Emergency Web App for Accessing the Medical Emergency Services

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***Abstract*-Nowadays, accessing emergency services and customer healthcare, in Spain, is done only by traditional phone calls to the number 061. In order to facilitate interaction between the emergency users and the emergency service system, we are improving and expanding new channels of personal communication. Given that the use of smart mobile devices is widespread in our society, we are developing a mobile application for emergency management, providing the same assistance as phone calls and adding some brand new features. We have developed requirements design and a functional specification of our new mobile application aimed at improving user interaction with the traditional emergency systems. The functionalities of the Web application are focused on providing a direct communication service, complete and effective, allowing quick and accurate intervention of the emergency services. Our purpose is to define a platform fully accessible to all users, regardless of their language and/or technological knowledge. Thus, the focus of this paper is mainly devoted to explain how to extend traditional applications based on emergency phone calls, to modern mobile applications considering not only web technologies, but also social networking behavior.**

Keywords-Healthcare Emergency System; User Interaction; Mobile Devices; Web Applications.

I. INTRODUCTION

Before the decision of the European Union (EU), in 1991, to have a single phone number for European emergency calls, accessing healthcare emergencies and medical urgencies is Spain was performed by dialing 061. The EU decision, legislated in Directive 91/396/EEC of the Council of the International Association of Emergency Managers (IAEM) Spain from July 29, 1991, defined the dialing number 112 for these European emergency calls and added, in cases where it is considered appropriate, this number will be introduced in parallel with any other emergency number that existed before.

The Medical Emergency Services (SEMs for its acronym in Spain) belong to any public health system integrally. Its main function is to provide medical care in all emergency situations, including disasters. Medical emergencies have two main assistance scopes: hospitable, through emergency services of the hospitals; and extra-hospitable, which can integrate different resources and types of assistance depending on the health model of the country in terms of integration or not integration of specialized primary assistance into a single health service and the type of the provision of services.

Therefore, extra-hospitable emergency health services are defined like a functional organization that performs a set of sequential human and material activities with fixed and mobile devices, with appropriate resources, coordinated, initiated from the moment in which the medical emergency is found. Thus, after consideration of the needs, it is assigned a response without mobilizing any resource or moves their devices to act in situ, perform medical transport if necessary and transfer the patient to the appropriate facility for definitive treatment.

The protocol of Emergencies Service and Medical Emergencies indicates that the incident or accident and the corresponding emergency assistance are done in a different intervention chain, as it is shown in Figure 1. Thus, the first people to intervene may be the patient, witness or designated first responders (firemen, police). This is the weakest link, as a few Spanish citizens are trained in first aid. Neither the personal of some services and institutions which expected higher occurrence of people or a greater probability of emergency are trained in these first aids. However, this reality increases the results in terms of survival, as witnesses and first involved people apply basic life support and defibrillation, while the first health equipment arrives, remain essential for the survival in cardiac arrest cases. The second link is a call initiation done by the first involved people through 112 or 061, and received by the Coordination Center, which serves the emergency phone, and according to its characteristics or severity, it is decided to follow action: resolution of the phone call, resource mobilization, or referral of the patient on their own to a given health center. So, as third link, the Coordination Center has the quest to obtain the appropriate resources for appropriate patients in appropriate timeframes.

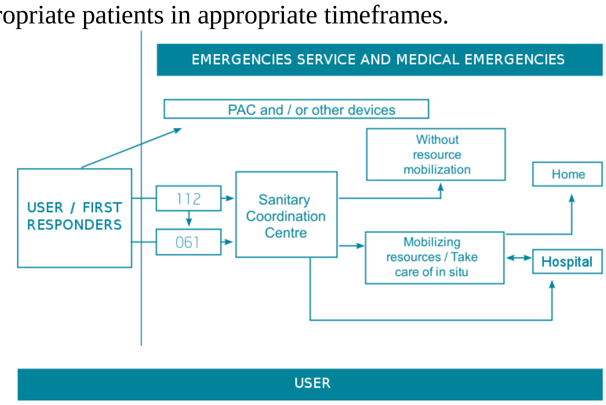

Fig. 1 Emergency Service Flowchart [1]

Early care services, transportation services and hospital emergency are not the scope of this paper. Within this response chain, the appropriate Emergency Services chain begins with the receipt to the call at the Coordination Center for following coordination of no health emergency devices.

In the specific area of the Autonomous Community of the Balearic Islands, where our university is also located, SAMU 061 (Emergency Medical Service 061) is a public Emergency Medical Service under the Health Service of the Balearic Islands that has the responsibility for healthcare emergencies and outpatient emergency in the territory of the islands [2]. Nowadays, the user who needs to access SAMU services should make a phone call by dialing 061 (link 2), based on the Protocol of Emergencies Service and Medical Emergencies described before, which will be run by an operator (link 3) who will manage the incidence and will organize the needed resources based on the information described by the user, as detailed above.

Such an approach would generate a list of services focused on assessing and responding to any emergency; thus, our new *Emergency Web Application* includes, among other features, the following functions: collecting user's personal data, emergency registration through a set of questions and emergency registration in state of panic, with the aim to improve the first customer assistance. In terms of interactivity, it will also be essential to make a detailed study of user in with the platform. Our purpose is to define a platform fully accessible to all users, regardless of their language and/or technological knowledge.

The paper is structured as follows: in Section II, research and implemented development related to this work is depicted. In Section III, the current technological environment of SAMU for the control and management of emergencies is overviewed. Section IV will present the solution we designed to provide new channels of communication between the user and SAMU. We conclude with some final comments and open problems in Section V and final observations in Section VI.

II. Related Work

Several functionalities have been studied and designed to improve access to healthcare emergency assistance and medical emergencies, so that they generate social benefit of these services and content, in particular to improve the interaction between the healthcare emergency system and their users. In fact, Alcalde [3] already anticipated the trend of access not only by telephone, but also through social networking, IP telephony, messaging and mobile applications, as well as video and image distribution. The authors propose new VoIP phone technologies and flexible architecture between different emergency centers.

The Fire Department at San Ramon Valley (California, U.S.A.) has developed an application that offers continued connection with 911 emergencies service by mobile phone [4]. The application takes advantage of their phone location, so that users that indicated they have been trained in Cardiopulmonary Resuscitation (CPR) and would be willing to help in an emergency can be messaged to do it. Therefore, the 911 dispatch center receiving a call for an emergency that is occurring near the trained user, will send a notification telling his/her help is needed in the surrounding area.

Other researchers from University of Texas [5] reveal next-generation emergency response technology related to mobile phones. Specifically, the smartphones can be placed directly on the chest to monitor breathing, heart rate, blood pressure and transmit this information directly to the operator of the call.

Besides, previous introduction to the study of user interaction is explained by Gómez and Juiz [6]; we explained the importance of adding a new channel of communication between emergency services and the user. Similar to the Fire Department App, the application communicates with the user via the mobile device (Fire App by notifications, our app by chat). Our application also intends to use a system similar to his personal data record. On the contrary, they have already integrated the location by GPS; however we will incorporate it in the future.

These are only a few examples from an increasing application list [7] that could include "SOS First Aid", "PocketCPR", "iRescue", among others, all of them taking advantage of social impact of mobile devices and trying to improve healthcare.

III. Technological Scope: The SENECA Platform

SAMU061 uses the product for emergency management services developed by Telefónica [8], known as SENECA platform.

Telefónica is an integrated operator of telecommunications, leader in Spain. Its activity is basically focused on fixed and mobile telephony business. However, in terms of health, Telefónica has been betting strongly for the development of innovative services in eHealth and telecare areas, especially for the elderly and patients with chronic diseases. It is important to add that Telefónica is a European Emergency Number Association (EENA) Advisory Board Member. EENA is a Brussels-based NGO set up in 1999 dedicated to promoting high-quality emergency services reached by the number 112 throughout the EU. So, Telefónica has registered its SENECA platform in EENA, supporting, giving and sharing eHealth solutions.

Specifically, SENECA is suite that includes four operational products available in the *SENECA Emergency Suite* (SES). SAMU 061 works through the second one, i.e. SENECA Health. The technological infrastructure of the whole SENECA platform is based on market standards and industry. They integrate in the process of implementation of Emergency Centers helping their customers in issues like operations analysis based on service needs and the current situation, definition and planning of change management activities, cooperation with the agencies, in an effort to stipulate protocol and methodology and management of the complete incident cycle, taking into account citizens, management operatives or intervention.

SENECA Platform includes a client-server architecture for Local Area Network (LAN) used by the management database server processes to communicate with incidences users. The operating environment of the SENECA shown in Figure 2 is based, in general terms, on the sharing of a common database between communications processes, management (CAD), geographic information systems (GIS) and its corresponding exploitation.

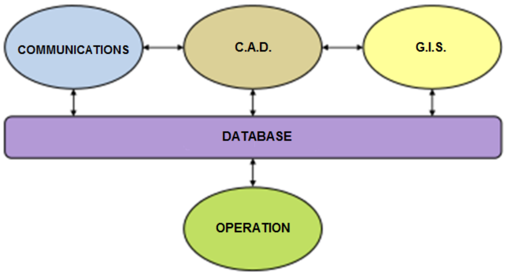

Fig. 2 SENECA Platform Data Base [9]

In terms of system, SENECA provides an integration of communications services and incident management based on a design addressed to the user. It provides an operator interface that clearly presents all necessary information and simplifying the decision-making for trained operators at call centers.

A. General Description

The SENECA emergency platform is comprised of a series of functional modules which can be divided into two groups:

Core Services [9]: Among its features are the following: voice integration, mapping information system, demand management (attention, location, dispatch, monitoring), basic alarm system, asynchronous event distribution bus, and storage of configuration data. The Core is also comprised of the following modules:

- Data Base: SENECA Data Base is based in the Oracle 10G R2 Data Base Management System. The data base stores information about SENECA Platform configuration, Business Data, Mapping Information, and system register messages.
- PABX: Private Automatic Branch Exchange is the voice commutation central used by the telephony system. It is possible to integrate itself with different manufacturers, included those based in VoIP technology.
- ACD: Automatic Call Distributor is a device that automatically distributes calls that access the PABX among agents.
- CTI: Computer Telephony Integration intended for interaction between a telephone call and actions taken by a computer system in an integrated and coordinated way.

Client modules: Contain functionalities of management and dispatching, where one can find the platform modules residing in the operating positions thereof. These are the graphic interface modules, which provide the functionality to users, and background modules serving the core.

- COMS: Communication Window that provides communication services of the operating station platform while maintaining control of telephony, phonebook, radios management, and recorders.
- GIS–Maps: Cartographic Viewer and positioning.
- CADM: Care and Dispatch Window, incidents control, authority and resources.
- COSE: Tracking Window of several information such as call letters, files, resources, information search, operator-definable filters, refreshment in real-time through the distribution bus events, among others.

B. Additional Modules

SENECA Platform has several additional modules related to Core Services and Client modules. Although they are not strictly necessary for its use in relation to management emergencies, it does offer a number of features and benefits to support the management mentioned. Thus, one can find:

- Mobile location: responsible for determining the position of the mobile phone calling to the emergency center that is managed and stored by the platform.
- Dispatching and integration of emergency calls made by deaf people is also provided.
- Integration with radio communication solutions.

C. Operating Environment

SENECA Platform is mainly aimed at emergency and medical emergencies centers, among which are 112 Coordination Centers, Health Care and Emergency Medical Services, Fire Corps and Rescue Services, Police Forces and Security Services and Civil Protection.

Telefónica leads the Spanish Emergency Centers, specifically 112 Coordination Centers in nine communities, as well as Health Care Services in six of them. In terms of safety, National Policy Force belonging to Ministry of the Interior, and Civil Guard are also lead.

IV. Emergency Web App

To improve the interaction between the user and the emergency center, we integrate a new communication channel taking advantage of the increased use of mobile devices accessing to the Internet. Our proposed solution consists on a cross-platform web application, easily adaptable to any mobile, and multi-language, making it accessible to all users, regardless of their technical knowledge and/or language. This last feature is really a requirement in several territories in Spain, e.g. the Balearic Islands, due to the huge number of foreign visitors per year. According to the Tourism Strategy Institute (INESTUR), in the Balearic Islands on 2009, shown in Table 1, more than 11.5 million tourists visited the islands through aerial and maritime ways, which means a special careful interest in the diversity of the idiom.

TABLE I. Foreign visitors per year

	Foreign	Spanish	Total
Aerial way	8.917.460	2.311.535	11.228.995
Maritime way	62.526	317.641	380.167
Total Balearic Islands	8.979.986	2.629.176	11.609.162

Thus, we have prioritized the multi-language feature and designed our application such that, once started, the application requests the language in which you want to be attended to.

Following, there is a form to fill a small number of fields about the user's personal data such as your name, address, telephone number, and more. This is followed by triage questionnaire to determine the type of emergency that the user suffers. Finally, the user gets in touch with an operator through chat system, or if the severity level requires it, it starts communicating via traditional phone call.

In technological terms, the mobile web application is developed in two main blocks: Graphical User Interface (GUI) Module and SENECA Integration Module.

A. GUI Module

In the Web Application GUI, the user interaction has been developed by Sencha Architect [10], the HTML5 visual app builder. Sencha has a code editor that guides to build any application using Model View Controller (MVC), thus both components that represent information and components that interact with user are easily identifiable, improving the development and subsequent maintenance.

Sencha Architect is mainly based on JavaScript language, and the visual part is edited with HTML5 and Cascading Style Sheets (CSS) to make it more attractive. One might add that configuration of visualization files, event files or data model files are structured following the JSON (JavaScript Object Notation) [11] syntax. However, developers may use their own IDE because there are no file dependencies, and Architect produces regular JavaScript files that can be edited with any IDE.

The GUI Module is structured according to MVC. In the Models information, the language model, the user data model and the triage model with relevant variables are included. To access these latest models, Sencha configuration Stores are accessed through a Proxy Ajax that contains the structure of the models described in Json files. In Views information, the application *Emergency Web App* is divided in several panels. The main TabPanel welcomes the user to the application and the language requested by a Select field. With the Tab Bar, it is possible to change to the form which asks for data to the user. Once this information is sent via Submit button, the user accesses the second form, where triage is performed based on the emergency class. After that, the application gives access to chat. The controller section is made from SENECA Integration Module.

B. SENECA Integration Module

We have used Service Oriented Architecture (SOA) [12] to establish the communication between our Web App and SENECA Emergency system. SOA is a software design and software architecture design pattern based on discrete pieces of software providing application functionality as services to other applications. To communicate, these services are based on a formal definition with platform and programming language independence. The definition of the interface [12] encapsulates the characteristics of an implementation, making it independent of the manufacturer, the programming language or the technology development. With this architecture, it is intended that developed software components are very reusable because the interface is defined according to a standard, so a C# service could be used by a Java application. In this sense, Mascaró defines SOA as a Super-abstraction [13].

One of the greatest economic and technological problems of the applications is scalability, either the ability to react and adapt without losing quality, or to be prepared to get bigger without losing quality in the offered services. SOA ensures the scalability thanks to its easy assembly of several systems which facilitates the interaction between different own systems or third parties. SOA is like a producer-consumer system based in services and messages, where there is almost a server provider, a consumer and a service repository.

As one can see in Figure 3, the service is a single and independent logical piece of a business process, integrated inside of the service, and interacts with the external world using an interface. Each service can have its own logic business rules easily accessible and modifiable at any time. The server provider starts when someone invokes the service. It drives the business logic and sends a response if it is necessary. Therefore, the service consumer sends a message to the provider to access the service.

SOA lets us develope global systems that interact with each individual business system. In fact, each system is a Web Service integrated in the WWW. In this case, SENECA Telefónica has created the Global System and the Emergency Web App is an individual system that interacts with Global, both being Web Services.

Web Services is a technology that uses a set of protocols and standards used for exchanging data between applications. Different software applications developed in different programming languages and executed on any platform, can use web services to exchange data. Interoperability is achieved by adopting open standards. OASIS (Organization for the Advancement of Structured Information Standards) and W3C (World Wide Web Consortium) organizations are the responsible committees for the Web Services architecture and regulation. Thus, Web services allow software and services from different companies located in different geographic locations can be easily combined to provide integrated services. Thanks to the great independence between the application that uses the Web Service and the service itself, changes in one of them over time should not affect the other, as long as the established agreements are maintained in the protocol.

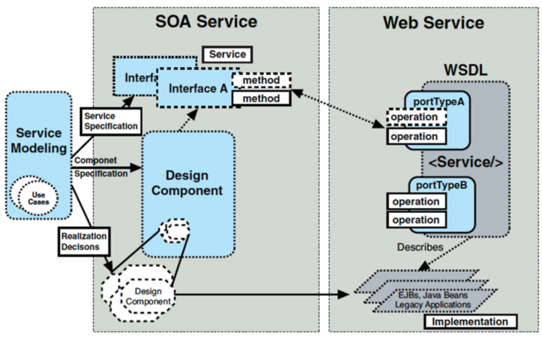

Fig. 3 SOA & Web Services [13]

The information exchanged between services is performed using messages. In our case the standard protocol to send these messages is SOAP (Simple Object Access Protocol) and the description format is WSDL (Web Services Description Language) format.

SOAP [14] is an XML based protocol for exchanging structured information in the implementation of Web Services in computer networks. SOAP offers a basic messaging framework upon which web services can be built. This protocol consists of three parts: an envelope, which defines what the message contains and how to process it, a set of encoding rules for expressing instances of data types, and a convention for representing procedure calls and responses. SOAP protocol has three main features: extensibility, neutrality, as SOAP can be used over any transport protocol, such as HTML, SMTP, TCP or JMS, and independency, because SOAP supports any programming model.

WSDL is an XML [15] which is used for describing Web services. WSDL describes how communication, i.e. the requirements of the protocol and message formats required to interact with the services listed in its catalog. Operations and messages supported are described abstractly and linked to concrete network protocol and message format.

The client program (our *Emergency Web App*) that connects to the Global Web service, can read the WSDL to determine what functions are available on the server. The special data types are included in the WSDL file in the form of XML Schema. The client uses SOAP to make the call to one of the functions listed in the WSDL. The WSDL gives us a description of a web service. Specifies the abstract interface through which a customer can access the service and the details of how to use.

The structure of any WSDL file always contains at least the tags *type* that defines the data type used by the Web Service, *message* for the type of messages, *portType* which includes the type of messages that define a communication, *binding* to see how the Web Service is implemented with SOAP, and *service* that indicates the Web Service location.

In the Emergency App, WSDL is used in several key roles. One of them indicates the logging mode to the Global Web service. The request asks user name and password in the format specified in the WSDL and the response returns the token logged. This information is required to the application, not to the user, to give it access to the Global Web service. By this token, Emergency App can access all functions provided by the Global Web services. The number and language format is also set by a WSDL, as well as the fields required to obtain user data and triage in emergency basis. The token must be included in all of the mentioned functions. When user changes the language, the whole application is reflected in the selected language. Global Web service is responsible for providing access and support to the chat service, once required fields are correctly filled in and sent. Another WSDL-based application closes the session thus releasing the token.

The selected technology to perform this SENECA Integration Module was Java through NetBeans IDE [16]. The integrated development environment has several complements that easily automate the consumer client creation. NetBeans interprets WSDL files; both in local and remote place, getting necessary functions and data types for generate objects and Java classes accessing the consumer server. Automatically generation of code based on WSDL interpretation gives as a result two objects and a service class, among others. Objects represent the requested message and the response message. At the beginning of the object one can see a WSDL fragment in XML according to the expected values. Service class encapsulates the messages, receives and sends it and shares information between those and Java objects. Thus, application is structured in a simple and easy way.

C. GUI Module next to SENECA Integration Module

Module GUI has been easily integrated in SENECA Integration Module on a single IDE, also NetBeans, which generates Web Service client that communicates with the Global Service. As we have mentioned before, Sencha has not any file dependence, so we only had to import this JavaScript files and JSON files that contain the data model. The response of the server, in JSON format, has been processed by a data treatment function, thus GUI Module can represent language and required camps of the questionnaire.

It is not the intention of the authors of this paper to describe the details of the Global Service, in parallel developed by Telefónica Sevilla Development Group. Therefore, the interoperability of both blocks with the SENECA platform is guaranteed regardless of language, platform and configuration.

V. RESULTS

Emergency Web App is a mobile application, even though its name induces confusion. We decided to use HTML5 in the development of this project to be independent of any platform (Android, IOS, WPhone, and Blackberry). We evaluated the use of Google GWT or some derivate (GXT, SmartGWT) that allow traditional Java programming, but the result of the compilation would have been an AJAX web application.

As a second option, we could write HTML5 code directly using some sort of framework or JavaScript framework. At this point, we evaluate two possible ways: jQuery Mobile, compatible with several devices and a powerful visual editor that facilitates development in HTML5; and Sencha Touch 2, developed by the same group as GXT Library, fully oriented to mobile devices.

At this point, we can say that the final choice was to use Sencha Touch 2 for the development of the client. As described above, Sencha has a programming environment, very comfortable and complete, known as Architect. Also, because it is practically based on HTML5, Sencha not only ensures the independence of the mobile device that the user could use, but, in fact, the application is accessible from any web browser. Hence, the final name has been chosen to be *Emergency Web App*.

The final result of the application, in terms of the graphics, has been extremely positive. Being based on JavaScript, integration with Web Service has been direct and without mishaps. In addition, the display emulates any mobile device, using a similar complements, whether buttons, bars, selectors and even sliding screen even visible from the web browser.

The left side of Figure 4 shows the running application emulating a web browser on an iPhone. Therein welcomes the application allowing modifying the language from the selector below. It starts in Spanish by default (Telefónica is who provides us the languages). By the bottom menu of the application, one can access the form that the user must complete before allowing access to chat. It lists the required fields to be filled. Once completed, the user does not have to re-fill again. Personal data will be registered for future access to the platform. As one can see in the right side of Figure 4, the sliding screen maintains the same visual effect when performing it with one's finger on a touch screen of the latest mobile. The graphical interface is not bounded to a specific size, but, on the contrary, is adapted to the size of the device that has been executed, so that it keeps its visual appeal whether it is a small mobile device, as if is in a tablet, a laptop or a personal computer.

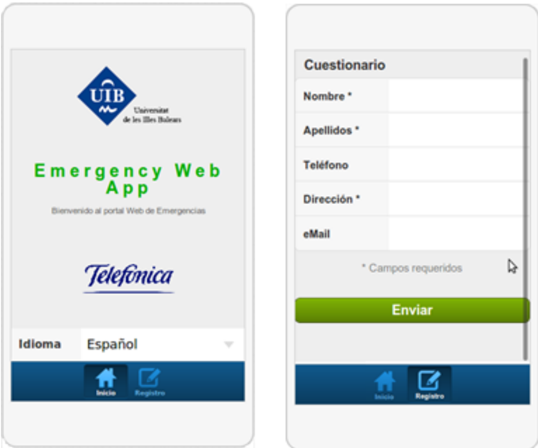

Fig. 4 Welcome to the application [6]

Regarding integration modules with Seneca Platform, creating a Web Server Client was the best option considering parallel work in specific modules would perform with Telefónica Technology Department in Sevilla. Apart from that, this application is an integrated module in the Platform Seneca, an existing service, functional, and for this project, unknown and without needing to know in depth its functionalities. Therefore, we can say that the two features that should meet *Emergency Web App* about multiplatform and multi-language have been successfully achieved.

VI. Conclusion and Future Work

According to the conclusions of the round table "Apps health, are we ready?" [17], it is expected that the number of mobile medical Apps and users that use them, are going to increase exponentially over the next two years. This conclusions stressed the importance of offering creative solutions adapted to the needs of users as patients are willing to pay for Apps "useful and effective" for the benefit of their health. On this basis, it is estimated that, in two years, there will be over 500 million people using medical Apps from mobile.

These expectation figures show the positive reception of the Apps related to medical emergencies by users. Even Telefónica company wishes to initiate and integrate communication through fax, SMS and internet/email and our work is to include this new functionalities in the Emergency Services chain.

The collection and storage of personal information of the caller is a valuable feature because of the possibility of making mistakes due to the poor quality of the call or the caller's state of nervousness or panicking. Through Emergency App, the time for obtaining user data is reduced because he completes the questionnaire in addition to the exact location of the emergency. If it is necessary to access the chat, according to the severity of the emergency determined by the triage, it must have the same priority as common call which ensures real-time attention.

In this paper, we briefly explained our development project in Cátedra Telefónica – UIB, which is not only for business interest based on a new product to offer through SENECA platform, but also for emergency systems, government entities and especially users want ease of access and communication in an area, where time reducing performance, reliability and security are vital in healthcare emergencies and medical emergencies.

VII. Acknowledgment

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