

---

## Contents

---

<b>Preface . . . . .</b>	<b>xi</b>
Daniel CÂMARA and Navid NIKAEIN	
<b>Chapter 1. Public Safety Network: an Overview . . . . .</b>	<b>1</b>
Tullio Joseph TANZI and Jean ISNARD	
1.1. Introduction . . . . .	2
1.2. A multi-level response . . . . .	4
1.3. Observation services. . . . .	4
1.3.1. Observations by satellites . . . . .	5
1.3.2. Ground-based observations . . . . .	6
1.3.3. Alert systems, their limits and some current research . . . . .	7
1.4. Communication services . . . . .	10
1.5. Telecommunications during the crisis . . . . .	12
1.6. Ad hoc networks . . . . .	15
1.7. Conclusion . . . . .	17
1.8. Bibliography . . . . .	18
<b>Chapter 2. The Evolutionary Role of Communication Technologies in Public Safety Networks . . . . .</b>	<b>21</b>
Karina Mabell GOMEZ CHAVEZ, Leonardo GORATTI, Tinku RASHEED, Dejene Boru OLJIRA, Riccardo FEDRIZZI and Roberto RIGGIO	
2.1. Introduction . . . . .	22
2.2. Communication technology evolution for public safety networks . . . . .	23
2.2.1. Review of the currently deployed technologies . . . . .	24
2.2.2. Future trends in public safety communications. . . . .	26
2.3. 4G long term evolution for public safety communications. . . . .	31
2.3.1. LTE standard overview. . . . .	31

2.3.2. LTE-based public safety networks: improvements and challenges . . . . .	32
2.3.3. D2D-LTE main challenges for public safety usages . . . . .	34
2.4. Public safety communication requirements and main challenges . . . . .	37
2.4.1. Deployment requirements of public safety communication networks . . . . .	37
2.4.2. Operation requirements of public safety communication networks . . . . .	40
2.4.3. Public safety communications main challenges . . . . .	44
2.5. Conclusions . . . . .	46
2.6. Bibliography . . . . .	46
<b>Chapter 3. Next-Generation Communication Systems for PPDR: the SALUS Perspective . . . . .</b>	<b>49</b>
Hugo MARQUES, Luís PEREIRA, Jonathan RODRIGUEZ, Georgios MANTAS, Bruno SOUSA, Hugo FONSECA, Luís CORDEIRO, David PALMA, Konstantia BARBATSALOU, Paulo SIMÕES, Edmundo MONTEIRO, Andy NYANYO, Peter WICKSON, Bert BOUWERS, Branko KOLUNDZIJA, Dragan OLCAN, Daniel ZERBIB, Jérôme BROUET, Philippe LASSERRE, Panagiotis GALIOTOS, Theofilos CHRYSIKOS, David JELENC, Jernej KOS, Denis TRČEK, Alexandros LADAS, Nuwan WEERASINGHE, Olayinka ADIGUN, Christos POLITIS and Wilmuth MÜLLER	
3.1. End-user validation of use cases based on operational scenarios . . . . .	51
3.1.1. SALUS use case description . . . . .	51
3.1.2. SALUS use case requirements . . . . .	53
3.1.3. SALUS use case validation . . . . .	54
3.2. Emerging wireless technologies for PPDR . . . . .	55
3.2.1. TETRA . . . . .	56
3.2.2. TETRAPOL . . . . .	56
3.2.3. LTE for public safety . . . . .	57
3.2.4. Wi-Fi and body area networks . . . . .	60
3.2.5. Challenges of waves propagation in crowds . . . . .	62
3.2.6. Comparison between the different wireless technologies . . . . .	62
3.3. Migration roadmaps . . . . .	64
3.3.1. Phase 1 – Non-mission critical cooperation with commercial LTE . . . . .	65
3.3.2. Phase 2 – PPDR organizations as LTE mobile virtual network operators . . . . .	66
3.3.3. Phase 3 – PPDR organizations as owners of LTE networks . . . . .	66
3.3.4. Techno-economic tool . . . . .	67
3.4. Security aspects linked to emergency communications . . . . .	68
3.4.1. Risk analysis . . . . .	68
3.4.2. A high-level overview of security features of PMR technologies . . . . .	74
3.5. Technical enhancements for PPDR communication systems in SALUS . . . . .	79

---

3.5.1. SALUS enterprise architecture . . . . .	79
3.5.2. Wireless sensors in PPDR systems . . . . .	83
3.5.3. Extensions to next generation networks . . . . .	84
3.5.4. Mobile ad hoc networks support for emergency communications. . . . .	87
3.5.5. Radio-channel attenuation within crowds. . . . .	89
3.6. Concluding remarks . . . . .	89
3.7. Bibliography . . . . .	91
<b>Chapter 4. From DMO to D2D. . . . .</b>	<b>95</b>
Xavier PONS-MASBERNAT, Eric GEORGEAUX, Christophe GRUET, François MONTAIGNE, Jean-Christophe SCHIEL, Guy PHILIPPE and Lirida NAVINER	
4.1. Direct mode operation communication in current PSN. . . . .	96
4.1.1. DMO overview . . . . .	96
4.1.2. DMO in TETRA . . . . .	97
4.1.3. DMO in TETRAPOL. . . . .	101
4.2. D2D solutions for future LTE PSNs . . . . .	102
4.2.1. D2D overview. . . . .	102
4.2.2. Classification of future D2D solutions . . . . .	102
4.2.3. Standardization/3GPP efforts . . . . .	109
4.3. Conclusion and perspectives . . . . .	122
4.4. Bibliography . . . . .	123
<b>Chapter 5. Interoperability for Public Safety Networks . . . . .</b>	<b>127</b>
Federico FROSALI, Francesco GEI, Dania MARABISSI, Luigia MICCIULLO and Etienne LEZAACK	
5.1. The role of PPDR communication system interoperability in national and international cooperation. . . . .	129
5.1.1. State of play of public safety interoperability in Europe . . . . .	129
5.1.2. Interoperability levels. . . . .	134
5.2. Use cases . . . . .	135
5.2.1. Example scenario . . . . .	137
5.2.2. Interoperability requirements . . . . .	139
5.3. A holistic framework for PS network interoperability . . . . .	141
5.4. Terminals for interoperability of current generations of PMR. . . . .	145
5.5. Interoperability on the next generations of PMR: transition between the present state of the art systems and the next generation. . . . .	149
5.5.1. Next Generation PMR requirements . . . . .	149
5.5.2. ETSI reference model for a critical communication system (CCS). . . . .	151
5.5.3. LTE evolution toward PMR services . . . . .	153

5.5.4. Spectrum allocation of next generation PMR systems . . . . .	155
5.5.5. PMR and commercial systems interoperability . . . . .	157
5.6. Acknowledgments . . . . .	159
5.7. Bibliography . . . . .	159
<b>Chapter 6. Joint Network for Disaster Relief and Search and Rescue Network Operations . . . . .</b>	<b>163</b>
Ram Gopal LAKSHMI NARAYANAN and Oliver C. IBE	
6.1. Introduction . . . . .	163
6.2. Overview and requirements of DRN and SRN . . . . .	164
6.2.1. Disaster recovery systems . . . . .	164
6.2.2. Search and rescue systems . . . . .	165
6.2.3. Key disaster recovery network and search and rescue network requirements . . . . .	166
6.3. Previous work . . . . .	169
6.3.1. Disaster recovery network solutions . . . . .	169
6.3.2. Previous search and rescue network solutions . . . . .	174
6.3.3. Shortfall of the existing solution . . . . .	177
6.4. Portable disaster recovery wireless network architecture . . . . .	179
6.5. Modeling and simulation of survivor movement . . . . .	180
6.5.1. Random motion with reward . . . . .	181
6.5.2. Levy walk models of PDRN survivor . . . . .	182
6.5.3. Simulation . . . . .	183
6.5.4. Simulation result . . . . .	184
6.6. Conclusion and future work . . . . .	189
6.7. Bibliography . . . . .	189
<b>Chapter 7. The Evolution of Intelligent Transport System (ITS) Applications and Technologies for Law Enforcement and Public Safety . . . . .</b>	<b>195</b>
Gary STERI and Gianmarco BALDINI	
7.1. Introduction . . . . .	195
7.2. Public safety organizations and requirements . . . . .	197
7.3. The evolution of intelligent transport system (ITS) applications and the role of public safety organizations . . . . .	200
7.3.1. Regulatory and standardization activities . . . . .	200
7.3.2. Wireless communication technologies used by law enforcers . . . . .	205
7.3.3. List of current and future ITS applications . . . . .	212
7.4. Operational and deployment aspects . . . . .	217
7.5. Case study of the digital tachograph application . . . . .	218
7.5.1. Background . . . . .	218
7.5.2. New version of the digital tachograph . . . . .	220

---

7.6. Case study on traffic prioritization for emergency vehicles . . . . .	224
7.7. Conclusions . . . . .	226
7.8. Bibliography . . . . .	226
<b>Chapter 8. Communication Technologies for Public Warning . . . . .</b>	<b>229</b>
Cristina Párraga NIEBLA	
8.1. Introduction . . . . .	229
8.2. Requirements on public warning technologies . . . . .	230
8.3. Influencing factors in the effectiveness of public warning . . . . .	231
8.3.1. Warning decision process . . . . .	231
8.3.2. The warning message . . . . .	234
8.4. Requirements on communication technologies . . . . .	238
8.4.1. Translating public warning needs into requirements for communication technologies . . . . .	238
8.4.2. Validation model and criteria . . . . .	241
8.5. Communication technologies for public warning . . . . .	243
8.6. Evaluation of communication technologies for public warning . . . . .	245
8.7. An overview of public warning systems . . . . .	249
8.7.1. MoWaS – the public warning system in Germany . . . . .	249
8.7.2. NL-Alert – the public warning system in the Netherlands . . . . .	250
8.7.3. BE-Alert – the public warning system in Belgium . . . . .	251
8.7.4. SAIP – the future public warning system in France . . . . .	252
8.7.5. Integrated Public Alert and Warning System (IPAWS) in USA . . . . .	253
8.7.6. Earthquake Early Warning (EEW) and J-Alert in Japan . . . . .	253
8.8. Conclusions . . . . .	254
8.9. Bibliography . . . . .	255
<b>Chapter 9. Enhancing Disaster Management by Taking Advantage of General Public Mobile Devices: Trends and Possible Scenarios . . . . .</b>	<b>261</b>
Olivier SEBASTIEN and Fanilo HARIVELO	
9.1. Introduction . . . . .	261
9.2. Crisis management overview . . . . .	263
9.2.1. Actors . . . . .	263
9.2.2. Different stages . . . . .	264
9.2.3. Resulting information chain . . . . .	266
9.2.4. Perimeter of action . . . . .	267
9.3. Mobile equipment and proximity communication . . . . .	267
9.3.1. Mobile devices . . . . .	268
9.3.2. Device-to-device communication technologies . . . . .	272
9.3.3. Mobile-based networks . . . . .	274

x Wireless Public Safety Networks 1

---

9.3.4. Architecture . . . . .	274
9.4. Mobile devices and proximity networks-assisted crisis management operations . . . . .	276
9.4.1. Early detection system . . . . .	276
9.4.2. Victim localization and characterization system . . . . .	282
9.4.3. Victim and population on-site assistance . . . . .	284
9.4.4. Information gathering, dissemination and exploitation . . . . .	286
9.5. Conclusion/perspectives. . . . .	292
9.6. Bibliography . . . . .	292
<b>Chapter 10. How to Ensure Quality Standards in Emergency Management Systems . . . . .</b>	<b>297</b>
Marcelo ZAMBRANO V., Manuel ESTEVE and Carlos PALAU	
10.1. Introduction . . . . .	297
10.1.1. Problem. . . . .	298
10.1.2. Scheme . . . . .	300
10.2. Background . . . . .	301
10.2.1. Emergency management . . . . .	301
10.2.2. Emergency management systems . . . . .	303
10.2.3. Command, control and information systems (C2IS) . . . . .	305
10.2.4. Quality in emergency management systems . . . . .	307
10.2.5. International Standardization Organization (ISO) and the emergency management. . . . .	311
10.2.6. Federal Emergency Management Agency (FEMA) . . . . .	313
10.3. Methods . . . . .	316
10.3.1. Quality parameters . . . . .	316
10.3.2. Ensuring quality and continuous improvement . . . . .	318
10.3.3. Integral and continued emergency management . . . . .	320
10.3.4. Agility . . . . .	321
10.4. Conceptual model . . . . .	322
10.5. Discussion. . . . .	324
10.6. Bibliography . . . . .	325
<b>List of Authors . . . . .</b>	<b>329</b>
<b>Index. . . . .</b>	<b>333</b>