of WS for certain applications certainly reduce the cost and development time as some of these services needed are already available.

One of these applications of WS within the SH is with the management of medications. Difficult prescription names, different instructions and the fact that a person

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might be taking several medicines at the same time can make this a difficult task especially for the elderly and persons with special needs. Using technology will certainly help this population to increase compliance and medication intake [2].

The SH environment can help with the management of medications. The authors in [3] provide a system called Medicine Information Support System (MISS) which integrates the doctor, the pharmacy and the SH to increase safety, manage the medications and increase medication intake and compliance. This system requires little action from the SH resident as it takes care of the process in a transparent way. This paper integrates WS technology with the MISS system to make it more interoperable, expandable and platform and language independent. The rest of this paper is organized as follows: Section 2 contains related work. Section 3 provides more details on the MISS system and how it was expanded by using WS. Section 4 details the prototyped implementation of this system. Section 5 contains the conclusion and future work.

2 Related Work

In [4] the author explains how today's devices are more powerful with more computational and communication power allowing this technology to be used in home applications. However these devices and appliances use different protocols, a lot of them proprietary. They proposed a solution based on WS to achieve interoperability, heterogeneity and scalability. They implement the WS stack in the devices or in the devices controller. Their main purpose for bringing technology into the home is to help the elderly to stay home longer, having the necessary assistance and reduce the learning curve, sharing a similar motivation of this work.

Even though in [4] the authors propose a solution based on WS for SH applications, in general SHs rely on the OSGi service platform [5]. Both technologies offer a set of unique features, so the combination of them can help providing new solutions. In [6] the authors describe a driver on top of OSGi in which devices can be dynamically added, invoked and mapped to different WS standards. Their vision is to have a centric platform in which the functionalities are provided as services and applications compose these services in a flexible way. The OSGi platform is used and drivers on top of OSGi are developed to support WS. Each WS is mapped into a service in the platform. This is a good attempt in trying to combine both technologies together but full integration it is still needed [7].

3 OSGi and Web Services in the MISS System

The Medicine Information Support System (MISS) is a system that helps patients to manage their prescriptions [3]. It improves safety by checking for conflicts among medications, health conditions and food. The way it does it is by integrating the doctor, the pharmacy and the SH in such a way that prescription information is forwarded from one subsystem to the other. It uses a trusted third party that defines the conflicts among medications, health conditions and foods. Prescriptions data is checked against the patient’s data stored at each subsystem to identify any possible conflicts. The next few paragraphs briefly summarize MISS and how we applied WS to it.

The doctor subsystem is where this process begins. The doctor enters the prescription details with the medications and dosage information. The doctor is assumed to have a record of the previous prescriptions and health conditions of the patient. The patient's record is checked against the new prescription to determine if a conflict exists. To detect a conflict we use a trusted third-party such as the Food and Drug Administration (FDA) or the Physician Desk Reference (PDR) who defines conflicts among medications, conditions and foods. After this check, prescription data is forwarded to the patient's preferred pharmacy via a secure communication channel.

The pharmacy subsystem performs a similar function of checking the prescription for conflicts with other medications. We assume that the pharmacy keeps a record of all medications previously picked up by the patient. A check for prescription conflicts is performed using the patient's data at the pharmacy and a trusted third party such as the FDA or PDR. If no conflicts are found a secure channel is used to forward the prescription data to the SH.

The SH subsystem performs a similar check for conflicts. It is assumed that the SH keeps an inventory of the medications and the food at home. The SH then check for conflicts among medications picked-up from different pharmacies and with food at home. Again a trusted third party defines the different conflicts.

The MISS system assumes a secure communication channel for forwarding data from the doctor to the pharmacy and from the pharmacy to the SH but no details of this secure channel are provided. One way this secure communication channel can be implemented is by using WS which will also make the different subsystems interoperable as WS are platform and language independent, a main feature of this technology [9]. This will allow for current system to keep working but also to be expanded by using this technology.

This work extends the MISS system by making WS a fundamental part of it. MISS makes use of stand-alone applications for the doctor and the pharmacy subsystems. It uses OSGi services at the SH to control the devices and application. This work uses WS to glue these three subsystems together providing interoperability and preserving the platform and language independence. It also allows other applications to use the Web Service provided if needed. This approach takes care of providing a secure mechanism for forwarding data among subsystems. The next section has a summary of a prototyped implementation of MISS using WS.

4 Prototyped Implementation Using Web Services

A prototyped implementation using the approach described above has been implemented in our SH Lab. For the doctor's subsystem an application has been developed in which the prescription details are entered and then forwarded to the pharmacy using a secure WS provided by the pharmacy that the doctor's subsystem invokes. The pharmacy WS provide the tools for the doctor to forward the prescription's data. When a prescription's data is received via this WS, the data will be transferred to the pharmacy's main system so that the pharmacist can starts preparing the prescription. When the prescription is ready the pharmacy subsystem use a WS provided by the SH to forward the prescription data from the pharmacy into the home system. This WS will allow data to be transferred from the doctor's subsystem to the SH also, such as

medical conditions. This allows the SH to have more data available and perform and final and more complete check for conflicts which will improve safety.

5 Conclusion and Future Work

The SH is a house equipped with technology to help the elderly and person with special needs to stay home longer. One way to help this population is with the management of medications. This is a task that can become difficult given the amount of data that needs to be handled. To increase compliance and medication intake several solutions have been proposed but the lack of a universal platform and language independent approach limit these. This paper presents a solution that integrates current systems and make use of service oriented approaches specifically WS. Future work includes the use of formal methods to validate that the data is transferred correctly, that privacy is respected and that the entire system performs its intended functionality. Also full integration among SOA such as WS and OSGi and the use of some WS sublanguages is something we would like to do in the future.

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