RADIO-HELP AS A SMART EARLY WARNING AND NOTIFICATION SYSTEM

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ABSTRACT

Crises can occur on any day in our lives. Contemporary society is increasingly exposed to a multitude of situations where it is required to reconcile the diverse information needs of differing groups of people in different places. The consequential level of economic and human loss depends on timely and relevant information distribution together with appropriate guidance to actual and potential victims.

The sharing, distribution and dissemination of adequate information in special and unexpected situations is one of the crucial roles of any governmental level. Unfortunately this role is not always fulfilled correctly. The current emergency and communication systems, controlled mostly by governmental agencies, are currently unable to satisfy the existing information needs of individuals as well as distributing the required information only to affected areas. Critical deficiencies of current warning system are highlighted in the paper, including failure of information channels during electrical black-outs and absence of positional based broadcasting.

The article describes Radio-Help as a possible solution based on the integration and exploitation of existing ICT. The special broadcasting sender transmits in HD-Radio or DRM mode data and voice to Personal Communication Terminals (PCT) that are, for the most part, already integrated within mobile phones. The role of PCT is compared with that of position codes in digital broadcasting. Matching of internal and received codes activates radio reception in the target location. The Radio-Help receivers could be realized as an integral part of any audio/video devices.

This paper outlines systemic approach to alternatives based on the integration and application of Radio-Help system with respect to real problems using examples in transport and electricity distribution.

Keywords: Communication; emergency; crisis; information; distribution; Radio-Help, position based broadcasting

INTRODUCTION

On March 11, 2011 a massive earthquake occurred near Japan, created extremely destructive tsunami waves which hit Japan just minutes after the earthquake. Millions of people were affected by lack of electricity, water, transportation and - information. A month after the earthquake the number of crash victims raised above 27 thousands of people. On the TV and Internet we watched practically on-line the big tragedy. For many

people on movies (especially driving their cars or watching tsunami from bridges) that were last seconds of their lives. They really got – in Japan - no warning information?

Japan has the most advanced earthquake early-warning system in the world. A nationwide online system launched in 2007, it detects tremors, calculates an earthquake's epicenter and sends out brief warnings from its 1,000-plus seismographs scattered throughout the country, one of the most earthquake-prone nations on the planet. (Birmingham, 2011).

Center European countries are outside the danger of tsunami, nonetheless flooding starts to be in many regions an unexpected, but frequent state of weather. The 2009 European floods were a series of natural disasters which took place in June 2009. Austria, the Czech Republic, Hungary, Poland and Slovakia were all affected. The heavy rains caused overflowing of the rivers Oder, Vistula, Elbe and Danube. At least 13 people were killed in the Czech Republic alone. Sudden and severe cloud-bursts caused floods, not only near big rivers but also in the countryside. In a few minutes, the water level in small rivers rose massively (e.g. from 35 cm to 6 m in region Novy Jicin). One of the first affects of these floods was the loss of electricity, the ability to watch TV and listen to the radio. Mobile phone transmitters were also damaged.

Just a year after, similar situation took place in Liberec region in August 2010. A massive flash floods killed people, destroyed homes and livelihoods. This region was faced never in history with such situation. Some 2,000 people were evacuated during the disaster, which destroyed two water treatment plants and dozens of homes. Many roads and bridges were damaged or made impassable by the floodwaters, and several rail lines were forced to close. The center of the town Frydlant was covered in 1,5 m of water. The cost of the damage during few hours caused were in excess of 300 millions of EUR. Almost 5,000 homes were for more than three days without either electricity or gas supply. More then 200 people had to be evacuated by helicopters…Why people did not leave their homes in time? Why did not get the urgent information that the level of the water will dramatically rise in minutes?

Czech TV on the channel CT24 permanently informed about crisis situation through live broadcast from floods areas, by running commentary of experts, politicians and representatives of regional government and rescue services. The TV organized a floods-facebook, which was full of videos and comments. People in affected areas got no information and instruction what to do... Nigger in the fence subsists on the fact, that one of the first affects of floods is a total electric black-out. Radios, TVs, Internet as well as mobile phones were shut up. The radio and TV broadcasting and Internet were possible to listen, watch and use far away from floods. The recipients of such broadcasting were people comfortably sitting in their chairs by TV or computer screens. No one fighting with floods had an advantage to take such kind of information...

In Liberec region as well as this year in Japan were available no systems of REAL notification of an emergency. Current early warning systems were evidently used, but they did not affect great deal of potential victims. Is it possible to find a systemic way how to improve it? (Skrbek, 2010-3)

Would be possible by different types of disasters - in current information age - to alert affected people in time and thus give them a better chance for saving their lives, health and materials? They just need adequate information, early enough for appropriate actions to be taken, in a multitude of places, situations and locations. Does the opportunity to do this, now exist?

COMMUNICATION NEEDS IN CRISIS AND NATURE DISASTERS

21st century civilization has been increasingly exposed to various crises: natural events, operational breakdowns and terrorism. Besides those at national and regional level, unexpected localized situations are emerging with increasing regularity – be they traffic (calamitous situations on motorways), or with relation to climatic influences (e.g. local flooding, wind storms etc.). The level of economic and human losses during these situations depends substantially on timely and high-quality notification. It needs to be targeted to every affected person in imminent danger to direct them to implement appropriate lifesaving and health and property protection.

Between 1900 and 2001, twenty eight "major" industrial accidents occurred worldwide ("major" meaning 50 or more deaths). Half of these have occurred since 1986. There has been a marked increase in the number of accidents, and the time interval between them is shrinking dramatically. Crisis situations have become an inevitable, natural and integral feature of our daily lives. Crises are no longer rare, random or peripheral phenomena. They are built into the very fabric and fiber of modern society (Mitroff, 2001).

The "Information Age" has not only brought international terrorism, but also an increased awareness of new types of contingencies (Boin, 2005) – breakdown of information and communication systems, energy black-outs, emergence of natural threats, bio-nuclear terrorism, etc. The current technical infrastructure for a system of crisis notification – in the interstate as well as intrastate context – was never designed to handle even "soft" situations such as electrical power black-outs. These would inevitably lead to the total loss of functionality of every modern technology.

It is pertinent to mention the absence of appropriate crisis communication during such widely publicized disasters such as the 2004 tsunami, the floods in New Orleans in 2005, and terrorist attacks in London in July 2005. In the Czech Republic, therefore, one can hardly overlook equivalent situations such as the floods in 1997, 2002, and 2006, and the damage caused by hurricanes Kyrill and Ema etc. The common denominator for all these situations was lack of adequate information.

Crises, large and small, confront us on a daily basis and we must, therefore, understand what can be done to lessen their impact.

Mitroff and Anagnos (2001), among ten major types of crises, outline the following:

- *Informational* (loss of proprietary information, false information or tampering with computer records).

- *Human resource* (loss of key executives, personnel or workplace violence).

Each results in an inability to communication or loss of information. Most major organizations (business as well as governmental) have some preparations for handling one or two types of crises, but few companies are prepared to deal with all types (Mitroff, Anagnos, 2001). Preparing for at least one crisis of each type familiarizes the organization with the processes for that whole type. One of first steps for crises prevention and/or elimination of their consequences is to provide instant information to the appropriate person in the correct location.

COMMUNICATION AS A TOOL OF EMERGENCY MANAGEMENT

"A disaster is an event concentrated in time and space, in which a society or one of its subdivisions undergoes physical harm, and social disruption, such that all or some essential functions of the society or subdivisions are impaired." (Rodríguez at all., 2007)

Society has a basic interest of ensuring its environment to behave like a dependable system (exhibiting safety, reliability, or survivability, etc.). This implies the necessity of preventing, eliminating or at least mitigating the negative impacts of disasters in order to safeguard or re-establish dependability as fast as possible. (Chroust, Finlayson, 2011).

Communications has become an increasingly critical function in emergency management. The dissemination of timely and accurate information to the general public, elected and community officials, and the media plays a major role in the effective management of disaster response and recovery activities. Communicating preparedness, prevention, and mitigation information promotes actions that reduce the risk of future disasters. (Haddow, Bullock, Coppola 2010)

Today's information and communication technologies provide the means for improving prevention and recovery in many different ways (Chroust, Finlayson, 2011):

- applying disaster prediction methods,
- providing adequate information on the status-quo and on best-practices fast and reliably by fault-tolerant communication means,
- establishing support logistics,
- simulating and optimizing interventions by tactical guidance, prediction and forethought planning,
- realistic training environments.

Effective disaster communications strategy has to provide timely and accurate information to the public in all four phases of emergency management (Haddow, Bullock, Coppola, 2010.):

- Mitigation - to promote implementation of strategies, technologies, and actions that will reduce the loss of lives and property in future disasters.

- Preparedness - to communicate preparedness messages those encourage and educate the public in anticipation of disaster events.
- Response - to provide to the pubic notification, warning, evacuation, and situation reports on an ongoing disaster.
- Recovery - to provide individuals and communities affected by a disaster with information on how to register for and receive disaster relief.

As planning proceeds for a disaster information network, these important goals should be pursued:

- improve decision making before, during and after emergencies through better access to a quality of data and information,
- identify users and their needs,
- promote efficiency and cost effectiveness,
- stimulate and facilitate mitigation.

To contribute to the well-being of the community following a disaster by ensuring the dissemination of information that (1) is timely, accurate, consistent, and easy to understand and (2) explains what people can expect from their government.

The provision of timely and accurate information directly to the public and the media is critical to the success of any response and recovery effort. An effective communications strategy allows emergency managers and community officials at all levels of government to provide information and comfort to disaster victims and, at the same time, manage expectations. Regular communications with the public and the media helps ensure that accurate information is being disseminated and reduces the chances for misinformation and rumors. Monitoring direct communications with victims and media reports helps identify potential problems with misinformation and rumors and allows emergency officials to address these issues before they become too widespread and damaging. (Haddow, Bullock, Coppola, 2010)

However the reality of early warning systems mostly responds the situation of its origination – as is described on example of the Czech Republic.

EARLY WARNING SYSTEMS IN THE CZECH REPUBLIC – HISTORY AND PRESENT

The origins of early warning system development, for population protection, can be found in the interval between the last two World Wars. Developments in military aviation, now using long range armaments, created a need for early warning systems for population protection. This was particularly critical in the beginning, as air strikes did not seem to be targeted solely at military objectives (by intent or otherwise). Armed forces were, therefore, created to give air attack protection. These efforts concluded in 1934, when passive defence organisation received a legal framework, first in France, then Germany, and a year later in several other European countries. On April 11th 1935, an

organization of Civil Anti-Aircraft Protection was established in Czechoslovakia under Act no. 82.

One of the organisation's key roles was to build a warning system to inform citizens about existing or imminent danger. Later, this system was specified as an early warning system, and included in Appendix I of the Geneva Conventions of July 8th 1977. (Under Act no. 239/2000, during peace time, the Fire Rescue Service of the Czech Republic is responsible for its operational, organisational, and technical provision).

One of the basic requirements of such a warning system was to build an extensive network of warning hooters. Compared with the initial setup, the present hooters, and the often linked municipal broadcasting systems, have been much improved. Currently, the Czech early warning system consists of more than 6,000 terminal devices that allow both manual and remote activation through a unified notification system consisting of 93 centres deployed throughout the Czech Republic. The system has a primary role of informing the population about general threats and to summon the Fire Rescue Services in the event of a fire. However, a system meeting the needs of a single-purpose mass warning can no longer satisfactorily respond to the growing number of new threats emerging as a result of new technological, transport, social and political developments.

On November 1st, 2001, the previous system of warning signals was replaced by three different sound signals representing general danger, fire alarm and equipment testing. Despite this simplification, few people can differentiate between three hooter sounds, let alone knowing how to react in a particular situation.

In practice, therefore, these warning signs go unnoticed by most people primarily because of the absence of additional verbal information. People usually conclude that this is an equipment test or Fire Rescue Service being summoned due to fire or accident. Although the new hooters can provide voice information in addition to a siren signal, fewer than 20% of warning points are equipped with them. Thus, even if a siren can be heard within a radius of 1 km, currently, general danger warnings can reach less than a quarter of the Czech Republic. Additional verbal information, given an optimistic assumption that it can be understood up to a distance of 500 m, will only cover 1% of its area (Skrbek, Kvíz, 2010).

Notwithstanding the low awareness of warning notification meanings, a major problem of the current system is that it can only draw attention to existing situations without warning against an approaching danger. Other problems contributing to an efficient warning system include:

- messages being not precisely targeted. The fixed infrastructure does not allow information only to predefined areas nor repetition of warning information to, for example, people approaching an affected area
- the low information content of a message. Only electronic hooters are able to provide additional verbal information about a state of emergency. Generally, people have to obtain additional situation information through other media

- inability to verify the state of the unified early warning and notification system. Information only flows one way from the operating terminals to the final devices. Thus, it is not possible to directly verify whether the final devices have carried out the task required and determine their operating status.

The Czech law 204/2000 set up the task to build an "Information system for crisis management support" (ISCM). The completion of this project is the authority of the Ministry of the interior of the Czech Republic – General Directorate of the Fire Rescue Service. In 2005 the National Security Council accepted the proposal for the creation of ISCM in three variants (Skrbek, 2009):

- complex solution – covering all user requirements and operated on an optimal technological platform,

- reduced solution – covering the majority of user requirements and operated on a reduced technological platform (solves approx. 2/3 of complex solution)

- minimum solution – covering the essential user requirements and operated on a minimized technological platform (solves approx. 1/3 of complex solution)

The Czech government decided 11.5.2005 (decision 572) to implement the cheapest version of ISCM. Integral part of the ISCM – the Unified System of Warning – to be realized in a minimized size!

In crisis situations, the primary task of the state executive is to guarantee continuity of state functioning. In such situations, everyone needs to obtain information support, and instructions which reflect coherent thinking: the most appropriate information, to the correct location and at the right time. Without this, every level of government would have to contend with situations often resulting in chaos and providing opportunity to thieves and criminal elements.

RADIO-HELP - A SMART SOLUTION

For harder terrorist attacks, which could be directly or in its consequences focused on the very essence of information infrastructure of the state, the Czech Republic has not prepared any electronic medium to be used for adequate crisis communication. The author of paper with his team designed the technical and media solution of direct local distribution of information called "Radio-Help", which shall be effective even in cases of total collapse of societal infrastructure. The solution, substance of which is protected by a variety of published Czech patent applications - PV 2008-131 (Personal crisis terminal), PV 2008-160 (Crisis radio and TV transmitter), PV 2008-253 (Personal service terminal), PV 2008-254 (Terminal of forced listening), PV 2010-260 (Encryption and decryption of broadcasting based on the position of listener) - preserves direct distribution of crisis communication, even in case of long-term collapse of electric network, classic radio and television broadcasting, mobile phones, landline phones and the Internet. One of the base functionalities of the system is the possibility of urgent (local and selective) notification in case of threats or crisis situations.

From technical point of view, the solution of targeted broadcast for a geographically defined area consists in a superposition of digital positional data to the transmitted information. The receiver of such signal is equipped with a positioning system. Broadcast targeting is performed by comparing the positional coordinates of the receiver (in the form of satellite positioning system) with the codes that are a part of the trigger partition in the beginning of each broadcasting session [Fig.1]. When an external position code, which is transmitted by an authorized transmitter, conforms to an internal position code of the receiver, the forced listening broadcast session is activated (i.e. the session targeted for listening in the defined area). More detailed information about the locally target distribution of information is listed in the authors' publications (Brunclik, Skrbek, 2008 a,b,c).

As it was described in Skrbek (2010a), the core task of the Radio-Help project was to find an appropriate technology for targeted one-way communication. It other words – it was necessary to define two main components of a radio-broadcasting system, sender and receiver, based on current transmitting protocols and technologies (Skrbek, 2009).

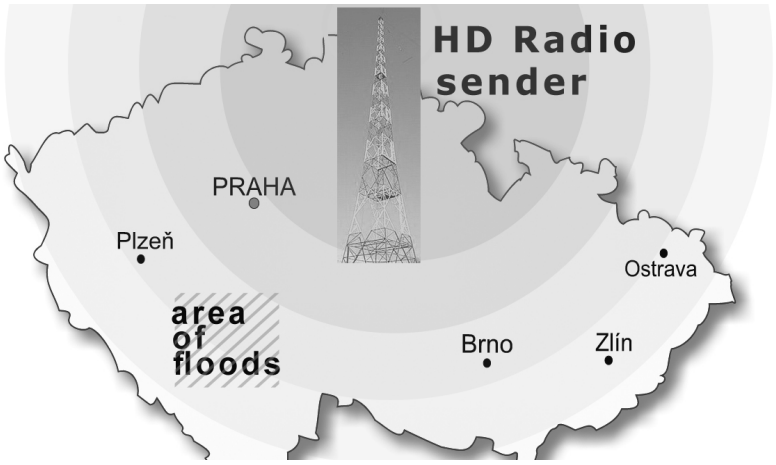

Figure 1. Radio-Help broadcasting for the affected area of floods (Skrbek, 2009)

The main requirements defined for a sender are as follows:

- the single sender has to cover a large region,
- the sender must be able to use a secure and safe dedicated frequency (under the state/military control),
- the sender has to be able to broadcast not only sound, but also identification codes for receivers,
- the broadcasting content must be under responsible control.

For these communications is possible to apply e.g. the existing, well proven, technology of HD Radio or Radio DRM. Both of these systems are analog with a superposition of digital signal (Skrbek, 2009). With HD-RADIO technology, broadcasters can use the current radio spectrum to transmit free analog simultaneously with new higher quality digital signals. This eliminates the static, hiss, pops and fades associated with today's radio caused by conditions known as multipath, noise and interference. It is necessary to say that the system Radio-Help is possible to start (at least to test) immediately at current RDS broadcasting systems.

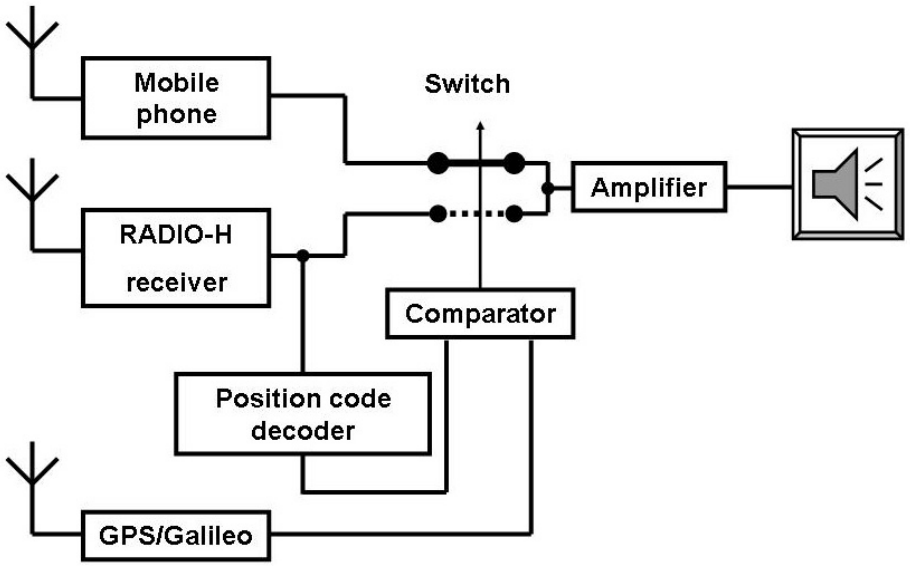

Figure 2. Block-scheme of Personal Communication Terminal (Skrbek, 2010a)

The crucial point of the system is the receiver - „Personal Communication Terminal" – PCT [Fig.2]. In principle it could be an HD-RADIO or DRM receiver that is integrated into wide-spread personal equipment, e.g. a mobile phone, but is independent and fully separated from its hardware and software. The recipient of any crisis communication would only hear sound from their own mobile-phone. The PCT could also be recharged by internal or external mechanical boost of the battery.

The PCT is equipped with a satellite position system (GPS, Galileo etc.) that generates position codes. 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. 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 crisis information. 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 centres, schools, factories etc.). Such systems just need once setup (e.g. by the initial switching on) the position code. Wide areas of applications bring the integration of Radio-Help receiver into sound systems in cars and navigation systems.

The Radio-Help system is intended to be an integrated design of technological, managerial and program components. Crisis communication would be mediated by morally and professionally competent, well known individuals with an ability to lead citizens to self-help rescue of lives, health, assets and elimination of panics. The responsibility to oversee the management of this activity would typically fall to state-owned radio-stations such as BBC Czech Radio etc.

Organisation of Radio-Help broadcasting supports and extends the current Early Warning System of central Rescue Services. The scheme of relations between subjects of Radio-Help system and Rescue Services is described in Fig. 3.

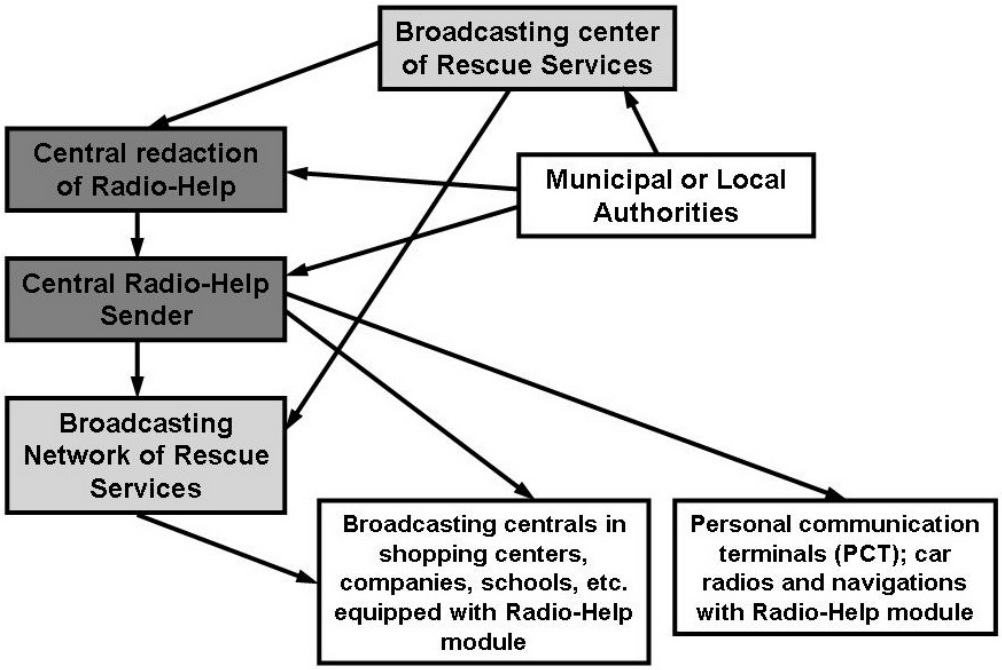

Figure 3. Block-scheme of relations of Radio-Help broadcasting [9]

System of Radio-Help is stable and workable in such situations like black-out of electricity, mobile phones, Internet and public broadcasting.

TRAFFIC APPLICATIONS

An important application of Radio-Help system for daily use is a Radio-traffic system. A radio traffic terminal is a broadcasting 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 chain road crashes.

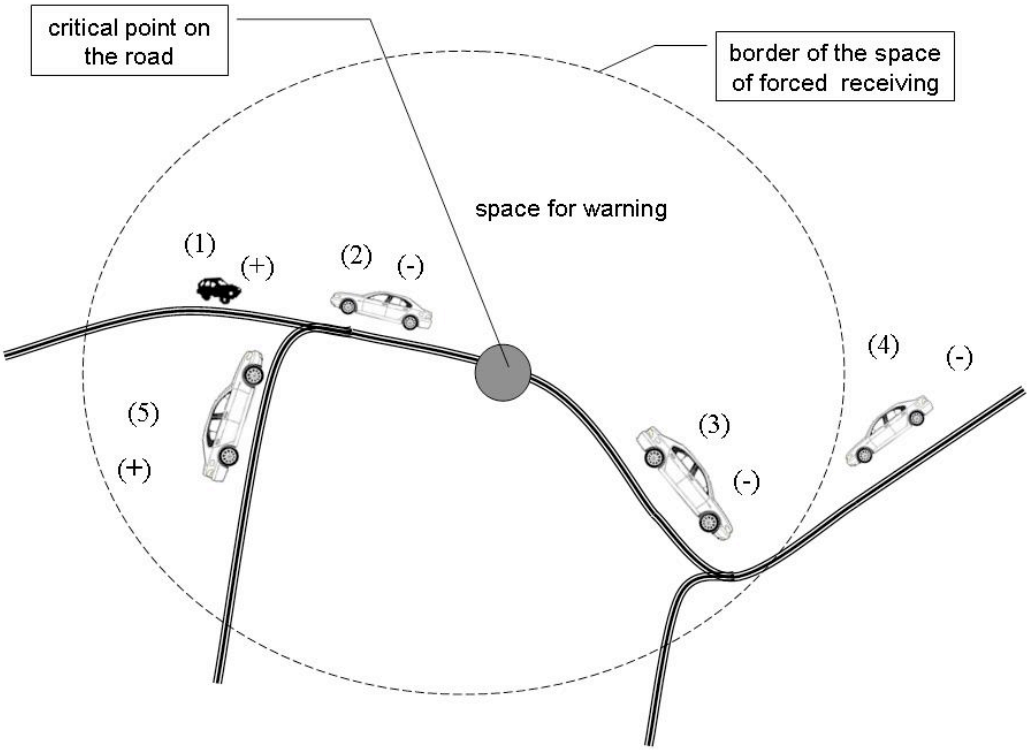

Figure 4. Principles of Radio-Help in traffic

Distribution of warning messages is described on the Fig 4. National Traffic Information Centre (NTIC) obtains the information about critical point on the road that significantly cut or eliminates traffic. Real danger could be drift, falling of the tree, petrol on the street etc. NTIC define the space in which car drivers have to be informed about a problem. Through the GIS system is generated position code that foregoes the warning report. The position code activates the forced receiving of the Radio-Help system, if the car is inside the space of warning. If the Radio-Help receiver is integrated with the navigation system, is additionally possible to define, if the vehicle goes to or from the point of the accident.

At the example on Fig. 4 the warning information would be received by cars 1 and 5, for cars 2, 3 and 4 this information is out of diver's interest and traffic terminal will not be activated.

All new European cars after 2013 will be equipped with an e-call system. In the case of a crash or bad accident that activates the e-call system, the information of the position of a crashed car is transmitted through mobile network to the emergency center (the phone number 112). The center will generate automatically the information for emergency broadcasting about the position of an accident and the type of it. This codeword will be in real-time mode broadcasted and the signal will activate the receiving system in cars approaching the point of an accident. The drivers will get warning information with an acoustic signal – e.g. "200 m ahead is a crash of three cars". In such case the driver will be able to react immediately also in cases of foggy or sand storm. Such process could dramatically eliminate the number of bad accidents, especially chain crashes.

CONCLUSION

Further situations and application areas of Radio-Help might include:

- Black-outs of electricity lasting to several days - disrupted water supplies, lack of stock and cash, population safety is at risk, etc.
- Local floods – coming unexpectedly, they cause substantial damage. Recognizing them and distributing relevant information early may result in radical cost savings due to timely and appropriate reactions. In the event of greater flooding, due to energy black-outs, traditional communication channels would not be accessible (TV and radio broadcasting, mobile phones and Internet).
- Heavy snow falls – these compromise road, air, and railway transport. Radio-Help would help stabilise the situation in the affected areas (such as restrictions on cars entering the affected areas, etc.)
- Terrorist attacks – under current legislation, the communication traffic may be significantly reduced in these circumstances. By law, police can switch off cellular networks, block the Internet and other communication media. In such cases, the existence of a central information channel would also be extremely important.

All these situations, although very different in nature, have one problem in common - how to ensure real-time dissemination of relevant information to the affected areas. Introducing Radio-Help might, in principle, fully meet the requirements of adequate, locally defined information spreading in all the above-mentioned situations.

It is possible to find similar aspects in the process of implementation of new generation of early warning systems in society and application of advanced ERP systems in companies – according to Antlova (2008) and Johansson, Sudzina (2009). The current problem of Radio-Help is not the technology itself but human (resp. managerial) aspect based partially on non adequate knowledge and understanding of the ICT potential, but mainly

on the resistance against changes of current system and fears of potential loss of good managerial positions (Doucek, 2009).

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