16
Emergency Communication Needs: Mobile Content

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1 Introduction

The attack on September 11, 2001 brought a new awareness of the utility of mobile communications in times of emergency. It also brought to attention two things that had been largely overlooked in the rush to promote the use of mobile phones: the frailty of wireless networks and the limited assistance that they can offer in emergencies. Most of the subsequent discussion since has focused on questions about the reliability of the systems in their ability to work when congested and when relay stations have been damaged or destroyed. However, neither before nor to a significant degree since has there been much focus on the other central problem: How can the content of communications over mobile networks contribute to solving problems in emergencies?

In this chapter we ask two kinds of questions: First, what content would users want from mobile phones and how might they use them? Second, who would provide such content and what might be the means by which it is managed and maintained? First let us review what current emergency uses are and how people use that content and functionality.

2 Emergency Communication Needs

Mobile communications worked to some degree well on 9/11 in the World Trade Center and in the hijacked airplanes. However, the mobile system became predictably overloaded in the regions affected, with domino effects nationwide. Small data transmitters such as Blackberrys and pagers worked as limited alternatives (Kapsales, 2004). Nevertheless, they demonstrated the

imaginative ways people sought out means to communicate, and showed that parallel technical systems can work in emergencies.

This disaster has sparked interest in the significance of certain kinds of emergency communications content that must now be regarded as high priority. This includes what was formalized following the Kobe earthquake in Japan as the "I am alive" (or IAA communication) function. This occurred in the form of widely reported personal communications from within the World Trade Center, in the form of ad hoc web sites established immediately following the destruction of the buildings, and in hundreds of human-interest stories in the press (Noam & Sato, 1995; Noam, 2001). We all saw the importance of providing anyone the opportunity to contact loved ones when caught in an emergency. Many such people sought advice, some of which might have been translated into tangible help such as instructions on how to escape danger. The deadly tsunami that struck the shores of the Indian Ocean in December, 2004 is another example.

Except in times of disaster we usually regard communication systems primarily as requirements for our social and economic needs, with special functions for national security and other governmental activities, plus emergency services such as police and firefighters (Anderson & Gow, 2000). When we suffer a disaster, however, we are starkly reminded of the utility of systems for saving lives, directing recovery work, and performing other highly valued functions, such as communicating with loved ones in extreme conditions. On September 11 we learned of the relief felt by those able to make contact with family from the streets and of friends and colleagues able to find each other from within the chaos of the escaping crowds. However, we also learned of the frustrations of those who encountered broken or busy lines, of data lost, and priority users unable to use dedicated systems.

In subsequent years companies and goverment bodies have focused on the considerable needs, and capabilities, in ensuring greater resilience and access. The possibility of increased interoperability is of particular interest, especially since the inhibitions so far have been more in the realm of regulatory practices (the allocation of spectrum) and competition policy. Military applications of equipment capable of spectrum switching have long existed, but for legal as well as commercial reasons they have until recently not been built into civil systems.

One of the surprising elements is that although questions about the reliability of wireline networks have long been a concern, the only special consideration that wireless networks have attracted in the literature has been the availability of lines, and the establishment and roll-out of enhanced emergency calls.

There have been several rulings by the Federal Communications Commission concerning the criteria for enabling 911 calls to be made from mobile telephones (FCC, 2001). The basic requirement, as specified in a series of orders since 1996, has been to improve the quality and reliability of 911 emergency services for wireless phone users, by strengthening rules to govern the availability of basic 911 services and the implementation of enhanced 911 for wireless services. Two technical goals are at the heart of these enhancements. One is the ability of any wireless telephone to override subscription status and complete any 911 call. The other is to enhance the ability of emergency services to find where an emergency call originated from by means of location identification data. These requirements have been phased in since 1999, though incompletely.

We can get some idea of the significance of this functionality by considering how people behave in emergencies when they have mobile phones (IBM, 2002). The fact that mobile phones are ostensibly commonly acquired for emergency use is revealing of people's expectations. Some studies of the extent to which the phones are used in emergencies show that although most people do not have occasion to make such use, the occurrence is common enough to regard the likelihood as reasonable. There are distinct differences internationally with regard to emergency uses and until recently the high level of ownership but often low level of usage in the U.S. was partly explicable by people acquiring phones solely for emergency use (Palen et al., 2000).

Chapman & Schofield (1998) determined through research in Australia that 1 in 4 users have reported a dangerous situation; 1 in 8 a traffic accident; 1 in 16 a non-road medical emergency; 1 in 20 a crime; and 1 in 45 being lost in the bush or being in difficulty at sea. There are also uses for more direct medical applications, such as transmitting ECG results to hospitals so that commencement of appropriate therapy can be organized more rapidly upon arrival. Other work on the sociological and psychological aspects of the use of mobile phone indicate that people in any case come to depend on connectedness (Geser, 2002) and the implication is that people, women in particular, use the mobile to ward off discomfort and perhaps fear even in normal circumstances (Townsend, 2000; Ling & Yttri, 1999). Indeed, the psychological comforts have often been pointed out by respondents to sociological enquiries (Plant, 2000).

We learn interesting things from such research about when and for what purposes people use mobile telephones in emergencies, but it still leaves the question, what kinds of data would be of use in the mobile environment?

What we might hope for could be divided into three categories: (1) Wireless networks should benefit from technologies and procedures that can give

us more resilient communications systems; (2) We can better make available large amounts of high quality data, data analysis and interfaces useful in disaster situations; and (3) The ways people use mobile telephones in emergencies can be improved through training and adopting new norms of behavior that make such functions and facilities more effective. The first of these will be addressed in other works currently under development (Columbia University Center for Resilient Networks); for the remainder of this chapter we will concentrate on the second with some consideration of the third.

To some degree the specific need depends on the intended audience. We could consider a structure of targeted data sets represented in appropriate forms for different users. Emergency services workers would want access to both detailed forms of static information, such as building plans, and dynamic data such as the status of fires, the locations of people, the endangered stability of structures, and so on. People caught in a forest, or a large commercial site such as an oil field, a chemical plant or refinery would appreciate instant information about escape routes or the means to assist endangered people.

In addition to the provision of and access to data, there needs to be considerable insight into how it can be used. For trained emergency services workers, this is less of an issue because they can be drilled in protocols and procedures, but for the general public it will be important to have an understanding of how emergency workers would use the available information. Similarly, emergency workers would need to know what specific information (about for example escape routes) is currently being supplied to those trapped so that they could anticipate how they might use that information. We can divide the kinds of data that might be provided into two categories, static and dynamic. The static would consist of data about fixed facilities or accepted procedures (such as evacuation plans) that can be accumulated on a regular basis. Dynamic data and information would include real-time feedback from sensors and other automatic sources, plus the manual feed of data to targeted users about changing situations.

Static Content:

- Building plans: The landlords of new skyscrapers have access to relatively high quality graphically appropriate data about the exact plan of the building and utilities. This data, in graphical form, could be made available in a form appropriate for mobile phones and show floor plans, office lay-outs, escape routes, and other basic building information.
- Information about planned escape routes, emergency procedures, and so forth, including contingency plans on alternative escape routes and emer-

gency access that have been agreed by building operators and managers. This could be extended to evacuation instructions on a larger scale as would be necessary to evacuate a factory site, a forest fire zone, or other endangered area.
- Technical data about building structures (materials, utilities, back-up provisions, etc.): Data about the structural characteristics of buildings, including simplified assessments of their ability to withstand fires of certain levels of intensity or in specific locations of the building. Similarly, the location of flammable or otherwise dangerous materials or structures, such as generators and fuel tanks, could be highlighted when relevant.
- Neighborhood layouts: Maps of escape routes so that plans could be generated and disseminated for areas around endangered areas. This could be extended to include instructions for urban evacuation routes and procedures.

Dynamic, Pushed Content:

- Automatically updated data from sensors (heat, smoke, water, movement, radiation, etc.) can now be offered, especially as the development of ad-hoc networks of sensors can provide direct communication links to local mobile phones.
- Data provided by personal mobile devices (location, damage, etc.) can be shared on networks of nearby phones.
- Short-term instructions and corrections to or status reports about static data, such as recommended alternative escape routes. This would be information constantly made available by emergency workers or other responsible persons.
- Reports on the status of individuals or small groups: Sensors to detect the location of people and perhaps with further capabilities that include their movements and even their state of distress.

These data and information sources need to be authenticated and managed to ensure that materials are relevant and updated. This is expensive. To ensure compliance, some providers of information will need to be guided by statutory obligations. Others will need to be guided by codes of conduct.

Further opportunities abound in relation to the content potentially carried by mobile emergency systems. Some are obvious and prototypes have been built or are being considered. These include instructions and physical directions on how to escape or avoid danger. Others include ad hoc networks of sensors that feed data to mobile devices. These might include mechanisms for

monitoring heat, motion, or water. They might eventually be able to include structural stability data such that impending danger from a collapsing building is measured and communicated. Advanced applications of GIS, especially when integrated into building layouts (as are currently used by some utility companies and occasionally by fire departments) offer other possibilities for content.

A considerable amount of this sort of data is already potentially available, but it is of highly variable quality, and perhaps even more troubling it is often regarded as commercially sensitive or too expensive to restructure for use in emergency work. Extensive prototypes and some commercial applications in Japan's DoCoMo i-Mode show how the use of graphic maps and games can present data, including geographical position, in an easily usable form. Local WiFi capabilities show how inexpensive transmitters can be used to provide high bandwidth access to nearby services and customized information. New models of mobile telephones, personal organizers, and other communication devices show improvements in interfaces and especially in the quality of screens. Similarly, microphone sensitivity and speaker power are already such that the telephones can be used more easily in times of stress than previously.

However, what is still absent is any indication of how large scale, standardized data can be collected and made selectively available on need. The criteria of need might be easily determined. Location would be an overriding priority, with emergency services and key government and management personnel given immediate access. But there should also be ways of determining how others, such as otherwise unidentifiable friends and relatives might be included in the prioritization. Hierarchies of material could also be specified, such that full data would be made available to people in the midst of a disaster, including building and street layouts, status reports, and so on, but only communication connections, without access to large amounts of what might be sensitive data, would be available off-site. Although we will not consider interfaces here, emergency situations have demanding requirements, especially when visibility is poor, hands are busy, or stress and distractions create severe psychological strain.

Arguably the most critical matters are not the quantity or even the absolute quality of the data but rather the utility of its presentation, the manner in which information is regarded as critical when emergency activities are carried out. The norms which are necessary to guide this change will come about slowly. But those who have personally been touched by a disaster in which they could conceive of the value of better communication will form a large group of early adopters. Norms are changing very quickly as functionality and fashion coincide to make well known certain uses.

In addition to making use of generally supplied emergency information, we might expect individuals to customize their mobile communications software for their own needs. This would be similar in practice to coding in personal addresses and telephone numbers, constructing chat group protocols, and other simple software tasks. It could become common practice, perhaps even a service offered by mobile telephone service providers, to code supplementary emergency call numbers into the telephone that might be activated in an appropriate manner. Perhaps that same function could automatically connect the caller with a central emergency information provider. That information could be accessed through a menu to bring the person to more personalized, more localized, or detailed data.

The acquisition of data will be costly, but even more costly are the management and update requirements. Further costs will be incurred if standby staff is required for emergency live feeds, new analyses, and labor intensive activities. The best way to mitigate these expenses will be to embed the emergency services with other routine activities of the communications function.

Who would be made responsible for the acquisition of data, how could it be monitored, checked for quality, and procedures standardized and enforced? Furthermore, who would pay for such services and the effort to produce initial data, and how would they be charged? One model might be a requirement on franchised telephone companies to pay for the service, through charges on customers.

A similar set of questions can be raised in relation to the quality of information supplied and the responsibility to keep it updated and accurate. Given the seemingly poor performance of data handling for infrequent, non-commercial uses (such as the erroneous, out of date spatial use data that led to the American bombing of the Chinese Embassy in Belgrade in 1999), we must be very cautious about the accuracy and timeliness of critical data. Some of these kinds of problems will surely become less significant as homeland security and earthquake disaster awareness rises.

Many of the suggestions offered so far would be unacceptable to some interests. Some of them violate common norms of what is inappropriate to share, such as office layouts. Some go still further and challenge data privacy. Even beyond these issues, commercially sensitive matters such as office facilities and the presence of and location of special equipment might militate against getting some of this information. One might hope also that a proper balance could be struck between intrusiveness and security on the one hand, and the value of the data for its utility in times of emergency.

3 Conclusion

The dreams of extensive networks of third-generation mobile telephones, or some more advanced, Internet protocol standard mobile communication devices have been directed to entertainment and commercial applications. While further imagination will bring about other uses perhaps more appropriate to our personal situations and needs, thinking about the functionality and content of mobile communications devices in times of emergency gives us a higher goal, one of importance to our lives and even large scale social interests. The opportunities here are extensive and deep reaching. They imply a new focus on the individual's needs, from escape and assistance to providing the means to communicate under conditions of destruction, stress, and surrounding chaos. But they also demand much imaginative thinking about the kinds of information that emergency workers can use and provide, how to manage the production and maintenance of that content, and perhaps most importantly, revisiting the most basic challenge of ensuring that these capabilities are appreciated and used.

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