

The improvement of the quality of life for elderly and relatives through two tele-assistance services: the Tele-CARE approach.

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Abstract. Tele-assistance services based on Information and Communications Technologies can notably improve the quality of life, for both elderly and their relatives, increasing their peace of mind, confidence and security. This paper describes two of the services which have been developed for the TeleCARE platform, Agenda Reminder and Living Status Monitoring, from the point of view of the improvement of the quality of life, their main functionalities and their distributed architecture, fully integrated with all the components of the platform.

1 Introduction

The first aspect we must analyse is the concept of tele-assistance. Tele-assistance is a set of services which, with the aid of new technologies in computing and tele-communications, allows elderly people to be connected to one or more specialised care centres, with specifically qualified staff, who can provide an appropriate response to situations arising, either by themselves or by mobilising other human or material resources belonging to the user or existing within the community.

Thus elderly people who do not need permanent care and the presence of other people can be sure that in any crisis, whether of anxiety and loneliness, accident, medical emergency, or any incident in their home, they can get in touch immediately with the care centre.

Therefore, the basic aim of tele-assistance is to help ensure that vulnerable people can remain in their habitual surroundings, thus improving their quality of life, increasing their confidence, their well-being and their safety, and avoiding the large personal, social and economic costs brought about by being uprooted from these surroundings, facilitating contact with their social and family environment and ensuring immediate intervention in the case of personal, social or medical crises to provide security and contribute decisively to the avoidance of their unnecessary transfer to residential centres.

Tele-assistance involves not only the specialised Centres, but also other family members in the care and monitoring of their elderly relatives, increasing the information available to them and producing an increase in their confidence, well-being and quality of life.

Tele-assistance is the very essence of the TeleCARE IST project (Camarinha-Matos and Afsarmanesh, 2002), whose aim is to provide a horizontal support for a structure composed of a number of organisations dedicated to attending to elderly people themselves and to their families.

At present there are a number of new technologies, such as mobile multi-agent systems, federated information management, secure communications, hypermedia interfaces, rich sensorial environments and the increased intelligence of home appliances, which make it possible to create high-performance systems. Specifically, mobile multi-agent systems and federated information management are the main technologies used to design and develop the TeleCARE platform, an infrastructure which is sufficiently flexible to house the other new technologies, and to serve as a basis for the construction of specialised assistance services.

Together with this basic infrastructure, two vertical services directly related to tele-assistance have also been developed: the “Agenda Reminder” service and the “Living Status Monitoring” service, and the main purpose of this paper is to present these.

The paper is structured as following: section 2 presents the description of the Agenda Reminder service and its functionalities, as well as a brief overview of the technological solutions proposed for supporting it; section 3 presents the other service, the Living Status Monitoring service; in section 4 a general view of TeleCARE system, as a result of the IST TeleCARE project, is shown; section 5 describes the architecture for supporting the Agenda Reminder and Living Status Monitoring activities with mobile agents; and section 6 presents the conclusions.

2 The Agenda Reminder

2.1 Introduction

The agenda planned for the TeleCARE platform aims to provide the elderly with a better well being by reminding them of the activities they have to do in order to keep them healthy and socially integrated, representing an important compensation for their loss of memory.

Both elderly care professionals and elderly relatives have stated that these people experience difficulties in remembering the things they have to do in order to have a better life and a better quality of life. They can even also voluntarily obviate the exact procedure of their behaviour, varying or ignoring physical exercises, meetings with several people or follow specific diets under their own criteria. The latter leads, usually, to a worsening of their quality of living, health status or to a slower recovery of their illnesses, facts which should be avoided as much as possible.

In order to achieve these aims, the “Agenda Reminder” service will provide the necessary software and hardware systems in the Care Centre, in the home of the elderly person and that of his/her relatives, allowing the management of the elderly person agenda.

Functionalities	Target users	Topology
- Start new agenda	Care professionals	Care Centre (coordinator) or Tele-assistance Centres
- Edit agenda entries: exercises, appointments, medication reminder, etc.	Elderly people	
- Send reminder & get confirmation		Elderly homes
- Generate alert to Care Centre	Elderly people's relatives	
- Generate alert to relative(s)		Relatives homes / work places

Table 1. Functionalities, target users and topology of the Agenda Reminder Vertical Service

2.2 Functionalities

As mentioned above, the “Agenda Reminder” must allow for management of the Agenda of an elderly person by entering appointments and/or events which he/she must not miss. Modifications to the Agenda are carried out by the staff of the Care Centre, who will act on proposals from the elderly person, from his/her relatives or according to requirements which they themselves believe appropriate.

The service will also allow for the management of reminders, and the distribution of possible alerts derived from these, to the different actors in the system.

In order to achieve these aims and given the functionality required, the vertical service will be structured in three subsystems:

- **Management of the Agenda:** This subsystem will centralise all management and maintenance of the activities of the elderly person, and so will be composed of tools to allow the Care Centre staff to deal with proposals for updates, and, based on these, to create, modify or delete an entry in the agenda. In addition, the Care Centre will directly enter all appointments or events it deems appropriate for the benefit of the elderly person.
- **Management of Proposals:** This subsystem will allow the actors involved (elderly people and/or relatives) to make proposals for creating, modifying and deleting events from the agenda.

Management of Reminders: The main objective of this subsystem is to generate automatic reminders of events for the elderly person, assuring, as far as possible, the correct receipt of the reminder, and, where appropriate, confirmation that the external action associated to the event has been carried out. Alerts will be generated in case the confirmation does not arrive, which will provoke direct communication by the staff of the Care Centre with the elderly person or other contacts external to the system.

Section 5, which covers the approach used in TeleCARE, analyses all of those technical aspects which make it possible to put into practice the considerations described in the Agenda Reminder service.

The next chapter will describe in the same way the vertical service related to the monitoring of the life of the elderly person.

3 The Living Status Monitoring

3.1 Introduction

The assistance is intended to be provided both on demand of the user (requested assistance) by means of e.g. alert buttons or hands free communication devices, and automatically (automatic assistance) via information provided by sensors. Furthermore, bi-directional information flows, together with complementary information sources (e.g. cameras and sensors) will provide more accurate characterization of the situation and will reduce the number of un-necessary dislocations of care personnel.

This service offers a number of benefits:

- From a social point of view, the elderly and their relatives enjoy a higher peace of mind, thus improving their quality of life.
- From an economic point of view, the adjustment of the response degree leads to important savings in home assistance costs.

Functionalities	Target users	Topology
- Define monitoring conditions		
- Collect sensors information		
- Call for assistance (alarm button)	Care professionals	Care Centre (coordinator) or Tele-assistance Centres
- Access elderly people's file		
- Locate elderly people	Elderly people	Elderly homes
- Contact / advise elderly people		
- Generate alert / warning to Care Centre	Elderly people's relatives	Relatives homes / work places(notification only)
- Generate alert / warning to relatives		
- Call emergency services		

Table 2. Functionalities, target users and topology of the Living Status Monitoring Vertical Service

3.2 Functionalities

The Living Status Monitoring (LSM) vertical service consists basically of monitoring and supervising the activities of the elderly person in his/her own home, by means of a number of devices which, upon detecting any irregular behaviour, inform the Care Centre so that the appropriate action can be taken.

In its operational state, the system will have the following functional subsystems:

- Management of Behaviour Profiles: This subsystem will make it possible to define standard behaviour profiles for each elderly person, and once these are related to the monitoring devices installed in the home, they will enable the system to distinguish between normal and irregular behaviour.

- Management of Monitoring This subsystem is the heart of LSM and will be responsible for carrying out the entire process of analysing the information collected by the devices and correlating this data with the profile of the elderly person, generating the pertinent notifications and/or alarms. All of the situations which occur will be stored in a log which will be used as feedback for the system, where appropriate, and to generate reports.
- Management of Communications This subsystem will be responsible for allowing direct communication with the Elderly person by means of the communications devices such as loudspeakers and/or the web cam installed in the home. The Elderly person may contact the Care Centre directly whenever he/she wishes, and the Care Centre and the Relative may establish communication and/or view the images from the camera installed in the elderly person's home.

Section 5, which covers the approach used in TeleCARE, analyses all of those aspects which make it possible to put into practice the considerations described in the Living Status Monitoring service.

The next chapter gives a summary description of the TeleCARE platform and of each of its component modules, which make it so flexible.

4 General View Of TeleCARE System

4.1 Introduction

As has been mentioned above, the TeleCARE IST project (Camarinha-Matos and Afsarmanesh, 2002) has developed an appropriate generic architecture which provides a horizontal base infrastructure capable of supporting the fundamental functionality, and on top of which it is possible to define vertical services dedicated, in this case, to tele-assistance. This heterogeneous, autonomous and widely distributed sector required a generic, open, flexible architecture, for which reason, two fundamental technologies are used in TeleCARE, a mobile multi-agent platform and federated information management.

4.2 TeleCARE Architecture

With regard to the modular structure of the system developed, the following block diagram shows the architecture to be installed at each node of the TeleCARE organisation.

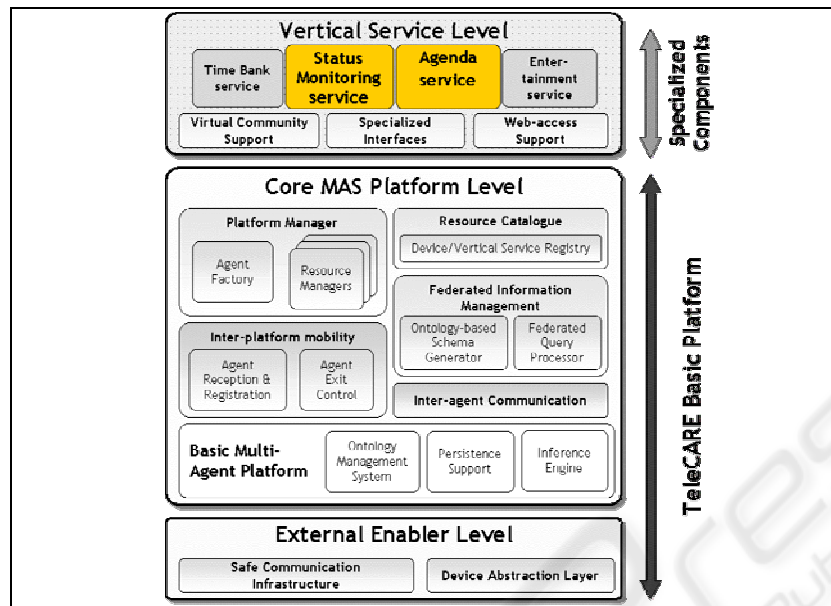


Fig. 1. Main components for a TeleCARE node

As the diagram shows, the major item is the TeleCARE Basic Platform, composed of basic modules which are capable of providing the essential functionality for system management and support for the dedicated vertical services to be implemented on it.

The coloured vertical services in the figure 1 are those described in this paper, which are described in more detail in chapters 2 and 3 respectively, and whose implementation in the TeleCARE platform will be described in detail in the following chapter.

5 Agenda Reminder And Living Status Monitoring In TeleCARE

5.1 Introduction

We shall first review all of the features which are common to both vertical services, and then study each service individually in order to explore its characteristics and demonstrate how they interact with the other modules in the platform.

To simplify this study, we shall assume two TeleCARE nodes, one in the Care Centre and the other in the elderly person's home. A third access point to the system is located in the Home or Office of a relative, with access to the system via Internet. This setup will enable us to describe both the Agenda and the LSM within a TeleCARE environment.

Both services make use of the Basic Multi-Agent Platform, that is, they are developed using mobile agent technology, with additional characteristics such as persistence and the use of a common ontology. They interact with each other and with the system through the use of messages (three kinds: aglets messages, TeleCARE messages and FIPA-ACL messages), making use of the properties granted by the Inter-agent Communication Module, or travelling around the different TeleCARE nodes thanks to Inter-platform Mobility. In addition to all of these possibilities, the agents can also store or access TeleCARE information through the Federated Information Management System, once more making use of a common ontology and making Federated Queries if they need to locate information outside the node itself.

As well as interaction with the Core MAS Platform, the rest of the architecture is used by the vertical services either through the Core itself, as may be the case with the External Enabler, or directly. The latter is applicable to the Specialized Interfaces for Elderly People and Web Access. Both the Agenda and the LSM use the specialised interface to interact with the elderly person, but use different means to interact with the staff of the Care Centre. In this case, they use the normal window based interface oriented towards people with some knowledge of computers. The other type of interface used is the web interface, and so both vertical services also use the Web Access module, which allows for communication between two totally different technologies, mobile multi-agents and TCP/IP, which is the basis for all services currently provided via Internet. All of these inner aspects are shown in a more detailed way in the other TeleCARE papers.

Having seen the similarities between the two vertical services with regard to their interaction with the basic TeleCARE platform, we shall now look at the individual aspects of each one.

5.2 Agenda Reminder

The Agenda service is initiated in the Care Centre. Once the agents responsible for carrying out the task have been created, we can say that the service is active in the Centre. There are two of these agents: the Agenda Reminder Server Manager agent and the Server Interface agent, but as shown in the following diagram, there may be a third agent responsible for Web access to the service: the Web Connector agent.



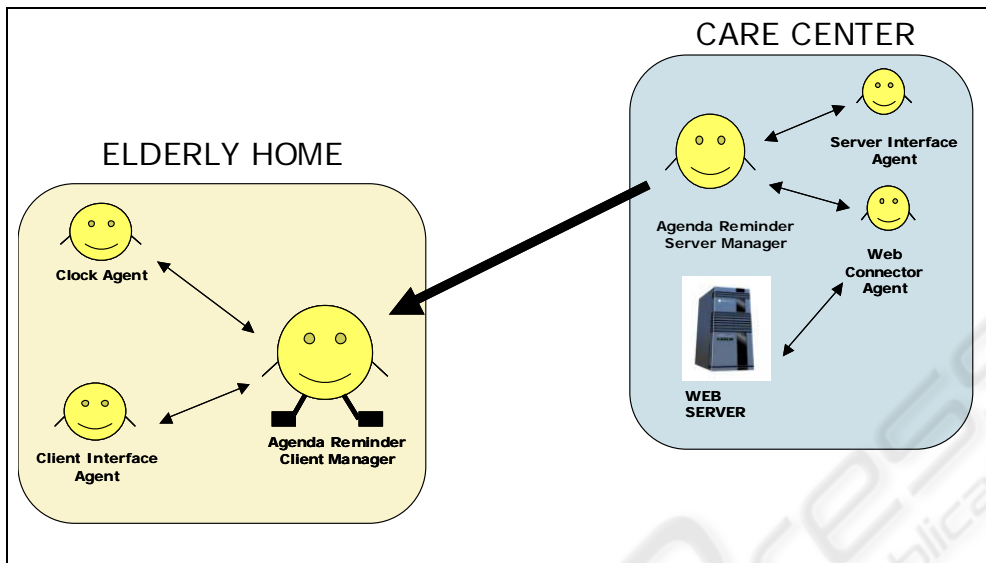


Fig. 2. Agenda Reminder deployment

Agenda Reminder Server Manager Agent – Responsible for the entire management and control of the vertical service at the Care Centre end, including tasks such as management of proposals, events and alerts, and the registration for the service of new elderly people.

Server Interface Agent – Its task is to manage the interface with the Care Centre staff, controlling the windows and incoming and outgoing data flow.

Web Connector Agent - In charge of setting up a bridge to the world of Internet, through a web server, which must also be installed on the node provided by the bridge. This agent does not belong to the Agenda, but forms part of the Web Access module and appears in the figure to demonstrate another interface option, precisely that which is used by relatives from their home or office.

Whenever an elderly person is registered with the Agenda service, An Agenda Reminder Client Manager agent is created in the Centre. This agent will travel (with the data on the elderly person) to the node installed in his or her house, to deploy the service there. This is a clear example of how agent mobility works. This deployment consists of creating the other two component agents of the service in the elderly person's home, the Clock agent and the Client Interface agent, as shown also in Figure 2.

Agenda Reminder Client Manager Agent – All communications between the two nodes pass through this agent. It is also responsible for managing proposals in the home, generating notifications and generating service-related alerts in the home.

Clock Agent – This is the service clock, and is responsible for launching the events at the appropriate time.

Client Interface Agent - This agent manages the interface with the elderly person, controlling the information which appears on the specialised interface and the

incoming and outgoing data, all of which are always oriented towards the elderly person.

Once the deployment has been carried out, it can be said that the Agenda is active in the elderly person's home. A scenario to this service is described below.

Agenda Reminder Scenario

Juan and Ana have respectively 72 and 68 years. They live in their rural house in an agricultural village 50 Km far from the urban centre. Juan is still in the first stages of the Alzheimer disease and suffers from memory problems. Ana suffers from arthritis in her hands and has difficulties to remember some daily tasks. Their daughter is employed in the city. They prefer to stay in their house instead of going to a care centre.

The system reminds them every morning the tasks of the day: for an instance, the system informs them that they have to buy something or that Ana has to go to the health centre in the evening for an analyse.

Before lunch the system recommends a diet adapted to the needs of Ana and Juan, as prescribed by the doctor.

During the evening, Ana goes to the health centre and Juan stays alone in the house. When Juan is watching the TV, the system reminds him that he has to take the pill that Ana has left on the table.

5.3 Living Status Monitoring

The LSM works in a similar way to the Agenda, but in this case different agents are involved. Figure 3 shows the set of agents involved in both the Care Centre and the elderly person's home. As with the Agenda, the service is initiated in the Centre, and services are launched from there to the homes as the elderly people are registered with the LSM. See figure 3.



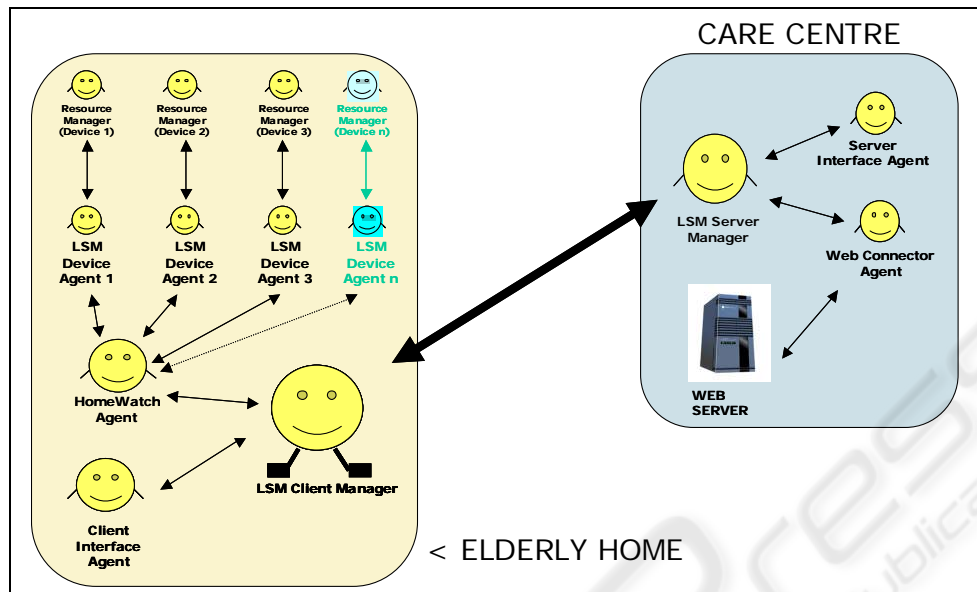


Fig. 3. Living Status Monitoring deployment

In this case also, two agents make up the service in the Centre, and here again there may be a third agent in charge of Web access to the service:

LSM Server Manager Agent – as with the Agenda, this agent is in charge of all the management and control of the vertical service at the Care Centre end, but its tasks are different: its basic tasks are the registration of new elderly people in the service, which includes inputting and later managing the elderly person's lifestyle pattern with which the system is parameterised, the management of alerts, direct connections to the home and the temporary activation or deactivation of the service.

Server Interface Agent – Its task is to manage the interface with the Centre's staff, controlling windows and incoming and outgoing data.

Web Connector Agent - Responsible for setting up a bridge to the world of Internet, through a web server, which must also be installed on the node provided by the bridge. This agent is physically the same one as in the case of the Agenda, since, as has been mentioned, it forms part of the Web Access module and not of the service.

The deployment of the service is the same as for the Agenda, once a new elderly person subscribes to the LSM. However, in this case, once the LSM Client Manager agent travels to the home, a greater number of agents are created to form the service, as shown in figure 3.

LSM Client Manager Agent – All communications between the two nodes pass through this agent, which is a bridge which stores all the information related to the Centre and the elderly person.

Home Watch Agent – The brain of the service, in charge of analysing what is happening inside the home. It collects and analyses all the information from the sensors, using the information on the elderly person's lifestyle and everything which has happened previously in the home. This analysis will bring about a response if an anomalous situation is detected; this response may take the form of an automatic call to the elderly person requesting a confirmation that he or she is well, or an alert sent to the Care Centre for the initiation of the appropriate action, which may include a direct connection with the home.

Client Interface Agent - This agent manages the interface with the elderly person, controlling the information which appears on the specialised interface and the incoming and outgoing data, all of which are always oriented towards the elderly person.

LSM Device Agents – For each of the devices located in the home, a device agent is created as a go-between. It will interrogate the resource catalogue to find out whether such a device exists, and if not will self-destruct, notifying the system of the non-existence of the device.

Resource Managers – As with the Web agent, these agents do not form part of the service, but appear in the diagram for the sake of completeness. They are created in the elderly person's home when the device they manage is installed. They are the agents in closest contact with the devices, and can even implement, when necessary, the proprietary code for the device. They constitute a device abstraction layer, making the devices transparent to the remainder of the system.

Once again, when the deployment is complete, Living Status Monitoring can be considered to be active in the elderly person's home. Then, a potential scenario can be studied in this home.

Living Status Monitoring Scenario

Mrs. Dolores Fernández is a 74 years old woman who lives alone in an apartment. One day, she wakes up feeling sick and contacts the healthcare service by pressing the panic button.

The healthcare service checks in the elderly person's information that this woman suffers from diabetes, and asks the woman about what she had for dinner the previous night. Then, the healthcare service recommends her to drink a glass of juice. After 30 minutes, they contact her again to check the status and welfare of the woman.

Later that day, sensors installed at the elderly person's home warn the assistance service that no movement was made since the last checking call. Then they ask her if everything is all right, without obtaining any response. The healthcare service alerts the emergency services and their relatives reporting her status, medical history and actions set in motion.

6 Conclusions

The main conclusion drawn may be that, after the TeleCARE IST project (Camarinha-Matos and Afsarmanesh, 2002), the development of the Agenda Reminder and

Living Status Monitoring services has demonstrated that the technology used for the project is the most appropriate for the type of Tele-assistance application in question.

The mobile multi-agent platform appears to be the best option for establishing a network of nodes which are heterogeneous, autonomous and with such a wide physical distribution. Its robustness to communications failures and the persistency facilities added in the project make it highly appropriate for remote assistance. In addition, the idea of federated information management is the best option for the conditions under study, since agents can be sent to collect information from each node, and at no time is there any centralisation of data, which would be highly inappropriate in this type of situation.

We do not wish to ignore security, both as regards the communications infrastructure and the management of the information; privacy is maintained at all times and access to information is controlled using both roles and user identification.

Finally, all of the aspects added to the system, such as the modular design, making use of abstraction layers at several levels, plug and play support and the use of standards or common practices where viable, have made it possible for the architecture to be generic, open and flexible, thus fulfilling the initial aim of the project.

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