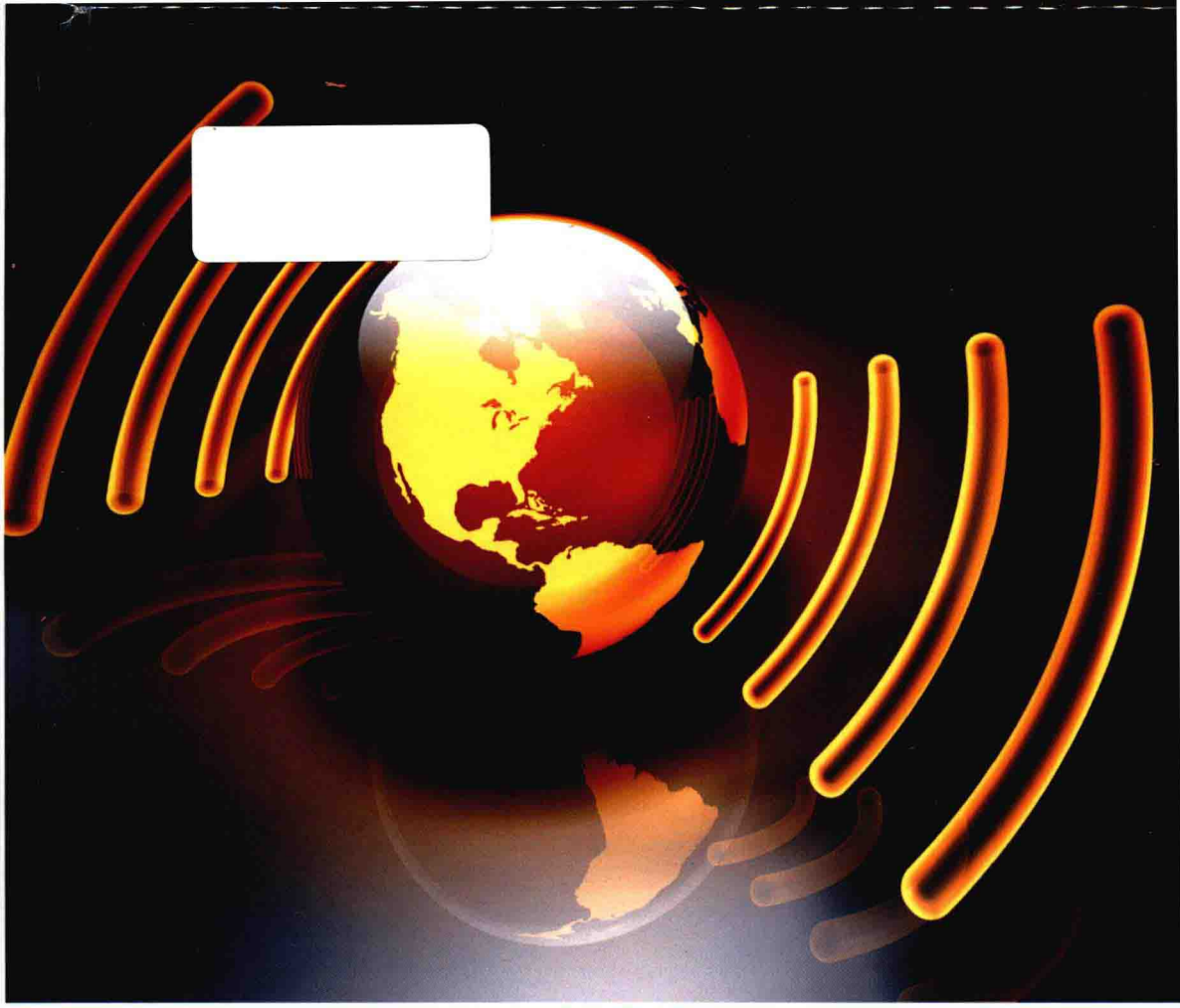

Wireless Public Safety Networks 1

Edited by
Daniel Câmara and Navid Nikaein

Overview and Challenges

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Wireless Public Safety Networks 1

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Preface

This book series is dedicated to the public safety networks (PSNs) field. PSNs are the networks established by the authorities for handling disaster scenarios. PSNs are the kind of networks established by the authorities to either warn the population about an imminent catastrophe or coordinate teams during the crisis and normalization phases. A catastrophe can be defined as an extreme event causing a profound damage or loss as perceived by the afflicted people. PSNs have the fundamental role of providing communication and coordination for emergency operations.

The series is organized as follows; this first book presents an overview of PSNs and communication systems with a particular focus on current and future challenges

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Preface written by Daniel CÂMARA and Navid NIKAEIN.

and trends. The second book[1] provides a system view, focusing on specific enabling technologies that can be exploited in the context of current and next-generation PSNs. The third book[2] describes applications and services dedicated to PSNs.

Emergency management phases

Disasters can be of different types: natural disasters, such as hurricanes, floods, droughts, earthquakes and epidemics, or man-made disasters, such as industrial and nuclear accidents, maritime accidents and terrorist attacks. In both cases, human lives are in danger and the telecommunication infrastructures may be seriously affected or even no longer operational.

The disaster management involves three main phases, shown in Figure 1:

– *Preparedness*: at this phase all the equipment and people should be ready to enter in action, if needed. It consists of training, equipment maintenance, hazards detection and education;

– *Crisis*: this phase goes from the break-out point (decision to respond), to the immediate disaster aftermath, when lives can still be saved. Crisis is understood as the society's response to an imminent disaster; it is different from the disaster itself;

– *Return to normal situation*: this phase consists of the building and maintenance of temporary communication mechanisms/structures while the regular mechanisms are being repaired or rebuild.

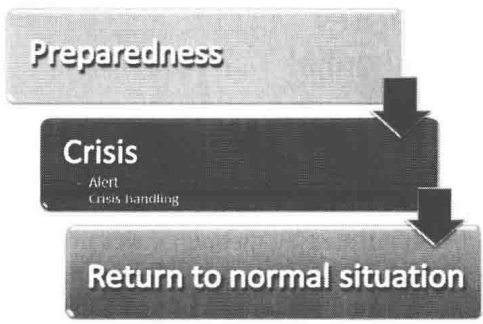

Figure 1. *Disaster management phases*

1 Câmara D., Nikaein N., Wireless Public Safety Networks 2, ISTE Press, London and Elsevier, 2016.

2 Câmara D., Nikaein N., Wireless Public Safety Networks 3, ISTE Press, London and Elsevier, 2016.

Crisis subphases

In a situation of crisis, the involved parties can be classified in the following way, taking into account also the degree of mobility they need:

– local authority(ies); fixed: the group in the administrative hierarchy competent to launch a warning to the population and the intervention teams;

– citizens; either mobile or fixed: non-professional people involved in the crisis;

– intervention teams; mobile: professionals (civil servants or militaries) in charge of rescuing citizens in danger, preventing hazard extension or any time-critical mission just after the break-out of the crisis; in charge of caring for injured people once the crisis is over;

– risk management center; fixed: group of experts and managers in charge of supervising operations. The risk management center works in close cooperation with local authorities;

– health centers; fixed: infrastructure (e.g. hospital) dedicated to caring injured citizen and backing intervention teams as for this aspect of their mission.

Alert phase

It is important to properly manage this critical phase as it is the moment where a quick response is the most efficient in terms of lives and goods saved. This means notifying professionals and people of the incoming hazard.

Warning makes sense if there is a delay between the very break-out of the hazard and the damages it could cause. This leaves time for people to escape and avoid the endangered area. Warning the population is typically the local authorities' responsibility since they are the only ones who can clearly appreciate the danger depending on local circumstances. Deciding that the situation is critical may be taken at governmental, national level. This is the case, for example, for earthquakes in all European countries.

Crisis handling phase

Coordination of intervention teams begins when the crisis breaks out. The local authorities alert them just before the population and then transfer the supervision to the risk management center. Later on, intervention teams still receive instructions from their local authorities, from the risk management center and the health center.

Intervention teams send back information to local authorities, risk management center and health centers about the situation and request for help. They typically use a specific purpose network deployed especially to attend to the needs of that particular event. Usually, the same network is used for receiving instructions and returning feedback.

Reference architecture

Public safety, or emergency networks, have as an objective to provide more information to authorities and to the population, and to help on the organization of the relief efforts in the case of a catastrophe. Figure 2 presents a generic reference architecture where we have the three main PSN communication systems, i.e. situation awareness, rapidly deployable and emergency alert ones:

– *situation awareness* is related to the elements responsible for providing an overall real-time picture of events with an assessment of the consequences on the population and on property. This kind of system helps authorities on the decision-making process;

– *rapidly deployable* systems allow the exchange between elements of the relief effort and also grant a communication channel with the support teams, in control rooms. In this way, the control teams can access field information and coordinate the relief efforts;

– *emergency alert* grants authorities the means to warn the population about possible dangers and the status of a given disaster in an efficient and fast manner, through several media routes simultaneously.

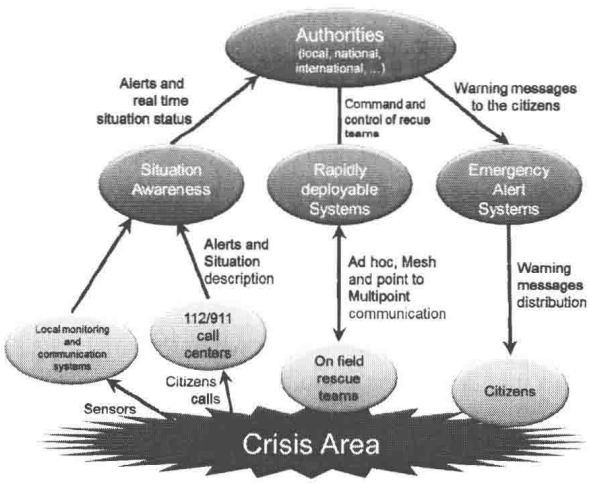

Figure 2. *Different elements of public safety systems*

Technologies

Different technologies can be used for PSNs: some were specifically designed to be used for the authorities in case of emergency, but others are standard ones. Figure 3 presents some of the possible technologies and how they can be organized to provide communication for the teams on the terrain. This series will discuss many of these technologies and how they are used on the field.

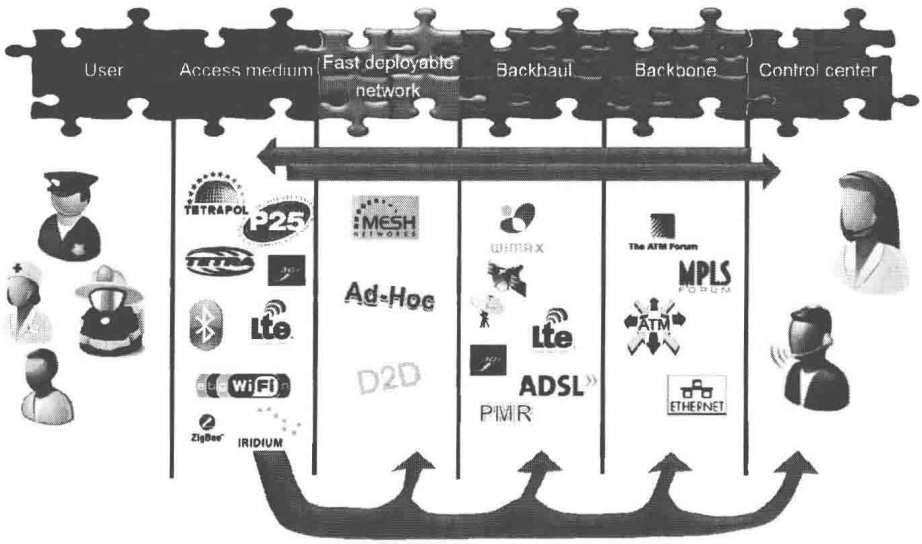

Figure 3. *Possible interconnections between technologies and actors*

Book overview

The aim of this first edited book is to provide a big picture on different elements of PSNs and dig into few challenges and trends in view of current and next-generation PSNs.

The book is organized into 10 chapters. Chapter 1 presents various techniques and technologies that can be used to build a PSN, and the main design choices to be made. The role of communication technologies in PSNs is analyzed in Chapter 2. Furthermore, the challenges to efficiently deploy, operate and interoperate present and future technologies and how these technologies can help public safety agencies to meet their expectations are described. The evolution of public protection and disaster relief (PPDR) systems in terms of new services and capabilities, by leveraging emerging broadband wireless technologies such as long term evolution (LTE) in addition to existing legacy PMR systems as TETRA and TETRAPOL are

discussed in Chapter 3. Direct communication technologies, as one of the most important PSN requirement to establish direct communication links between terminals without the presence of any form of infrastructure, and proximity services are presented in Chapter 4.

Chapter 5 analyzes the interoperability issues in PSN, with particular focus on European networks, and points out some agreements and treaties active between particular countries (most of them in northern Europe). Chapter 6 proposes a portable disaster recovery network solution to jointly address disaster network discovery and search and rescue networking problem. The role of intelligent transport system (ITS) and related technologies to augment the capabilities of PSNs, in particular, emergency crisis and law enforcement, as well as two real world use cases are presented in Chapter 7. The authors also provide an overview of current regulatory and standardization activities of ITS in relation to public safety activities. Chapter 8 investigates the effectiveness of public warning and identifies requirements and communication technologies for public warning. This chapter also provides an overview of public warning systems. In Chapter 9, authors elaborate on both network-centric and network-assisted disaster management process with particular focus on the benefits that can be obtained from the mobile devices. Finally, Chapter 10 discusses about the quality and usability of the emergency management systems, how to increase it and how to ensure its quality.

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