ME: Multimodal Environment Based on Web Services Architecture

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Abstract. Information, documents and knowledge for each person and for public and private organizations are fundamental in each activity, and they may be the products or services they provide or supply. The daily activities and decision-making processes are usually based on many different pieces of information, which could be handled on PDAs and mobile devices in general, or stored on laptop computers using a lot of different forms, such as spreadsheets, e-mail messages, Web information obtained as the result of a Google search or a query, and so on. Simulating and managing services and information in catastrophic events and emergencies does not represent an exception. This paper describes the Web Services architecture of the Multimodal collaborative knowledge oriented Environment (ME), a platform designed to manage data, information and services for catastrophic events such as earthquakes, floods and dangerous natural phenomena.

Keywords: Web Service architecture, Multimodal interaction, disaster management.

1 Introduction

ICT pervasiveness in daily activities, the wide use of tools such as mobile devices, and the achievement of Web 2.0 technologies is stimulating new perspectives opening new and wider boundaries for Web Services, and defining distributed architectures.

In particular, the use of the Web distributed architecture and natural communication process by multimodal interaction improve the people accessibility and fruition of services. Everything becomes a Web Service: information, data, multimodal interaction; all these aspects are managed as an XML flow that implements the interoperability between different resources.

This paper presents the Web Services architecture of the Multimodal collaborative knowledge-oriented Environment (ME), a platform devoted to manage data, information and services for catastrophic events, such as earthquakes, floods, and so on. In fact, in a catastrophic situation, information and data collected by the observatories and operation rooms of the civil protection and the land officies, about

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building designs, building permits, and emergency plans can be necessary for preventing and promptly react to this catastrophic situations. In catastrophic events such as earthquakes, managing data contained in contingency and town plans requires scientific data related to the history of seismic events in the interested area, and geographic data should be involved. These data can be texts, numeric data, visual information, and so on. Contingency plans, for example, usually contain text and images. Speech or videos are generally preferred for tutorial purpose. In this scenario ICT can define a new manner for managing catastrophic events also using virtual social networks potentialities to improve people awareness on problems and solutions about these events and to promote cooperation among experts. Therefore according to the multiform data, information and services features and modalities used for their I/O they usually involve more than one transmission channel. For these reasons the ME software platform takes into account of the different types of information, their sources, the different situations, locations and times. The ME platform is the answer to the need of an interoperable and distributed software application that uses a Web Service architecture. Web Services technology is based upon the principle of distributed systems and its components communicate with each other only by passing messages (generally represented by XML files). A component may be a program execution on a computer or a device, such as a computer, a printer, and so on.

The architecture adopted for ME platform is particularly useful in the situation of catastrophic events because its distributed nature permits to work using different devices everywhere and every time with mobile devices as well as computers allowing multimodal input and output management.

The remainder of the paper is organised as follows. Section 2 is described the role of mobile Web services in catastrophic events giving some basic notions of Web service architecture and Service Oriented Architecture. In section 3 the architecture of the Multimodal collaborative environment ME is presented. Section 4 gives some examples of application of the ME environment in catastrophic events. Finally section 5 concludes the paper.

2 The Role of Mobile Web Services in Catastrophic Events

Effective prevention and assistance coordination for catastrophic events are crucial aspects, as they involve many organizations and people. Indeed, they need to coordinate their organizational efforts to prevent a disaster, reduce the probability of a disaster happening, or reduce the damages of unavoidable disasters.

The problem of providing real time information services has been widely discussed in the literature. De Rubeis et al. in their work [1] describe a questionnaire defined at the "Istituto Nazionale di Geofisica e Vulcanologia (INGV) since June 2007" that was addressed by Internet to no specialist people in order to evaluate seismic effects as felt by them. Gilles Mazet-Roux et al. in their work [2] describe QWIDS (Quake Watch Information Distribution System); this system allows a quick and robust data exchange using permanent TCP connections. QWIDS is based on a client-server technology in which the information published by the server is immediately pushed (via CORBA methods), using XML files. Rubbia et al. in [3] describe the experience of using the website for the Colfiorito earthquake of 1997 as a tool for the dissemination of technical and scientific information for public bodies and research centres. The authors underlined how this website "had the merit of diffusing, elaborating and interpretating data in (nearly) real time for an event of great scientific, and also social, relevance, for the world of research and, more in general, for the public of the Internet."

The development of social software, social networks and mobile technologies is opening new fronteers in the production and delivering of information and data when catastrophic events such as earthquakes happen. People can actively participate and can be actively involved in these processes. ICT tools are useful in catastrophic situations, as demonstrated in the experiment carried out and described in [4], where "the difference between the communications based on paper or electronic forms, as well as the impact of numbers and states of victims and numbers of rescuers" are highlighted. In particular, the authors propose an agent-based computer simulation approach for designing rescue collaborative plans.

A Service Oriented Architecture that ensures interoperability, supporting a variety of data for health care emergency from disparate systems was proposed in the AID-N project [5], where different tools interact using Web Services. Similarly, the ME architecture proposed in the next section of this paper is a Web Service architecture. Before describing it in section 3, some notions about Service-Oriented Architectures and Web Service architecture are given.

Service-Oriented Architectures (SOAs) implemented with Web Services are available at any time, in any place, and on any platform. Web Services indicate a new type of Web applications that cooperate exchanging messages with each other independently from the platform. The Web Services Architecture Working Group (W3C) defines a Web Service as: "a software system designed to support interoperable machine-to-machine interaction over a network. It had an interface described in a machine processable format (specifically WSDL). Other systems interact with the Web Service in a manner prescribed its prescription using SOAP messages, typically conveyed using HTTP with an XML serialization in conjunction with other Web related standards" [6].

Technologies on which Web Services are based, just mentioned in the definition, are:

- XML, eXtensible Markup Language [7]
- SOAP, Simple Object Access Protocol [8]
- WSDL, Web Services Description Language [9]
- UDDI, Universal Description, Discovery and Integration [10]

The use of these technologies and other standards enables Web Services communication and cooperation by means of the Web.

UDDI (Universal Description, Discovery and Integration) is a service of public registry where it is possible to register services that in SOA architectures are contained in the Service Registry.

Web Services use UDDI in order to implement the Service Registry, publishing and searching for Web Services. It maintains information on services such as URL and the manner to access. Even UDDI is a Web Service. This allows the implementation of a system using a Service-Oriented Architecture. Figure 1 shows the schema (classification) of the functioning of a system with SOA architecture based on Web Services.

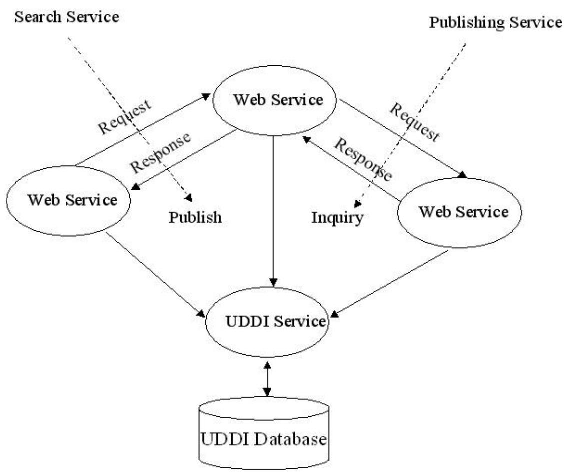

Fig. 1. Web Services functioning

In particular, the use of a Web Service architecture with mobile devices represents a very interesting opportunity but, at the same time, it can have several drawbacks. First of all the intermittent connectivity to the network needs supplying services when they become available. Secondly, messages need to be adapted to the device and the transmission features.

The Web Service message protocol SOAP supports Web Services on limited devices, providing a Web Service engine with run-time call de-serialization.

In [11], the JXTA open framework, which enables Web Service sharing in peer-to-peer networks is presented. It provides a peer-to-peer protocol that allows smart-phones, PDAs, PCs and servers to communicate and collaborate seamlessly in a highly decentralized manner. The SOAP protocol has been adopted in the ME Web Service architecture too.

3 The ME Architecture

The architecture of a natural and easy-to-use Web-based system, the ME system, devoted to manage data, information and services for catastrophic events is presented, considering the multimodal interaction as a Web service.

The purpose of the service network is providing people with information from different information sources and solving problems arising in different situations. The system allows people to interact multimodally; it is based on an architecture that promotes a collaborative approach for sharing data, information and services during catastrophic events; it can be available at any time, in any place, and on any platform. A Service-Oriented Architecture (SOAs) implemented with a Web Service approach is characterised by these features.

Web Services, as described in section2, are software systems designed to support interoperable machine-to-machine interaction over a network using a set of XML-based open standards. Information, data and multimodal interaction too, are all conceived as Web services.

The multimodal interface is a Web service, which exchanges multimodal messages (speech, sketch, handwriting, point, context) and sends its request to other Web Service applications (for example *Emergency plan application, Social networking application, Operation room application, Plans definition applications*, and so on) and receives their response. The aim is to make easier information and services knowledge sharing in crisis scenarios using Web Services. Each thing is a Web Service, the multimodal interaction management, the plan definition, the emergency plan application, the social networking application, and so on. They are seen as asynchronous messages that exchange XML documents across a network. Web Services are also responsible for mapping the XML documents into and out of executable programs, objects, databases, and applications. When a person uses the "Multimodal interaction management services application" it sends its request to another Web Service among the "Emergency plan application", "Social Networking application" or any other Web service, as shown in Figure 2, and it receives a response by XML files. Inquiry and publishing services are managed by UDDI.

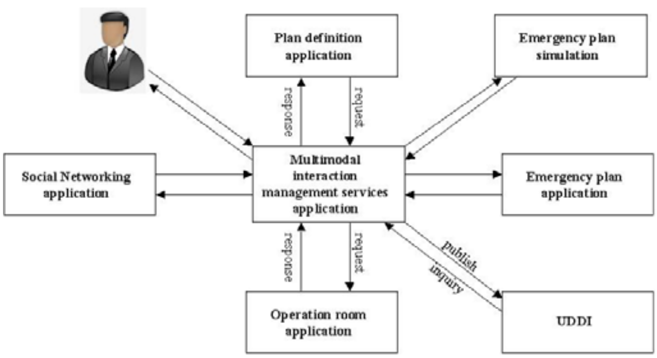

Fig. 2. ME Web Service architecture

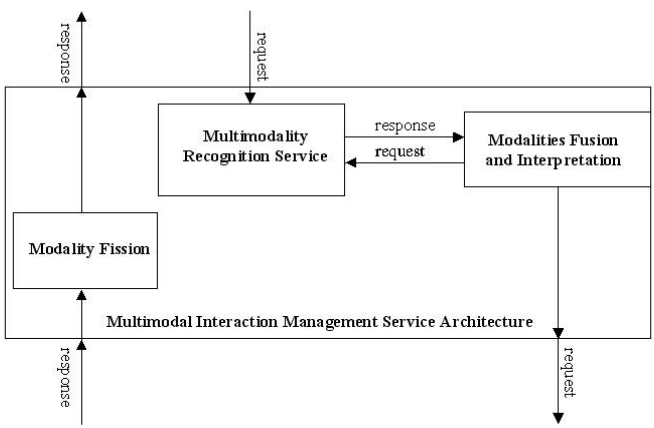

Fig. 3. Multimodal interaction management service architecture

Multimodal interaction is particularly important for managing emergency and catastrophic events, and it is a critical aspect when using mobile devices. It can be considered as a Web Services architecture in a SOA perspective.

In particular, according to this general architecture the “Multimodal interaction management services application” (Figure 2) is a Web Services application that manages the multimodal interaction independently from the used device. Multimodal interaction management services application, once interpreted the multimodal input, requires Web Services, which require multimodal output produced according to the required service.

Let us suppose John, after an earthquakes needs to know the less dangerous locations where going with his family; for this reason he is inerested in knowing paths that is possible to cover to reach that locations, not interrupted by debris. His house is deeply damaged and all his digital devices, with the exception for his mobile phone, have been destroyed. He can connect himself with other people using social networks and with civil protection services using his mobile phone. He can send his request of information using voice and sketch and he obtains a visual answer returning a map of the area of interest showing the path and locations John can reach with his relatives.

When John sends his request, an XML file for each input channel is sent to the “Modality Recognition Service”. The recognized modal input is sent to the “Modality Fusion and Interpretation” service. The multimodal input is therefore interpreted and the request to the “Emergency plan” sends its response to the “Modality Fission” service. This services manage the output , arranging information according to the used mobile devices and the situation in which the user is in. The Web Services architecture that uses SOA approach is particularly useful; in fact, the different Web Services communicate independently from the adopted platform, exchanging messages implies using the HTTP protocol.

4 Application Scenarios

This section discusses some application scenario of the ME platform for catastrophic events. The first scenario involves the “Social Networking” Web Service, the second scenario is connected with the “Plan definition application” and the third is about the “Emergency plan simulation”.

4.1 First Scenario

John is coming at home by car when he feel the hearthquake that is alarming his city since four months ago. The previous week his colleague Anne has said him of the possibility to have more information and news on risks connected with this phenomenon using RISCOM, a Social Network implemented by experts in different sectors and among them in the earthquake field, which allows both to obtain precautionary information on seismic events (e.g., behaviors to be adopted, plans to be followed) and to receive news during emergency situations such as for example locations of meeting points. John had registered himself as a member of RISCOM.

During the way, John decides to connect himself to the RISCOM by using his mobile phone. He with naturalness says by speech "Social Network RISCOM". The

Multimodal interaction management services application is immediately activated and it requires the activation of the “Social Networking application” (see Web Service architecture in Figure 2).

The mobile phone shows on the touch screen the list of tha available Social Networks. John scrolls the list by moving the finger from up to down. He selects the Social Network RISCOM to visualize all precautionary information on earthquakes. John decides to register the address of the RISCOM on the mobile phone by saying "Register RISCOM”.

In the evening John is coming to his home. During the dinner John alerts a strong seismic shock and he decides to rush on the street with his family. All streets are full of scared people who do not know what to do. John tries to know the meeting points activated in his city and connects himself to the RISCOM requiring this service. He takes-out the mobile phone and says "RISCOM". The phone connects automatically to the previously stored address allowing John to instantly access the RISCOM. Once connected to RISCOM John says "Show the map" to visualize the meeting point closest to him. John needs to have a deeper look at the map and says "Zoom please", while he opens his right hand in front of the display. The map shows the meeting point where John can go to receive all the assistance he needs.

4.2 Second Scenario

A seismologic Institute has been provided a survey system using a Macro-seismic Questionnaire in order to collect perceptions and observations of people involved by earthquake. By using a satellite localisation system the Institute localizes John that is in an area involved by the seismic event, and sends him an SMS with questionnaire to be fill out. The questionnaire is devoted to analyse the consequences and effects of the seismic event on people and things. John, after some days from the seismic event decides to answer to the questionnaire. He is using his mobile phone because he is camped in a backpacking tent.

At the question: “Where were you during the earthquake?” John answers by speech “I was at home”, at the question “What were you doing?” he answers “I was sleeping”. At the question “how many people close with you felt the earthquake?” he answers selecting “3” by using the keyboard. The ME platform enables John to access Web Services by multimodal interaction with his mobile phone improving accessibility everywhere and in different situations, and enables experts and civil protection structures to collect and share information and knowledge such as for example knowledge related with “seismic maps” that are used for the “Plan definition application”.

4.3 Third Scenario

Let us suppose to be in the Securtown city. All is planned at Securtown to make happy and safe citizens. Securetown includes a rural area with isolated buildings. The combined use of acoustic alarms.

Tricks daily threaten this harmony and for this reason civil protection and a lot of public and private organizations act to prevent and manage risks and emergencies.

A very relevant activity is the risk prevention simulating the catastrophic event with the involvement of population.

On February 20 a simulation of earthquakes with Richter magnitudo of 6.5 has been planned at Securtown. This event interrupts the electricity, gas and water supply. Alarms with a battery are activated to alert population, audio, text and visual messages are sent by mobile devices to provide people with information for coordinating them on what they have to do. That is, the operation room send to the "Multimodal Interaction management" Web Service the XML files with the multimodal messages for people, according to the "Emergency plan simulation" Web Service request.

Mr. Smith, head of the operative room, sends a message to alert people on the need to leave buildings and to reach the lose meeting point: the meeting point is showed on a map in order to facilitate its localization. All people perform action according to the simulation plan and reach the meeting area suddenly. While is reaching the meeting point John perceives some voices near a collapsed building. He immediately sends by mobile to the operative room a request of assistance and send an image that can better explain the situation.

5 Conclusion

Information, data and more generally each kind of service involved in the daily activities of individuals and organizations can be provided by different sources and by distributed applications. The heterogeneity of sources could imply information presented using different modalities (speech, visual, and so on) and their possible evolution over the time requiring different forms of treatment. Do not except data, information and services supplied in emergency situations or devoted to prevent and manage natural catastrophic events. They can involve information and data characterizing contingency plans, town plans, scientific data related to the seismic events in the interested area, geographic data in different processes. Emergency situation, moreover, can be particularly critical to access services and data using mobile devices, in terms of availability of technological resources such as bandwidth, intermittent connectivity to the network, or physical and or psychophysics people situations.

This paper has described the framework (ME) Web Services architecture that permits to access these information and data used in catastrophic events such as earthquakes, floods, and so on, and to access and manage services using multimodal interaction on mobile devices. The importance of using multimodal interaction for managing services and sharing information is a focal point for emergency situations. In fact, using different modalities and/or their combination represents a very effective manner to supply services in critical situations. Some modules of the framework supporting multimodal interaction have been deveopped. As a future work strong activities of developping and evaluating the framework as a whole are planned.

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