VirtualECare: Intelligent Assisted Living

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Abstract. Innovative healthcare projects are arising in today's society, normally presenting as major advantage the reduction of care provider's costs. Being these advantage a legitimate one, we are trying to take it a step forward through the use of proactiveness, decision making techniques, idea generation, argumentation and quality, not only of the in transit information, but also of the provided service as well. With these objectives in mind, the VirtualECare project was born. In this paper we are going to briefly present the project and make a position of the actual developments in this first year of work.

Keywords: e-Health, Ambient Intelligence, Assisted Living, Active Ageing.

1 Introduction

Once the human population is progressively ageing, it matters that the elderly in need of special attention, is growing. Old age brings new problems (e.g. entertainment, health, loneliness), aggravated with the lack of specialized human resources to assist their necessities. Besides that fact, one may point out, for example, that pressure exists in government and society (e.g. budgetary restraints, cost of medical technologies and cost of internment) that will force readjustments of actual entertainment and/or health care practice, which may also affect other co-related public systems [1, 2].

This work looks at the role that inter-organization cooperation and learning plays within the innovative processes of a smart home for care of the elderly, and, suggests a framework that allows a set of organizations to strategically model a collaborative environment that is conducive to innovation. The major idea is to enhance elderly quality of life, allowing them an "active ageing", thus being able to participate in social, economic, cultural, spiritual, civic and family affairs, physically and labor, remaining active contributors to their families and communities [1]. The path to pursue, in order to achieve the presented idea, relies on a mix of different sensibilities from Artificial Intelligence, such as Decision Trees and Automated Learning, coupled whit different computational paradigms and methodologies for problem solving, such

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as Agent Based Systems and Group Decision Support Systems [3], thus being able to achieve a high level of "intelligence" in what may be denominated as "Smart Healthcare Homes" [4].

1.1 Contextualization

In the last years we have assisted to a proliferation of various research projects in order to increase the quality of care services and reduce the associated costs, especially the ones that require the patient to be delocalized from his natural habitat (Home). Normally these tend to be simple and basic reactive alarm systems without many requirements from the support platform point of view [5-7]. In our opinion these systems were very useful to delineate a path for others to follow. Taking this path we have presented the VirtualECare project [8, 9] which we believe will be the next generation of remote proactive healthcare system with, in our case, Group Decision techniques for problem solving.

2 Application Scenario

The main goal of VirtualECare is to improve end user's quality of life allowing them to enjoy the so-called active ageing. To achieve this purpose we will take advantage of the enormous evolution new technologies have assisted in past years.

To better understand the amplitude of VirtualECare, let's consider the following scenario [10]:

"*John has a heart condition and wears a smart watch that takes his blood pressure three times a day. His watch also reminds him to take his medications and the proper dosage for each medicine. If anything is unusual, his watch alerts both him and the Group Decision Support System (GDSS). John also has a PDA that contains an interactive health control table where he can monitor his medications, schedule his exercises, manage his diet and log his vital statistics. The GDSS has access to this table so they can keep up to date on his condition. Currently, John's watch detects that his blood pressure is unusually high. The GDSS receives a grade B and calls him to check what might be causing his high blood pressure (diagnose). At the same time John receives a checklist of possible causes to review. John compares this list to his own health control table in his PDA to see what might be wrong. Meanwhile, the GDSS decides John should come to an appointment.*

Later on, Laura is at home and decides to phone her dad. During the VoIP phone call she realizes he isn't looking very well. She decides to review his Electronic Clinic Process and comes to her attention that dad's has being having high blood pressure. However she also realizes that VirtualECare GDSS already has being alerted and is already taking care of it. Laura can know relax, and don't annoy dad with health questions."

The presented scenario requires an infrastructure to support all the several intervenient and provide basic interaction mechanisms. On top of this infrastructure an extensive number of services can be deployed and/or be developed.

3 VirtualECare

The VirtualECare is an intelligent multi-agent system not only to monitor and to interact with its costumers (being those elderly people or their relatives), but also to be interconnected to other computing systems running in different healthcare institutions, leisure centres, training facilities or shops. The VirtualECare [9] architecture is a distributed one, being their components unified through a network (e.g., LAN, MAN, WAN), and each one with a different role (Fig. 1).

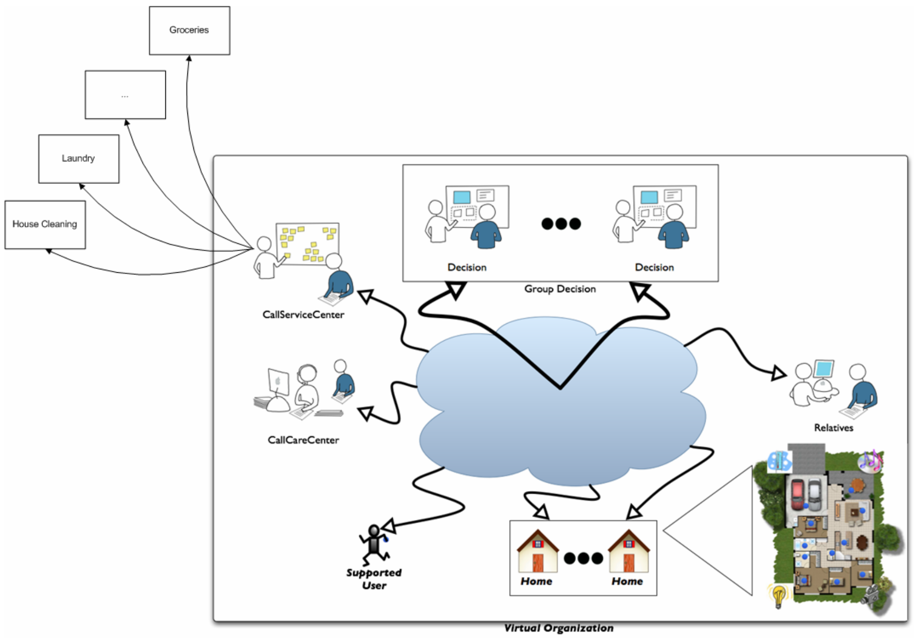

Fig. 1. VirtualECare

SupportedUser **–** Patient with special healthcare needs, whose critical data is sent to the ***CallCareCenter*** and forwarded to the ***Group Decision Supported System***;

Home **–** ***SupportedUser*** natural premises. The data collected here is sent to the ***Group Decision Supported System*** through the ***CallCareCenter,*** or to the ***CallServiceCenter***;

Group Decision **–** It is in charge of all the decisions taken at the VirtualECare platform. Our work will be centred on this key module;

CallServiceCenter **–** Entity with all the necessary computational and qualified personal resources, capable of receiving and analyze the miscellaneous data and take the necessary actions according to it;

***CallCareCenter* –** Entity in charge of the computational and qualified personal resources (i.e., healthcare professionals and auxiliary personnel), capable of receiving and analyze the clinical data, and to take the necessary actions.

Relatives SupportedUser - Relatives which may and should have an active role in the supervising task of their loved ones, providing precious complementary information (e.g., loneliness).

In order to the Group Decision Support System take their decisions, one needs of a digital profile of the SupportedUser, which may provide a better understanding of his/her special needs. In this profile we may have different types of data, ranging from the patient Electronic Health Record to their own personal experiences and preferences (e.g., musical, gastronomic). It will provide tools and methodologies for creating an information-on-demand environment that can improve quality-of-living, safety, and quality-of-patient care.

3.1 Infrastructure

Considering the above scenario, and the needs it implies, we have designed a first proposal of a generic, configurable, flexible and scalable infrastructure as presented in Fig. 2. It is expectable that on top of it an extensive number of services will

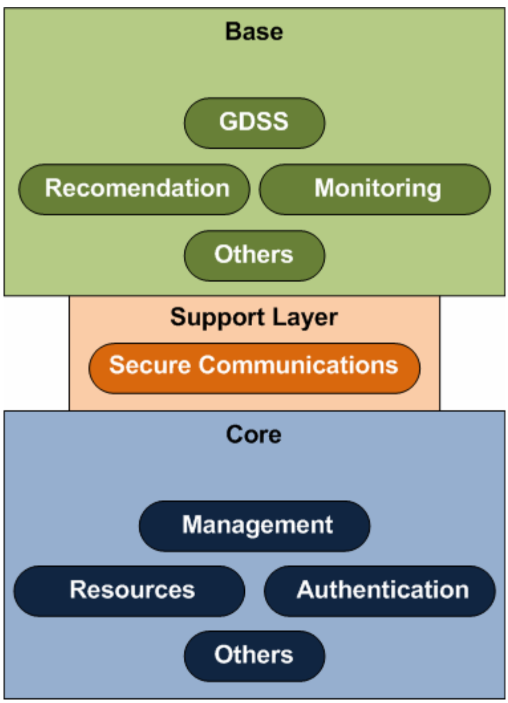

Fig. 2. VirtualECare Infrastruture

progressively arise. These services must, and are being, developed as Web Services, thus allowing the coexistence of several, different, software languages interacting with each other through the use of common messages.

The fundamental components of the proposed infrastructure are:

- *Secure Communications* – in order to all the components interact, a secure communication infrastructure is mandatory;
- *Management* – responsible for configure and monitor the involved components;
- *Resources* – responsible for every component registration and manage the resources catalog;
- *Authentication* – every component must authenticate itself in order to be able to interact with others;
- *Recommendation* – responsible to make problem solving recommendations;
- *Monitoring* – responsible for interacting with all the sensors and report its results to the GDSS;
- *GDSS* – responsible for Decision Making.

4 VirtualECare Simulation Environment

Simulation consists of creating an alternative reality to represent a real object. When making a simulation, generally one expects to predict how a given object or system behaves in the real world. This way, it is possible to draw conclusions about the behaviour of the system being studied and about its feasibility without having to actually build the system. It is very important to select the most important characteristics or behaviours of the system to simulate so that the results are as accurate as possible. These parameters to select may comprise not only the object being simulated but also the environment that surrounds the object. In the last years, this technique has grown a lot mainly thanks to advances in computer systems performances. Simulation is used to model complex systems that are either too expensive or too dangerous or simply impossible to assemble in the real world due to its characteristics. Some of the common uses of simulation are the modelling of natural systems (e.g. weather forecasts, storm evolution, and earthquake damage), testing and optimizing new technologies, and the construction of new or special buildings (e.g. the new skyscrapers, dams).

The VirtualECare project represents a complex infrastructure and architecture, so it is advisable to create a simulation environment that allows for the system to be tested and assessed before a real life deployment. In our case, we clearly need to study the behaviour of the system when specific cases occur, ranging from the reactive cases (e.g. react to a temperature change) to the more complexes (e.g. there is no movement in the last room the person was spotted for a long period of time) [11]. We also want to know what will happen in cases of malfunctioning in some components or if all the alarms went on at the same time. This is in fact one of the main advantages of simulation: it enables us to study specific scenarios that can hardly occur but are possibilities, without having to face the consequences of them really happening. We are therefore using simulation for studying the behaviour of the several project components and improve them before all the equipment is acquired.

Our simulation consists of a house with four rooms, the environment around the house and the user itself. When implementing this, the first step was to select which parameters to simulate. We have already acquired the 1-Wire temperature and luminosity sensors and this data does not need to be simulated. However, the rest of the components and/or sensors are being simulated to ensure that we have an “as real as possible” environment. We are, therefore, simulating the movement, humidity, fire, flood and gas alarm, the vital signs of the user which comprise the heart beat rate, the body temperature and the blood pressure and an outside weather station. In the actuators side, we are simulating all kinds of home appliances, ranging from an oven or a coffee machine to the lights or HiFi.

A major decision that we took was to develop all our simulation using OSGi and R-OSGi bundles [11-13]. This means that the current architecture and logic organization of the components is the same that the final system will have. By doing so, we expect to fasten the last phase of the development of the project since we will only need to replace the generation of the simulated data by the real components. The rest of the system remains the same and has already been hardly tested, which gives us great confidence on the performance of the final system. It is therefore clear that the simulation occurs only in the generation of the data from the sensors and in the state of the appliances.

5 Conclusion

In this paper we briefly present the VirtualECare project and make a position of its recent developments. We also present how, thru simulation, our idealized platform and architecture is already able to monitor a patient and his respective natural habitat. This is our initial approach to a potential resolution that we are now trying to take a step forward thru the built of a functional prototype in a central Portuguese Hospital to make the necessary real life tests in order to adequately fundament our project or make the necessary adjustments.

Because of our simulation platform, we were already able to improve and make some adjustments to our infrastructure and respective architecture before its full implementation, making us more confident on the future behaviour of our prototype.

However we are yet only addressing, through simulation and eventual deployment, a very small part of the amplitude of the project. In parallel we are also idealizing, and in some case implementing, the remaining component and joining our efforts to give all of them the needed proactiveness (e.g.: GDSS, CallCareCenter, CallServiceCenter and Relatives) [8, 9, 14].

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