Chapter 16
Public Safety Networks

Giuliana Iapichino
EURECOM, France

Christian Bonnet
EURECOM, France

Daniel Câmara
EURECOM, France

Fethi Filali
EURECOM, Qatar

ABSTRACT

Disaster can be defined as the onset of an extreme event causing profound damage or loss as perceived by the afflicted people. The networks built in order to detect and handle these events are called Public safety networks (PSNs). These networks have the fundamental role of providing communication and coordination for emergency operations. Many of the problems of the PSN field come from the heterogeneity of systems and agencies involved in the crisis site and from their mobility at the disaster site. The main aim of this book chapter is to provide a broad view of the PSN field, presenting the different emergency management phases, PSNs requirements, technologies and some of the future research directions for this field.

1. INTRODUCTION

Public safety networks (PSNs) are networks established by the authorities to either warn and prepare the population for an eminent catastrophe, or as support during the crisis and normalization phases. The characteristics and requirements of these networks may vary considerably depending on their purpose and placement. They are always mission critical; once deployed, PSNs have to be reliable since lives may depend on them. As an example, reports from September 11th point out that communications failures contributed directly to the loss of at least 300 fire-fighters and prevented a good management of the rescue efforts which contributed to the loss of many other lives, (9/11 Commission, 2004), (McKinsey & Co, 2002). Moreover, communication failures were one of the obstacles in the co-ordination of the rescue resources in the 1995 Kobe earthquake (Lorin, Unger, Kulling & Ytterborn, 1996). These failures further prevented outsiders from receiving timely information about the severity of the damages. The communication breakdowns delayed the relief efforts which could have prevented the loss of numerous human lives.

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Reliability of equipments and protocols is a serious matter for any type of network, but it is even more important on the context of PSNs. Maintaining communication capabilities in a disaster scenario is a crucial factor for avoiding preventable loss of lives and damages to property (Townsend & Moss, 2005). During a catastrophe such as an earthquake, power outage or flooding, the main wireless network structure can be severely affected and "historically, major disasters are the most intense generators of telecommunications traffic" (Townsend & Moss, 2005). The public communication networks, even when available, may fail not only because of physical damages, but also as a result of traffic overload. Therefore, the regular public networks alone are often not sufficient to allow rescue and relief operations (Townsend & Moss, 2005).

However, equipment failures and lack of connectivity are not the only problems faced by PSNs. Traditionally, PSNs have been owned and operated by individual agencies, such as law enforcement, civil defense and firefighters. Even further, they may belong and obey to commands related to federal, state or municipal governments. All these different PSNs are often not interoperable, which may represent a problem in the case of a catastrophe (Balachandran, Budka, Chu, Doumi, & Kang, 2006). During the last few years some initiatives, such as MESA, have tried to solve the problem of interconnectivity among different agencies.

The main objective of this book chapter is to give to the reader a broad view of Public safety networks and to highlight some of the next challenges and research issues on this field. The rest of this chapter is organized as follows: Sections 2 and 3 introduce respectively the disaster management phases and the most important factors for Public safety networks in emergency situations. After that, on Section 4, we present some of the most important tools, projects and initiatives on the field of PSNs. Section 5 describes some of the most challenging aspects of the ongoing research on PSNs, and finally, Section 6 presents some final considerations about the field.

2. EMERGENCY MANAGEMENT PHASES

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

Disaster management involves three main phases:

1. Preparedness must be to some extent envisaged:
   - PSN must be operational when some disaster occurs.
   - To observe the Earth, to detect hazards at an early stage.
2. Crisis from break-out (decision to respond) to immediate disaster aftermath, when lives can still be saved. Crisis is understood as the society's response to an imminent disaster; it must be distinguished from the disaster itself.
3. Return to normal situation must be envisaged with provisory networks.

Figure 1 represents the three main phases of a disaster management in a temporal scale underlining each different state.

In this way it is possible to represent all the phases in a state diagram as shown in Figure 2.

Preparedness

The first phase called preparedness involves missions accomplished in normal situation. They are basically of three kinds:

1. Observation. The observation system has two main functions:
   - Detection of hazards. Satellite can play a role to that respect by means of