Wireless Emergency Alerts: An Accessibility Study

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ABSTRACT

Since 2001, entities in the U.S. have produced studies which address issues regarding the progress of including people with disabilities in emergency planning at the Federal, state and local levels. There is general agreement among these stakeholders that there must be engagement of emergency personnel, robust, reliable and accessible emergency communications to ensure a high quality of public safety. A key step is the development of emergency communication technologies that serve emergency management and public safety personnel's ability to communicate with the public. It is critical that these next-generation warning systems be developed such that persons with disabilities are given equal access to emergency alerts. This paper discusses a research and development effort to identify the accommodations needed by people with disabilities in these next-generation, mobile emergency alerting systems. Prototyping mobile phone-based emergency alert systems are discussed and summative findings from field trials conducted with sensory challenged individuals are presented.

KEYWORDS

Emergency communications, mobile devices, alerting, accessibility, Short Messaging Service, wireless, Federal Communications Commission

INTRODUCTION

Public policy mandates that Federal agencies consider people with disabilities in their emergency preparedness planning. To ensure this, an Interagency Coordinating Council on Emergency Preparedness and Individuals with Disabilities (ICCEP) was formed, comprised of senior leadership from 23 Federal departments and agencies. There is general agreement among members of the ICCEP and other stakeholders that there must be engagement of emergency personnel, robust and reliable emergency communications, and communications with those serving people with disabilities to ensure a high quality of public safety and accessibility during emergency situations. Officials at the Federal Communications Commission (FCC) and other Federal agencies have verified that proper planning ensures emergency personnel are better equipped during an emergency in how best to ensure safety of life and property (FCC, 2007; Partnership for Public Warning, 2004).

In August 2004, the Federal Communications Commission (FCC) released a *Notice of Proposed Rulemaking* (NPRM) to review the Emergency Alert System (EAS). Organizations representing the interests of people with disabilities expressed their concerns through the public comment process about the accessibility of next generation, digitally-based alert and warning systems in the FCC rulemakings (Wireless RERC, 2004, 2005). In response to the FCC's Rules Regarding the EAS, assistive technology manufacturers, wireless providers and other stakeholders agreed that technological advances have the potential to deliver targeted messages to specialized audiences over multiple platforms, including wireless. Several recommendations made by the Wireless RERC about the potential of digital wireless technologies to assist people with disabilities appeared in the FCC's *1st Report and Order and Further NPRM*, which stated: "we amend the FCC rules to ensure that persons with disabilities have access to public warnings (FCC, 2005)." On point the Wireless RERC commented that all wireless device users would benefit from a multi-modal approach to providing accessible, wireless emergency alerts communication. In addition to filing comments before the FCC, the Wireless

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Emergency Communications (WEC) project of the Wireless RERC examined approaches to transmit emergency alerts and warnings to wireless devices; researched interoperability issues; evaluated various technology solutions for transmitting accessible emergency alerts and warnings over wireless networks; and worked with other stakeholders, including the emergency management community, to test the parameters of proposed systems.

WIRELESS USE AMONGST PEOPLE WITH DISABILITIES

In 2008, the American Red Cross responded to more than 70,000 disasters (American Red Cross, 2008). Many of the injured were among the more vulnerable populations – the aged and people with disabilities. According to the National Organization on Disability an estimated 54 million United States residents have some type of disability. Not included in this number are approximately 38 million Americans (12.4% of the total population) who are over the age of 65 years (United States Census Bureau, 2008) and represent a population that frequently faces many of the same limitations as people with disabilities. By 2030 the over 65 population will double to 70 million or 20% of the total U.S. population. Unfortunately, current technologies designed for use during emergencies seldom address the needs of persons with disabilities.

Today, more than 87% of the U.S. population use wireless services or products (CTIA, 2009). In 2009, the Wireless RERC conducted a survey of user needs which revealed that people with disabilities are significant users and early adopters of wireless products and services. The survey of more than 1600 people with disabilities showed that in 2007 85% used wireless devices, 65% used wireless devices every day, and more than 77% of survey respondents indicated that wireless devices were very important in their daily life. As more of these users rely on wireless devices as their primary source of communication, receiving emergency alerts on these devices must be considered when developing technology to facilitate emergency and public safety communications; especially in light of the fact that the current Emergency Alert System (EAS) broadcast over television and radio is not a fully accessible solution.

Wireless information and communications technologies play an increasing role in aspects of independent living for people with disabilities. For example, video phones and video relay services are making it possible to have telephone conversations in sign language. Wireless technologies are also becoming part of the unique social and cultural fabric of the deaf community with text messaging used as a key mode of communication for people who are deaf and hard of hearing. Emergency broadcasts and 911 telephone services are being adapted to utilize new wireless data networks and mobile devices. Some of those involved in development activities are working toward assuring that the content in the emergency alerts and communications be understandable, available in accessible formats, and capable of receipt by persons with disabilities over different networks and devices, including mobile and wireless.

Presently, the public can subscribe to services which provide emergency alerts to their mobile phones. Most of these services carry advertising, have limited features, and are in formats that are not accessible by people with disabilities. Some companies, such as Nokia, Research In Motion (RIM), and AT&T, have made the effort to establish internal disability offices to inform the development of accessible features for their consumer devices and to provide outreach to disabled consumers. Government, industry, academia and users working together can ensure that full accessibility to next generation alerting systems is available for the safety of all Americans.

PROTOTYPING ACCESSIBLE WIRELESS EMERGENCY ALERTS

An important approach to the development of inclusive emergency communications systems was the design and implementation of appropriate user interfaces. The Mobile Alerting Framework (MAF) is a server-side architecture and framework for development of small-scale services that disseminate alerts to mobile phones using Short Message Service (SMS) and mobile World Wide Web (WWW) access. Although SMS and the web may not be adequate channels for mobile emergency alerting on a massive scale (Traynor, 2008), these technologies are ideal for evaluating the user experience of a mobile alerting system. Both are ubiquitous technologies that permit application development using readily available equipment, software and services. SMS and mobile WWW work well together as complementary technologies. SMS is a “push” operation capable of delivering a message without an explicit request from a subscriber; however it has a limited message length of only 160 characters. On the other hand, there is no restriction on the amount of data that can be transferred from a web server; however this transfer requires an explicit request or “pull” by the client. Pairing the technologies allows SMS to push notification of an alert to the subscriber, following which mobile web service can be used to pull additional information from a web server. When coupled with customized client software running on the user’s mobile phone, the underlying use of SMS and mobile Web access as a transport channel can be rendered invisible to the user and allow the researcher complete control of the user experience.

Several prototypes were implemented using the MAF. These prototype systems included mobile phones that receive and display alerts as conventional SMS messages and mobile web pages as well as mobile phones running client software capable of presenting alert content with accommodations for blind / low vision and hearing impaired users. These prototypes consisted of systems capable of receiving live alerts of weather emergencies from NOAA's National Weather Service as well as systems that simulate the FCC's forthcoming Commercial Mobile Alert System (CMAS). In the weather alert system the body of the SMS message presents the most critical information contained in the weather alert including the type of weather event, the affected area and the expiration time of the alert. Additionally, the message contains a hyperlink to a web page containing the alert's full content formatted for accessibility and mobile viewing.

By coupling the MAF with client software running on the subscriber's mobile phone, a level of control of the user experience was achieved. Without the client software, the emergency alerts could not be distinguished from ordinary incoming SMS messages and accessibility was limited to the features provided by the phone's SMS application and web browser. With the client software, an incoming SMS alert was automatically identified, a distinctive alarm signal was raised and the content of the alert was then presented to the user in an accessible manner. Use of client software also afforded the capability to override phone settings (such as disabled ring tone) that may interfere with the notification of a critical alert.

To accommodate visually impaired users, a mobile client was constructed featuring an auditory user interface. As with all of the project's client software, users were notified of incoming emergency alerts with the standard attention signal of the EAS consisting of the combination of 853 Hz and 960 Hz sine waves. Alerts with a lesser severity (such as a "Tornado Watch" versus "Tornado Warning") consisted of the EAS tone in a series of short, rhythmic bursts of decreasing amplitude. Synthesized speech was used to read emergency alerts to the user and for user interaction with simple spoken menus and prompts. To address hearing impairments, the mobile clients used distinctive vibration patterns to notify users of incoming alerts. Similar to the auditory attention signals, critical alerts were introduced with intense continuous vibration while alerts of lesser severity were introduced with a pattern of rhythmic bursts. In addition to a system using a conventional presentation of an alert as English text, a prototype was developed that used video to convey an alert in American Sign Language (ASL) as well as in standard English text. This ASL system was designed only to elicit user feedback on ASL as a possible enhancement to textual alerts, thus the system uses prerecorded videos and was not functional as a "live" alerting system.

Mobile clients were also developed to simulate the upcoming CMAS as mandated by the FCC. These systems were simulations and did not interface with a live source of genuine emergency alerts. These mobile clients incorporated similar accessibility features as described above, however the message formatting and alert signals conformed to the requirements of CMAS. Alert message length was limited to 90 characters and the message included the five mandatory fields from the CAP: event type, area affected, recommended action, expiration time and sending agency. The audio attention signal uses the EAS two-tone signal in a prescribed temporal sequence of one long tone of two seconds followed by two short tones of one second with a ½ second pause between tones. The vibration attention signal followed the same temporal pattern.

EVALUATIONS

Twelve field trials and two focus groups were conducted to examine the accessibility and effectiveness of EAS and CMAS alerts to wireless devices. Nine field trials focused on EAS requirements and evaluated the presentation of simulated EAS alerts using both the integrated SMS and Web applications of various BlackBerry devices as well as Cingular 2125 Smartphones running our mobile client software offering enhanced notification and accessibility features. Three trials focused on the more limited requirements of CMAS; delivered simulated CMAS alerts to Cingular 2125 Smartphones running client software that conformed to the proposed CMAS guidelines and offered simple accessibility enhancements. Each field trial was conducted at a location where the test participants were free to engage in a variety of activities during a 90 minute test window. During this time three to four simulated emergency alerts were sent to each participant's mobile phone. Participants were shadowed by an observer to monitor for system failure and log usability problems. The observers' instructions were to take note of the field test participants' reaction to incoming alerts, how they handled the device (carried in pocket, hand, purse, etc.), as well as note the characteristics of the environment (i.e., noisy lobby, quiet break-room). They were strictly prohibited from assisting the field test participant with the device itself. The session began with the group taking a pre-field test questionnaire that assessed the extent to which the individual used a mobile phone, how they currently receive, react to and confirm emergency information, and their level of interest in and usefulness of receiving emergency alerts on their mobile phones. They then received the mobile devices and a technical briefing on the operation of the phone. They were asked to disperse around the building and grounds and were sent a series of simulated emergency alerts. The participants reactions were intended to mimic a real-life outing including being engaged in a conversation (with the observer), being introduced into a new environment (host facility), or otherwise engaged in an activity that diverted their attention from the mobile phone and anticipation of incoming alerts. Following the trial, participants completed a post-field test questionnaire to gather qualitative and quantitative data on their experience with the system. Each field trial concluded with an open ended discussion that included all participants in the trial.

Every trial was composed of approximately thirty participants representing people with various levels of self-identified sensory disabilities, and people without a disability. Although the evaluation focused on sensory disabilities, some test participants also reported mobility and cognitive impairments. Within each group were users of various levels of technical proficiency with wireless devices: technically savvy, defined as frequently utilizing multiple applications on a wireless device; some technical know-how, defined as frequent use of a mobile device for voice or text communications; and infrequent user of technology, defined as an individual who may only use a mobile device during personal emergencies or to make long distance calls.

In addition to the EAS and CMAS trials, two focus groups were conducted to assess if ASL video enhanced understanding of textual CMAS alerts by people who are deaf. The focus groups consisted of 13 participants, all of whom were conversant in ASL and comfortable reading English. Focus group participants were presented with conventional text alerts, as well as text alerts coupled with video clips presenting an ASL translation.

FINDINGS

In the EAS trials, more than 83% of the participants stated the wireless emergency alerting system they evaluated was an improvement over other methods they currently employ to receive emergency warnings and alerts. Of blind and low-vision participants, 100% regarded the alerting of the accessible client software an improvement, however only 43% regarded the alerts via SMS and the Web as an improvement over their current system. The low satisfaction of the SMS and Web system with this population appears to be due in part to accessibility features of the mobile devices they were given not being sufficient in addressing their particular accessibility needs. Of deaf and hard-of-hearing participants, 80% found the alerts presented with our accessible client software to be an improvement and 77% found the SMS and Web emergency alerts to be an improvement over their current methods of receiving alerts.

For the CMAS trials, 83% of visually impaired participants found the accessible CMAS system to be an improvement over their current source of emergency alerts. Of participants with hearing impairments, 70% found the CMAS alerts to be an improvement. Generally speaking, the EAS trials received higher rates of approval because more detailed information could be provided in the alerts, versus the very limited information allowed by the 90 character restriction of CMAS.

Some participants expressed concern over the quality of the synthesized voice used in the EAS trials. Additionally, the alert attention signal and vibrating cadences were a concern of some participants. Some stated that the vibration was not strong enough to capture their attention unless they were holding the phone; however vibration strength varies among mobile phone models. For example, the BlackBerry devices used in the evaluation produced a stronger vibrating cadence than the Cingular 2125 Smartphones. The specifics of message length and attention signal received varying degrees of satisfaction depending upon the individual's level of sensory impairment, the device itself, and personal habits (where they carry the device, if it is always on, etc.).

Participants of the ASL focus group all agreed that ASL video alerts would be a useful tool for people that are deaf and literate in ASL. Some participants felt that the combination of the text and ASL together gave them fuller understanding of the message than either on its own. One somewhat surprising result of the evaluation was the difficulty of understanding some phrases typically used in National Weather Service alerts, such as "take cover" or "low-lying area"; these idiomatic expressions do not translate well into Deaf English or into ASL, so the word choice used in text or ASL alerts should be carefully considered.

CONCLUSION

Moving forward, the Wireless RERC recommends that it is important to engage the emergency management community involved in emergency communications and alerting devices in reaching individuals with disabilities during emergency crisis situations. By better understanding the importance of inclusive and accessible technological solutions, valuable response time to special needs populations, especially people with disabilities can result in more efficient use of public safety and emergency management personnel during natural and manmade disasters. In addition, manufacturers who incorporate emergency alerting into mobile wireless handsets should examine features such as attention signal volume and vibration strength and consider making these features customizable in order to accommodate various end-user preferences. Retailers can also benefit from these findings as other work with hearing aid compatible cell phones shows that user and salesperson education is a critical factor in ensuring persons with disabilities purchase the correct products for their needs; industry is urged to make sure clear labeling explaining emergency features is on product packaging and in stores, and that sales staff understand the emergency and accessibility features in products.

Evaluations suggest that mobile devices offer an opportunity to improve dissemination of emergency alerts to disabled populations. Testing of various prototypical solutions to make these alerts more accessible show that simple accommodations can be made that greatly increase the accessibility of these alerts. As government and industry move forward in rolling out next-generation alerting systems such as CMAS, the needs of citizens with disabilities must be taken into account in the design and evaluation of such systems. Tens of millions of Americans are affected by some form of disability and it is essential that they have equal access to emergency information.

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