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**Utilisation and potential improvement of mobile networks and alternative  
methods in catastrophe prevention communication**

Doctoral (PhD) Thesis

author's review

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## 1. Outline of the scientific problem

By the 21<sup>st</sup> century the priority of the tasks carried out by the armed forces have significantly altered due to the radical changes in international security, so in addition to territorial defense a great emphasis is laid on fight against terrorism, prevention of ethnic conflicts, making and sustaining peace, prevention of catastrophes and eliminating their consequences. Although this later field is not included among the roles of the Hungarian Army, it has such specialised abilities, technical devices and human resources that are not available to any other organisation in Hungary. It includes, among others, unparalleled logistic support through which the army is capable of ensuring supplies during long-lasting defensive operations, large area forest fires, floods and extreme conditions caused by the winter weather. It proved this ability—despite the difficulties of supply—during the spring flood of 2006 recently.

In the complex system of catastrophe prevention, involving, in addition to the political and professional management, the army, catastrophe prevention, police force, border guards, ambulance and several other local and national bodies, information exchange and communication has an outstanding role. One of the most important tasks is ensuring the connection among the participants in the rescue or preventive operations, and the managing local and national bodies.

In operations where co-ordination of the work of several tens of thousand people is required, the planning, organisation and implementation of the tasks cannot be feasible without well-prepared telecommunications systems, where a fundamental prerequisite is continuous availability, high degree of reliability and interoperability.

Based on the experience gained from the natural catastrophes of the past few years it can be stated that the existing communicational platforms do not fully comply with these requirements. During the spring flood of year 2000, the outdated radio equipments of the different organisations using different bandwidths and technologies that were unable to communicate with each other caused serious problems in ensuring co-operational communication among the participants of the defense operation. This problem was solved by the base stations planted and mobile devices provided by the mobile telephone service providers by the end of the critical period. From this event on emergency broadcast was unimaginable without mobile telephones in the era of floods and other catastrophes occurring in an ever increasing number. Although the importance of service-based public mobile telecommunication has decreased in the information exchange of alarm organisations since

the introduction of the Unified Digital Radio Broadcasting System (EDR) in Hungary, its viability and applicability in other areas of emergency broadcast have become obvious as a result of favourable experience and accelerated technological development. Thus it has to be examined and analysed how their existing services could be utilised to ensure management tasks of the defense operation in the event of catastrophes, and what technological and operational solutions could improve their applicability in emergency broadcast services.

The implementation of parallel communicational channels and platforms is fundamental in increasing availability and reliability of broadcast services, which can also be implemented through appropriate application of various satellite communication solutions. Thus, through the special features, abilities and civil usage potential of the various satellite broadcasting networks, the alternative solutions of their integration into catastrophe prevention communication has to be investigated.

Although recently there have been some advancements in the legal regulations and the systems applied on this field, the deep analysis of utilising civil technologies has not yet been carried out. Therefore my thesis investigates how public mobile telecommunication systems could increase reacting ability and work-efficiency of the authorities and rescue bodies in the event of catastrophes and in the emergency situations thereafter.

## **2. Research Objectives**

1. To draw up such organisational regulative, operational and technological solutions that enable effective utilisation of civil mobile telecommunication infrastructures and services in emergency broadcast.
2. To justify the applicability and the need of utilisation of mobile telephone networks and services in various catastrophe prevention communication applications, and to propose actual technical solutions to ensure efficient implementation in emergency situations.
3. To prove, through the dangers threatening earth-based telecommunication infrastructures, the necessity of integrating the satellite segment into catastrophe prevention communication and to offer alternatives to practical implementation.

### 3. Research methods

During the study of available literature I elaborated on legislation, organisation, planning and technology of both catastrophe prevention and civil and defense broadcast, and also paid attention to their development.

I investigate the impact of catastrophes on telecommunication networks through the events occurring after theoretical preparation. I explore the legal background of utilising public electronic broadcast systems in emergency situations, drawing conclusions on the limits of practical applicability.

I explore the structure, operation, features, services and applicability of Hungarian emergency radio systems.

In the National High-level service for Communication and Informatics of the National Communications Authority I studied the reports that arrived in the event of catastrophes from electronic broadcast service providers, from which, through induction, I draw conclusions on the general preparedness to emergency situations, and the operation and deficiencies of the guarding system.

I examine the structure, operation, features and services of the public earth-based mobile telephone and the different satellite systems, based on which I make recommendations on their use in catastrophe prevention.

I confirm the capabilities of adaptive antenna-systems with experiments, based on which I draw conclusions on their applicability in catastrophe prevention communications.

Based on the information on the practical experience, demands, possibilities and anomalies received—from the professionals of the Ministries in charge, Authorities, service providers, Companies and other related professional organisations (IHM, HM, MEH, NHH, OKF, Magyar Telekom Nyrt., Hungaro DigiTel Kft., HM ARMCOM Zrt., Pro-M Zrt., Bonn Hungary Kft. etc.)—through the interviews carried out simultaneously with the above, mainly theoretical research and investigation I analyse the general situation of emergency broadcast, and synthesising the results I systematise my ideas and present the direction of development and my propositions.

#### 4. Short description of the research carried out

The main body of my thesis is built up of three chapters.

In the **first chapter**, following the definition of the basic terminology indicating the position of catastrophe prevention, I explore its legal background and examine the evolution of emergency broadcast and its integration into the effective legal regulative system. Next I introduce the position of catastrophe prevention communication prior to the introduction of EDR through the compatibility problems of the radio systems used by the different rescue bodies. In the third section I explore the features and applicability of the EDR system from the view of system-technology and service providing.

In the **second chapter** I introduce the developmental technologies through the structure, operation and services of the different generations of public mobile telephone networks, and explore their potential use in the normal and emergency communication of the rescue bodies, in civil alarm and information, and also in emergency calls. I propose alternative solutions to increase the local throughput of mobile telephone networks. Through the investigation of adaptive antenna systems I introduce the potential application in the different segments of catastrophe prevention communication. At the end of the chapter I introduce my concept of the structure, operation and application potential of the Authority Access Control System (Hatósági Hozzáférés Vezérlő Rendszer, HHVR) proposed by me, with the help of which a priority access could be granted for rescue organisations to the network of mobile service providers in the event of emergency and catastrophe situations.

The **third chapter** summarises the hazard elements threatening earth-based broadcast systems, presents their vulnerability, thus justifying the necessity of the application of satellite systems in catastrophe prevention communication. Later, through exploring the features of VSAT and SCPS systems, I introduce their potential utilisation in emergency and I propose a solely service-based satellite solution. I present my concept of the implementation of a mobile broadcast complex that would be capable of restoring GSM and EDR services on the catastrophe-struck areas through making up a temporary communications system using satellite channels. Finally, I propose the implementation of a satellite broadcast system for national defense purposes.

At the end of my thesis I summarise my conclusions and present my new scientific results and propositions.

## 5. Summary Conclusion

1. Hungarian legislation enables the use of the networks of broadcast service providers for catastrophe prevention purposes; yet, so far only the framework and the general tasks have been specified, the implementation regulations and action plans on practical issues have not, or not fully. Since providing the services in all circumstances is a fundamental interest of the service providers, the government and the civil population as well, I propose the review and, if needed, the modification of related legislation and action plans from a practical view.

I propose the modification of the roles of the National Communications Authority (NHH) practicing authority in connection with preparation of broadcasting services to emergency situations, to ensure uniform requirements and more effective control and professional supervision.

The effective use of national broadcast resources in special periods and increasing reacting ability require the restructuring of the guarding system of the segment. This could require the implementation of a central network-supervision system (OEHR) that works with a central resource-registration system within the Emergency Broadcast and Control Department (NHH-VHEO). Its fundamental aim would be to carry out the centralised management of the use of resources for national security, national economy and national defense purposes.

2. The development of public mobile telephone networks is granted due to market competition, effective demand and an increasing demand for mobile broadband applications, and entails complete technological renewal. Due to the lack of competition no such development can be expected from the EDR-system, so an ever increasing gap will be formed between the technological and service standards of the public and emergency systems. GSM/UMTS systems are also suitable for satisfying the requirements of rescue bodies and offer several additional services in comparison to the TETRA-solution, thus their parallel or reserve application in emergency broadcast can significantly increase the security and reliability of both normal and special period broadcasts. Access to the two types of networks could be ensured through the use of two-norm terminals as well, that could make shifting between the technologies easier when necessary.
3. In the event of severe natural catastrophes or emergency situations resulting from terrorist activities it is important to ensure mobile telephone network access to the

staff of rescue bodies and other organisations participating in the defense work, even despite the damage of the infrastructure or significant jams due to the increased civilian traffic load. It can be achieved through activating a multi-tier Authority Access Control System that switches the networks from normal operation to priority call-management mode, to the extent required by the actual situation, based on a central decision, with the partial or full restriction of „civilian” calls.

The outstandingly high civilian or authority traffic demand emerging in the catastrophe-struck areas could be handled via specialised, containerised, earth- or air-transportable, quickly plantable and configurable base-stations fitted with adaptive antenna systems that are capable of operation even in extreme conditions.

4. The wide availability of mobile telephone systems, the cross-country coverage and the various attention-raising and message-delivering (voice, text, image, video) applications ensure its applicability as part of the civilian alarm and information system. Implementing the technological background of mobile localisation technologies and improving the accuracy of direction measurements through adaptive antenna systems increases the efficiency of E112 emergency call service and civil alarm and information services.
5. A basic prerequisite of the utilisation of public mobile telephone networks in emergency broadcast is the integration of the knowledge related to the various services into the educational system for the appropriate preparation of the staff of rescue organisations and the population. Information on the operation of the alarm and information system, its services, the different behavioural patterns worked out for the various situations, and the aim and consequences of activating the Authority Access Control System could be carried out through leaflets and other publications. Simultaneously, it would be practical to start the preparation of students in public education institutions as part of civil defensive skills or in form-master classes.
6. As part of the earth-based critical infrastructure, the EDR and GSM/UMTS networks are both open to several such risk factors that could hinder or prevent their intended use. The management of rescue bodies and co-operating organisations, planning, organising, controlling and logistic support of operations should be ensured even in these conditions, which is possible with great security via utilising satellite applications. There are several alternatives, from vertically covering the full scope of communications via satellite services, to the application of dedicated satellites for defence purposes. The establishment of such broadcast complexes could be feasible by

which temporary broadcast systems could be built, which are capable of ensuring EDR and GSM/UMTS services both on their own or in co-operation with the undamaged earth-based infrastructure.

## **6. New scientific results**

1. I worked out a complex broadcast structure that is based on, and supplementing the EDR system with the potential of public earth-based and satellite networks, and as part of this complex, the concept of Authority Access Control System adapted to the Hungarian conditions that would provide priority access to the networks of national mobile telephone service providers for the management and operative staff of the rescue bodies and co-operating organisations in the event of emergency and catastrophe situations.
2. I worked out the framework of a new organisation operating as part of NHH, which would be responsible for the planning, management, control and supervision of emergency broadcast on national level, and capable of optimally harmonising the available telecommunication resources in special periods with the help of a centralised database and a national network-control system for defense, national security and national economy purposes.
3. I worked out the alternatives of utilising satellite telecommunication systems in catastrophe prevention, and also the plan of a mobile broadcast complex that could, by using satellite communication channels in the event of severe injury of the earth-based infrastructure, ensure EDR and GSM/UMTS services on the catastrophe-struck areas.
4. I presented the effect of using adaptive antenna systems on mobile telephone base stations for the various areas of emergency broadcast, such as civilian alarm and information, emergency call system, and the communication of the rescue bodies and the population. I outlined the plan of a containerised base-station that is capable of handling outstanding mobile traffic and transportable via ATV or helicopter, which is capable of locally increasing or recovering the throughput of mobile telephone systems.



## **7. Practical usage of the research results, recommendations**

1. I recommend the fine-tuning, supplementing and actualisation of the regulation of emergency broadcast, for establishment of firm legal basis and resolving present anomalies of introducing new services, systems and system-elements.
2. In addition to the possibilities provided by EDR, I recommend the establishment of the conditions for the parallel utilisation of mobile telephone services, and also the introduction of HHVR for the support of the communication of rescue bodies in normal and special periods for an increased security of broadcast. Further, I propose the local extension of network capacity, the building and integrating of special earth- and air-transportable base-stations fitted with adaptive antenna systems to satisfy the increased mobile telephone traffic demands of the defensive forces on catastrophe-struck areas.
3. I propose the introduction and integration of locality-dependant services of the mobile-telephone systems into the civil alarm and information and E112 emergency call systems, and also the application of adaptive antenna systems for increasing the accuracy of localisation technologies in home infrastructures.
4. I propose, for the event of significant breakdown, damage or destruction of earth-based communications infrastructure, the establishment of the conditions for the application of satellite communication systems, and also the development of such universal broadcast complex that is capable, both on its own and in co-operation with earth-based networks, by utilising satellite capacity, of providing a temporary emergency broadcast system and ensuring EDR and GSM/UMTS services.
5. The thesis can be used in all levels of education and in each faculty of the ZMNE (Miklós Zrínyi National Defense University) as a source material for any kind of research, and as a recommended reading for the related courses.