A Simple Taxonomy for Mobile Emergency Announcement Systems

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ABSTRACT

Mobile communications networks and devices can be and have been used by authorities to warn and instruct the general public during crises. However, our understanding of ***how*** mobile technologies could ***best*** be used for emergency announcements (public warnings) is currently limited. To clarify one part of this field of study, we define and describe a simple taxonomy for mobile emergency announcements (MEA) systems. The taxonomy has three categories: pre-planned MEA systems, ad-hoc MEA systems and semi ad-hoc MEA systems. Differences in functional, security and other requirements were found between MEA systems belonging to different taxonomy categories, both concerning how each category of MEA systems can meet the common requirements, and concerning which requirements are the most important for each category of MEA systems. The differences between the categories were especially clear for these requirements: the understandability and credibility of the MEAs and the security of a MEA system.

Keywords

Mobile emergency announcement system, MEA system, taxonomy, pre-planned MEA system, semi ad hoc MEA system, ad hoc MEA system, civil defense, public warning, disaster recovery, incident management, crisis information

INTRODUCTION

In the developed world traditional broadcast media are loosing their penetration and the general public's media use is growing exceedingly motley (Directorate-General Information Society, 2004; FCC, 2004, p. 13; Jääsaari, Kytömäki and Ruohomaa, 2003, p.15-26). For civil defense and crisis management authorities this trend poses new challenges. When a crisis occurs and emergency announcements (public warnings) need to be sent, how can authorities make sure that correct information reaches enough people in the affected area fast enough?

At the same time, mobile communications networks and devices have become ubiquitous in the developed world and they spread with accelerating speed throughout the developing world as well. We believe that methods and models are needed for using these networks and devices wisely and efficiently in civil defense and disaster recovery situations. This analysis started from the question: "How much planning and testing goes into a particular mobile emergency announcements (MEA) system and does the amount of planning and testing have implications on how that particular MEA system should be designed or used?"

Motivation for MEAs in General

People usually get most of their information about major disasters and accidents through mass media (radio and television). However, most people typically receive the first bits and pieces of information about such emergencies through interpersonal communication (Wiio, 1995). This interpersonal communication poses a risk since communications between people tend to be ambiguous at best, and on many occasions the message changes on the way. This is one reason why we need emergency announcement (EA) systems that can target a group of people in the affected area with one or more EAs that they can rely on, i.e. they know that the EA contains the latest and most up-to-date information and comes from a reliable source.

Current mobile communications networks and devices have useful features for crisis recovery and management: the devices (and with them, hopefully, their human users) can be located and messages can be sent to groups of located devices. However, the reliability and security of some mobile technologies seem inadequate for emergency announcements (Valtonen, Addams-Moring, Virtanen, Järvinen, Moring, 2004). We believe that when new mobile

technologies mature, MEA systems will be designed based on them. More importantly, we believe that in certain situations, MEAs can be successfully sent using current mobile technologies, despite of their shortcomings.

Motivation for This Taxonomy

We wanted to see if meaningful differences in the requirements for MEA systems can be found by categorizing these systems. In particular: are there types of MEA systems that do *not* need to meet *all* the requirements for MEA systems presented in earlier literature (FCC, 2004; McKinley and Turk, 2004; Samarajiva, Anderson and Zainudeen, 2005; Valtonen et al., 2004)?

Terms and Definitions

Emergency announcements (EA) are messages that the authorities send to the general public in an emergency or crisis. *Mobile Emergency Announcements (MEA)* are EAs sent to mobile communications devices such as mobile phones, PDAs etc. (Valtonen et al., 2004) In this article *a MEA system* refers to those parts and components of a MEA sending and receiving system that are designed, used or controlled by emergency management authorities.

The mobile communications networks and devices considered in this article are *mobile phones and networks* of these types: Global System for Mobile Communication or second generation systems (*GSM*, 2G), Universal Mobile Telecommunications System or third generation systems (UMTS, *3G*) and fourth generation systems (*4G*). The possible format for MEAs primarily considered is the different generation systems' short message services' (SMS) *text messages*.

Mobile positioning and *mobile location* are two different things, although in everyday conversation they are often used as they would mean the same. Mobile positioning means determining the position of a mobile device within the mobile network, and mobile location means estimating the geographical location based on the mobile positioning. (MobileIN.com, 2004)

Scope

Our frame of reference for mobile networks and phones is a Scandinavian and European view (how the networks are configured or how the phones are typically used in these areas). However, we have not included language or other strongly local features in our analysis, so the taxonomy should be also more generally applicable.

Goals

Our aim is to make it easier for researchers, system designers, crisis response authorities and other stakeholders to analyze requirements for different MEA systems. We thus set out to find one possible basis (a taxonomy) for analysis and decision making concerning MEA systems. We will first define and describe a simple taxonomy for MEA systems. We will then analyze existing emergency announcements systems and recent emergency situations to test how the taxonomy fits reality. Then we will analyze each MEA system category in our taxonomy against the requirements indicated by the FCC (2004), McKinley et al. (2004), Samarajiva et al. (2005), Valtonen et al. (2004) and Wiio (1995), to find out if the taxonomical category of a MEA system (in this case the roughly estimated amount of planning and testing before the MEA system is used) affects the requirements for that MEA system.

PROPOSED TAXONOMY

We propose the following, rather coarse-grained, categorization of MEA systems:

1. pre-planned MEA systems
2. semi ad hoc MEA systems
3. ad hoc MEA systems

The differentiating dimension between these three categories is: "How thoroughly (e.g. how long beforehand and in how extensive detail) have the authorities *planned* to use this particular technology *for MEAs*?" The central characteristics of the three MEA system categories are explained below.

Pre-planned MEA Systems

As the name suggests, pre-planned MEA systems are designed and built to enable the authorities to send MEAs in a crisis situation. They are built to be robust (reliable) and they are used in emergencies if they continue functioning at least sufficiently despite of the emergency conditions. Typical characteristics for a pre-planned MEA system are, for example:

1. it takes a long time to develop the system (from months to years)
2. the system can be thoroughly tested, both technically, functionally and organizationally (for example through intra- and inter-authority training scenarios), in its actual operating environment

3. it takes a short time to take the system into use (optimally from seconds to minutes after the decision to send one or more MEAs through the system is reached)
4. the system is well-known to the authorities that developed it (due to 1 and 2 above)
5. the system is well-known to the authorities that use it (due to 2 above)
6. the system is well-known to the public, as informing the public accompanies system development and testing
7. the risk of the general public not believing the MEAs that the authorities send is minimized (due to 6 above)
8. the risk of the general public misunderstanding the MEAs that the authorities send is minimized (due to 2 and 6 above)
9. the system can become an attractive target in itself for organized crime activities, terrorism, revolutionary forces, acts of war etc. (due to 7 and 8 above)

Semi Ad Hoc MEA Systems

We define semi ad hoc MEA systems thus: they are designed and built to enable the authorities to (re)create the needed infrastructure so that the general public can receive MEAs in a crisis area. They are built to be energy-efficient or energy-independent and robust (reliable), and at least one component of an ad hoc MEA system is mobile. They are used in emergencies if the pre-planned MEA systems are not available or do not function sufficiently, either as a complement or as a replacement for pre-planned MEA systems. Last minute adjustments to software or hardware may be needed before a semi ad hoc MEA system is used. Typical characteristics for a semi ad hoc MEA system are, for example:

1. it takes a long time to develop the system (from months to years)
2. the system can be tested technically, functionally and organizationally (for example through intra- and inter-authority training scenarios), but the mobile component can not necessarily be tested in all possible use areas
3. it takes a rather short time to take the system into use (from hours to days after the decision to send one or more MEAs through the system is reached)
4. the system is well-known to the authorities that developed it (due to 1 and 2 above)
5. the system is not necessarily well-known to the authorities in the area where it is used (due to 2 above)
6. the system is not necessarily well-known to the public in the area where it is used (see 2 and 5 above)
7. a risk exists that the local public may not believe the MEAs that the authorities send (due to 6 above)
8. a risk exists that the local public may misunderstand the MEAs that the authorities send (due to 2, 5 and 6 above)
9. the system can become a target in itself for organized crime activities, terrorism, revolutionary forces, acts of war etc. (though this is perhaps not quite as likely as for pre-planned MEA systems, due to 7 and 8 above)

Ad Hoc MEA Systems

Ad hoc MEA systems, in turn, are originally designed and built for other purposes than to enable the authorities to send or the general public to receive MEAs. They are put to MEA use after the emergency is an already happened fact and when other MEA systems are not available or do not function sufficiently. Ad hoc MEA systems are a replacement or a complement for other MEA systems. Typical characteristics for an ad hoc MEA system are, for example:

1. there is no time prior to the emergency for system development, for training of the authorities or for informing the public
2. there is little or no time for testing the system before it is taken into use
3. the system has to be taken into use very soon after it has initially been thought of
4. the system, *in the role of a MEA system,* is most likely "developed" and used by the same authorities (due to 1-3 above) – there is little time for separate roles to emerge
5. the system, *in the role of a MEA system,* is not well-known to the authorities (due to 1-3 above) – but it should be well-known in its original role
6. the system, *in the role of a MEA system,* is not well-known to the public (due to 1 and 2 above) – but it should be well-known in its original role
7. a considerable risk exists that the general public may not believe the MEAs that the authorities send (due to 6 above)

8. a considerable risk exists that the general public may misunderstand the MEAs that the authorities send (due to 1, 2, 5 and 6 above)
9. the system is unlikely to become a target in itself for organized crime activities, terrorism, revolutionary forces, acts of war etc. (due to 1, 3 and 6-8 above)

TAXONOMY PROPOSAL IN A NUTSHELL

	Well known as MEA to the authorities	**Not well known as MEA to the authorities**
Well known as MEA to the general public	Pre-planned	N/A
Not well known as MEA to the general public	Semi ad hoc	Ad hoc

Table 1. The MEA systems taxonomy visualized

Our taxonomy can be visualized as in Table 1 above.

CURRENT SYSTEMS AND RECENT SITUATIONS THAT FIT THE TAXONOMY

We know of no pre-planned MEA systems that would be operational at the time of the writing of this article (late February 2005). However: there are (or have been) at least a couple of systems alike pre-planned MEA systems. For example, the Dubai Government in the United Arab Emirates has an extensive communications system towards residents of Dubai, based initially on mobile phones and text messages (Dubai e-Government, 2004). Dubai Civil Defence appears as one of the providers of push-type services on the official website. Yet, the website gives an impression that the service is for registered users only and not for the general public (i.e. anyone who has a mobile phone), so this service does not necessarily constitute a MEA system according to how Valtonen et al. (2004) defined MEA.

Additionally, Murdoch University in Perth, Western Australia, has developed and, during the summer of 2004, successfully tested "a proof-of-concept trial of a public warning system incorporating SMS, voice, fax, email, and on-line channels". The tested prototype system required user registration and utilized multiple communication channels for the MEAs, which were sent in several tests and in two real-life emergency situations, caused by an approaching cyclone and a bushfire, respectively. This project has now ended, with recommendations of further research and development. (McKinley et al., 2004)

In our opinion, the planning and functional design of the fourth generation mobile phone systems have already advanced so that it seems very likely that capability for MEAs will be a built-in, i.e. pre-planned, feature of all 4G systems. This direction is also indicated by the draft for "Specifications of a National All-Hazards Warning System for Sri Lanka" (Samarajiva et al., 2005, p. iii, 1). The draft envisions that mobile phones and networks will be a natural part of the country's all-hazard warning system by year 2016. Also in the USA, the FCC (2004, p.2,13) raises the issue of widening the base of technologies used for public warnings.

We know of only one semi ad hoc MEA system. In Alberta, Canada, they have designed and built a vehicle capable of (re)establishing mobile communications to an area where communications have been adversely affected by a smaller accident or a full-blown emergency (Meadahl, 2004).

Considering ad hoc MEA systems, after the terrorist attack on World Trade Center in New York on 11th September 2001, pager and mobile phones based technologies were used by the Wireless Emergency Response Team (WERT) in attempts to locate survivors (Malone, 2004). This was clearly ad-hoc emergency communication, and we might call at least part of the utilized technology solutions an ad-hoc MEA system. Unfortunately, this effort could not save lives.

In contrast, after the South-East Asia earthquake and tsunami disaster of 26th December 2004, many people were saved through authorities' creative use of mobile phones and networks. Examples are the Swedish, Norwegian and Finnish teleoperators who, in cooperation with authorities, utilized locating technologies and group text messages to instruct their customers about tourist evacuation flight schedules and pick-up points (MTV3, 2004; Maney, 2005). There is no exact data yet about how many lives were saved through various uses of mobile phones, but already during the first few days at

least 71 people were found thanks to mobile positioning (Lanka Business Online, 2004). Thus the 2004 Indian Ocean tsunami rescue effort may well mark the first ever large scale use of ad hoc MEA systems.

SYSTEMS AND SITUATIONS THAT DO NOT FIT THE TAXONOMY

There are also other systems, that remind of MEA systems, but do not fit either into the definitions of our taxonomy categories or into the Valtonen et al. (2004) definition of MEA used in this article:

- from authority to authority communications systems, such as the Royal National Lifeboat Institution's (RNLI) radio and wide area paging system (Zetron, 2001), Mobile Broadband for Emergency and Safety Applications (Project MESA, 2005), Terrestrial Trunked Radio (TETRA) (ETSI, 2005), Wireless Deployable Network System (WIDENS) (Koponen, 2004) and the Finnish radiation and nuclear authority's (STUK) routine use of GSM text messages to contact their preparedness personnel (Säteilyturvakeskus, 2003, p. 32)
- systems where messages are sent by a MEA service provider to pre-registered (paying) MEA customers only, such as the Global 2000 group's RAMOS radiation monitoring GSM text message service in Austria (Global 2000, 2003) and the City Alert Texting System C.A.T.S. in Britain (Eazytext.com, 2004)

REQUIREMENTS ANALYSIS FOR THE THREE TAXONOMY CATEGORIES

In this section we analyze each MEA system category in our taxonomy against the requirements indicated by the FCC (2004), McKinley et al. (2004), Samarajiva et al. (2005), Valtonen et al. (2004) and Wiio (1995) to find out if the taxonomical category of a MEA system affects the attainability or the relative importance of the different requirements for that MEA system.

Targetability: Locating Those at Risk

Targetability (FCC, 2004, p. 12; McKinley et al., 2004, p. 3, 17;Valtonen et al., 2004) is an important requirement for all taxonomy categories, because of the personal nature of a mobile device. If a person hears of a disaster on the television or receives an emergency announcement (EA) through the radio, he or she can assume that the message was not personally targeted and that the decision on how to act is at least partly based on personal responsibility and judgment. In contrast, if a person receives a MEA to his or her mobile phone he or she is likely to assume that the MEA was specifically meant for him or her. Consequently, the actions requested in the MEA may feel much more compulsory for the MEA recipients than for recipients of more general EAs.

Thus, if a MEA is received by people who are not in the crisis area, they may take action that is unnecessary at best and dangerous at worst. Therefore, using accurate mobile positioning and mobile location methods for locating people (or, more exactly, their mobile devices) in a crisis area is important, and especially so if ad hoc or semi ad hoc MEA systems are used, as they will introduce an extra element of surprise to the recipients' reactions.

The EU and US legislations both require that mobile operators must be able to provide authorities with the mobile location data for an emergency call from a mobile phone to the general emergency number (112 and 911, respectively) (EP & EC, 2002, art. 10; FCC, 2005). Moreover, the EU allows that member states legislate for additional uses of mobile location data, when such legislation serves public security (EP & EC, 2002, art. 15).

Security: Preventing Misuse or Deactivation of MEA Systems

The importance of the security requirement (FCC, 2004, p. 16-17; McKinley et al., 2004, p. 5;Valtonen et al., 2004) varies between the taxonomy categories, due to the differences in how MEA systems in the different categories come into being. For a pre-planned MEA system the security requirements are high. This is mostly due to this category's characteristics nr 6-9 described above – if a MEA system is highly believable for the general public and if it simultaneously is a possible target for various adversaries, it should be designed accordingly.

In sharp contrast, as ad hoc MEA systems are, per definition, not identified beforehand, it is difficult to imagine a successful attack against them. So the security requirements on an ad hoc MEA system are the lightest of these three taxonomy categories. Consequently, an ad-hoc MEA system should not be used for too long: lengthy use may create additional security risks.

Semi ad hoc MEA systems' security requirements are somewhere in the middle of the other two, in our opinion. The security requirements on the system are at least moderate (due to this category's characteristic nr 9 described above). Yet, the threat scenario may contain elements that are quite different from the threat scenario concerning pre-planned MEA systems (e.g. some adversary hijacking the mobile component of a semi ad hoc MEA system). Though it does, at first glance, seem as a difficult task to plan an attack against a system about which the adversary does not know where it is

going to be used, we must remember that an active adversary, who creates a man-made incident, will indeed have at least a shrewd guess about the general operations area to-be of at least one semi ad hoc MEA system.

Understandability: Making Sure MEAs Make Sense and Do No Harm

The understandability requirement is addressed by all earlier requirements literature that we found (FCC, 2004, p. 15-16; McKinley et al., 2004, p. 19; Samarajiva et al., 2005, p.2, 7;Valtonen et al., 2004; Wiio, 1995). From the taxonomy categories' characteristics lists presented above we see, that there are marked differences between the categories in how great the risk of misunderstanding is. This requirement is always important, and especially so if ad hoc or semi ad hoc MEA systems are used.

Credibility: Ensuring that MEAs Are Believed

Even though credibility (FCC, 2004, p. 9; Samarajiva et al., 2005, p. 7; Wiio, 1995) is an always important MEA system requirement, due to the different characteristics of our three taxonomy categories, they offer different levels of credibility. The authorities can not realistically expect that MEAs sent through semi ad hoc or ad hoc MEA systems will always be believed.

To ensure credibility, a pre-planned MEA system should maintain a good reputation. During normal (non-emergency) conditions it could, for example, provide necessary education about what to do in an emergency. The more people learn, the better judgment they will have in emergencies. Education can help people to correctly assess the credibility of MEAs sent through semi ad hoc and ad hoc MEA systems, too.

Coverage and Application Range: Reaching Enough People

One important requirement for MEA systems is coverage, called "population reachability" by Valtonen et al. (2004). So, even when pre-planned MEA systems have come into being, semi ad hoc MEA systems will be necessary for at least two reasons. First, for sparsely populated areas, building a semi ad hoc MEA system may be easier than building a pre-planned MEA system; and second, in an emergency, the infrastructure of a pre-planned MEA system might be impaired. Hence, semi ad hoc MEA systems can be used to enlarge or to recover the coverage of pre-planned MEA systems.

Ad hoc MEA systems' whole idea and raison d'être is to recover the coverage lost due to problems with other MEA (or EA) systems. When even the semi ad hoc MEA systems are destroyed or severely impaired, ad hoc MEA systems may be the only source of information. Their coverage varies in different situations, though – for example, there typically are more usable resources for ad hoc MEAs and thus a better coverage available if an emergency happens in a shopping center compared to a skiing resort.

Other Requirements Show only Small Differences between the Taxonomy Categories

Other MEA system requirements, such as the ability to push content, reliability and tolerable cost (Valtonen et al. 2004) do not, in our opinion, uncover real differences between the taxonomy categories. Neither do relevance or being action-oriented (Samarajiva et al., 2005, p. 7), redundancy (FCC, 2004; McKinley et al., 2004, p. 3, 17; Samarajiva et al., 2005, p.7) or timing (Samarajiva et al., 2005, p.7;Valtonen et al., 2004). These are all important requirements for all categories of MEA systems.

DISCUSSION

It appears that of the taxonomy categories we propose, only pre-planned MEA or EA systems have been considered in earlier scientific publications and other sources (Eazytext.com, 2004; FCC, 2004; McKinley et al., 2004; Samarajiva et al., 2005; Valtonen et al., 2004). Even though practical examples of ad hoc MEA systems (MTV3, 2004; Maney, 2005) and at least one semi ad hoc MEA system (Meadahl, 2004) exist, we have not found any scientific publications or other documents that would identify concepts akin to our taxonomy.

Our taxonomy is simple, but already at this granularity it helps us to identify clear dissimilarities between the requirements for different taxonomy categories of MEA systems.

Our analysis indirectly suggests that the definition of MEA should be reconsidered. If authorities send an emergency announcement into an crisis area and only to pre-registered mobile devices (as opposed to locating "any and all" mobile devices and sending the emergency announcement to all of them), under some conditions this, too, could be labeled as utilizing a MEA system.

One practical question related to the development of MEA systems is: how to integrate different existing and new emergency announcement systems and still keep the announcements that are sent through them consistent? This corresponds to the Write Once Message Composition requirement of McKinley et al. (2004, p. 3), which their system appears to have fulfilled well. Another possible solution is that only one government division takes the responsibility of

issuing EAs and MEAs to all EA and MEA systems, no matter what kind of emergency. However, this approach may create a single point of failure, which is not acceptable for any emergency announcement system.

Ad hoc MEA systems can not be fully controlled by a government. Therefore, and due to the different credibility levels described above, in case of inconsistency, the pre-planned or semi ad hoc MEA systems should hold priority over ad hoc MEA systems. Additionally, the pre-planned and semi ad hoc MEA systems could instruct people to be prepared for ad hoc MEAs if they themselves fail.

Furthermore, the role of non-emergency education, pre-emergency information and the knowledge level of the general public can not be emphasized enough. We only need to consider the school girl, who observed the strange behavior of the water and promptly told her parents what she remembered about tsunamis from a geography lesson, ultimately saving almost 100 people (Owen, 2005; SIS, 2005) and contrast that with the many grown-ups who curiously followed the receding water only to be washed away when the waves turned on them. It becomes glaringly clear that detailed and concrete enough information lies at the root of even the very young ones' ability to react appropriately in a crisis.

One obvious solution to the understandability problem connected to the ad hoc and semi ad hoc MEAs, besides education to the general public, is careful consideration of the content of the MEA or MEAs to be sent. In our opinion, there is information that can safely enough be sent through ad hoc MEA systems and, on the other hand, there maybe is information that should not be sent through MEA systems at all. Generally "safe" messages that would most likely not endanger anyone could contain such information as:

> *You are in an emergency area.*
> *Stay calm, help yourself and those around you.*
> *Use only text messages.*
> *Do not make voice calls.*
> *Help is coming in two hours.*

Such information could keep communications resources - the mobile phone networks, in this example - operational and maybe even help the rescue efforts by calming people. Note that the above example MEA contains 150 characters and would fit in even an ordinary GSM text message (their limit is 160 characters).

FUTURE WORK AND CONCLUSIONS

In the future, this taxonomy may develop into a multidimensional taxonomy with more granularity. More intermediate taxonomy categories or some type of scale to measure where in the "space of potential requirements" a certain category of MEA systems would belong could also be developed. This could make the planning and design process of MEA systems and the information and training related to them more efficient in the long run.

Yet a basic and important question remains: how do we balance different classes of MEA system requirements (e.g. security requirements such as the authenticity, integrity and non-repudiation of the MEA content) with each other and with other MEA system requirements (e.g. coverage, targetability and the understandability of the MEA content)? Our taxonomy does not give a direct answer, but takes one step towards it - hopefully in the right direction.

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REFERENCES

1. Directorate-General Information Society (EU) (2004) Fuel for the Information Society. At http://europa.eu.int/information_society/industry/content/index_en.htm. Referenced: 23-FEB-2005.
2. Dubai e-Government (2004) The mDubai site. Available at http://www.mdubai.ae/. Referenced: 23-FEB-2005.
3. Eazytext.com (2004) C.A.T.S. City Alert Texting System. At http://www.cityalert.co.uk/static/index.htm. Referenced: 23-FEB-2005.
4. EP & EC, European Parliament and Council of the EU (2002) Directive 2002/58/EC on privacy and electronic communications. Available at: http://europa.eu.int/eur-lex/.
5. ETSI (2005) TETRA. At: http://www.etsi.org/etsi_radar/cooking/rub7/tetra_a.htm. Referenced: 24-FEB-2005.

6. FCC, Federal Communications Commission (USA) (2004) Review of the Emergency Alert System. At http://www.fcc.gov/eb/Orders/2004/FCC-04-189A1.html. Referenced: 23-FEB-2005.
7. FCC, Federal Communications Commission (USA) (2005) Enhanced 911 - Wireless Services. At: http://www.fcc.gov/911/enhanced/. Referenced: 25-FEB-2005.
8. Global2000 (2003) ATOM/RAMOS Radiation Monitoring System. Available at http://www.global2000.at/. Referenced: 23-FEB-2005.
9. Jääsaari J., Kytömäki J. and Ruohomaa E. (2003) Yleisradio – Yleisökertomus03 (audience report 2003). At http://www.yle.fi/yleista/kuvat/2003yleisokertomus_kevyt.pdf. Referenced: 23-FEB-2005.
10. Koponen K. (2004) WIDENS – Overview – Motivation. At: http://www.widens.org/. Referenced: 24-FEB-2005.
11. Lanka Business Online (2004) Saving Grace. At http://www.lankabusinessonline.com/new_full_story.php?subcatcode=5&catname=ICT&newscode=620330730. Referenced: 23-FEB-2005.
12. Malone B. (2004) Wireless Emergency Response Team (WERT) - Emergency Wireless Communications. At http://public.ansi.org/ansionline/Documents/Standards%20Activities/Homeland%20Security%20Standards%20Panel/Emergency%20Communications%20and%20Citizen%20Readiness%20Joint%20Workshop/Workshop%20Presentations/. Referenced: 23-FEB-2005.
13. Maney K. (2005) Cell phones, Net could have saved thousands from waves. At: http://www.usatoday.com/tech/columnist/kevinmaney/2005-01-04-maney_x.htm. Referenced: 25-FEB-2005.
14. McKinley M. and Turk A. (2004) Newsbug. Multi-channel public emergency messaging system. Final report. Available at http://www.itri.tv/newsbug/. Referenced: 23-FEB-2005.
15. Meadahl M. (2004) Emergency vehicle given workout. At http://www.sfu.ca/mediapr/sfu_news/archives/sfunews09090413.html. Referenced: 23-FEB-2005.
16. MobileIN.com (2004) Mobile Positioning. At: http://www.mobilein.com/mobile_positioning.htm. Referenced: 25-FEB-2005.
17. MTV3 (2004) Kymmenen Uutiset (television news, in Finnish), 29-DEC-2004. Content also available (in Finnish) at http://www.mtv3.fi/uutiset/ulkomaat/ulkomaat.shtml?2004/12/339217. Referenced: 30-DEC-2004.
18. Owen J. (2005) Tsunami Family Saved by Schoolgirl's Geography Lesson. At http://news.nationalgeographic.com/news/2005/01/0118_050118_tsunami_geography_lesson.html. Referenced: 24-FEB-2005.
19. Project MESA (2005) You and MESA – What can project MESA do for public protection, public safety, national defense organizations and the citizens they serve? At: http://www.projectmesa.org/you/home.htm. Referenced: 24-FEB-2005.
20. Samarajiva R., Anderson P. S. and Zainudeen A. (2005) Interim Concept Paper: Specifications of a National All-Hazards Warning System for Sri Lanka. At: http://www.lirneasia.net/wp-content/Concept%20Paper%203Feb05_01.pdf. Referenced: 25-FEB-2005.
21. Säteilyturvakeskus (2003) Toimintakertomus ja tilinpäätöslaskelmat 2003 (annual reports 2003). At http://www.stuk.fi/stuk/fi_FI/avainluvut/_files/71376479375589879/default/STUK_toim.kertomus_2003.pdf. Referenced: 23-FEB-2005.
22. SIS, South Island School (Hong Kong) (2005) Tilly Smith's Story. At: http://www.sis.edu.hk/School%20Features/Tsunami/Links/TillySmiths%20story.html. Referenced: 24-FEB-2005.
23. Valtonen E., Addams-Moring R., Virtanen T., Järvinen A.and Moring M (2004) Emergency announcements to mobile user devices in geographically defined areas. In B. Carle and B.Van de Walle, editors, Proceedings of the 2004 Information Systems for Crisis Response and Management (ISCRAM) workshop.
24. Wiio O.A (1995) What we know about communication in a crisis. IAEA Workshop on Information to the Public, in Helsinki on May 9-12th 1995.
25. Zetron (2001) Faster Call-out Helps Save More Lives. At http://www.zetron.com/pages/english/realw/real138.html. Referenced: 24-FEB-2005.