A Web and mobile-based system for the coordination of civil protection authorities and population warning

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ABSTRACT

In this paper we present a scenario based system for the instant notification and coordination of local authorities after an emergency crisis using web and mobile technologies. The system was implemented for the case of forest fires. Forest fires are a natural phenomenon in forest ecosystems; however, they are also one of the greatest disaster hazards. Despite the fact that they cause a statistically smaller number of victims compared to other natural hazards, such as earthquakes, their consequences to the environment as well as the life and economy of the communities are devastating. Wildfire prevention is currently the focus of many efforts; however less attention is given to operational readiness and emergency response in such cases. The presented system allows users (e.g. civil protection agencies) to proactively create scenarios that will be executed during a crisis in order to warn and coordinate local authorities, general public etc. Each scenario consists of several steps and at each step any number of messages can be sent to different groups of users. Therefore, the system enables different groups of people to receive general information, specific instructions and guidance during the crisis and after crisis information.

INTRODUCTION

Natural crises (earthquakes, volcanic eruption, tornadoes, floods, fires, hurricanes, landslides, storms, droughts) cause serious threat to life, property and the environment itself [1].

Crisis management activities, to deal with these threats, are usually including the following activities:

- Preparation and prevention
- First response
- Recovery

In the presented work we are focusing on the "First response" after an environmental crisis outbreak. The readiness of all relevant actors to act promptly and efficiently in order to avoid as much loss as possible (e.g. human, animal and agricultural losses) is a very important factor towards successful crisis management [2]. As a result it is very essential to provide first responders with the competencies and support to manage the mental and emotional demands of their roles [3].

Responding activities after an environmental crisis have to focus on two directions [4]:

- Early warning and intervene to ensure safety
- Dealing with the actual crisis through provision of immediate information and coordination activities to all relevant stakeholders (e.g. fire fighters, civil protection officers, volunteers etc)

Inadequacy of response or lack of capacity is recognized as an important reason behind countries' and/or regions' failure to respond to forest fires. The evidence from the Greek (2007) and Portuguese (2003) case studies (forest wildfires) strongly supports this conclusion [5].

Innovative Information and Communication technologies can play a vital role towards the achievement of effective and well coordinated early warning and response system [6] providing vital capabilities to:

- Connect between the detectors, the civil protection officers and the people/property in danger
- Provide automatic response systems (e.g. sprinklers, automatic off switch for gas supply etc.) [7]

This paper is focusing on the first of the above two types of early warning and response systems, presenting a scenario based system for the instant notification and coordination of local authorities after an emergency crisis using web and mobile technologies. The system was implemented for the case of forest fires but it can be applied on any other physical disaster case. It has been developed in the framework of an Interreg IVC project named PROMPT (Proactive Human Response to Wildfires Outbreak: Measure and Prepare for it - http://www.prompt-interreg.eu/). The aim of the project was to exchange experiences and good practices in order to improve regional development policies for coping with fires right after their breaking out in very sensitive areas, such as the forestry ones.

The presented system can be used in a wide range of crisis situations where mobile infrastructure remains functional. The system is web based, developed using open source technologies. It supports different levels of users with specific privileges. Users (e.g. civil protection agencies) are able to proactively create scenarios that will be executed during a crisis in order to warn and coordinate local authorities, general public etc. Each scenario consists of several steps and at each step any number of warning and/or coordination messages can be sent to different group of users. Therefore, the system enables different groups of people to receive general information, specific instructions and guidance during the crisis.

The paper is structured in the following way:

- In the first section we present related work concerning early warning and guidance support Information Systems world widely, with emphasis on natural crisis management.

- In the second section the system's functionalities and architecture are included.

- In the third section we present in detail the operational aspects of the system, giving a hypothetical practical scenario of usage.

- Finally, we give the conclusions and planned further work based on the experience until now.

RELATED WORK

The shared knowledge and experience regarding the use of Information and Communication Technologies (ICT) in Civil Protection, contains a variety of tools, systems and solutions. Within all level of civil protection units, National or Local, the focus on a secure, ICT crisis management system, that can be act on-time and efficiently, strongly influence both existing and future benefits.

What exist at operational level of a crisis, are systems for administration of the data needs and data sources, filtering and forwarding the appropriate information, just after the incident. The latest years, the means are the Mobile handsets and the format are the SMS through both, broadband and GSM.

In order to deliver a mass, targeted SMS message, you need to know the phone number of everyone who is actually in a specific area at a given time. In case of professionals, volunteers and stakeholders it is easy to pre-collect and spread SMSs through a stable server and a well structured data base. It is easy also to divide in separate pre-defined teams of receivers – actors of immediate response – fact that used in many Regions and Countries today.

A Dutch case study [8] shows a system, built into GSM, that closely resembles one way message paging. Depends on handset firm, called "Cell Broadcast" or "Area Information" or "Local Information". This bearer is a downlink only direction that does not need to communicate with each terminal individually. To send out a broadcast message, the server simply asks each base station to stream the text of the message and all the phones – that have this service active or "accepted" - attached to that base station, receive it at the same time. There is no signaling to each mobile, no data base to interrogate. This kind of communication is working even when all systems are jammed with load caused by phone use or SMS.

An important benefit of the cell broadcast include the integration of technology in all new age mobile handsets, but the legal issues of using this service without permission of the owner, are still complicate in many countries.

Recent developments in early warning and disaster risk reduction process in the Czech Republic, shows the warnings that disseminated by means of a state emergency system and the role of SMS messages in such a system.

The "Crisis Mobile Phone Project" [9] was designed for operative connection of all crisis management actors (from state government to municipalities). All rescue departments, public and private, who participate in crisis management, were included in the system structure. The project was provided with a mobile GSM network, which uses one Mobile operator (provider). By technical point of view there were special combined SIM cards with two numbers, special numbers, high calling priority for these numbers in non-crisis situations and the highest calling priority in crisis situations. Calling priority defined as overlapping of normal GSM calls and SMS by the emergency numbers, as well as routing of such calls and SMS through secure Mobile Switching Centers (MSC) in case of a damage. Secure MSC are those with extra power systems, offering a 'non power cut' guarantee.

The project allows all crisis management actors to be connected during crisis with the use of unified communication devices, giving the ability of "first" information, even if the system is overloaded, as well as the ability to send back in the same way, critical information for the incident.

More or less all such integrated systems nowadays, try to expand the amount and the security of critical information that arrives on a mobile device.

SYSTEM ARCHITECTURE AND FUNCTIONALITY OVERVIEW

As already mentioned the system that we present in this paper is a scenario based web platform for the instant notification and coordination of local authorities and warning of local population after an emergency crisis outbreak, using web and mobile technologies. While the system is currently used for the case of wildfires outbreak, it consists a prototype that can easily be modified and applied in a wide range of other crisis situations.

The system was developed using open source web technologies and combining them with an SMS gateway via an HTTP API. The frontend of the application is accessible from a web browser while the backend is consisted by the web and database server and the mobile infrastructure. More specifically the system is based on the Drupal content management system. Additional modules that implement the scenarios and SMS functionalities where developed and incorporated to the content management system. In order to access the mobile infrastructure and send the SMSs, the web server communicates with the SMS gateway sending an HTTP request. In our case the HTTP API of the Clickatell Gateway is used, however any other SMS Gateway that provides an HTTP API can be adopted. The architecture of the system is shown in Fig. 1.
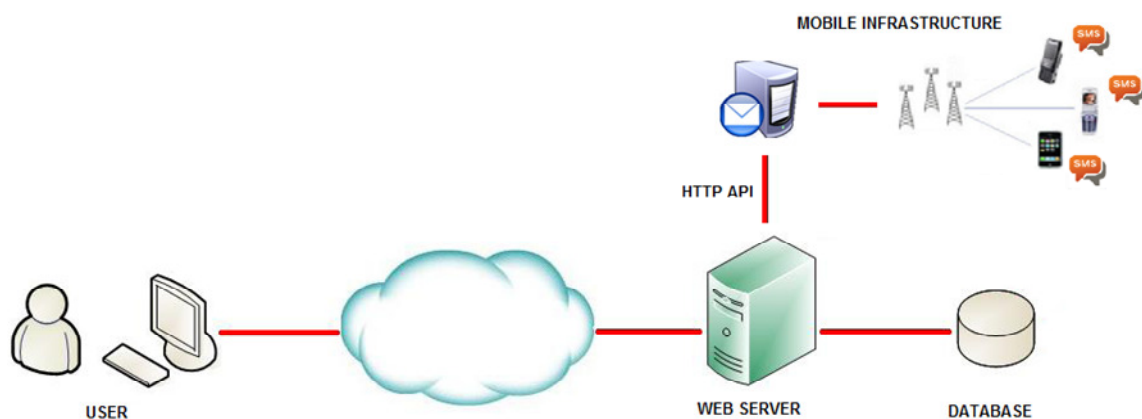

Figure 1. System Architecture

The system supports three types of users: a) Civil protection users that are able to administer the platform and organize and execute scenarios. b) Registered users, that are users from public organizations or come from the local population and civil protection believes they could play an important role in case of an emergency. c) Guests, which are users that cannot receive notifications via SMS but are able to access the public section of the web system and get useful information about crisis situations and how to react in such a case.

As already mentioned the system is scenario based. That means that civil protection is able to create in advance scenarios that can be executed after an emergency outbreak in order to coordinate or notify the involved organizations or the local residents. Each scenario has several steps and at each step an SMS or a group of SMSs are sent to a user or a group of users. Scenarios can be executed step by step, omitting some steps if desired. The functionalities of the system are presented in detail in the next section.

METHODOLOGY

In this section we present in detail all the functionalities of our system and a use case scenario. As mentioned before, registered users may include civil protection and other local authorities or organizations. Registered users are divided to platform administrators and normal users.

In order to create a new account to the system, the new user has to fill an online form. During the registration process the user has to choose a username and provide a valid email address and the name of the organization they belong to. Then, she must provide some personal information that includes name, surname, name of organization, and her mobile phone number. The mobile phone number is required for the SMS functionality. Finally, the user has to choose a four digit personal identification number (PIN). This PIN code is always included at the end of any SMS send from the system. The PIN code functionality improves the credibility and the reliability of our system in two ways, as the user is able to check:

- The authenticity of the SMS. Sender's name or sender's number is not enough because they can be spoofed easily.

- The integrity of the SMS. For various reasons like GSM network issues, device-specific issues etc, some SMSs face the possibility to delivered corrupted.

When the registration form is submitted the new account, for security reasons, is by default disabled. A user with administrative privileges has to check the provided information and then he may enable the new account. As soon as the account is enabled the new user receives an email with a one-time login URL in order to set a password for his account.

Platform's administrators are responsible for the user's administration, the content provided online, and the platform's scenarios. All this functions are accessible from the administrators' menu, shown in Fig. 2.
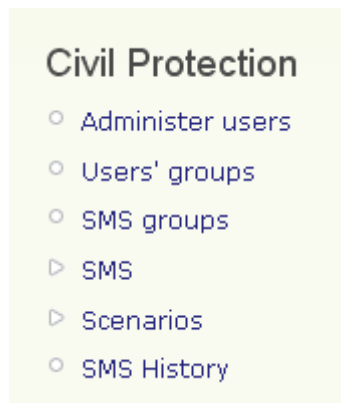

Figure 2. Platform's administrators menu

Administer users

The administrator views a list that contains all the usernames registered to the platform. For every account he may view the status of the account (enabled/ disabled), if the user is administrator ("civil protection" in our case), when this account has been created and the last login date to the platform. Also, she can sort and filter this list using any of the above information as criteria. Furthermore, the administrator may edit any information related to the account such as username and password or any personal information including the PIN code. The deletion of an account is also possible. Finally, platform administrators may create new accounts and automatically send email notifications to the new users.

Users' groups

The users' of the platform can be organized into groups. Every group has a unique name and, optionally, a short description. The groups may contain practically an unlimited number of users and the platform supports an unlimited number of groups. Also, it is possible for a user to belong to several groups.

SMS

SMSs are the main functionality in order to communicate with the platform's users. Platform's administrator is able to create and store any number of SMS messages. Every SMS has a short description (title) and the actual SMS body. The length of each SMS is up to 195 characters. This limit depends on the SMS gateway and it ensures that multilingual content is supported for the SMS's body. Moreover, we have allocated the necessary characters for the PIN number at the end of each SMS.

The interface provides a list with all the SMS messages proactively stored to the platform. For every message the title and the creator of the messages is presented. The messages may be sorted by their title (default) or by their creator. Finally, administrators may delete or edit any of the messages stored in the platform.

The last option to the SMS menu is called "Send a single SMS". In this option, the administrator is able to select a saved SMS or just to type a new one and to send it to single users and user groups. The system checks for possible overlaps between user groups and single users so that every user receives each SMS only once. For example, if the administrator wants to send an SMS to the groups A & B, and user X belongs to both groups, user X has to receive the message in one copy. When all messages have been delivered to the SMS gateway the administrator is informed for the total number of the SMSs that were sent.

Figure 3. Create a new scenario

SMS group

Like user groups, administrators are able to organize single SMSs to SMS groups. Administrators are able to create, delete and update the groups. Each SMS group has a name, a short description and it may contain any number of SMSs.

Scenarios

The platform supports the feature of predefining and creating scenarios. The scenarios are a good way to organize the procedure of sending SMS messages to the right users, the right time and with the right order. A three step wizard is available for creating a new scenario. At the first step the user provides a title and a short description for the scenario. At step two, the user defines the phases of the scenario. In each phase the administrator creates pairs of SMS groups and user groups. The system supports any number of phases. During this step the administrator is able to delete a phase or change the order of the phases (Fig. 3). Finally, the administrator saves the scenario and the wizard is terminated (step 3).

A list that contains all saved scenarios is also available. The administrator is able to execute or edit any scenario. If she chooses to edit a scenario, the scenario wizard starts receiving as input the selected scenario. If the administrator chooses to execute a scenario, a new list that contains the pairs SMS groups and users' groups appears in the predefined order. At this point, the administrator is able to execute any phase of the scenario or all phases consecutively.

SMS history

The final option to the platform's administrator menu is the "SMS history". This functionality provides a full history of all SMS messages that have been sent from the platform. That includes both the delivery of single SMSs or SMSs from the execution of a scenario. For each SMS the system logs the content of the SMS, recipient's phone number, the status of the SMS (delivered or not) as provided from the SMS gateway, a unique string for this delivery (also provided from the SMS gateway), sender's username and of course the date and time that the SMS was sent. This log information is saved to the database. For security reasons, platform's administrators have read-only access to it.

Use case scenario

In this section we present a possible use case scenario that could involve the application of the system from civil protection for the case of forest fires. The scenario is the following:

"Civil protection in Western Greece elaborates and designs an operational plan that could be applied in case of forest fires outbreak during the summer period. In the framework of this plan, working groups that involve civil protection, local authorities and local population are formed. Each group has specific tasks to accomplish and a very important point for the success of the plan is the early warning and successful coordination of all involved parts."

All involved individuals (civil protection officers, people working for local authorities, local inhabitants that could play an important role in case of such a crisis, volunteers) register into the system and provide all necessary information, including their mobile phone numbers. Since mobile phones are "always on" devices, it will be easier for them to get notified in case of an emergency. Civil protection employees use the system to create and store SMS that could be sent in case of forest fires outbreak in order to warn and provide instructions to the users of the system. Moreover, using the scenario wizard, several scenarios that could be applied in several different situations are proactively created and saved. Each scenario involves different SMSs and different user groups or individual users.

"A forest fire breaks out near Ancient Olympia. Civil protection should apply the operational plan in order to warn the involved parts and coordinate their reactions."

In this case the members of civil protection select the appropriate scenario(s) that should be executed in order to achieve the goal of warning, coordinating, providing guidance and protecting local population. An administrator from civil protection executes the selected scenarios (step by step or as a whole). Due to differences between the real situation and the designed scenario, single SMSs are also sent to selected recipients.

"The situation met with success. The fire danger was eliminated and no one was injured."

Civil protection officers are able to study the history of the executed scenario(s) and according to lessons learnt from this emergency they can modify some phases of the scenario(s).

CONCLUSION

In this paper, a scenario based system for the instant notification and coordination of local authorities after an emergency crisis was presented. The system combines web and mobile technologies, enabling civil protection agencies to apply their operational plans, by executing scenarios and sending messages to mobile devices. The system is currently deployed for the case of forest fires but can be used for other emergency situations as well.

In the future we plan to perform an evaluation of the system after a period of pilot usage under real circumstances. Moreover, we intend to extend its functionality to MMS, so that photos, videos and other multimedia content are attached to the messages that are sent. Finally, we will work on performing 2-way communication, allowing users to send valuable feedback during the emergency situation.

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