Extended Abstract

Last Mile – the Neglected Element of Early Warning Systems

Jan Skrbek

Department of Informatics, Technical University of Liberec, Liberec, Czech Republic

E-Mail: jan.skrbek@tul.cz

Tel.: +420-485-3582-442

Accepted: sciforum-004476

Introduction

Ten years after tragically tsunami attack in Indian Ocean the situation in early warnings of stakeholder of natural disasters is dramatically improved, but still is not ideal. Following paper brings several critical views on current situation in a special aspect of Early Warning Systems – namely „last-mile“ of communication channels in emergencies and special situation. It introduces possibilities and advantages of addressable forced broadcasting (Radio-Help) and describes a major component of its receiver – personal communication terminal. There are also mentioned the managerial aspects of distribution of emergency information and possibilities of using the suggested system in daily life.

After the catastrophic tsunami attack in December 2004 with 230 thousand victims the significant research agencies focused their activities on the research and implementation technologies and resources, enabling the early identification of tsunami threats. In this area, significant progress has been achieved. They were created functional mathematical models, reflecting specific situation and allowing simulate the flow of natural disasters and effectively identify the degree of danger and threats. Level of risk by such events has been greatly reduced [3].

Current early warning systems are aimed at encouraging residents and institutions in situations that can be expected to advance tens of hours. Such emergencies are mostly connected with natural disasters like hurricanes and storms. Distribution of information in unexpected situations (tsunami, unexpected earthquake, terrorist attack,…) is the subject of various solutions, based not only on technologies opportunities and capabilities, but mainly on policy decisions on governmental level. An increasing number of terrorist attacks at the beginning of 2015 reveal some weaknesses of current early warning systems – e.g. distribute needed information during forced shutdown of mobile networks and Internet.

An Emergency Population Warning

The origins of building early warning systems for large groups of population could be found between two world wars last century. One of the base requirements of warning systems was to build an extensive network of warning sirens. An integral part of warning technologies has been training people how to behave in cases of threat and danger. The performance of alerting infrastructure decreased dramatically after the collapse of communist regime at European countries at the beginning of nineties. It becomes increasingly difficult to bridge the "„last-mile"" between local emergency management authorities and the population in times of crises [5].

The introduction of new technologies brings intense challenges to their application for the „last-mile" communication in the frame of early warning systems. However, there is no unified concept for newly conceived schemes of communication channels. The approaches of individual countries and regions to the „last-mile" communication differ from each other even dramatically [3], [4].

Recently published a number of papers deal with the issue of accessibility and usability of communication channels. Klaft [5] on the example of subscription-based "Katwarn" system (multi-channel alerting system, which offers the possibility to distribute alerts via SMS, e-mail, and pagers) tested reception of warning information (majority participants were people with some affiliation to emergency management). The alert message was randomly generated and sent on August 24th, 2009 at 14:09 CET. Approx. 25% of participations noticed and read the alert within ten minutes. This ratio increased to 32.4% within twenty minutes, to 47.9% within one hour. After five hours more than 35 % of participants didn't make any action (!).

Another Katwarn case study observed actual user behavior on the same subscription-based system. After sending the test alert message at 9:58 a.m. to approx. 14 thousands subscribed users, the log files of the information website were analyzed to see how often the site had been accessed. Within ten minutes were identified only 6.1% of alert recipients. This number increased to 8.5% within 30 minutes and to 11.6% within two hours. After 24 hours, the ratio reached 17.4% (!).

Research in Indonesia costal municipality [10] provides information about quantification of access to media by the type of media and time of the day. In the morning the main availability to get access is represented by mobile phones (63 %), TV (60 %), radio (55 %). Access to TV and radio raises during the day to 88 % (TV at the evening) and 64 % (radio). Sirens cover less than 48% of people.

The role of early warning systems does not finish with the end of emergency. It is necessary to maintain communication connection even in times of crisis and in subsequent stages, i.e. recovery and resilience. Major problem remains to scientists and policies - how to effectively deliver the authorized recipient in case of emergency necessary adequate information in a timely manner, i.e. at the right time to the right place.

It is evident that in the case of dramatic situations of X-events type (long-term failure of electric power grid, electromagnetic pulse,…) our civilization will lose all possibilities associated with modern communication technologies [1]. A similar situation is becoming a reality, however, immediately after any larger accidents and disasters. Tsunamis, earthquakes, floods and hurricanes are accompanied by blackouts of electricity, dropouts of mobile networks and the Internet. In the period of global increase of terrorism grow needs for immediate transmission of information and guidance to people in vulnerable zones. In many situations is appropriate to provide different information to people located in different places [7].

For efficient transfer of information is optimal to use the widest range of communication channels and options. It is, however, evident, that the applicability of some advanced technologies, especially based on mobile communications, is in many types of disasters very limited.

On the other hand - no system is ever perfect. The answer for a question - "High" or "low" technology is better for crises communication - seemed to be very simple: as "low" as possible by the principles – with a respect to potential loss of technological and energy infrastructure. Next paragraphs describe original solution of information channel that fulfill main demands for efficient communication channel in disasters and crises.

Main Principles of Radio-Help

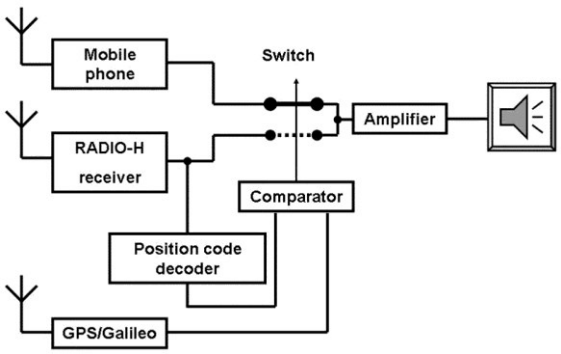
The default requirements for RADIO HELP system were an effort to eliminate the shortcomings of the current distribution of warning messages. Radio-Help in its concept uses existing technological components and solutions, but integrates them into new functional units. The basic requirements, which should the designed system meet, are:

- the availability of adequate information to every people,
- independence on functionality of mobile networks and the Internet,
- mediation of trusted information from an authorized source,
- geographical addressability for distribution of information,
- security of the system - resistance to abuse,
- financial and time feasibility,
- possibility of continuous testing and auditing functionality,
- usability for other applications.

In terms of overall design is a key issue the choice of communication media. As an optimal, affordable and widely tested for the purpose Radio-Help seems to use the concept of HD Radio. In principle, HD Radio technology is based on superposition of digital channels to analog signal carrier frequency of radio transmitter.

The crucial point of the system is the receiver - „Personal Communication Terminal" – PCT. In principle it could be an HD-RADIO receiver that is integrated into wide-spread personal equipment, e.g. a smart phone. The PCT could also be recharged by internal or external mechanical boost of the battery.

Figure 1. Personal Communication Terminal – block scheme [7]



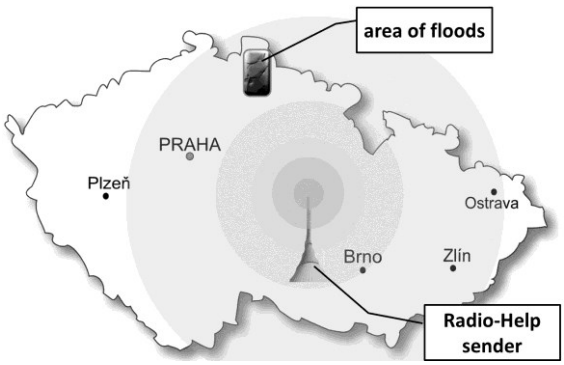
Solution of addressable receiving of the Radio-Help is that superposed digital signal of the transmitter carries in encrypted form an "address" of geographic area for which the transmitted information is intended. The PCT is equipped with a satellite position system (GPS, Galileo etc.) that generates position codes (Fig. 2). The transmitter of Radio-Help digitally sends an identification code for the targeted area (i.e. the position code) and/or a special code of an individual PCT (Special codes could be used for responsible persons that have to be notified regardless of their position). The PCT continually checks the internal and/or position code of the Radio-Help sender and activates itself for receiving the broadcast only with matching of the internal and received identified code. If position and/or internal codes of PCT and broadcasting sequence do not match, no sound is activated on the receiver. If internal and receiving codes match, the system automatically switches the receiver on for reception of needful information. Switch-of code broadcasted at the end of each session switches the receiver back into standby mode.

The only thing required to upgrade a current mobile phone (with GPS) is the addition of one Radio-Help chip with a code comparator. The receiver of Radio-Help can be integrated into any audio and audio/video devices. Immediately it could be used in all voice sirens and public information systems (e.g. in supermarkets, shopping centers, schools, factories etc.). Such systems just need once setup (e.g. by the initial switching on) the position code.

The exclusive transmitter

The transmitter of Radio-Help is a crucial point of the entire system. It is an authorized radio transmitter (controlled by the state or the army), which must be able to long-term broadcast from a protected area also in the case of a forced radio silence. It provides nationwide coverage of crisis broadcast throughout the country via analogue, preferably LW or MW transmitter, in whose modulation is superposed digital signal. For a dissemination of verbal information is sufficient channel with a frequency range of 200 to 4000 Hz. On one analog carrier signal is thus possible to simultaneously superposed multiple digital information channels for parallel addressed broadcasting to multiple locations or e.g. in multiple languages.

Figure 2. Radio-Help broadcasting for the affected area of floods [9]



Results and Discussion – Example of Practical Application of Radio-Help System in Traffic

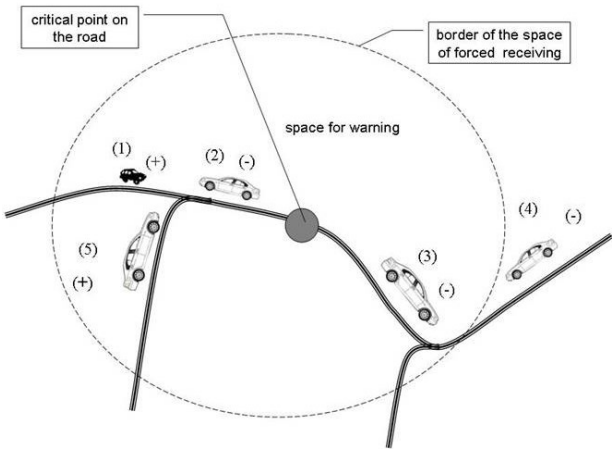
Any early-warning emergency system has to be positively accepted by potential and real users and regularly tested in terms of functionality and possibilities of improvement and development. The best

form is the sustainable use of the system for the transmission of information of "very practical content" which learns users to use the system effectively.

Wide areas of applications bring the integration of Radio-Help receiver into sound systems in cars and navigation systems. A “Radio traffic terminal” is a device receiving information through one unique communication channel in any region. It provides a forced voice (and/or data) session, activated only in a particular geographical area thus delivering warning messages only to the relevant recipients. In practice, we may be able to provide a road user, depending on his current position and travel direction, with automated information on a danger ahead (traffic accident) almost immediately.

The radio traffic terminal system uses Radio-Help technology enhanced by a GPS system. If warning data could be broadcast from an extensive eCall system, it would be very efficient in helping decrease the number of car’s accidents.

Figure 3. Principles of Radio-Help in traffic application [7]



Conclusion

The aim of this paper was to indicate the current status system, possibilities system, weaknesses and opportunities of current early warning systems. Greater attention has been paid to the Radio-Help system, which is capable - in the case of governmental support - to ensure information distribution to needy people in appropriate areas.

Acknowledgments

This paper was supported by the SGS research project of the Technical University of Liberec “New possibilities of advanced information and communication technologies in solving of uncommon situation”.

References and Notes

1. CASTI, John, L. *X-events: The collapse of everything*. 1st ed. New York: HarperCollins Publisher, 2012, ix, 326 p. ISBN 00-620-8828-9.
2. COOMBS, Timothy, W. *Ongoing crisis communication: planning, managing, and responding*. 3rd ed. Thousand Oaks, Calif.: SAGE, 2012, xv, 231 p. ISBN 14-129-8310-X.

3. GOLNARAGHI, Maryam (Ed.). Institutional Partnership in Multi-Hazard Early Warning Systems: Synthesis of Seven Good Practices in Multi-hazard Early Warning Systems. Heidelberg: Springer, 2012, p. 217-238. ISBN 978-3-642-25373-7.
4. KEENEY, Harold, Jr., Steve BUAN and Laura DIAMOND. Institutional Partnership in Multi-Hazard Early Warning Systems: Multi-Hazard Early Warning System of the United States National Weather Service. Heidelberg: Springer, 2012, s. 115-158. ISBN 978-3-642-25373-7.
5. KLAFFT, Michael. Diffusion of emergency warnings via multi-channel communication systems an empirical analysis. In: *2013 IEEE Eleventh International Symposium on Autonomous Decentralized Systems (ISADS)*. Mexico City: IEEE, 2013, p. 1-5. ISBN 978-1-4673-5069-3. DOI: 10.1109/isads.2013.6513437.
6. KLAFFT, Michael and Hans Georg ZIEGLER. A Concept and Prototype for the Integration of Multi-Channel Disaster Alert Systems. In: *EATIS' 14*. Valparaiso, Chile: IEEE, 2014, s. 1-4. ISBN 978-1-4503-2435-9. DOI: 10.1109/isads.2013.6513437.
7. SKRBEK, Jan. Advanced Early Warning Systems and Radio-Help – State-of-the-Art. In: *2013: Information Technology, Human Values, Innovation and Economy, 21st Interdisciplinary Information Management Talks*. Linz: Trauner Verlag, 2013, s. 39-46. ISBN 978-3-99033-083-8.
8. SKRBEK, Jan, David KUBAT, Tomas ZIZKA, Jiri KVIZ a Klara ANTLOVA. Ambient Traffic Services Based on the Use of Agile Warning and Notification System Radio-Help. In: *AMBIENT 2012 : The Second International Conference on Ambient Computing, Applications, Services and Technologies*. Barcelona: International Academy, Research, and Industry Association, 2012, p. 7-11. ISBN 978-1-61208-235-6.
9. SKRBEK, Jan. Advanced Ways and Means of Civilian Notification in Crisis Situations. In: *Proceedings of the 10th International konference: Liberec Economic Forum 2011*. Liberec: Technical University of Liberec, 2011, s. 419-426. ISBN 978-80-7372-755-0.
10. TAUBENBÖCK, H., N. GOSEBERG, G. LÄMMEL, N. SETIADI, T. SCHLURMANN, K. NAGEL, F. SIEGERT, J. BIRKMANN, K.-P. TRAUB, S. DECH, V. KEUCK, F. LEHMANN, G. STRUNZ a H. KLÜPFEL. Risk reduction at the "Last-Mile": an attempt to turn science into action by the example of Padang, Indonesia. *Natural hazards*. 2013, vol. 65, issue 1, p. 915-945. ISSN 1573-0840

© 2015 by the authors; licensee MDPI and ISIS. This abstract is distributed under the terms and conditions of the Creative Commons Attribution license.