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M-Learning for Elderlies: A Case Study

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Abstract. In this article a case study about m-learning for elderlies using mobile devices is presented. The study focuses on a practical study about language learning for elderly students that attend classes in the so-called Inter-university program for Elderly People. The recent surge of university programs for elderly people requires novel solutions related to learning methods, directed by the special needs of this sector of the society.

Keywords: elderlies, m-learning, mobile devices, disabled people.

1 Introduction

There is an ever growing need to supply constant care and support to the disabled and elderly and the drive to find more effective ways to provide such care has become a major challenge for the scientific community [3]. During the last three decades the number of Europeans over 60 years old has risen by about 50%. Today they represent more than 25% of the population and it is estimated that in 20 years this percentage will rise to one third of the population, meaning 100 millions of citizens [3]. In the USA, people over 65 years old are the fastest growing segment of the population [1]and it is expected that in 2020 they will represent about 1 of 6 citizens totaling 69 million by 2030. Furthermore, over 20%

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of people over 85 years old have a limited capacity for independent living, requiring continuous monitoring and daily care [2]. Some estimations of the World Health Organization show that in 2025 there will be more than 1000 million people aged over 60 in the world, so if this trend continues, by 2050 will be double, with about the 80% concentrated in developed countries [6].

Education is the cornerstone of any society and it is the base of most of the values and characteristics of that society. The new knowledge society offers significant opportunities for AmI applications, especially in the fields of education and learning [5]. The new communication technologies propose a new paradigm focused on integrating learning techniques based on active learning (learning by doing things, exchange of information with other users and the sharing of resources), with techniques based on passive learning (learning by seeing and hearing, Montessori, etc.) [4]. While the traditional paradigm, based on a model focused on face to face education, sets as fundamental teaching method the role of the teachers and their knowledge, the paradigm based on a learning model highlights the role of the students. In this second paradigm the students play an active role, and build, according to a personalized action plan, their own knowledge. Moreover, they can establish their own work rhythm and style. The active methodology proposes learning with all senses (sight, hearing, touch, smell and taste), learn through all possible methods (school, networking, etc.), and have access to knowledge without space or time restrictions (anywhere and at any time).

There are different studies that have used the Ambient Intelligence to facilitate learning. In [3], Bomsdorf shows the need to adapt intelligent environments to changes depending on the educational context and the characteristics of users. Morkenet al. [6] analyze the characteristics of intelligent environments for learning. They focus on the role of mobility in educational environments and the role that acquire the mobile devices. Naismith et al. [7] conducted a detailed study describing the role of mobile devices in education, analyzing the characteristics of the devices and their capacity for learning in educational environments. All these approaches are focused on the role of learning in Ambient Intelligence environments, but none of them is oriented on learning for dependents or elderly people. The following section presents a multiagent architecture that facilitates learning methodology using an active through mobile devices.

This work presents a practical study about language learning for elderly students that attend classes in the so-called Inter-university program for Elderly People at the Pontifical University of Salamanca, Spain. The recent surge of university programs for elderly people requires novel solutions related to learning methods, directed by the special needs of this sector of the society. With the aim of obtaining an improvement in the French language learning, we have tested different methodologies. The one presented in this paper is an empirical one, based on the M-learning paradigm. This paper focuses in the combination of the new information technologies along with the traditional teaching. In this way it

will be possible to combine the advantages of the face to face teaching with the advantages of distance learning. It will be necessary to upgrade the systems of evaluation/accreditation to assess the knowledge or skills acquired during the learning process. To achieve this objective, we propose the use of mobile devices, intelligent systems and wireless communications. The aim is to provide complementary methods to the traditional learning strategies. The proposed mechanism was tested in a case study, trying to evaluate the impact of the new approach on the elderly students.

The rest of the paper is structured as follows: Next section introduces the problem that motivates most of this research. Section 3 describes a case study to test the proposal and, finally, Section 4 shows the results and the conclusions obtained.

2 Background

This section presents the problem that motivates this research. More specifically, we will focus in two main concepts: Learning techniques oriented to elderly people and mobile learning techniques. In the following paragraphs we revise the related work about these two concepts.

2.1 Learning Techniques Oriented to Elderly People

Elderly student are acquiring a relevant role in Spanish universities. Different factors as the improvement in the quality of life and the educational interests of this sector of the population contribute to these new educational needs. In 1973, professor Pierre Vellas created the first university program for elderlies in Toulouse. Since then, the growth of these university programs has been unstoppable, and now they exist in practically all the continents. Focusing on Spain, the University of Alcalá de Henares and the Pontifical University of Salamanca were the first university in including a university program for elderlies in 1993. These educational programs presented a new challenge regarding learning methods adapted to the special needs of the new students. These students present a series of special characteristics: They usually compose a heterogeneous group, with different academic background (we can find students with basic education and students with university degrees), different ages (it can vary from 55 to 80 years), and different level of language domain. In Spain, most of these people studied a foreign language, French in most of the cases, but most of them don't have memories about this language. In general they are students that attend the classes and are interested in continuing with the students in the subsequent years.

Apart from the special characteristics of this new student profile, there is another obstacle: there not exists a didactic method oriented to elderly students.

All the existing methods are oriented to children, teenagers or young people. It has only been possible to find an English method oriented to elderlies [10]. The existing learning methods are not appropriated for the special characteristics of these new students. Thus, it is necessary to investigate in new learning techniques and methods oriented to satisfy the special requirements of this social sector.

2.2 Mobile Learning Techniques

The experience acquired after teaching French during a decade to elderly students, it is possible to conclude that the new information and communication technologies (ICT) are still a challenge for these students. The impact and growing use of the ICTs in our society it is a reality and it is not possible to live without them. The use of the ICTs can help to notably improve the quality of life of elderlies and facilitate their integration in the information society. The advances in ICTs in this century are very important, and in parallel, the traditional educational model has been substituted for new paradigms that incorporate e-learning methods. One of the advantages of these methods is the elimination of temporal and location barriers. There are different types of e-learning methods. It is possible to distinguish:

- E-learning is electronic learning, and makes use of communication networks as Internet or Intranets and platforms as Moodle, specialized in tele-learning.
- B-learning or blended learning is a combination of traditional teaching and electronic learning (E-learning). It combines attendance modules and non-attendance modules.
- M-learning or mobile learning represents a step ahead in educational models. It adapts the learning methods to mobile devices such as mobile phones, PDAs, tablets, pocket pcs, i-pads, etc. An specialization of m-learning is MALL (Mobile assisted language learning), focused on language learning from mobile devices [11].

In this paper we focus on M-learning, and more specifically in MALL. Klopfer 10 indicates that the mobile devices should incorporate five characteristics to be appropriated for mobile learning: portability, social interactivity, context-awareness, connectivity and individuality. M-learning can be combined with traditional learning methods. It is necessary to remark that M-learning is a ubiquitous method and avoids temporal and location restrictions. Moreover, M-learning becomes more important as the mobile devices become more important. According to a study of ITAD consulting, for the year 2015, the mobile Internet penetration worldwide will reach 37%. According Soichi Nakajima [12] the mobile Internet has reached a final take-off stage in Western Europe and North America, so far only been seen in Japan for almost a decade and to a lesser extent, South Korea. This growth in the number of smartphones has a big impact in the

information society, and most of the users are now replacing the typical mobile phone. Besides applications for mobile phones makes smartphones much more attractive to users and also be the way to make more mobile connections [16]. The World Summit Award Mobile Content (WSA-mobile), is a global initiative of the European Academy of Digital Media – EADiM to select and promote contents and creativity in websites [14]. The project MOBIlearnof the European Comission join together universities and telecommunications companies from Europe, Israel, USA and Australia, with the aim of defining theoretical models for learning process carried out by means of mobile technologies. The Learning and Skills Network (LSN) organization promotes MoLeNET (Mobile Learning Network) to design educational products based on mobile devices [13]. In Spain, the University RoviraiVirgilicreated apodcasting Project to improve language learning [8]. Lingling Yang remarks the importance of language learning through mobile devices [8]. In [15], Jan Herrington describes a case study in australian universities to learn using smartphones and iPods.

There are different studies that have used the Ambient Intelligence to facilitate learning. In [4], Bomsdorf shows the need to adapt intelligent environments to changes depending on the educational context and the characteristics of users. Naismith *et al.* [18] conducted a detailed study describing the role of mobile devices in education, analyzing the characteristics of the devices and their capacity for learning in educational environments. All these approaches are focused on the role of learning in Ambient Intelligence environments, but none of them is oriented on learning for dependents or elderly people. The following section presents a case study to evaluate a learning methodology using an active through mobile devices.

3 Case Study: University Program Oriented to Elderlies

This study has two objectives: i) To improve language learning in university programs oriented to elderlies, and ii) to contribute to integrate the elderly people in the information society, making use of the information technologies. At present there are various tools to facilitate the active learning, such as forums, wikis, email, chat, virtual campuses, and so on. However, none of them is focused to language learning for elderly people. This paper presents an interactive system specifically designed for language learning for elderly people and people with visual disabilities. The proposed approach includes new interaction techniques adapted to be applied in mobile devices. Interaction techniques have been used to design Ambient Intelligence interaction mechanisms suitable for use in teaching languages to people involved in courses at the university program for elderlies. Therefore, interfaces have been made simple and straightforward and have facilitated interaction through touch devices. The application developed for mobile devices contain a series of tests that individuals can complete to carry out language learning. Thus, the student uses a type of interface that allows him to interact with the system.

After revising the related work, it has been observed that the existing approaches are oriented to language learning for young students. Young students use mobile devices in their daily life, and it has not been possible to find any project oriented to people up to 55 years. In this sense, the approach presented in this paper proposes an innovative perspective where the students are elderlies.

The application is based on a navigation menu using the accelerometer available in many mobile devices, especially in the iPhone platform. This application may solve the problems that elderlies have while using a menu with different options. Cutting-edge devices have touch screens and it's impossible for them to identify where they are pressing. A movement recognition algorithm has been created in order to collect all data necessary for the successful operation of the system [19].

4 Results

To evaluate the proposed approach, the system was tested with two different groups of students at the university program for elderlies at the Pontifical University of Salamanca, Spain. The tests consisted of 2 tests for two different groups, one performed in Group 1 and another made to Group 2. The first test involved 12 individuals, while the second test involved 15 individuals. The sex of individuals was not taken into consideration to perform this test, because this parameter has not been considered as significant for this study. Each of the individuals completed one of the tests proposed in the mobile application, and noted by 10 questions. After the test, each individual completed a form on which he was asked about the evaluation of the test. The test assessed 5 items:

- Usefulness of the test. This item is valued feedback from users about the usefulness of the test as a learning tool.
- Easy to use mobile phone. This item assesses the usability of the proposed application.
- Utility as a tool for teaching languages. This item is valued feedback from users about the usefulness of the tool for language learning.
- Using mobile phone before for similar activities. This item is valued the ease and frequency of use of mobile devices.
- Overall assessment of the test. This item assesses the overall opinion about the test users.

The results obtained in the experiment are show in the following table:

Table 5 Results for the items.

	G1	G2	G1+G2
Utility of the test			
Very Useful	75 %	60 %	55,55 %
Quite Useful	0 %	40 %	33,33 %
Useful	25 %	0 %	11,11 %
Not very useful	0 %	0 %	0 %
Not useful	0 %	0 %	0 %
Easy to use mobile phone			
Very Easy	50 %	20 %	11,11 %
Easy	0 %	60 %	55,55 %
Normal	50 %	0 %	22,22 %
Difficult	0 %	0 %	0 %
Very difficult	0 %	25 %	11,11 %
Utility of the approach as a tool for language learning			
Very appropriated	25 %	20 %	33,33 %
Quite appropriated	0 %	20 %	11,11 %
Appropriated	75 %	0 %	0 %
Not Very appropriated	0 %	20 %	11,11 %
Inappropriate	0 %	40 %	22,22 %
Previous use of the mobile phone for similar activities			
Yes	100 %	80 %	88,88 %
No	0 %	0 %	0 %
Not answer	0 %	20 %	12,12 %
Global evaluation of the test			
Very satisfied	25 %	40 %	33,33 %
Quite satisfied	25 %	60 %	44,44 %
Satisfied	50 %	0 %	22,22 %
Not Very satisfied	0 %	0 %	0 %
Unsatisfied	0 %	0 %	0 %

Taking into account these results, it is possible to conclude that the approach is promising and can be of interest for this sector of the population. The participants in this experiment provided some feedback about the proposed approach: they indicated that the approach is very interesting for certain aspects, as verbs learning, and it is innovative, since it is not useful for them the use of mobile devices in the classes. Some of them also indicated that it would be of interest to improve the proposed approach with accessibility facilities, specifically to augment the size of the fonts.

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PANGEA – Platform for Automatic coNstruction of orGanizations of intElligent Agents

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Abstract. This article presents PANGEA, an agent platform to develop open multiagent systems, specifically those including organizational aspects such as virtual agent organizations. The platform allows the integral management of organizations and offers tools to the end user. Additionally, it includes a communication protocol based on the IRC standard, which facilitates implementation and remains robust even with a large number of connections. The introduction of a CommunicationAgent and a Sniffer make it possible to offer web services for the distributed control of interaction.

Keywords: multiagent platform, Web services, virtual organizations, IRC protocol.

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1 Introduction

One of the current lines of investigation for multiagent systems aims to create an increasingly open and dynamic system. This involves adding new capabilities such as adaption, reorganization, learning, coordination, etc. Virtual agent Organizations (VOs) [1][2] emerged in response to this idea; they include a set of agents with roles and norms that determine their behavior, and represent a place where these new capabilities will assume a critical role. Possible organizational topologies and aspects such as communication and coordination mechanisms determine in large part the flexibility, openness and dynamic nature that a multiagent system can offer.

There are many different platforms available for creating multiagent systems that facilitate the work of the agent; however those that allow for the creation of VOs number much fewer, and it is difficult to find one single platform containing all of the requirements for a VO.

The remainder of the paper is structured as follows: the next section introduces some existing platforms. Section 3 presents an overview of the main characteristics of the platform. Finally, section 4 explains a case study and presents some results.

2 Related Works

All platforms for creating multiagent systems existing to date should be studied according to two principal categories: those that simply support the creation and interaction of agents, and those that permit the creation of virtual organizations with such key concepts as norms and roles. We will first present those platforms that do not incorporate organizational aspects. The FIPA-OS [4] agent platform was created as a direct derivative of the FIPA [3] standard. Another agent platform is the April Agent Platform (AAP) [5] which, unlike the majority of platforms using Java, implements the April language [6]; its development and technological support has been discontinued. One of the strong points of this platform is that it provides services to facilitate the development and deployment of agents on the Internet and is also compliant with Web Services and Semantic Web standards.

One of the most recent platforms still in development is JASON [7][8]. Its greatest contribution is the easy implementation of BDI agents [10]. The Java-developed platform contains AgentSpeak in its nucleus, an interpreter agent that acts as a language extension [9]. The platform offers two operation modes: one that runs all agents in the same machine, and another which allows distribution using SACI (Simple Agent Communication Infrastructure) [11], which in turn uses KQML [24] language instead of RIPA-ACL [23]. In practice, the most used platform for developing multiagent systems in real case studies is JADF (Java Agent Development Framework) [12]. The JADE platform focuses on implementing the FIPA reference model, providing the required communication infrastructure and platform services such as agent management, and a set of development and debugging tools. Jadex [13] is a software framework for the

creation of goal-oriented agents following the belief-desire-intention (BDI) model. The Jadex project facilitates a smooth transition from developing conventional JADE agents to employing the mentalistic concepts of Jadex agents.

With the exception of JASON, these platforms follow the FIPA standard, can create agents (some with different models), and manage communication among agents and services. With VOs, however, it is necessary to consider the normative and organizational aspects that the platform itself must provide. MadKit [20] was one of the first platforms to consider basic organizational aspects. The platform architecture is rooted in the AGR (agent-group-role) model [14]; however, while it can handle the concept of role, it does not consider a role a class entity, and the behavior associated with the role is directly implemented in the agent who assumes it. Roles are strongly linked to agent architectures. This approach harms the reusability and modularity of organizations [15].

Another pioneering platform with regards to structural aspects was Jack Teams [16]. JACK Teams is an extension of JACK Intelligent Agents [17], which provides a team-oriented modelling framework. Both are extensions of the Java programming language; the implemented source code is first compiled into regular Java code before being executed.

S-MOISE+ is an organizational middleware that follows the MOISE+ model [18]. It is an extension of SACI [11] where the agents have an organizational aware architecture. Our research found systems developed in conjunction with JASON and using S-Moise+ as middleware to achieve a more complete model [19]. The result was J-Moise+ [20], which is very similar to S-Moise+ regarding overall system concepts. The main difference is how the agents are programmed: in S-Moise+ agents are programmed in Java (using a very simple agent architecture), while in J -Moise+ they are programmed in AgentSpeak.

One of the main disadvantages of VO oriented platforms is the slight loss in the concept of service and, consequently, the management of these services and the Directory Facilitator (DF) described in the FIPA standard. THOMAS was developed in response to this twofold need. THOMAS is based on the idea that no internal agents exist and architectural services are offered as web services. As a result, the final product is wholly independent of any internal agent platform and fully addressed for open multiagent systems [21].

Finally, one of the most complete and recent platforms that we found is Janus [22]. Janus is the next step towards platform organizations known as TinyMAS (no longer under development.). This platform was specifically designed to deal with the implementation and deployment of holonic and multiagent systems. Its primary focus is to support the implementation of the concepts of role and organization as first-class entities (a class in the object-oriented sense). This consideration has a significant impact on agent implementation and allows an agent to easily and dynamically change its behaviour [15].

In conclusion, it could be said that when dealing with all aspects of complex multiagent systems such as VOs, it is also necessary to deal with multiple levels of abstractions and openness, which is not the case for most solutions.

3 Architecture Overview

As we have mentioned, we are looking for a platform that can integrally create, manage and control VOs. In general terms, the proposed platform includes the following characteristics:

- Different models of agents, including a BDI and CBR-BDL architecture.
- Control the life cycle of agents with graphic tools.
- A communication protocol that allows broadcast communication, multicast according to the roles or suborganizations, or agent to agent.
- A debugging tool.
- Module for interacting with FIPA-ACL agents.
- Service management and tools for discovering services.
- Web services.
- Allow organizations with any topology.
- Organization management.
- Services for dynamically reorganizing the organization.
- Services for distributing tasks and balancing the workload.
- A business rules engine to ensure compliance with the standards established for the proper operation of the organization.
- Programmed in Java and easily extensible.
- Possibility of having agents in various platforms (Windows, Linux, MaccOS, Android and IOS)
- Interface to oversee the organizations.

Figure 1 displays the principal entities of the system, and illustrates how the roles, norms and the organizations themselves are classes that facilitate the inclusion of organizational aspects. The services are also included as entities completely separate from the agent, facilitating their flexibility and adaption.

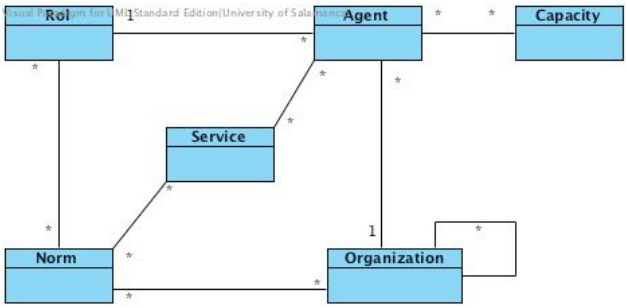

Fig. 1 Principal classes of the system

When launching the main container of execution, the communication system is initiated; the agent platform then automatically provides the following agents to facilitate the control of the organization:

OrganizationManager: the agent responsible for the actual management of organizations and suborganizations. It is responsible for verifying the entry and exit of agents, and for assigning roles. To carry out these tasks, it works with the OrganizationAgent, which is a specialized version of this agent.

InformationAgent: the agent responsible for accessing the database containing all pertinent system information.

ServiceAgent: the agent responsible for recording and controlling the operation of services offered by the agents.

NormAgent: the agent that ensures compliance with all the refined norms in the organization.

CommunicationAgent: the agent responsible for controlling communication among agents, and for recording the interaction between agents and organizations.

Sniffer: manages the message history and filters information by controlling communication initiated by queries.

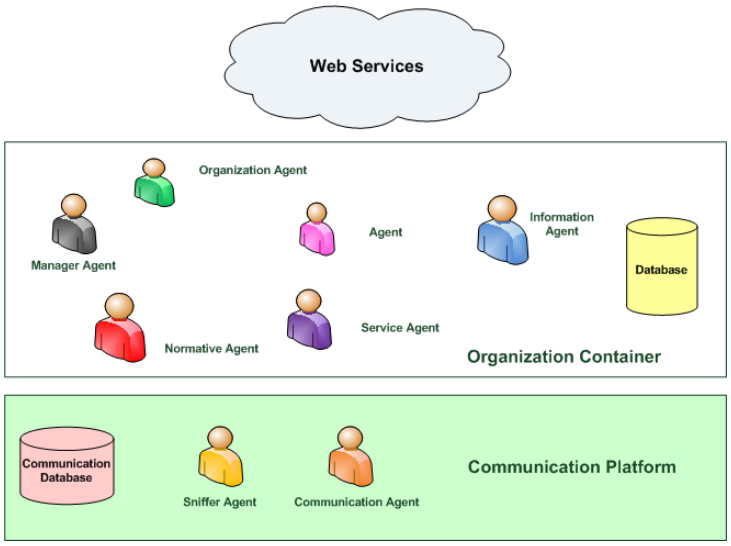

Fig. 2 Architecture

The platform examines two modes of operation. In the first mode, the agents reside in the machine itself, while in the second mode the platform allows for the possibility of initiating all agents in different machines. The latter case has the disadvantage of allowing only minimal human intervention since it is necessary to previously specify the address of the machine where each of the agents are to reside; however it has the advantage of greater system distribution.

We hope to create a service oriented platform that can take maximum advantage of the distribution of resources. To this end, all services are implemented web services. This makes it possible for the platform to include both a service provider agent and a consumer agent, thus emulating a client-server architecture. The provider agent knows how to contact the web service; once the client agent's request has been received, the provider agent extracts the required parameters and establishes the contact. Once received, the results are sent to the client agent.

Each suborganization or work unit is automatically provided with an OrganizationAgent by the platform during the creation of the suborganization. This OrganizationAgent is similar to the OrganizationManager, but is only responsible for controlling the suborganizationn, and can communicate with the OrganizationManager if needed. If another suborganization is created hierarchically within the previous suborganization, it will include a separate OrganizationAgent that communicates with the OrganizationAgent from the parent organization. These agents are distributed hierarchically in order to free the OrganizationManager of tasks. This allows each OrganizationAgent to be responsible for a suborganization although, to a certain extent, the OrganizationManager can always access information from all of the organizations. Each agent belongs to one suborganization and can only communicate with the OrganizationAgent from its own organization; this makes it possible to include large suborganizational structures without overloading the AgentManager. All of the OrganizationAgents from the same level can communicate with each other, unless a specific standard is created to prevent this.

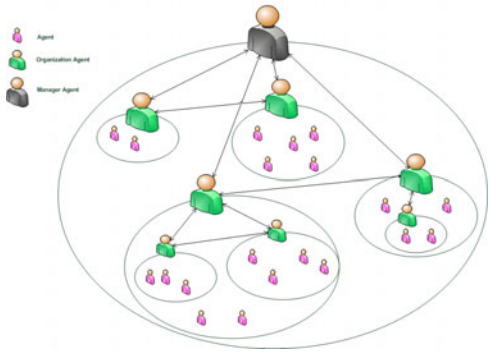

Fig. 3 OrganizationManager and OrganizationAgents

3.1 Communication Platform

This section will focus on describing the communication platform and protocol. As observed in Figure x, the communication platform includes two main agents: the CommunciationAgent and the Sniffer. The first is in charge of checking the

connections to confirm that the agents are online and see which ones have disconnected. It is also in continual communication with the NormAgent to ensure that the agents respect the lines of communication and comply with the standards. The Sniffer is in charge of recording all communication, offers services so that other agents can obtain history information, and facilitates the control of information flow for programmers and users.

The IRC protocol was used to implement communication. Internet Relay Chat (IRC) is a real time internet protocol for simultaneous text messaging or conferencing. This protocol is regulated by 5 standards: RFC1459 [25], RFC2810 [29], RFC2811 [28], RFC2812 [26] y RFC2813 [27]. It is designed primarily for group conversations in discussion forums and channel calls, but also allows private messaging for one on one communications, and data transfers, including file exchanges [25]. The protocol in the OSI model is located on the application layer and uses TCP or alternatively TLS [29]. An IRC server can connect with other IRC servers to expand the user network. Users access the IRC networks by connecting a client to a server. There have been many implementations of clients, including mIRC or XChat. The original protocol is based on flat text (although it was subsequently expanded), and used TCP port 6667 as its primary port, or other nearby ports (for example TCP ports 6660-6669, 7000) [26]. The standard structure for an IRC server network is a tree configuration. The messages are routed only through those nodes that are strictly necessary; however, the network status is sent to all servers. When a message must be sent to multiple recipients, it is sent similar to a multidiffusion; that is, each message is sent to a network link only once [29]. This is a strong point in its favor compared to the no-multicast protocols such as SimpleMail Transfer Protocol (SMTP) or the Extensible Messaging and Presence Protocol (XMPP).

One of the most important features that characterize the platform is the use of the IRC protocol for communication among agents. This allows for the use of a protocol that is easy to implement, flexible and robust. The open standard protocol enables its continuous evolution. There are also IRC clients for all operating systems, including mobile devices.

All messages include the following format: prefix command command-parameters\r\n. The prefix may be optional in some messages, and required only for entering messages; the command is one of the originals from the IRC standard.

The following diagram illustrates the message flow required for an agent to enter an organization. These messages use the command PRIVMSG followed by the parameters indicated by the arrows in the diagram.

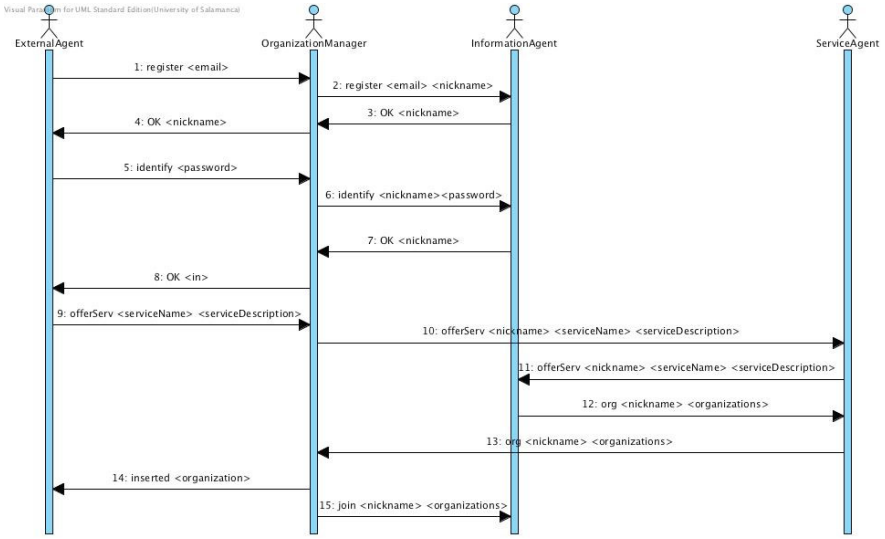

Fig. 4 Sequence of steps for an agent to enter an organization

4 Case Study and Results

The platform we have developed can create a general type of organization, and includes the possibility of creating open and highly dynamic systems. In order to test the architecture, a case study was prepared to simulate a working environment. Four organizations were created to simulate four different departments within a company: accounting (composed of 4 accounting agents, one manager and 2 secretaries); quality control (composed of 2 evaluating agents and two training specialist agents); technical services (composed of 6 technical agents); and customer service (composed of 8 telephonist agents). According to the role of each agent, there are specific services offered that allow them to resolve the queries they receive. In one possible case, the client agent contacts the telephonist agent, which simply receives the requests and redirects it to the agent qualified to resolve the request. The telephonist agent extracts the key words from the message sent by the client and contacts the Services Agent to determine which agent can address the required service. If the message contains the keyword “invoice”, the query will be handled by the Accounting agent; if the keyword is “switch on” it will be handled by the Technical agent. Once the client is in contact with the appropriate agent, the agent can communicate with other agents in its organization to carry out the task.

Four 30-minute simulations were performed with 20 different types of requests randomly provided. Studying the Evaluation and Sniffer agents it was possible to study how both the simulation and message flow unfolded. Focusing specifically on the Sniffer, it is possible obtain summary charts and diagrams, and specific numbers. Once the query is made, the Sniffer consults the database, filters the data and returns a URL that displays the desired data.

It is possible to obtain the number of each type of message that a specific agent has received. Each message includes a tag that identifies the type of message, which makes it possible to filter information.

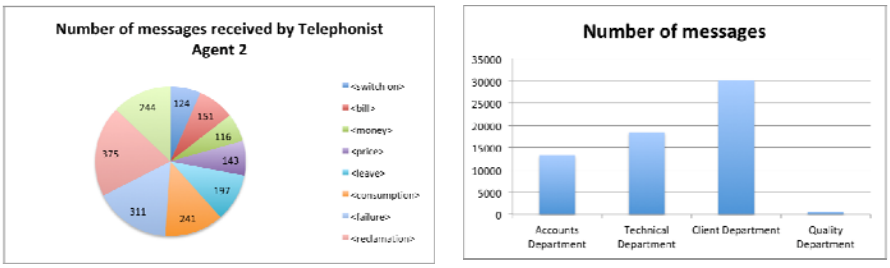

Fig. 5 Diagramas of messages.

It is also possible to obtain a diagram of messages according to organization instead of agents. Using the message identifier, it is also possible to see which agents processed a given request; using the Evaluation agents we can determine the number of requests processed by each agent.

We can conclude that the architecture we are developing has great potential to create open systems, and more specifically, virtual agent organizations. This architecture includes various tools that make it easy for the end user to create, manage and control these systems. One of the greatest advantages of this system is the communication platform that, by using the IRC standard, offers a robust and widely tested system that can handle a large number of connections, and that additionally facilitates the implementation for other potential extensions. Furthermore, the use of the Communication and Sniffer agents, offers services that can be easily invoked to study and extract message information.

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